the wonders of nature

Volumes 1 & 2

By Vance Ferrell

HUNDREDS OF FACTS ABOUT
THINGS ALL AROUND YOU
TO HELP YOU KNOW THAT GOD MADE EVERYTHING
AND THAT HE LOVES YOU

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EDS 21

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EDS 21

"Unfortunately, in the field of evolution most explanations are not good. As a matter of fact, they hardly qualify as explanations at all; they are suggestions, hunches, pipe dreams, hardly worthy of being called hypotheses.."-*Norman Macbeth, Darwin Retried (1971), p. 147.

"No one has ever found an organism that Is known not to have parents, or a parent. This Is the strongest evidence on behalf of evolution."- *Tom Bethell, "Agnostic Evolutionists," Harper's, February 1985, p. 61.

"As by this theory, innumerable transitional forms must have existed. Why do we not find them embedded in the crust of the earth? Why is not all nature in confusion [of halfway species) instead of being, as we see them, well-defined species?-- *Charles Darwin, quoted In H. Enoch, Evolution or Creation (1966), p. 139.

"Where are we when presented with the mystery of life? We find ourselves facing a granite wall which we have not even chipped . . We know virtually nothing of growth, nothing of life."-*W. Kaempffert, "The Greatest Mystery of All- the Secret of Life," New York Times.

"I think, however, that we must go further than this and admit that the only acceptable explanation is creation. I know that this is anathema to physicists, as indeed it is to me, but we must not reject a theory that we do not like if the experimental evidence supports it."-*H. Lippson, "A Physicist Looks at Evolution," Physics Bulletin 31 (1980), p. 138.

"I am not satisfied that Darwin proved his point or that his influence in scientific and public thinking has been beneficial.. the success of Darwinism was accomplished by a decline in scientific Integrity."*W.R. Thompson, Introduction to *Charles Darwin, Origin of the Species [Canadian scientist].

" 'The Darwinian theory of descent has not a single fact to confirm it in the realm of nature. It is not the result of scientific research, but purely the product of imagination."-*Dr. Fleischman. quoted in E Meidau, Why We Believe in Creation, Not Evolution, p. 10 [Erlangen zoologist].

"The hold of the evolutionary paradigm is so powerful that an idea which is more like a principle of medieval astrology than a serious twentieth century scientific theory has become a reality for evolutionary biologists."- *Michael Denton, Evolution: A Theory in Crisis (1985), p. 306 [Australian molecular biologist].

"[Darwin could) summon up enough general, vague and conjectural reasons to account for this fact, and if these were not taken seriously, he could come up with a different, but equally general, vague and conjectural set of reasons."- *Gertrude Himmelfarb. Darwin and Darwinian Revolution (1968). p. 319.

"The particular truth is simply that we have no reliable evidence as to the evolutionary sequence . . One can find qualified, professional arguments for any group being the descendant of almost any other."-J. Bonner, "Book Review,"American Scientist 49:1961, p. 240.

"It was because Darwinian theory broke man's link with God and set him adrift in a cosmos without purpose or end that its impact was so fundamental. No other intellectual revolution in modern times. . so profoundly affected the way men viewed themselves and their place in the universe." *Michael Denton, Evolution. A Theory in Crisis (1985), p. 67 [Australian molecular biologist].

"I had motives for not wanting the world to have meaning; consequently assumed it had none, and was able without any difficulty to find satisfying reasons for this assumption . . The philosopher who finds no meaning in the world is not concerned exclusively with a problem In pure metaphysics; he is also concerned to prove there is no valid rason why he personally should not do as he wants to do . . For myself, as no doubt for most of my contemporaries, the philosophy of meaninglessness was essentially an instrument of liberation. The liberation we desired was simultaneously liberation from a certain political and economic system and liberation from a certain system of morality. We objected to the morality because it interfered with our sexual freedom."*Aldous Huxley. "Confessions of a Professed Atheist," Report: Perspective on the News, Vol. 3, June 1966, p. 19 [Grandson of evolutionist Thomas Huxley (Darwin's closest friend and promoter) and brother of evolutionist Julian Huxley. Aldous Huxley was one of the most influential liberal writers of the 20th century].

Book 21 - Wonders of Nature: Vol 1

table of contents

- VOLUME 1 -

- VOLUME 2 -

Volume 1 of Wonders of Nature has 84 pages and Volume 2 has 96 pages. But, since both books are indexed together (for ease in locating a desired topic), the paging of Volume 2 begins at 101. Thus, in the index, all topics with page numbers above 96 will be found in Volume 2.

Book 23 - Evolution Handbook

Why this series of books?

Evolution is a problem for several reasons:

First, evolution makes atheists out of people and lowers morality. Charles Darwin, in a famous statement, admitted the fact. He said that, since people were descended from apes, then mankind is totally untrustworthy and morally bankrupt. Evolution teaches that savage competition and warfare is the highest good and best source of development.

Second, evolution is riddled with fallacious thinking: As you will quickly see in this book, or any others in this series, evolution ignores the most obvious facts and twists and misapplies evidence to fit its objective. Correct logical reasoning is based upon correct premises; if the premises are wrong, the conclusions built upon them will be skewed and unreliable. In the schools of today, evolutionists teach men to ignore and misapply facts.

Third, evolution is false science—and most people, not having been trained to work with scientific tools, feel unable to successfully reply to "science." Please, do not let the subject buffalo you! The problem is not science, but evolutionary interpretations. Although you may not have been educated in scientific research methods, you can understand the basic facts; and that is what counts. All that it takes is common sense. In these books, you will read the facts and find that they disprove evolution.

It has been said that every fact of science can be explained either by creation or evolution. Actually, that is not correct. Most scientific facts can be explained better by creation than by evolution, while many facts cannot be adequately explained by evolution at all.

Fourth, evolution floods the media and the schools with its message. It seems impossible to withstand or oppose the deluge. Yet there is a way: Let the people know the basic facts, so they can learn the truth for themselves. The facts disproving evolution are not complicated. They appeal to thinking minds far better than evolutionary myths.

Fifth, it appears that all the scientists are on the side of evolutionary theory. That also is untrue. Many reputable scientists clearly recognize its falsity (although there are also many who fear to speak up, lest they lose their jobs). In this series, we provide you with thousands of statements by scientists who do not believe in evolutionary theory.

In the summer of 1989, the author learned that the California State Department of Education had recently notified the private, non-taxfunded Graduate School of ICR that it would have to close its doors if it did not teach evolutionary origins and processes in its science classes.

Since the early 1970s, the Institute for Creation Research has been the largest group working to educate the public in regard to the evidence disproving evolution. An attempt to close their college because it will not teach that which it knows to be error—and has satisfactorily been proven to be error—is ridiculous, yet this is what the situation has come to in our nation. We have reached a point in America where evolutionary theorists control the science organizations and are seeking to take over every school in the land.

The ruling, seeking to force the closure of the ICR Graduate School in southern California, crystalized in the present writer a conviction that an in-depth book, or set of books, was needed to help awaken the thinking public to what scientific facts really have to say about creation science and evolutionary theory. These books are the result.

Each volume in this set deals with a special topic area; and, together, all the books cover a far greater scope and include more quotations than any other single book or set of books ever produced. It is our sincere concern that this information will enlighten many minds to the truth of the situation. Evolutionary teaching is one of the greatest hoaxes ever perpetrated.

The author wishes to thank Dr. Henry Morris, director of the Institute for Creation Research, for his encouragement to produce these studies. Grateful appreciation is also extended to the William Jennings Bryan College, in Dayton, Tennessee, for opening their library archives of creation-evolution materials. As some of you may know, Bryan College was founded as a result of the 1925 Scopes trial in that city.

- *Vance Ferrell*

Book 21 - Wonders of Nature: Vol 1 **QUICK STUDY GUIDE 5**

Why This Book?

This book is part of a set of books disproving evolution. Taken together, these volumes provide hundreds and hundreds of reasons why evolution is foolishness. The theory is totally unworkable, impossible, and unscientific.

One of the many powerful evidences that God created everything, and that, the stars, earth, animals, and people did not make themselves-is those very stars, earth, ani-. mais, and people! Just look about you!

Everything is marvelously designed.

The more we consider the things of nature, the more we must admit that everything is marvelously planned and organized. It is clear that a divine Hand is guiding the galaxies, the planets, the plants, and the animals.

For over two centuries, scientists have called this the "argument by design." They tell us it is a powerful reason why evolutionary theory cannot be true.

Yes, it Is God who made us, and not we ourselves. Turn the pages of this book and read wherever you will,-and you will be confronted by irrefutable evidence of the existence of the Creator.

All of nature is His workshop. What can be more terrible than, in view of all this evidence, to try to deny His existence?

After reading this book, you may wish to obtain the other books in the series. They are all very worthwhile. For each one points you to your Creator.

The first 20 books in this low-cost series were designed to give you a clear, broad understanding of why evolutionary theory on this subject is totally fictional. Each volume was prepared in three levels of increasing simplicity—so everyone could understand it.

PART TWO of each of those 20 books is the most in-depth of the three studies, yet is still written in relatively simple language. The sidelined portions provide the key facts and, by themselves, could be used as a classroom text for 7th and 8th graders. **This is LEVEL THREE. It is often 40-50 pages in length, and is suitable for high school and college level students.**

PART ONE of each of those 20 books contains the guick Study Guides. They provide a brief summary of the best of Part Two. These study guides are quite readable, cover the basic facts, and can -be used as a good introduction to the subject before you purchase any or all of the 20 books and read more deeply into the subject. Each Quick Study Guide Is also designed as a grade school classroom textbook. **This is LEVEL TWO. It is generally 9-12 pages in length, and is suitable for 5th to 8th grade levels, on up.**

PART THREE in each of the 20 books is called "Creation for Children," and is the most simplified of all. It can be read and understood by children as young as ten years old. With explanations, it can also be read to younger children. Older folk, who do not read a lot, will also appreciate it. **This is LEVEL ONE. It usually has 1-2 pages, and is suitable for 4th to 6th grade levels, on up.**

When reading in the 20 books, when you start to read Part Two, if it seems a little deep (though we tried to keep it simple), then go back and first read Part One (Quick Study Guide). If you have trouble with Part One, turn to Part Three (Creation for Children) and begin there. Wherever you start, do not fear that you cannot grasp it. The truth is simple facts and common sense; it is the evolutionary errors which are devious and peculiar! Only Part Two includes the quotations and illustrations.

All the material in Part One (Quick Study Guide) of the first 20 books in this series is also available in the book, The Evolutionary Handbook.

All the material in Part Three (Creation for Children) is available in the book, Evolution is a Myth.

In addition, there is a two-volume set, Wonders of Nature: Vols. 1-2, which gives hundreds of examples of how nature points to its Creator. These is another proof of Creation.

The Creator's Handiwork

MATTER AND STARS

There is far more to the universe than hydrogen, spheres of gas, and arguments over senseless cosmology theories. There are also wonders. The universe around us was designed by a great Intelligence. Without careful planning nothing could hold together, nothing could exist.

1 - OUR AMAZING UNIVERSE

THE ELEMENTAL FORCES OF THE UNIVERSE—There are several basic forces in nature which would destroy the universe—or not let it form—were it not for the delicate balance between them.

> "There is another aspect of modem astronomical discoveries that is, in my view, as remarkable as the evidence for the abrupt birth of the Universe. According to the picture of the evolution of the Universe developed by the astronomer and his fellow scientists, the smallest change in any of the circumstances of the natural work, such as the relative strengths of the forces of nature, or the properties of the elementary particles, would have led to a Universe in which there could be no life and no man."— *Robert Jastrow, "The Astronomer and God," in The Intellectuals Speak Out About God (1884), p. 15. [Jastrow classifies himself as an agnostic.]

1- Gravity. Gravity is the weakest force in the universe, yet it is in perfect balance. If gravity were any stronger, the **smaller stars** could not form, and if it were any smaller, the **bigger stars** could not form and **no heavy elements** could exist. Only "red dwarf" stars would exist, and these would radiate too feebly to support life on a planet.

All masses are found to attract one another with a force that varies inversely as the square of the separation distance between the masses. That, in brief, is the law of gravity. **But where did that "2" [square] come from?** Why is the equation exactly "separation distance squared"? Why is it not 1.87, 1.95, 2.001, or 3.378; why is it exactly 2? Every test reveals the force of gravity to be keyed precisely to that 2. Any value other than 2 would lead to an eventual decay of orbits, and the entire universe would destroy itself!

(Another example would be the inverse-square law, which was mentioned in chapter 1 in connection with the red-shift and the visibility of quasars. According to this law, light diminishes exactly according to the square of its distance from the observer; not 1.8, .97, or some other fraction, but exactly 2.)

2 - Proton to neutron ratio. A proton is a subatomic particle found in the nucleus of all atoms. It has a positive electric charge that is equal to the negative charge of the electron. A neutron is a subatomic particle that has no electric charge. The mass of the neutron must exceed that of the proton in order for the **stable elements** to exist. **But the neutron can only exceed the mass of the proton by an extremely small amount—an amount which is exactly twice the mass of the electron.** That critical point of balance is only one part in a thousand. If the ratio of the mass of the proton to neutron were to vary outside of that limit—chaos would result.

The proton's mass is exactly what it should be in order to provide stability for the entire universe. If it were any less or more, atoms would fly apart or crush together, and everything they are in which is everything!—would be destroyed. If the mass of the proton were only slightly larger, the added weight would cause it to quickly become unstable and decay into a neutron, positron, and neutrino. Since hydrogen atoms have only one proton, its dissolution would destroy all hydrogen, and hydrogen is the dominant element in the universe. A master Designer planned that the proton's mass would be slightly smaller than that of the neutron. Without that delicate balance the universe would collapse.

3 - Photon to baryon ratio —A photon is the basic quantum, or unit, of light or other electromagnetic radiant energy, when considered as a discrete particle. The baryon is any subatomic particle whose weight is equal to or greater than that of a proton. **This photon-to-baryon ratio is crucial**. If it were much higher than it is, **stars** and **galaxies** could not hold together through gravitational attraction.

4 - Nuclear force. It is the nuclear force that holds the atoms together**. There is a critical level to the nuclear force also.** If it were larger, there would be no **hydrogen**, but only helium and the heavy elements. If it were smaller, there would be only hydrogen, and no **heavy elements**. Without hydrogen and without heavy elements there could be no life. In addition, without hydrogen, there could be no **stable stars**. If the nuclear force were only one part in a hundred stronger or weaker than it now is, **carbon** could not exist—and carbon is the basic element in every living thing. A 2 percent increase in the nuclear force would eliminate **protons**.

5 - Electromagnetic force. Another crucial factor is the electromagnetic force. If it were just a very small amount smaller or larger, **no chemical bonds** could form. A reduction in strength by a factor of only 1.6 would result in **the rapid decay of protons** into leptons. A three-fold increase in the charge of the electron would render it impossible for **any elements** to exist, other than hydrogen. A three-fold decrease would bring the destruction of all **neutral atoms** by even the lowest heat—that found in outer space.

It is of interest that, in spite of the delicate internal ratio balance within each of the four forces (gravitation, electromagnetism, and the weak and strong forces), those four forces have strengths which differ so greatly from one another that the strongest is ten thousand billion billion billion billion times more powerful than the weakest of them. **Yet evolutionary theory requires that all four forces originally had to be the same in strength during and just after the Big Bang occurred!**

It should also be noted that evolutionists cannot claim that these delicate balances occurred as a result of "natural selection" or "mutations"! We are here dealing with the basic properties of matter. The proton-to-neutron mass ratio is what it has always been—what it was since the beginning! **It has not changed, it never will change. It began just right; there was no second chance!** The same with all the other factors and balances to be found in elemental matter and physical principles governing it.

THE ORDER OF THE UNIVERSE—Everywhere we turn in the universe we find the most perfectly planned arrangements. It is all simply stunning. The more knowledge we attain, the more involved, yet delicately designed is the planning and order.

> "Everywhere we look in the Universe, from the far flung galaxies to the deepest recesses of the atom, we encounter order — . We are presented with a curious question. If information and order always has a natural tendency to disappear [because of the Second Law of Thermodynamics], where did all the information that made the world such a special place come from originally? The Universe is like a clock slowly running down. How did it get wound up in the first place?"—*P. Davies, "Chance or Choice: Is the Universe an Accident" In New Scientist 80 (1978), p. 506.

> "Systems spun out by the brain, for no other purpose than our sheer delight with their beauty, correspond precisely with the intricate design of the natural order which predated man and his brain."—* W Pollard, Man on a Spaceship (1967), p. 49.

All of this is a great mystery to honest, thinking men and women.

> "The very success of the scientific method depends upon the fact that the physical world operates according to rational principles which can therefore be discerned through rational inquiry. Logically, the universe does not have to be in this way. We could conceive of a cosmos where chaos reigns. In place of the orderly and regimented behavior of matter and energy one would have arbitrary and haphazard activity. Stable structures like atoms or people or stars could not exist. The real world is not this way. It is ordered and complex. Is that not itself an astonishing fact at which to marvel"—*P. Davies, Superforce: The Search for a Grand Unified Theory of Nature (1984), p. 223.

The greatest minds have stood in awe at the information content and intelligent order exhibited throughout the universe:

> **Max Planck**—"At all events we should say, in summing up, that, according to everything taught by the exact sciences about the immense realm of nature in which our tiny planet plays an insignificant role, a certain order prevails—one independent of the human mind. Yet, in so far as we are able to ascertain through our senses, this order can be formulated in terms of purposeful activity. There is evidence of an intelligent order of the universe."— *Max Planck, May 1937 address, quoted in A. Barth, The Creation (1988), p. 144.

> **Albert Einstein**—"Well, a priori [reasoning from cause to effect] one should expect that the world would be rendered lawful [obedient to law and order] only to the extent that we [human beings] intervene with our ordering intelligence . . [But instead we find] in the objective world a high degree of order that we were a priori in no way authorized to expect. This is the 'miracle' that is strengthened more and more with the development of our knowledge. "—*Albert Einstein, Letters to Maurice Solovine (1958), pp. 114-115.

> **Sir James Jeans**—"Our efforts to interpret nature in terms of the concepts of pure mathematics have, so far, proven brilliantly successful."—Sir James Jeans, The Mysterious Universe (1930), p. 143.

> **Sir Isaac Newton**—"The six primary planets are revolved about the sun in circles concentric with the sun, and with motions directed towards the same parts, and almost in the same plane. Ten moons are revolved about the earth, Jupiter, and Saturn, in circles concentric with them, with the same direction of motion, and nearly in the planes of the orbits of those planets; but it is not to be conceived that mere mechanical causes could give birth to so many regular motions, since the comets range over all parts of the heavens in very eccentric orbits. "—Sir Isaac Newton, Mathematical Principles (2nd Ed, 1686), p. 543544.

THE ANTHROPIC PRINCIPLE IN THE UNIVERSE—Scientists recognize that there is a strange quality running through nature all about us, that enables life to exist on our planet. This is called the "anthropic

principle." " It appears that water, atmosphere, chemicals were all perfectly designed for living things to exist, and, in a special sense, for mankind to exist.

This is quite obvious to any thinking individual who is willing, without prejudice, to consider the things of nature in our world and outside of it.

(However, you should be made aware of the fact that there are evolutionists who produce a twist on the obvious "anthropic principle," by saying that elements and molecules magically by themselves decided to arrange themselves into stars, planets, water, air, and living creatures for our benefit. In the thinking of those atheists, that was the guiding principle in all evolutionary processes. Therefore the term, "anthropic principle," is sometimes used in a sense different than a creationist would use it.)

> "There really is a place for teleology and related concepts in today's science. . Arguments, drawn in the main from modern theoretical cosmology . . may convince the reader of an astounding claim: there is a grand design in the Universe that favors the development of intelligent life. This claim, in certain variations, is the 'anthropic cosmological principle.' "—* W Press, "A Place for Teleology?" in Nature 320 (1988), p. 315.

There are many other examples that could be cited in nature which require the most delicate of balancings in order for the stars, planets, life, and mankind to exist. Before concluding this section, we will consider but one more**: the distance that the moon is from the earth**: If it were much closer, it would crash into our planet, if much farther away, it would move off into space.

If it were much closer, the tides that the moon causes on the earth would become dangerously larger. Ocean waves would sweep across low-lying sections of the continents. Resultant friction would heat the oceans, destroying the delicate thermal balance needed for life on earth.

A more distant moon would reduce tidal action, making the oceans more sluggish. Stagnant water would endanger marine life, yet it is that very marine life that produces the oxygen that we breathe. (We receive more of our oxygen from ocean plants than from land plants.) **Why is the moon so exactly positioned in the sky overhead? Who placed ft there? It surely did not rush by like a speeding train, then decide to pause, and carefully enter that balanced orbit**.

2 - CITY IN THE SKY

Did you know there is a city in the sky complete with streets and avenues down which you may travel as you journey from one galaxy to another? The entire universe is laid out in a definite pattern to help you find your way around as you go from place to place. For centuries we knew about the "houses"—the stars. Then we learned about the "city blocks" —the galaxies. But not until the middle of our century did we began to realize that they are strung out along networks of thoroughfares; streets and boulevards in this city above us.

THE LUMPS—**The scientists today speak of "clustered clumps of lumps." We first knew of the "lumps." These are the stars**. For thousands of years, we could see a myriad of stars overhead each night; the experts tell us we can see a maximum of 2,000 at any one time, or a total of 6,000 in all (although some ancient Greeks that tried to do so, said they could only count 1,056 stars in the sky.) At any rate, human eyesight cannot pierce the veil beyond the sixth magnitude.

But all this changed in 1608 when a young apprentice in the Netherlands decided to play games. While his master, the spectacle-maker Hans Lippershey, was away one day, the apprentice amused himself with lenses—and discovered a combination that made things appear closer. He showed this to Lippershey, who enclosed the lenses at two ends of a tube. Two years later Galileo (1564-1642), using the new invention, turned a telescope on the sky. From that point onward, mankind began to see much more.

If we imagined the entire solar system shrunk in size to that of Manhattan Island, the sun would be only a foot across. On the same scale, the nearest star, Alpha Centauri, would be 5,500 miles (8851 km) distant—in Jerusalem. That closest star, Alpha Centauri, is 4.3 light years, or 25 trillion miles away.

Later, those things which the astronomers today call "clumps" were found:

THE CLUMPS—The next big question was whether the thousands of "spiral nebulae" in the sky, such as the one in Andromeda, were just dust clouds—or actually island universes. Then the new 200-inch telescope at Mount Palomar turned its eye upon them—and discovered that they were indeed systems of stars—millions of stars all grouped into organized patterns, each circling a central ball of stars.

Individual stars were seen in the first two (which by the way are each about half the size of our galaxy or the Andromeda galaxy), and many wondered whether the Andromeda nebula could be resolved into individual stars. Then stars were seen! *Edwin Hubble found Cepheids (pulsating stars) in them. In 1943, *Walter Baade, working at the

Mount Wilson Observatory, discovered other types of individual stars in the center of the Andromeda galaxy. **That shining disk was composed of more than a hundred million individual stars!**

Additional evidence was uncovered in the 1940s, and, shortly after this**, the spiral arms of our own Milky Way Galaxy were mapped** by William Morgan in 1951.

The Andromeda galaxy is about 2.5 million light years away from us, whereas the average distance between galaxies is generally 20 million light years.

Our own galaxy is part of the Local Group of 19 galaxies. Of these, ours, Andromeda, and Maffel One and Maffel Two are the largest. (The latter two are partially obscured by dust clouds, so are more difficult to see.)

The total number of stars in the known universe is estimated to be at least 10,000,000,000,000,000,000,000 (10 billion trillion). Our own galaxy contains In excess of 200,000,000,000 (200 trillion) stars. It is estimated that more than half of those stars belong to small star systems, each one with two, three, or four stars circling one another.

All the stars in our galaxy (the Milky Way) revolve around its center. At the distance at which our sun is located from the center, Earth and the rest of our solar system are moving at a speed of about 150 miles per second around that center. This speed includes nearby stars, which with us are all journeying around the galactic center.

The center of our galaxy is in the direction of the constellation Sagittarius, and is 27,000 light years away. The total diameter of the galaxy is about 100,000 light years. The thickness of the disk is some 20,000 light years at the center and falls off toward the edge; at the location of our sun, which is two-thirds of the way out toward the extreme edge, the disk is perhaps 3,000 light years thick. But these are only rough figures because, from where we are, the galaxy has no sharply defined boundaries.

The center of the disk and the center of the galaxy do not appear brighter to us because of immense clouds of obscuring gas. It is estimated that we see no more than 1/10,000 of the light of the galactic center.

The diameter of the sphere of the observable universe is thought to be 25 billion light years across.

In all the heavens, only three galaxies may easily be perceived with the naked eye. These are the Large and Small Magellanic Clouds (the former is 150,000 and the latter 170,000 light years away), and the Great Nebula in Andromeda.

The lumps and the clumps had been found. Now it was time for what the astronomers call "the super-clusters." The story behind this remarkable discovery is an interesting one:

THE CLUSTERS—George Gamow's Big Bang theory, developed in the 1940s, intrigued many minds. But the universe was far too lumpy to have been produced by a smooth outflow of radiation. Yet the full truth about galactic distribution was still unknown.

It had been decided that, in accordance with mathematical probabilities, galaxies could only be randomly distributed throughout the universe. **But by the end of the 1940s, 36 "small" clusters of nearby galaxies had been discovered**. The more the universe was studied, the more it was found to be even "clumpier" than had earlier been imagined possible!

Using the new wide-angle 48-inch Schmidt telescope at Palomar Observatory, *George Abell completed a photographic survey in 1956, and established beyond doubt the existence of widespread galactic clustering. **During that survey, 3,000 plates were exposed—and on some of them 50,000 galaxies appeared in an area of the sky no larger than the bowl of the Big Dipper.** In 1958, what came to be known as the "Abell Catalogue" was published. It contained 2,712 "rich clusters"—each cluster containing hundreds or thousands of galaxies. This catalogue included a complete count of all rich clusters visible to a distance of three billion light years.

But scientists were slow to accept *Abell's findings, because it violated *Gamow's theories. Surely matter could not be so unevenly distributed throughout interstellar space! **Discovery after discovery revealed that the universe was arranged, not according to random mathematical probabilities, but as if by a carefully preplanned design**.

As he himself studied these findings, Abell found that the clusters tended to clump together into still larger clusters. **Then "Gerard de Vaucouleurs, a French astronomer discovered the "super-cluster,**" a flattened cluster of tens of thousands of galaxies that spanned 40 million light years—which was only a few million light-years thick! By the end of the 1970s, **he determined that this "Local Supercluster" was even larger: with a diameter of 160 to 240 million light-years, and trillions upon trillions of suns.**

Carefully working through the rapidly increasing data, * Brent Tully in 1987 concluded that ***de Vaucouleurs's Local Supercluster was actually part of a vast complex of superclusters that filled 10 percent of the observed universe. One billion light-years long and 150 million light-year: wide, it contained millions of galaxies—and was more than 100 times larger than any previously known structure. In addition, Tully found indications of four other massive systems that were of similar size.**

By now, the theorists were pulling their hair out. All this totally disproved their precious explosion theories of the origin of matter and the universe.

> "Not even Zektovich had predicted a universe as lumpy as that described by Tully. A Cosmological model that could produce such vast structures would have to include large density fluctuations in the moments after the Big Bang. The catch, of course, is that the resulting uneven expansion should also be reflected in irregularities in the background radiation—which is in fact extremely smooth . . The enigma of large-scale structures continues to defy solution."— *Peter Pocock. Galaxies (1988), p• 121.

Among themselves, the cosmology advocates are in despair, although their glowing student textbook articles give no hint of their troubles.

Working with this vast amount of data, scientists carefully developed out a map of all the galaxies within a billion light years from our world. Divided into a million squares, each was shaded in accordance with the number of galaxies it contains (with black for none, to white for 10 or more). The map shows the galaxies in clusters and filaments, somewhat like delicate embroidery. **Looking at the map, we see that celestial streets, lanes, and broad thoroughfares run all through the sky. They lead from one galaxy to another,—yet within each of those galaxies is to be found over 100 million stars.**

All this was carefully designed for the use of God's creatures.

3 - JOURNEY INTO OUTER SPACE

Why was our sun made? It was placed in space by a Master Designer in order to give light and heat to one inhabited planet.

Why then were all the billions of other stars made?

> **Yes, they provide us with twinkling stars to look at, but is that the only reason for their existence? Could it possible that—for most of them—each was also made to give light and heat to at least one circling planet?We know that the utter complexity of everything throughout creation is so immense and awesome, that there is no doubt but that the One who made so many amazing things in our own world, surely has the ability and power to make millions of other inhabited worlds.**

Why should only ours have plants, animals, and people on it? The present writer suggests that there may well be large numbers of inhabited worlds circling other suns throughout the immensity of outer space.

Someday, when the conflict of good and evil is past, we hope to be able to travel out into space and view those other worlds. We do not yet know what they will look like, but we already have some idea of what the stars and galaxies look like**. What would it be like to take such a journey outward through space, and view the handiwork of the Creator?**

Let us for a moment take such a trip!

The following facts about our solar system, and the stars and galaxies outside of it, are based on astronomical data recorded by professionals. A majority of the information was unknown prior to 1950.

BEGINNING THE JOURNEY—Heading upward, we first pass our own moon. It is larger, in relation to the planet it orbits, than is any other moon in our solar system. It was given to us for a purpose. The other planets, because they are uninhabited, do not need light at night, but we do. So we were given an unusually large moon.

We are journeying outward now. We will not take time to stop by **Mercury** with its 2-year days, and 88-day years, or bright blue-white **Venus**, which is the closest and generally the brightest planet to our world.

We pass **Mars** with its brilliant red landscape, and several enormous volcanic craters. Looking down, we sight one of them; Olympus Mons (also called Nix Olympica) is over 300 miles [482.8 km] wide at the base—twice that of the largest volcano on Earth: the one that is the island of Hawaii. The top of the crater of Olympus Mons is over 40 miles (64.3 km] wide. The volcano is surrounded on every side by a system of Martian canyons that dwarfs anything on Earth. It stretches across a distance equal to the full breadth of the U.S., and the canyons are up to four times as deep as the Grand Canyon, and six times as wide.

But more is ahead. Passing the asteroid belt with its interesting rocks of various sizes, we approach gigantic **Jupiter.**

Before us is this reddish giant with its swirls of intermingled reddish, whitish, and brownish hues. Circling it are 16 moons and a delicate ring system. As we pass, we see just below us the "great red spot" on its face. The surface features on Jupiter continually form and reform, but this mysterious 25,000-mile oval is always somewhere on its surface. It is thought to be the vortex of a hurricane that has been whirling for at least seven centuries. And now tiny Io, one of Jupiter's encircling moons passes near us. **An active volcano is exploding on its surface as we gaze down on it.**

Soon **Saturn** comes into view. It has a banded surface, 17 moons, and the most dramatic set of rings in our solar system. Ring particles that vary in size from dust grains to boulders speed along within these rings. We now know that the rings number in the thousands. Each ring circles the planet at a different speed.

A moon orbits within the largest gap in the rings, and at the outer edge of the farthest rings, a pair of moons run a continual race with each other! **Prometheus** orbits Saturn in less than 15 hours, constantly overtaking the rings. Nearby **Pandora** circles the planet in more than 15 hours, moving slower than the rings**. Scientists have worked out the complicated mathematical formula by which these two moons —maintaining these special orbital speeds— keep particles from flying out of the outer rings of Saturn**. Because of this, they have named them the **"shepherd moons."**

Then we see the nearest large moon to Saturn, **Mimas**, with a single massive crater enclosed within 6-mile-high walls. Now impressive **Titan** comes into sight. This gigantic moon of Saturn is 3,446 miles across, or half as large as our own Planet Earth.

Yet we must keep going, and soon we near **Uranus** and its own rings. From one of its 15 moons, Triton, we see plumes of gas ascending out of the ground. Another one, **Miranda,** has deeply-ridged craters, and canyons. If we had time we would enjoy exploring this unusual place. But now our destination lies farther away, past **Neptune** with its eight moons and four narrow rings, and **Pluto** with its one moon, **Charon**.

DEPARTING OUR SOLAR SYSTEM—Leaving our own solar system with its sun and nine planets, we head outward.

But we are still in our Milky Way Galaxy**. It is shaped something like a disk with a large round spherical cluster in the center.** The great majority of other galaxies, or "island universes," are shaped in about the same way**. Because of the similarities, in describing our own galaxy, we shall be better able to grasp the beauty of so many of the others.**

Did you know that there is color out in space? We already saw that the planets in our own solar system come in a variety of atmospheric and surface colors and shapes,—but there is also color in the stars, galaxies, and nebulae.

THE DISK—Within the outer saucer (the flat disk) of our island universe, the colors of the stars tend to be blue-white, intermingled here and there with yellow and reddish ones. Within this disk there are so many stars that the Designer sandwiched dark clouds in the middle of it to cut down on the light. This provides a muted contrast to the glory one will encounter as he journeys from our planet in the outer disk—into the central sphere at the center of the galaxy.

THE SPHERE—In the center of the island universe, the saucer bubbles out into a large cluster or sphere of stars. (We will here refer to it as a "sphere" to avoid confusion with the clusters outside the disk, to be described shortly; however this massive central cluster of stars is not a spherical solid.) The stars in this sphere tend to be pink!

Just now, though, we rise perpendicularly out from the saucer,—and soon we arrive at a point where we can look down at the majestic panorama of the saucer and its central sphere. There it is, stretched out below us. What a sight to behold! An outer disk, primarily of blue-white stars, rotating around a central sphere of stars that is pink-white. The Designer did His work well. It is indeed a glorious sight!

COMPARING THE TWO—In different galaxies, the galactic disk and the bulge at the center vary in proportion to each other. In some, the bulge spans 100,000 light years, nearly swallowing the disk and its pattern of spiral arms. In other island universes, the disk is as much as 200,000 light years across, and the central bulge is quite small. Variety of beautiful objects is the rule amid the scenes of nature on earth, and we find that it is the same in worlds and galaxies far away.

THE ARMS—The disk generally has a thickness of only 1/100th of its diameter. Within this narrow plane, a pattern of spiral arms rotates slowly about the galactic center. If the arms were perfect in arrangement, they would become tiresome to the eye, but instead there are interruptions, even ragged spurs here and there—that delight the eye of the beholder.

As on earth, everything in outer space is designed for beauty and utility.

ENTERING THE CLUSTERS—Circling outside of the disk and central sphere, are several hundred globular clusters. Each of these is a round ball composed of millions of stars. Imagine the scene for a moment: the outer bluish disk rotating slowly around a central pinkish sphere of millions of stars,—and around it all—hanging like chandeliers—are clusters of stars above and under the disk! And these clusters are pinkish also! Again, I say: What a sight!

ORBITS WITHIN THE CLUSTERS AND CENTRAL SPHERE—Within the central sphere (and also in the globular clusters above and below the disk), **thousands of millions of stars circle in large orbits around a common center,—but the orbits are elongated (elliptical)!** Each star has a different plane of orbit, so it all appears like "wheels within wheels" circling at different angles. There is a majestic complexity to all this, yet none of the stars ever collide with each other. It is inconceivably complicated, yet startlingly beautiful.

Oh, if an evolutionist or one who is undecided is reading these words; bow before your Creator and give Him your heart—and acknowledge His authority in your life. The elliptical orbits within the sphere and clusters could not make themselves, and once made they would quickly destroy themselves without the continual guidance of their Maker.

These elliptical orbits, steeply inclined to the plane of the disk, literally fling stars from within the central sphere to tens of thousands of light years out into space—far beyond the outer planes of the encircling disk,—before bringing them back down within the sphere to turn around in the narrow-width part of their orbits. If you are acquainted with the elliptical orbits of comets, you will understand that it is in the narrow part of the orbit of these cluster stars deep within the cluster—that the most dramatic part of their journey occurs**. For here they travel the fastest, as they pass into, around, and away from the narrow curve of the small end of their elliptical orbits**. One collision here would result in massive destruction—but it never happens. How astounding must be the view as these giant suns wheel in and out, intersecting, crossing ever so near—yet never striking one another.

DISK ORBITS—In contrast with the elliptical orbits of the stars within the central sphere and outer clusters, the orbits of stars within the disk are nearly circular and generally placed within 300 light years of the middle plane of the disk.

WITHIN THE SPHERE—Approaching the central bulge of each galaxy is like coming towards the vast entrance to a throne room, for within the bulge there are almost no obscuring darker clouds. The glory of what is inside that central sphere must be most impressive. Stand there with me for a moment and gaze down into it, as gigantic flaming worlds flash by—and pass around a massive region within the very heart of the clustered sphere of stars. What is in that center?

VIEW FROM ABOVE—We cannot take time just now to find out. Instead, we rise vertically up above the plane of the disk. Higher and higher we go**. Down below us the blue-white disk stars, intermingled here and there with stars of other colors, revolve slowly and grandly in their giant 100,000-year orbit around the central sphere which, itself, glows brightly with pink stars.**

> **THE CLUSTERS—As we continue to ascend straight up—away from the disk—we find that we are entering that world of giant star clusters** that lie outside of (above and below) the disk and the central sphere. These are like "chandeliers" hanging grandly, as it were, above and below the disk at various heights. Ranging from 15 to 300 light years in diameter, these clusters appear like isolated, sparkling pink jewels suspended in space, scattered here and there above the disk. Each cluster may contain tens of thousands to a few million stars, yet each cluster has a combined mass about a millionth of the disk and central sphere. These clusters are scattered here and there outside of the disk and central sphere,**—and, as it were, transform the disk into a gigantic ball-like shape, like a saucer with smaller balls floating above and below it and all inside an immense invisible outer limiting sphere that none ever pass beyond! Oh, the wonder and beauty and careful design of it all is fantastic. Such intelligent order and lovely coloring was made for intelligent people to behold. It was not simply placed out there for no reason at all.**

Think of the beauty of the bluish disk, with variegated yellow and white stars scattered through it; the large pink central core; with pink star clusters on both sides around it. Yet none of the clusters are outside of **an invisible outer encircling limit**. That such a boundary should exist is unexplainable to the astronomers, so they have theorized that a mysterious "black halo" of "dark matter" (which they call "antimatter", magically holds everything together within each island universe and keeps collisions from occurring, and keeps it all from flying apart. But if such theorized bands of black matter are needed outside to keep everything from flying outward,—then what keeps the orbits of the sphere, clusters, and disk within from crashing together under the pressing weight of that invisible encircling antimatter? (In chapters 1 and 2, we learned that if antimatter was out there, encircling the galaxies, those particles, like a magnet, would be drawn in to the matter and unite with it, instantly destroying both.) All these theories of man are stale, flat, and useless. Let us instead behold the reality, and bow in reverence before the One who made it all and holds it all together!

CLUSTER ORBITS—These giant pink outer clusters circle in their own orbits, and this is their path; it is an amazing one: Each entire cluster of millions of stars travels far up above the disk, then orbits down **THROUGH** it, and then far below on the other side of the disk, and again passes upward through it and begins circling high overhead again! **Yet, in all that continual orbiting of these clusters around the central sphere—but through the disk,—they never crash into any stars!**

This fact is utterly astounding, as is the fact of those elliptical orbits of stars into the central sphere and then up, out, and high overhead again, without crashing together.

It is difficult to grasp the total impossibility of such a situation. Each cluster contains hundreds of thousands of stars, yet each cluster travels in a tight elliptical (narrowed) orbit up above the disk, then down and through the disk—past millions of stars without colliding with them,—and then down far below the disk, and then up and through it again. Keep in mind that each cluster of stars has a diameter that is in the thousands of light years, yet no collisions occur.

Talk about "pure mathematics;" you surely have it here! No man, no computer in the universe could keep up with the intricacies of all those millions of interconnected orbits—and design it all so that no collisions would ever occur. Yet we are here viewing only one of millions upon millions of similar galaxies!

Island universes are as astounding as anything we see here on Planet Earth! Their structure and workings are as complicated as the human eye, the human ear, the human brain, the tongue, and their interconnections.

THE SPIRAL ARMS—Another mystery is the spiral arms of the disk. According to physical laws**, turning as they do, they ought to quickly become muddled together.** But this does not happen. Instead, there are billions of island universes scattered throughout the vast limits of space, yet all of the spiral ones which we can view have their distinct arms.

The problem is that the stars that make up the arms are known to rotate at greatly different speeds. Some are slower and some are faster, so any initial arm arrangement ought to be disintegrated into a confused mass early in the life of a galaxy. But this does not happen. Someone is guiding all those stars, and keeping them in their course.

HOW CAN IT BE?—And then there are those involved, interrelated star orbits within the clusters and within the central sphere. **How do they continue without all of them crashing into one another? And how could the clusters pass through the disk without most horrible collisions occurring?**

ORION NEBULA—We are still in Milky Way Galaxy, and now we enter back into the disk toward a certain point near one of its outer arms. We are approaching the area where our own solar system is located, but instead of going there**, we come to the Orion Nebula.**

Gigantic walls of clouds of various colors form on all sides just before us, and a vast opening lies before us. What is beyond that immense doorway in the sky? We would like to go through the opening, but our attention diverted. We will return to that mysterious opening in the sky later, when we again have an opportunity.

> **PLANETARY NEBULA—Off in the distance we have discovered a planetary nebula, with its mysterious hydrogen rings** that are light years across, each ring encircling a central star. The colors in the giant ring nebula fluoresce brilliantly in ultraviolet radiation from the star in the center. We head toward it—and pass directly through the great circle in its center. All around us, within the disk, we see stars and nebulae.

BINARY STARS—Because we are within the disk, we are closer to the individual stars, and can see them better. Everywhere we turn, we see double stars circling one another. How can this be? They ought to crash into one another or fly apart. Yet there they are, placidly circling one another year after year, century after century**. A surprising number of the stars that we see about us are these mutually-orbiting binary stars. There are also triple and quadruple stars also, carefully circling one another! More than half of all the stars in the sky are in small systems of 2, 3, or 4 stars circling one another.**

What is the purpose of those small-system stars? Let me suggest that they have been placed there in order to provide continual daylight to inhabited planets orbiting within those systems.

SUPER-NOVA—Suddenly we see a super-nova that has only recently undergone a rapid expansion. It has become very large, and clouds of hydrogen are radiating outward from it. Already they are beginning to form a lovely nebula. We stop to gaze upon it. The glory of it is awesome.

Have you ever walked down a forest path? On each side you see beautiful trees and plants. There are red and blue flowers here and there. Occasionally you see something unusual. Perhaps it is a squirrel bounding up a tree. This is the way it is as you travel among the stars. There are so many things to see. But once in a while, just as in a forest, something unusual happens which adds to the interest. Super-nova are just such an uncommon occurrence. They add beauty among the stars, for they reflect nearby starlight.

As we journey through the nebula, we see all about us vast curtains of glorious light, glowing in the starlight as shimmering castles.

By design, a super-nova would not occur near an inhabited planet, so no one would be ever endangered. Why can we be so sure? The incredible mathematical formulas we have already observed in action provide powerful evidence. A Master Designer is in total charge of His creation.

A CLOSER LOOK AT A STAR—In all of our travels so far, we have not taken time to closely examine any of the stars. Nearby we see Mira. It seems well that we should pause to consider it for a moment, and in so doing we will learn a little of the complexities of these large stellar objects. Mira in the Constellation Cetus is a long period variable star. Some of these variable stars are very regular in their changes from greater to less brightness, while others are so unusual that no cycle can be predicted. The irregular variables are unpredictable both in maximum and minimum brightness, as well as in time span. The extreme rapidity with which some of them change is astounding. Sometimes in only a few hours a variable may become 15 or 20 times brighter than its minimum.

Mira changes slowly over a period of about 331 earth-days. Viewing it from our planet, it changes from a very bright 1.7 (average 3.5) magnitude star to an invisible 9.6 (average 8-9) magnitude one. At its brightest, it gives about 1,000 times as much light as at its minimum. No one knows why it changes brightness. It is at its brightest for only 10 days, and then it wanes for 8 months, after which it rises again, sometimes very rapidly. As with most of the long-period variables, Mira is a red-giant star, and is thought to be a little larger than Betelgeuse, which is one of the largest stars we know of.

For some strange reason, Mira has heavy lines of titanium oxide vapor in it. Equally strange, although its light greatly diminishes at minimum, its heat only, falls off to about a third. Even at maximum, Mira gives only 1/10th as much light in proportion to its enormous heat, as does a white star like Vega. At minimum, Mira's ratio of heat to light falls as low as 1 to 500.

Mira is a cool star, for even at its brightest, its surface temperature of 1600 degrees F. is not enough to melt steel. Although its bulk is 27 million times that of our sun, it only gives off 1000 times as much heat. More wise designing: if this super-giant star were as hot as smaller stars, its mass would radiate so much heat that it would be something of a neighborhood problem.

Radial velocity measurements indicate that Mira is approaching us when it is the faintest, and moving away from us when it is the brightest! It is moving in a gigantic orbit around something else. The orbit would be 35 million miles in diameter. It has been discovered that Mira is a double star; it has a bluish companion and they circle one another. But this mutual orbit is not enough to properly explain Mira's extreme brightness to darkness. There are great mysteries in Mira which we do not understand. For example, contrary to physics, Mira is hottest, not when it is rising in brilliancy, but when it is fading.

But now, it is time to leave Mira. There are so many other things to see.

STAR SIZES AND COLORS—After traveling among them for a time, we begin to realize that stars can vary greatly in their sizes and colors. Here are but a very few examples of their wide range in both color and diameter (measured in miles):

Sirius B - dark white - 32,000.

Proxima Centauri - orange - 218,000.

Alpha Centauri B - light orange -848,000.

Sol (our sun) - yellow - 884,000.

Procyon - light yellow - 1,500,000.

Sirius - white - 1,700,000.

Eta Augigae - light blue - 3,000,000.

Beta Corvi - yellow - 9,500,000.

Arcturus. - yellow-orange - 17,000,000.

Alnilam - blue - 27,000,000.

Menkar - light-red - 48,000,000.

Alpha Aquari - yellow - 95,000,000.

Alpha Arae - orange - 287,000,000.

Betelgeuse - red - 433,000,000.

What a range of colors!

On this basis, our sun would be about 1/8 inch in diameter, and Betelgeuse, a red giant, would be about 6 1/2 feet across! If Betelgeuse were where our sun is, its outer edge would extend far beyond Earth and enclose Jupiter!

CEPHEIDS—Scattered throughout the galaxy, we find Cepheid stars**. These are pulsating stars**, and each in its own pattern is as accurate as the most accurate of clocks. Some say that Cepheids regularly expand and contract in diameter, but, whatever the cause, these stars become brighter and dimmer in accord with a definite rate of pulsation.

They are as accurate in their pulsations as are the calls of crickets in the field in relation to atmospheric temperature! The same Hand that guides the crickets, guides the Cepheids.

NEBULAE—**Traveling on now, we pass through massive nebulae (plural of nebula; another plural is nebulas) composed of clouds of beautiful colors, lighted up by nearby stars.** Before us is **Rho Ophiuchus,** an enormous dark cloud of gas, glowing blue, red, and yellow with reflected light from nearby bright stars. The nebulae come in all kinds of colors!

Then we come to the **Veil Nebula**. Swirling veils of blue and pink clouds reach out vast distances into space. Within and beyond it we see the apparent intertwining of stars glowing brightly.

The **Rosette Nebula's** pink ionized hydrogen glows brightly in a vast circular swirl of clouds around a central opening. Behind both clouds and opening, stars form a brilliant background.

COLOR EVERYWHERE—In another view, the yellow-red light of **Antares,** and the blue light of a nearby star is enfolded in glowing clouds of pink, red, blue, and white. From our angle of view, we can see that, apparently near it but actually far off, is a brilliant white star cluster. The combination of colors and objects is incredible and seemingly never-ending. And it is all made for the happiness of those that love God.

On and on we journey, ever beholding new, more glorious vistas of beauty within the arms of the disk of our Milky Way Galaxy.

OTHER GALAXIES—So vast is the Milky Way Galaxy that, if it were reduced to the size of the United States, the Earth would be far smaller than the smallest dust mote, and barely visible through an electron microscope.

But there are other galaxies in space that are three times larger than ours. And there are smaller ones also. The smallest galaxies, called the "dwarf galaxies," are only 1 /30th as large as our Milky Way Galaxy, but even they contain about a hundred thousand stars.

As we journey onward we will visit these various galaxies. We will find that, perhaps, three-fourths of them are disk-shaped with arms. Some of these are "barred." These are called "spiral galaxies." Other galaxies, called "ellipticals," are more spherical. Still others are the "irregulars, " and come in many unusual, but beautiful shapes.

Barred galaxies are spiral disk galaxies, but with a bar protruding from each side of the central sphere. Near the end of the bar on each side a large arm extends off to the side. This means that, when you journey from the stars in the outer arm to the central sphere, you travel down a boulevard of millions of stars on all sides of you!

The **elliptical galaxies** are slightly elongated spheres—which are filled with stars! Although somewhat more clustered in the center and less so in the outer portion, they are still fairly evenly spaced throughout the sphere. Ellipticals are different from spiral galaxies, not only in shape, but also in two other ways: (1) They have almost no binary or multiple (two to five or so) star systems in them, mutually circling one another. (2) They have little or no dark gas in them, as is found in the disk of the spirals. This means that the glory within the ellipticals must really be something to behold!

The **irregular galaxies** come in a variety of interesting shapes and sizes. Looking at them is like gazing upon a field of flowers and plants. The sheer diversity is pleasing to the eye and quite interesting. It must be quite an adventure to travel through an irregular galaxy.

MAGELLANIC CLOUDS—Two of these irregulars are **the Large and Small Magellanic Clouds,** which, back on our own planet, were only visible in the Southern Hemisphere. Only they and the Andromeda Nebula could be seen with the naked eye from Earth. Like old friends, we are now glad for the opportunity to visit them as we journey through space.

Before, the Large and Small Magellanic Clouds looked like luminous cloudy patches, but now as we approach through space toward them, we find each one has billions of stars. They glow pink from billows of energized hydrogen lit up by swarms of stars within them. The delicately pink radiated arms of the Tarantula nebula glows brightly inside.

RING GALAXIES —Astronomers have found about two dozen ring galaxies. Each one of these has a massive central spherical cluster of stars. At some distance outside of it is a large ring, composed of millions of stars. Some of these galaxies are also called "polar ring galaxies," and appear much like our planet Saturn, with its large central sphere and outer rings. Before we have concluded our trip, we will need to visit one of them. Surely it will be a magnificent sight. Will it have the pink and blue colors we are familiar with in the disk galaxies, or will they be different? When we reach one we will find out.

LEAVING THE MILKY WAY GALAXY—Now we take our leave of the Milky Way, , our home galaxy, and head outward as we wing our flight to **the galaxy in Andromeda**, , the nearest island universe. Arriving there, we come upon unique nebular objects new to us, but other than this, we find it to be as glorious in light and color and shape as our own Milky Way Galaxy**. Yet our journey has only begun. There are 100 million more galaxies to visit.**

ONLY THE BEGINNING—We are only at the beginning of an intergalactic journey. We will be able to stop frequently and make new friends or visit with old ones. When we wish, we will be able to return to our home planet and work in the garden, walk in the woods, or view the sights from the mountaintops. Top on our list of priorities, will be time to worship God.

To sing His praise will be our greatest privilege, for He is more wonderful than anything He has created in the universe. It is awesome to consider that a Being of such massive power could be so kind, thoughtful, and tender.

PATHWAY THROUGH THE STARS—As we mentioned earlier, scientists spent years mapping the galaxies in the sky**. When the task was completed, they found that the galaxies were arranged in networks which look like delicate lacework. That was wise planning by the Master Designer. For now, as we travel onward, we will be able to journey down streets and avenues lined with galaxies, scattered here and there**. In this way, it will be easier to keep track of where we are going.

On the average, each galaxy has 100 million stars**. And one inhabited planet probably circles each of a majority of those stars.** Oh, what must they be like! Perfect plants and animals, exquisitely-designed landscapes. Having entered the disk of the Andromeda Nebula**, we now speed to a nearby star, and then head toward its planets.** There, just before us, is a planet with a deep blue atmosphere—far deeper than our own, for it has the water-saturated vapor canopy our planet lost at the time of the Flood. The blueness reveals that it is a planet with oxygen and water. Living creatures and intelligent beings will be there. We head downward.

Is it a dream? No, it is real. With the exception of the concept of inhabited planets, each fact we have here described about our own solar system, or the stars, galaxies, and nebulae outside of it, has been observed by astronomers.

And it can be yours someday to explore. Surrender your life to God and let Him be your guide, and your future is secure. "Trust and obey, for there is no other way" to find that eternal peace of heart that you so much desire.

The Creator's Handiwork

the earth

Although many of its ecosystems were damaged by the worldwide Genesis Flood, yet our planet remains wonderfully designed for living. Later, in chapter 19, we will learn more about the effects of the deluge. But now, for a few moments, let us consider some of the many factors that make our world so livable. Because entire volumes could be written on this topic, we will briefly focus our attention on three topics: atmosphere, water, and soil.

Introduction

1 - THE ATMOSPHERE

Ours has been called the "water planet;" it is also the "air planet." These are two special qualities about our world that are not to be found on any of the other planets in our solar system.

The air surrounding our world is called the atmosphere. Air has no color, smell, or taste, yet without it there could be no living plants or animals on the earth. People are known to have survived more than a month without food, and more than a week without water. **But without air they die within a few minutes**.

Without air, there would be no weather. We could have no wind, and no storms which bring us much-needed water. Without wind there would be no movement of the trees and plants **and our world would be very still. It would also be silent,** for without air we could hear almost nothing. Most sound travels through the air (although some travels through rock, metal, and water.) Sound cannot travel in a vacuum.

Without air**, birds could not fly**. Air provides resistance to motion, and it is this resistance which enables birds and planes to fly through the air**. Without air, there would be no clouds. The sky would maintain a dreary blankness** day after day. **The sky would not be blue**; instead it would be black.

Air is composed of several invisible gases. About 98 percent of those gases are nitrogen and oxygen. Two-tenths of all the air is composed of oxygen (21 percent). **Without oxygen we could not survive**, for we need it continually in our blood and tissues. **Plants would quickly die without it also**. They need it just as they need carbon dioxide.

But eight tenths of the air is seemingly useless to us; it is nitrogen (78 percent). Surely, it must have a purpose also; everything else does. Actually, it is invaluable. Oxygen is combustible; that is, it can be set on fire and burn**. If there were no nitrogen in the atmosphere, the world would have burned up** as soon as the first fire had been ignited by lightning, or the first two flinty rocks striking one another had sparked. Even iron would have burned. We have cause to be very thankful for the nitrogen in the air around us.

The remaining 1 percent of air consists almost entirely of the gas argon. But there are also small amounts of neon, helium, krypton, xenon, hydrogen, ozone, carbon dioxide, nitrous oxide, and methane gases.

All those various gases are invisible**. What if they were even slightly opaque?** Our world would be totally dark. The gloom of eternal night would be upon us, even though the sun shined brightly overhead. Ocean water looks fairly clear, but 200 feet [61 m] down, the sunlight is nearly gone, and 300 feet [91 m] down darkness prevails. The atmosphere over our heads is hundreds of miles deep and covers all the earth. If the gases in it were not transparent, we would all live in perpetual darkness. The world would be ice cold**. The warming rays of the sun would be blocked out before reaching us.** The tiny photosynthesis factories contained within each plant leaf could not operate. **No food would be produced**, and all the plants and animals would die.

There is also some dust in the air**. This is what provides us with beautiful sunset colors** on the clouds and in the sky. A cubic inch of air normally has about 100,000 solid particles. The air over the mid-Pacific has about 15,000, and the air above large cities has 5 million particles per square inch.

There are other things in the air also: salt from the ocean, pollen from plants, floating microbes, and ash from meteors which burned upon hitting our atmosphere. There is also water vapor in the atmosphere—**and that vapor is vitally important; without it we would quickly perish! It is part of the water cycle**. But more on that in the next section of this chapter.

Because air has weight, we have barometric pressure, wind movement; and air resistance. The weight of all the air in the world is about 5 quadrillion tons (That is a 5 with 15 zeros after it). The weight of the air in a pint [.47 l] jar is about that of a small capsule or an aspirin tablet. The greatest air pressure is found at the earth's surface, where it averages about 15 pounds [6.8 km] pressing down on every square inch [2.54 sq. cm]. The amount of air pressing down on your shoulders is about 1 ton (1 short ton is 2,000 lbs. [907 km]). Fortunately, you do not feel this weight because it is pressing on you from all sides.

Without air, we could not have weather, and without weather conditions there could be no rain. The sun causes air to move by heating it. The warm air rises upward into the colder areas above it—and clouds form. Sideways pushing and shoving of the warm and cold air against one another causes more turbulence. But what causes rain? We will consider that shortly.

Did you know that there are "air tides" as well as ocean tides? Movements of the earth in relation to the moon and sun cause ocean tides, but the gravity from the moon and sun causes air tides also. This means that plants and people weigh a little less when the moon is overhead.

What can be slower than air? Actually, few things are faster! Although air may appear to move slowly most of the time, the air molecules within it travel at extremely rapid speeds. The warmer the air, the faster the molecules move. At freezing temperature they are really "slow"—only moving at about 1,085 miles [1,746 km] an hour! That is 1 1/2 times faster than the speed of sound at freezing temperatures.

The exosphere is the highest layer of air above us and starts at about 300 miles [482.7 km] up. There is hardly any air at that height. Below that is the ionosphere,' which is 50 to 300 miles [80.4482.7 km] above the earth. Electrically-charged ions found in this part of the atmosphere protect us from solar winds and other radiation entering from outer space. The beautiful aurora borealis, or northern lights, glows in this region. The bottom of the ionosphere bounces radio waves back to earth. **Without the ionosphere, most radio communications would be virtually impossible.** The ionosphere is important for its shielding effect from solar rays and meteors. Without the atmosphere **the thousands of meteors which arrive regularly would strike the earth,** destroying animal life and vegetation.

Below the ionosphere is the very important stratosphere, which extends from about 7 miles to about 50 miles [11.26 to 80.4 km] above us. This is where the ozone layer is found. **Without that blanket of ozone, ultraviolet rays from the sun would quickly destroy all life on earth**. This is also the highest warming layer of the atmosphere. As the sun's rays strike the ozone, it warms it. **The ozone layer helps warm the entire planet**. It is about 12 to 21 miles [19.3 to 33.8 km] up, and the warm layer is just above it. Below the ozone layer, the stratosphere is cold (about -67°F [-55°] over the U.S.), but without the ozone layer it would be far colder! The upper stratosphere—in the warm layer about 30 miles [48 km] above the ground,—the temperature is about 30°F [-1 °C].

The troposphere is of extreme importance, **for this is where the clouds are,—and where our rain comes from.** This region extends from the surface up to about 7 miles [11.26 km], but varies with weather conditions. Every thousand feet [3,048 dm] you go upward through the troposphere, the temperature drops about 3-4°F. The troposphere is the region where weather occurs; above it there are neither clouds nor storms. Above the north and south poles, it ends about 5 miles [8 km] up; above the equator, it ends about 10 miles [16 km] above the earth's surface.

Air helps to make soil because it contains oxygen, carbon dioxide, nitrogen, and moisture. The oxygen, carbon dioxide, and water combine with the chemical elements in the rocks. Along with plant, wind, and water action, this causes the rocks to decay and break down into small particles.

Without air, plants would quickly die. Air is absorbed and used throughout the plant. **Without air in the soil a plant cannot survive**. Even the Florida cypress (one of only two trees in the world which can have its roots permanently submerged) grows "knobs" which stick above the surface of the swamp in order to take in air.

Human beings would also die without that air. All the cells in our bodies must have oxygen. They use it to change food into energy. When you breathe, air enters your lungs. The blood stream takes oxygen from the air in the lungs and carries it to all parts of your body. Fresh air also makes us feel more comfortable, for it removes the warm, damp blanket of air next to our skin. People who work in the open air, or who know to keep their houses properly ventilated are much healthier and live longer.

Fresh air also has negative ions, which are important in the maintenance of good health.

2 - WATER

Another marvelous substance is water which, when pure, is also colorless, odorless, and tasteless. There is a lot of rock and other material beneath our feet, but covering the surface of the planet there is more water than anything else. Seventy percent of earth's surface is water. Without it, nothing could live. Your body is about two-thirds water.

There is a million million gallons of water in a cubic mile of ocean (that is 1 with 12 zeros after it). Of the 326 million cubic miles [524,631,800 c km] of water on earth, much of it (97 percent) is in the oceans, but there are also large amounts beneath our feet. The upper half-mile [.8 km] of the earth's crust contains about 3,000 times as much water as all the rivers of earth. Only about 3 percent of the earth's water is fresh. About three-fourths of that fresh water is frozen in glaciers and icecaps. There is as much frozen water as flows in all the rivers in 1,000 years.

We can be thankful that so much water is frozen! If it were to melt, all the seaports of the world would be below the ocean's surface, and much of the continental coastal areas would be lost to us also.

All living things contain lots of water. It is truly the element of life. Your body is about 65 percent water—the same as a mouse. An elephant and an ear of corn is about 70 percent; a chicken is 75 percent water; a potato, earthworm, and pineapple are 80 percent; a tomato is 95 percent; a watermelon about 97 percent.

You can live a month without food, but **only a week without water**. A person that loses more than 20 percent of his normal water content becomes over-dehydrated and dies a painful death. Each of us must take in about 2 1/2 quarts [2.4 l] of water each day in water and food. On the average, a person takes in about 16,000 gallons [605 hl] of water during his lifetime.

Plants, animals, and people must have a daily inflow of nutrients. **Water dissolves those nutrients so they can be carried throughout the body in the blood stream**, taken through cell walls, and utilized by the body**. The chemical reactions can only take place in a fluid environment.** We are here briefly describing processes which are so utterly complex that mankind still has only the barest understanding of them.

Water is needed to grow plants. It requires 115 gallons [435 l] of water to grow enough wheat to bake a loaf of bread. To produce 1 pound [3.7853 l) of potatoes takes 500 pounds [1,892.6 l] of water. About 41 percent of all water used in the United States is for irrigation.

A larger amount, 52 percent, is used to keep the factories going**. Without water much of the manufacturing would stop**. It takes 65,000 gallons [2,460 hl] to make a ton [.9072 mt] of steel; 10 gallons [37.85 l] to refine a gallon [3.753 l] of gasoline; 250 tons [226.8 mt] to produce a ton [.9072 mt] of paper. In industry, it is especially used to clean, liquidize, but, most of all, to cool.

Without water mankind could accomplish little, much less survive long**. Yet it is all based on the water cycle**. Water evaporates from oceans, lakes, and rivers. Taken up into the air, it falls as fairly pure water in the form of rain or snow. About 85 percent of the water vapor in the air comes from the oceans. Plants also add moisture to the air. After water is drawn up from the ground through the roots, it passes up to the leaves where it exits as vapor. A typical tree gives off about 70 gallons [265 l] of water a day, and an acre [.4047 ha] of corn gives off about 4,000 gallons [151 hl] a day. This continual drawing of water from the roots up through the stems, trunk, and through the leaves gives torgor (stiffness) to the plants. Without it, they would wilt, become flabby and die.

The oxygen and water given off by plants is part of the **reason why you feel more refreshed near plants** than in a desert or on a city street.

Water can be a solid, a liquid, or a gas. No other substance appears in these three forms within the earth's normal range of temperature.

Nearly every substance in the world expands as it warms and contracts as it cools. But water is different: As it cools, it continues to contract, and then, **a few degrees before it freezes at 32°F [0°C],—it begins expanding**. As it continues to cool, it continues to expand. For this reason, ice is lighter in weight than an equal amount of water. **So the ice floats on water,** instead of sinking into it—and filling all the lakes and rivers with solid ice in the winter. Because ice expands, **the ice sheet on the surface of a pond pushes sideways** and lock against the banks on either side. Below it, the water continues to remain liquid and the ice insulates the water from becoming too cold and freezing also. If it were not for this cooling expansion factor, no plants, fish, frogs, or any other wildlife could survive a winter in rivers and lakes where freezing occurs.

It is a miracle that water is liquid at livable temperatures. Other substances (such as H^2Te, H^2Se, and H^2S) which are similar to water (H^20), are gases at normal temperature, and do not change into water until the temperature falls to -148° to -130°F [-100°C to -90°C]! As their formulas show, they are very similar to water, each having two atoms of hydrogen, but, instead of an atom of oxygen, they have an atom of tellurium, selenium, or sulfur. If water was like them, **there would only be steam; no water, no water vapor, no clouds, no snow, and no ice**.

Still another amazing quality of water is the fact that, between the time it begins to boil and when it turns to steam,—**it stores so much energy as it is heated**. When water reaches 212°F [100°C], it does not immediately turn to steam, but instead there is a pause, during which the water absorbs additional heat without any rise in temperature. This heat is called latent heat. More than five times as much heat is required to turn boiling water into steam as to bring freezing water to a boil. Thus, steam holds a great amount of latent heat energy. Because of that fact, **steam can be used to operate machinery.**

Water vapor also has a tremendous amount of latent heat energy. This energy is released when the vapor cools, condenses, and falls as rain. The high latent heat of water is related to its remarkable heat capacity. **Heat capacity is the ability of a substance to absorb and hold heat without itself becoming warmer**. Water can do this better than any other substance in the world, except ammonia!

For example: If three solid substances (gold, ice [frozen water], and iron) were placed at the temperature of absolute zero, which is -460°F [273.3°C; 0°K]. (Absolute zero is the theoretical temperature where a substance contains no heat of any kind.), and then all three substances were heated, making sure that all three were receiving (absorbing) the same amount of heat,—when that point was reached where the gold melted at 2016°F (-1138°C],—the ice would still be -300°F [-184.4°C]! If additional heat were equally applied to the ice and iron, when the iron began to melt at 2370°F (-1334°C], the ice would finally have reached 32°F [-0°C]!

Another example: take two cooking pots and put nothing in the first (make sure it is a worthless pot!) and fill the second with water, set both on two fires on the stove. Very quickly, the second will get extremely hot and may turn red. At the same time, the water in the second pot will only be starting to get warm! **It had been absorbing heat energy without itself changing much in temperature.**

This ability of water to absorb heat or lose heat without itself hardly changing temperature is an amazing quality. It is for this reason **that the oceans can store large amount of heat and keep the planet warmer**—without that water turning to steam. **Conversely, the water can give up a lot of heat before it turns to ice**. For the same reason, fish and plants can over-winter in lakes, ponds, and rivers without freezing, and they can go through the summer without the water boiling them to death!

Water has powerful dissolving ability. It can dissolve almost any substance, including some of the hardest rocks. It also dissolves the nutrients that plants and animals need for nourishment. Dissolving the nutrients in soil, it carries them to plant roots, and thence up through the plant to cells within the plants. It also dissolves the food that animals and people eat. Within the body, it carries those nutrients to each cell, and then carries off wastes.

This solvent quality enables you to wash things with water. How would you like to take a bath in turpentine, kerosene, paint thinner, or cleaning solvent? **Water cleans best and does it without injury.**

Capillary action is the ability of a liquid to climb up a surface against the pull of gravity. Because of this, water is drawn up from the roots into the tops of trees hundreds of feet in the air. **The capillarity of water helps pull it through the soil, through plants,—and through body tissues as well**.

Surface tension is the ability of a substance to stick to itself and pull itself together. **Water has one of the highest surface tensions of any substance**. Because of this, water forms into drops; it is actually clinging together! Water molecules cling together so tightly that insects can walk on it. This tension is also a sticking factor. **It makes water able to stick to things—and wet them. In doing this, it can dissolve substances and then transport them to another location**.

3 - SOIL

The ground beneath your feet has a lot more mysteries and marvels to it than you might think. In chapter 5 (*Origin of the Earth*), we learned that there is a thick layer of granite beneath all the continents. This granite gives rigidity to the continental masses, and is the foundation upon which rests the sedimentary strata, laid down by the Flood. This granite also provides a base on top of which are underground river channels, various pockets of minerals, petroleum, etc. Still farther up is to be found the soil which is close to the surface. **Air, water, ice, roots, flood, and glaciers all work to crumble the rocks near the surface. Plant and animal remains, and body wastes, add to the mixture, and soil is the result.**

When plants die, they decay and form humus, an organic material that makes the soil more fertile. Animal remains add to the humus. Bacteria in the soil help the plants decay. Animals that burrow in the soil help mix it.

An extremely valuable creature is the earthworm. It swallows soil as it burrows, chews it up, and excretes it again. **The result is a finely pulverized soil**. Earthworms feed on dead plant material in the soil. The worms help break down the humus—the decaying matter—in the soil. The necessary air for plant growth enters the soil through the burrows made by the earthworms.

The topsoil is the best soil for growing plants. It is seldom more than a foot deep [30.5 cm]. below is the subsoil, which may be 2-3 feet]61-91 cm] deep. This is not as rich, for the earthworms and microbes have not worked it over, and it lacks the humus.

The ideal soil is structured so that each grain is not entirely separate, but sticks together with others in small crumbs. Humus is valuable in helping the soil stick together in this way. A good soil texture is one in which particles are not too small (clay) or too large (sand, pebbles, or small rocks). The best soils will be a mixture of sand, clay, or silt without too much of either, plus a good amount of humus.

There are small creatures, bacteria (also called *microzyma*) which live in the soil and help condition it.

As the evening cools, dew forms on the plants and ground and waters the earth. Plants reach their roots down into the ground and tap underground water. But the earth has been damaged. The aerial and underground watering system was partially deranged at the time of the Flood. Another problem was deposition by flood waters of sections of clay, sand, exposed rock, gravel, and calcite, iron, selenium and other beds. Soils may lack calcium or have too much (and thus be too acid or alkali).

When too much rain falls, erosion results as soil is carried off. Rain also leaches the soil, taking nutrients downward into the ground. But while the top layer is leached by rainwater**, minerals in the rock beneath it can be reached by plant and tree roots, which draw up more nutrients. In addition, humus can be built** up by falling leaves and stalks, and by man as he works with the soil.

The result is garden plants containing the nutrients needed for life**. We plant, tend, harvest, and eat the plants** and obtain the vitamins, minerals, carbohydrates, and proteins needed for the sustenance of life**. We drink the water from the skies, and bathe our bodies in it. The sunlight falls upon us and deepens our health. Amid all the work, we grow stronger**. It is all part of a good plan by One who looked upon the world when it was first made and declared, "It is good."

4 - CONCLUSION

In air, water, and soil we see basic provisions for life on our planet. It is true that the Flood damaged the soil and inundated much of the world with oceans. But in and through it all a careful plan is revealed, so that plants, animals, and man can live in our world. Yes, it takes work, but work was given to mankind as a blessing.

The promise has been given that someday the earth will be restored to the Edenic beauty it had before the Flood. But even now we have many good things. This world was designed for plants, animals, and people to live**. The arrangement did not come about by chance. Too many factors are involved, and if even one was missing, life could not exist here.**

Recent scientific studies have disclosed that if the sun had been just a little closer or farther away from our planet, no life could survive. Scientists have discovered that if the Earth was only one percent closer to the sun, or one percent farther away from it,—we would all quickly perish!

If the earth's magnetic outer barrier did not exist, solar winds and other radiation would render it impossible for anyone to live. If the oceans did not exist after the Flood, not enough rainfall could fall on the continents. Without broad oceans there would not be enough oxygen, since small ocean plants called plankton make most of it. Without the ability of water to absorb and retain heat—plus the great ocean currents—much of the world's continental areas would be too hot or cold to live in. We cannot drink seawater, and without winds and storms we could not have rain, rivers, lakes, and countless other blessings.

Yes, our world was designed for people, animals, and plants**. A molten mass cooling down (such as is theorized by evolutionists as earth's beginnings), could not have produced the intricate arrangement that makes possible the web of life we now see about us on planet Earth.**

THE VIEW FROM SPACE

Western astronauts and Soviet cosmonauts have had an opportunity to see the earth from outer space. All who have done so have been awed by the sight. Here are a few selected quotations from men who have had an unusual opportunity to realize how wonderfully designed is our planet.

"Space is so close: It took only eight minutes to get there and twenty to get back."—
Wubbo Ockels, in Kevin W. Kelley, The Home Planet (1988) [Netherlands].

"There is a clarity, a brilliance to space that simply doesn't exist on earth, even on a cloudless summer's day in the Rockies, and nowhere else can you realize so fully the majesty of our Earth and be so awed at the thought that it's only one of untold thousands of planets.*"—Gus Grissom, Gemini: A Personal Account of Man's Venture into Space (19678) (USA]*.

"The sun truly 'comes up like thunder,' and it sets just as fast. Each sunrise and sunset lasts only a few seconds. But in that time you see at least eight different bands of color come and go, from a brilliant red to the brightest and deepest blue. And you see sixteen sunrises and sixteen sunsets every day you're in space. No sunrise or sunset is ever the same."*—Joseph Allen, "Joe's Odyssey," in Omni, June 1983, p. 63 [USA]*.

"We entered into shadow. Contact with Moscow was gone. Japan floated by beneath us and I could clearly see its cities ablaze with lights. We left Japan behind to face the dark emptiness of the Pacific Ocean. No moon. Only stars, bright and far away. I gripped the handle like a man hanging onto a streetcar. Very slowly, agonizingly, half an hour passed, and with that, dawn on Earth.

"First, a slim greenish-blue line on the farthest horizon turning within a couple of minutes into a rainbow that hugged the Earth and in turn exploded into a golden sun. You're out of your mind, I told myself, hanging onto a ship in space, and to your life, and getting ready to admire a sunrise. "*—Valeri Ryumin, 176 Days in Space: A Russian Cosmonaut's Private Diary — And an Incredible Human Document, p. 15 [USSR]*.

"Firefly meteorites blazed against a dark background, and sometimes the lightning was frighteningly brilliant. Like a boy, I gazed open-mouthed at the fireworks, and suddenly, before my eyes, something magical occurred. A greenish radiance poured from Earth directly up to the station, a radiance resembling gigantic phosphorescent organ pipes, whose ends were glowing crimson, and overlapped by waves of swirling green mist.

" 'Consider yourself very lucky, Vladimir,' I said to myself, 'to have watched the northern lights.' *"—Vladimir Remek, in Kevin Kelley, The Home Planet (1988), [Czechoslovakia]*.

"I shuddered when I saw a crimson flame through the porthole instead of the usual starry sky at the night horizon of the planet. Vast pillars of light were bursting into the sky, melting into it, and flooding over with all the colors of the rainbow. An area of red luminescence merged smoothly into the black of the cosmos. The intense and dynamic changes in the colors and forms of the pillars and garlands made me think of visual music. Finally, we saw that we had entered directly into the aurora borealis.*— "Aleksandr Ivanchenkov, in Kevin Kelley, The Home Planet (1988), [USSR]*.

"The Earth reminded us of a Christmas tree ornament hanging in the blackness of space. As we got farther and farther away it diminished in size. Finally it shrank to the size of a marble, the most beautiful marble you can imagine. That beautiful, warm, living object looked so fragile, so delicate, that if you touched it with a finger it would crumble and fall apart. Seeing this has to change a man, has to make a man appreciate the creation of God and the love of God."*—James B. Irwin, in J.B. Irwin and W. A. Emerson, Jr., To Rule the Night (1982) [USA]*.

"Suddenly from behind the rim of the moon, in long, slow-motion moments of immense majesty, there emerges a sparkling blue and white jewel, a light, delicate sky-blue sphere laced with slowly swirling veils of white, rising gradually like a small pearl in a thick sea of black mystery. — It takes more than a moment to really realize this is Earth; this is *home*!"*—Edgar Mitchell, Noetic Scientific Brochure (1982) [USA]*.

"On the way back [from the moon] we had an EVA [extra-vehicular activity, or spacewalk] I had a chance to look around while I was outside and Earth was off to the right, 180,000 miles away, a little thin sliver of blue and white like a new moon surrounded by this blackness of space. Back over my left shoulder was almost a full moon.

"I didn't feel like I was a participant. It was like sitting in the last row of the balcony, looking down at all of that play going on down there . . I had that insignificant feeling of the immensity of this, God's creation."*—Charles Duke, Jr., in Kevin Kelley, The Home Planet (1988) [USA]*.

"Several days after looking at the Earth a childish thought occurred to me—that we the cosmonauts are being deceived. If we are the first ones in space, then who was it who made the globe correctly? Then this thought was replaced by pride in the human capacity to see with our mind."*—Igor Volk, in Kevin Kelley, The Home Planet (1988) [USSR]*.

"You see layers as you look down. you see clouds towering up. You see their shadows on the sunlit plains, and you see a ship's wake in the Indian Ocean and brush fires in Africa and a lightning storm walking its way across Australia. You see the reds and the pinks of the Australian desert, and it's just like a stereoscopic view of all nature, except you're a hundred ninety miles up. *"—Joseph Allen, "Joe's Odyssey," in Omni, June 1983, p. 63 [USA].*

"Myriad small ponds and streams would reflect the full glare of the sun for one or two seconds, then fade away as a new set of water surfaces came into the reflecting position. The effect was as if the land were covered with sparkling jewels."*—Karl Henize, in Kevin Kelley, The Home Planet (1988) [USA],*

"The Pacific. You don't comprehend it by looking at a globe, but when you're traveling at four miles a second and it still takes you twenty-five minutes to cross it, you know its big."*—Paul Weitz, quoted in Henry F.S. Cooper, A House in Space (1976) [USA].*

"Although the ocean's surface seems at first to be completely homogeneous, after half a month we began to differentiate various seas and even different parts of oceans by their characteristic shades.

"We were astonished to discover that, during an flight, you have to learn anew not only to look, but also to see. At first the finest nuances of color elude you, but gradually your vision sharpens and your color perception becomes richer, and the planet spreads out before you with all its indescribable beauty. "*—Wadimir Lyakhov, quoted in J. E. and A. R. Oberg, Pioneering Space (1986) [USSR].*

"We were able to see the plankton blooms resulting from the upwelling off the coast of Chile. The plankton itself extended along the coastline and had some long tenuous arms reaching out to sea. The arms or lines of plankton were pushed around in a random direction, fairly well-defined yet somewhat weak in color, in contrast with the dark blue ocean. The fishing ought to be good down there."*—Edward Gibson, quoted in Henry F.S. Cooper, A House in Space (1976) [USA]..*

"As we were flying over the Mozambique Channel, which separates the island of Madagascar from the continent of Africa, we could clearly see the transverse sand bars at its bottom. It was just like a brook one waded in childhood. *"—Lev Demin, in Kevin Kelley, The Home Planet (1988) [USSR].*

"The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day we were aware of only one Earth." *—Sultan Bin Salman al-Suad, in Kevin Kelley, The Home Planet (1988) [Saudi Arabia].*

"We had various kinds of tape-recorded concerts and popular music. But by the end of the flight what we listened to most was Russian folk songs. We also had recordings of nature sounds: thunder, rain, the singing of birds. We switched them on most frequently of all, and we never grew tired of them. It was as if they returned us to Earth. "*—Anatoli Berezovoy, in V. Gor'koy and N. Kon'kov, Cosmonaut Berezovoy's Memoirs on 211-Day Spaceflight (1983) [USSR].*

"A strange feeling of complete, almost solemn contentment suddenly overcame me when the descent module landed, rocked, and stilled. The weather was foul, but I smelled Earth, unspeakably sweet and intoxicating. And wind. Now utterly delightful; wind after long days in space. *"—Andriyan Nicolayev, in Kevin Kelley, The Home Planet (1988) [USSR].*

The Creator's Handiwork

the plants

We often take the plants around us for granted, yet without them we would quickly die. They provide man and animals with oxygen and nourishment. Only plants can make food out of the raw materials of water, sunlight, and minerals. Directly or indirectly, the rest of us eat what they produce.

There are so many wonders in plants; wonders to be found in fruit, flowers, leaves, trunk and stems, and roots. As you read, search for just one item that could be made by the random, harmful effects of an occasional mutation:

CROSS POLLINATION — Flowers Supply bees with nectar; bees transfer pollen from one flower to another, thus preserving the life of the plant. Bees with their long slender tongues can reach the nectar, which other insects cannot. The tiny bee just bristles with body hairs. As it takes the nectar, those hairs pick up the pollen from the flower's stamens.

Some bee flowers have stamens with special levers, triggers, or piston devices for dusting pollen on some particular spot on the bee. Going from one flower to the next, the bee deposits that pollen at the next flower. On each bee flight, the tiny insect somehow knows never to gather nectar and pollen from two different species. It always confines itself to just one species. In this way, the pollen is always carried only to another flower of the same species.

Some flowers are pollinated by beetles. Several hold the beetles in a trap while the stigmas receive the pollen and the stamens sprinkle a fresh supply on the bodies of the prisoners. Then they open an exit by which the beetle escapes.

The flowers which sunbirds pollinate, stand erect and provide a landing platform. The petals of the flower are shaped into a tube which exactly fits the length and curvature of the bird's bill.

Certain flowers in the tropics are pollinated by bats which eat fruit. So the flowers give off a special fruit-like odor—but only at night. This attracts the bats to come to them.

Some flowers are pollinated by flies. Since flies like smelly carrion, these flowers attract them with similar odors.

When the beetle, Catonia, lights on a magnolia flower, its weight springs a trigger like trap that releases a sudden shower of petals that sprinkle pollen on the beetle's back. Alighting at the next flower, its back rubs against the stigma and the pollen goes onto it. Neither the insect nor the plant devised these things.

When the bee arrives at the Iris, it follows a distinct marked line—a center line—on the iris flower that directs it down to the nectar well in the center. In the process, the bee moves under the drooping stigma which rolls pollen off its back. This stigma is curved downward like a bent finger. Farther on in, its back picks up a fresh supply of pollen from the anther under which it is forced to stand in order to suck up the nectar. Meanwhile, the stigma "finger" has straightened up—so that as the bee backs out, its fresh pollen supply will not be scraped off and thus self-pollinate the flower.

Certain flowers, such as the honeysuckle and petunia, have only a faint odor during the day. In the evening, when certain insects which should pollinate them are out, they produce a powerful scent.

Each flower has a different story to tell about how it attracts insects, provides a "door step" for them, presents guide-line colors leading into the flower, and works out its various arrangements of anther and stigma.

AJUGA PLANT— When the locusts move across North Africa, eating everything in their path, they never touch the Ajuga plant. This is because there is a hormone in the Ajuga which is identical to an insect hormone in locusts and most other insects. That particular hormone induces molting,—the shedding of the outer coat of skin as the insect grows.

If the locust eats the Ajuga, it will cause him to molt and shed his skin. But, because the Ajuga hormone is five times stronger than that found in locusts, it would pop his skin too fast. So locusts that eat the Ajuga quickly lose the skin around their mouths and they starve to death. Most leave it alone.

FIG AND WASP—When California planters introduced the Turkish fig, they found it bore no fruit. The trees were covered with flower buds which dropped off without ripening. The problem was that they had brought no fig wasps for that particular fig tree. American entomologists went to Smyrna in Turkey and brought back the fig wasp for that particular fig tree. They then named the fine-tasting fruit the Calimyrna.

Most experts believe that every type of fig in the world has its own particular wasp. But others say that some fig species do not need wasps (for example, Black mission and Adriatic figs). At any rate, those that do could not survive without their particular wasp. This wasp spends its life pollinating that one type of fig tree. The tree in turn provides a home for the young of the fig wasp.

Here, briefly, is how the female wasp does her work; the story of the male fig wasp is equally complex.

There are two kinds of figs: (1) the male fig (caprifig) which is very small and not for eating. It grows the pollen which produces the other kind of fig. (2) the female fig (the Calimyrna, Smyrna, or *Turkish* fig), which is so delicious. Because the flower parts of the fig are all inside the fig, there is no possibility that wind could pollinate the flowers. The little wasp must do it, or there will be no figs and when the fig tree dies, it will leave no descendents.

The **fig wasp is** the size of a fruit fly—about 1 /16 inch [.159 cm] long. It crawls into the fig through a hole in the male fig, and there it lays its eggs. The fig wasps hatch from the eggs, and the young feed upon pollen inside the fig, which itself is odd since most flowers have their pollen on the outside of the flower, not inside the fruit. Then, after mating, the tiny wasps leave their birthplace. They are covered with pollen as they emerge from the fig. The little female wasp must work quickly for it only lives 12 hours. Going from fig to fig, it enters through the small hole at the end, pushing its way through a row of staminate flowers, and comes to rest on a bed of pistillate flowers found in the center of the fig. It is searching for the male fig, so it can lay its eggs, but it enters every fig, thus pollinating the female figs in the process. That is an important fact: the little wasp knows that it must enter every fig it finds, for it cannot tell them apart from the outside; yet once inside, it knows it can only lay its eggs inside the male fig.

The female wasp deposits eggs which hatch into larvae and which, in due time become a new generation of wasps.

These mate with each other inside the fig. Leaving it, they are dusted with pollen from the staminate flowers surrounding the entrance. The fig wasps fly away and search for another fig tree of the same type to repeat the process. They spend their brief lives going from one fig tree to another, pollinating each one,—but they never go to a fig tree that is not of the same type. If they did, we would only have one type of fig, but as it is we have several types. **No one knows how they manage to find their particular fig tree, and the tiny hole of the fig on that tree.**

Wind cannot pollinate figs, for the pollen cannot get inside the tiny hole. But without pollination, there would be no fruit, no seeds, no fig trees. From the very beginning, there had to be both fig wasps and the fig tree with its fruit. Otherwise we would have no figs and fig wasps today.

YUCCA AND MOTH —Without a tiny white moth —the pronuba moth,—the large yucca would die. This desert plant appears like a cluster of sharp swords pointing out in all directions. Out of its center arises the stalk of a bright, beautiful flower that looks something like a white lily.

Hiding in the ground is a small moth which never comes out during the day. It only comes out at night—on a certain night.

The flower, in turn, only blooms at certain times of the year—and only at night. When it blooms, immediately the pronuba moths break out of their cocoons beneath the sand.

What brought them out of their hiding places down in the desert sand at exactly that moment? How could a tiny wasp in the ground know that a flower had bloomed? No one knows. Struggling up out of the sand, the tiny female moth flies up into the air and circles around until it catches the scent of the flower, and then goes to it.

Arriving there, the moth, which has eaten nothing for a long time, ignores the nectar but instead goes to the top of the stamens of the first flower and, with its tiny feet, carefully scrapes together a wad of pollen that is three times as big as its head. Holding onto it with jaws and legs (it was born with specially enlarged ones for this purpose),—the insect flies to another yucca plant. Backing down into the heart of a flower, the moth pierces a hole with an egg-laying needle (a lance like ovipositor) and lays eggs among the seed cells in the green pod at the base of the pistil.

Next, the insect climbs to the top of the pistil on that same flower. It has a cavity just the right size to receive the wad of pollen. Carefully the moth stuffs the cavity with the pollen. The top of the pistil looks like there is a funnel-shaped opening within it. Into that opening the moth pushes the pollen. By doing this, seeds will grow at the base of that particular pistil. But it was at that same base that the moth laid its eggs. Some of those seeds will provide food for the baby insects when they are later born. If the moth pushed the pollen into the top of the wrong pistil, its babies would die.

Time passes as the pronuba eggs mature and the yucca seeds ripen. When the moth's larvae (caterpillars) emerge from their eggs, they are surrounded by delicious food. They eat and grow larger. But they never eat all the seeds. Their nutritional needs never require eating all the seeds at the base of that particular pistil.

Then, about two months after hatching, each one cuts a hole through the pod, spins a silk thread, and lets itself down to the ground. Arriving there, it digs a hole, crawls in,—and waits about ten months till the next flowering.

But what happened to that mother moth? After flying to one flower, taking pollen to another, laying eggs and pollinating the pistil,—the little moth dies. After leaving the ground it never once eats, but only does its work of providing for the future of its babies and the yucca plant.

There is still more: Each species of Yucca plant has its own special moth! The flower is so constructed that it can only be pollinated by one particular type of moth.

During certain years, the flowers do not appear on the plants. If the moths came out at that time, they would die—and the Yuccas would die later on. But, instead, the moths only come out when the flowers appear—even if the moths have to wait till the second or third year to come out of the ground!

> "Could blind chance have achieved such perfection [referring to the Yucca plant and the pronubia moth]?."— **Ernsi Mayr, "Accident or Design: the Paradox of Evolution, " in The Evolution of Living Things (1962), p. 3.*

> "It is a considerable strain on one's credulity to assume that the famous yucca moth case could result from random mutations."— *'Ernst Mayr, Systematics and the Origin of Species (1942), P. 296.*

THORNY ACACIA— The thorny acacia tree of central Africa can tell when animals are feeding too heavily on it. When that happens, it begins producing a chemical called *tannin* k. The tannin combines with other chemicals in the leaves, producing a bad taste. Scientists found that the tannin level is normally quite low, but within 15 minutes after leaf damage, tannin levels in the leaves nearly doubled. In addition, they discovered that when this happens, the tree gives off an odor, warning other nearby acacia trees to be on guard. In response, they immediately begin producing more tannin in their leaves also!

LADYSLIPPER— The Lady's Slipper Orchid has two stamens. The lip is shaped like a smooth slipper with in-rolled edges, so the insect cannot get out by the way it entered. So it must move toward the back, or point of attachment to the stem, where there are two small exits. Heading that way, the creature must first pass beneath a stigma which takes pollen from the insect. Then it must brush past one or the other of the two stamens which sprinkle more on it. Leaving the flower, the insect never goes to another flower on the same plant, because only one flower will be open at any given time. In this way self-pollination does not occur.

RICE —Rice is a land plant and must have oxygen in its root to survive. Yet it must be submerged in water—often 15 feet [46 dm] deep—in order to grow and seed. The rice must grow and keep above the water! In flood-prone areas, rice grows as much as a foot a day in order to keep its topmost leaves above the surface of the flooded rice paddy. The rice plant draws in water through its exposed leaves, as well as through a sheath of air surrounding its submerged stalk.

Rice gives off one carbon dioxide molecule for every oxygen molecule it takes in. But, because the carbon dioxide dissolves more quickly in water than does oxygen, a vacuum is created within the plant which pulls in yet more air! You could not draw air through a hose to a depth of 15 feet (46 dm], but the rice plant can draw air down its stalk that far, because of that partial vacuum.

PLANT ODDITIES— The yellow evening primrose opens only at dusk,—and so swiftly that it can be seen and heard. The buds sound like popping soap bubbles as they burst.

Seeds of the African baobab tree sprout more easily if they are first eaten by a baboon and passed through his digestive tract. Its digestive juices erode the tough seed coat, permitting water to penetrate more readily.

In a single growing season, 10 small water hyacinths can increase to more than 600,000 plants, and form a mat of thick vegetation an acre in size and weighing 180 tons [163 mt]!

The stems of the blue-eyed grass, a type of wild iris, are not strong enough to support more than one blossom at a time. So one flower blooms each morning, and then dies that night so that another can bloom the next day.

Bamboo can grow three feet [9 dm] in 24 hours.

The ocean contains eighty-five percent of all the plant life in the world.

A typical plant or tree receives about 10 percent of its nutrition from the ground; the rest comes from the atmosphere and sunlight.

The giant water lily, victoria regia, has leaves so large that a small child could sit on it without its sinking. The leaves are eight feet across.

Lichens have been found on bare rocks in Antarctica as close **as 264 miles [424.85** km] to the South Pole. No other plant or animal life lives that near to the South Pole.

The dwarf mistletoe in America builds up hydraulic pressure within it—equal to that found in a truck tire! It does this in order to use that water pressure to catapult its seeds out to a distance of almost 50 feet [152 dm] at a speed of close to 60 miles (96.5 km] per hour. The dwarf mistletoe is a water cannon!

Tiny discs of chlorophyll move about within plant cells and adjust for different light and heat conditions. When the sunlight is too strong, the little discs turn edgewise! On an overcast day, they lie as parallel to the sky as they can in order to take in the most light.

Some plants die as soon as they have flowered, while some trees live up to 4,000 years. There is a bamboo plant in the mountains of Jamaica which takes 32 years to mature, and then flowers once and dies.

Puffball and mushroom spores have been found in large amounts 35,000 feet [10,668 m] in the air.

The Mediterranean squirting cucumber uses water pressure to shoot **its seeds 40 feet** (122 dm] away.

GALL—When the gallfly lays its eggs in the leaf or stem of a plant, a large ball-like growth occurs. This gall, as the growth is called, serves as a home for—and gives food to—the developing insect. Galls are of great variety, both in shape and color. Several different types of insects produce galls in plants as "nests" for their young.

Until recent decades it was thought that the gall was produced by the plant as a means of protecting itself from injury. But it is now known that the gall was produced because the insect injected *a plant growth hormone* into the leaf or stem! This is incredible; an *insect* manufacturing *plant* hormones in its body! Once injected, the hormone causes the growth to occur. How could an insect invent plant hormones?

THE COLOR OF PLANTS—Light from the sun contains all the colors of the rainbow. When it strikes the plant, the plant absorbs the red and purple rays and uses them in photosynthesis. *"Photosynthesis"* is that marvelous action by which a chunk of sunlight and a chunk of water are transformed into carbohydrates (simple and complex sugars).

Because the plant absorbed the red and purple rays, the yellow and green ones are reflected back outward. This gives the landscape its great beauty.

It could have been the other way around, and the plant could have absorbed the yellow and green, and reflected the red and purple! Instead of the restful colors, we could have been surrounded with violent ones. If red, yellow, and green had been absorbed, we would see deep blue and violet in the plants. This would have been too depressing. If green, blue, and violet had been absorbed, we would only see brilliant reds and oranges all about us. This would have been too exciting and overstimulating to the nerves.

Instead we have soothing green as the predominate color of vegetation.

MADRONE AND MANZANITA —In California, the madrones and manzanitas have thick, heavy leaves that can endure the cold winters. In wintertime they are broad-leaved evergreens. But in mid-summer, when their leaves are in the greatest danger of drought, they shed their leaves. When the stem leaf breaks off and the leaf falls, at the base of the petiole is to be found a corky layer. This seals off the plant, so that, even though the leaf is gone, no fluids will evaporate out through that opening. This serves as a plug to stop the passage of water from the stem. Otherwise these large bushes would dry out and die.

AIR PLANTS— Some plants grow on trees and not in the soil. But they are not parasites, for their nourishment is not obtained from the tree, but from the air! Air plants, such as tropical orchids, have a mass of tissue around the roots which absorbs water from the air.

EELGRASS— Eelgrass grows submerged in the shallow water of bays and estuaries near the seacoast. It is like regular grass, but much longer. Eelgrass is the only flowering plant that blooms underwater! Its pollen is shed into the water, and is carried by currents to other nearby plants.

POLLINATION—Night-blooming flowers are white or yellow, so they will be visible in the darkness. To make sure they will be found by pollinating insects, they are also provided with fragrant odors. Many of them are closed and odorless during the daytime.

Wind-pollinated flowers do not have brightly colored corollas. They do not need them, since they do not need to attract insects to pollinate them.

The brilliant flowers are generally pollinated by insects. These flowers are also equipped with odors emitted into the air during the day in order to attract insect visitors.

Sometimes the petals have guidelines (stripes) to help insects land and enter the flower at just the right place. In order to get into the nectar pots, the insect first passes by the anthers and stigma, which are always in front of the nectar pots.

AUSTRALIAN PLANT ROOTS —In the Australian back country (the "bush") the natives search for a certain small plant which, although it only has about 4 inches [10.16 cm] of leaves above the soil, has roots which are larger than footballs and full of water. These roots are reservoirs to be drawn upon during the almost continuous dry weather in those regions. Finding these, the aborigines split them open and drink the water.

There is another desert plant in the Australian "out-back" which has roots which are shaped like long strings of sausages, 10 to 18 feet [30-55 dm] in length. Finding them, the natives will hang them on trees so that the water will run out.

MALLOW—As do many other plants, the leaves of the mallow weed follow the movement of the sun across the sky. Then, as soon as the sun sets, all the mallow plants turn and face east to where it will rise in the morning.

DUVANA—The *Duvana dependens* grows a special gall, an enlargement, on its stem which is of no use to the plant itself. But the moth *Cecidosis eremita* needs that gall in order to survive. It comes to the Duvana and lays its eggs in that gall.

KELP—The California Kelp is to be found a halfmile off the coast of California. It grows in giant kelp forests which are 25 feet [76 dm] tall. Millions of baby fish and crabs grow up in the tangled leaves of these forests. Thousands of other fish and sea creatures live there also. It provides food, shelter, and nesting places for millions.

In addition, bald eagles swoop down and obtain their food from creatures at the top of this forest, and harbor seals get their food from it also. But most of the creatures in the kelp forest are not caught and they grow up and replenish the marine ecological system.

All the creatures eating the kelp leaves are no problem; it simply grows more leaves. Yet the spiny sea urchin is different; it is a menace, for it cuts through the kelp stem. But the sea otter is in the kelp forest also, and it thoroughly enjoys eating sea urchins.

Thus the balance continues. Only man can upset it by over harvesting the kelp or killing the sea otters.

COAST REDWOOD—This tree on the Northern California coast sprouts from one of the smallest of seeds, yet grows taller than a 35-story building or the Statue of Liberty. It easily reaches 350 feet [107 m] in height, and the tallest one is 375 feet [114 m]. Twenty feet across and 65 feet around, its roots only go down 3 or 4 feet [91-122 cm] , but they spread out 80 feet [244 dm] on each side. The first branch is over 150 feet [457 dm] up, and its bark is over a foot thick. It more than a thousand years old (while the giant Sequoia in the Sierra Nevada Mountains is 4,000 years old).

These 350-foot [114 m] high giants along the Northern California coast rain down their tiny seeds, but most of them are eaten. Only 10 percent of the redwood in the forests came from seeds; 90 percent came from sprouts.

At the base of each tree, and surrounding it in a circular collar, are wartlike growths from its roots. These are called "redwood burls." If a tree gets into serious trouble from fire, bugs, etc. , it will send a hormone message to the burls and immediately they will sprout! As many as 100 will sprout up around the parent tree. In 20 years, each sprout will be 50 feet [152 dm] tall and 8 feet [24 dm] in diameter.

The coast redwood grows in only one place in the world: the northern California coast. This is partly due to the moderate climate, but another reason is the fog that comes in nearly every day during the hot and dry **part** of the year and drips down, moistening trees, ground, and roots. Without that fog the coast redwood could not live.

SORREL—On the ground beneath the tall coast redwood is the tiny sorrel. This is a three-leaved plant which is designed to grow in the continuous shadow of the giant trees, above which the sky is frequently overcast with fog. The small leaves of the sorrel lie flat catching every bit of skylight they can.

But occasionally the sunlight shines through a patch in the tree tops—and hits those leaves. Immediately, the little plant must do something or it will die. This is because it is designed for shadowed living, not sunlit living! Within a short time, the sunlight will wither the plant and it will perish.

Quickly, the little plant folds its three leaves upright—like shutting an umbrella. This shuts out the sunlight and heat. Only exposed now is the bottom side, which on most plants also has chlorophyll, but on the sorrel has a purple screen to protect the plant.

As an added protection, sorrel primarily grows by sending out runners. In this way, many plants are connected underground. They all cooperate with one another in an emergency and if one gets into a patch of sunlight, it sends out a message to the others and they send more moisture to it.

ANCHOMANES— Plants of the Anchomanes genus only have one leaf, produce heat like warmblooded animals, and make insect food. Anchomanes only grow in Africa. Above the root, there is only one leaf,—but it is about 20 feet [61 dm] tall and 6 feet [183 cm] wide! When it blooms, it generates heat by burning carbohydrates. The flower only opens at night, has no scent, and is a dark maroon color. Yet somehow it is located by a certain pollinating beetle. Arriving at the flower, the beetles feed on small granular lumps on the underside of the flower, made especially for them. Soon large numbers of beetles have arrived, and they mate and lay their eggs on the flower, where the young develop without damaging the plant.

DUTCHMAN'S PIPE—The Dutchman's Pipe has a tubular leaf that wraps around its flower. This leaf is coated with wax. Certain insects are attracted by the strong odor of the flower and land on the leaf. As soon as an insect does, it slides down its slippery sides into a chamber at the bottom. There, the ripe stigmas receive the pollen that the insect brought with it, and pollination takes place.

Three days then pass by with the insect trapped by hairs near the bottom and the wax farther up the sides. After that, the flower's own pollen ripens—and dusts the insect. As soon as that happens, the imprisoning hairs wilt and the waxed slide of the funnel—like flower bends over until it is nearly level. The insect now walks out with his supply of pollen—and flies off to do it again. One might think that the insect could starve living like that, but all the while it is inside the flower it is feeding on a feast of stored nectar.

CORNSILK TUBES—Cornsllk is that golden hair which protrudes out of an ear of corn. When a single bit of corn pollen lands on the pink silk at the top of the ear, it stays there because the silk thread is sticky. That extremely tiny pollen grain then begins making a tube that eats its way into the thread. If the grain lands near the outer end of the silk, this tube may lengthen by ten inches as it travels down the inside of the thread of "silk." It is striving to reach an egg cell far below at the base of the thread. Arriving there, it will slowly transform it into a kernel of corn.

LONG-LIVED POLLEN—Each grain of plant pollen is enclosed in a case that is almost indestructible. It does not decay as do the other parts of the plant. Pollen grains thrown out by plants have survived for long periods of time. Even after they finally die, the outer hull continues to retain its same shape. This is why pollen can be found wherever man searches for fossils. Pollen grains have been found in the lowest strata—the Cambrian —of Grand

Canyon, showing that plants were living and thriving way back in the beginning. And would we expect otherwise? Without plants in the beginning, none of us would be alive today!

VARIEGATED POLLEN—There are over half a million flowering plants in the world, plus large numbers of trees, bushes and other plants. Yet every species of plant in the world that produces pollen—makes a uniquely shaped pollen grain! No two plant types form the shape of their pollen in exactly the same way.

Under a microscope, a grain of pollen looks like an exquisite jewel. The grains may look like disks, footballs, canoes, dumbbells, crystals, etc., but no two will be exactly alike unless they come from the same species.

OPHRYS ORCHIDS—Certain varieties of the Ophrys orchid have on their petals what appears to be a three-dimensional picture of a female wasp, complete with eyes, antennae and wings. The petal even gives off the odor of a female in mating condition! When the male arrives to mate, he only pollinates the flower.

MILKWEED—The milkweed produces glycosides which provide no nourishment to the plant, but instead protect the monarch butterfly which feeds upon the plant. Without that protection, the Monarch could not survive, for it only eats from the milkweed during its lifetime.

Certain plants, including the milkweed, produce a sticky fluid, which protect them against aphids. When aphids come to dine, they suck out some of this fluid—and it causes a sticky, coagulated mess in their tubes and stomach. The aphids either depart immediately or die.

RABBIT AND AMANITA— The Amanita is one of the deadliest things in the world. Mushroom experts declare that the Amanita is the only mushroom in the world which will kill a person. Unfortunately, it comes in many different colors. (In America it is most commonly seen in the "death angel," a pure white variety; if you see any growing on your lawn or in the woods,—warn your children to leave them alone!) If no antidote is given within 30 minutes, death will follow.

But the rabbit can eat the Amanita without experiencing any ill effects. The poison in this mushroom *(phallin) causes* it no harm. No one knows why the rabbit is unaffected by one of most powerful poisons known to mankind.

MOVING THE POLLEN AROUND— In most instances, a plant places the fresh new supply of pollen on exactly the place on the insect where, but a moment before, it removed the pollen from the previous plant. Yet there are exceptions. Sometimes the pollen is collected by the plant in a different location on the insect's body than it was deposited by the previous flower. So what does the insect do? In such cases a certain type of insect will pollinate that particular species of flower—and before entering the second flower, it will obligingly shift its load to the proper flower pick-up point!

SCORPIURUS—The pod of the Scorpiurus, resembles a nice, tasty centipede. Sighting it, birds grab it and fly off with it. Gripping it in their teeth, the pod breaks open and scatters seeds as they go. Landing, they find that it is not edible and spit out the now-empty pod.

BUCKET ORCHID—This orchid has a slightly fermented nectar which makes the bee wobbly on its feet, causing it to slip into a bucket of liquid. The only exit is along a route that causes it to wriggle under a rod that dusts the bee with pollen.

ANT AND ACACIA TREE—Acacia trees have beautiful flowers in the spring. If you were to look closely you would find the Pseudomyrma ant in them. It lives in the Acacia tree and feeds on special fruit on the leaves. This fruit does not contain any seeds, and has nothing to do with producing more Acacia trees. It is only there to provide food for the Pseudomyrma ant.

But, because that fruit is there, the little ant is there. In turn, the ant travels about over the tree and chases off—or eats—other insects which would eat the Acacia leaves. They even destroy climbing vines which would kill the tree, as well as small nearby trees which could grow and shade their special tree. Each tree has its own resident colony of ants which feed on and protect it. This acacia is the only plant in the world that produces the animal starch, glycogen.

One type of acacia has swollen thorns in which the ants hollow out nests. When an ant queen discovers an unoccupied tree, she burrows into a green thorn and lays her eggs. The larvae are fed with carbohydrates from the leaf tips. Eventually the colony of ants on one tree may number 30,000, when all the thorns are occupied. Then the colony splits into two, and part of it swarms to another tree.

CAMBIUM LAYER—A marvelous outer circle of cells is on every tree. It is called the cambium. This is the growing edge of the tree. On the inside, it makes *xylem* tubes—thus increasing the amount of wood in the tree. On the outside of the cambium layer, it makes *phloem* tubes—which adds on more outer stem or bark. No scientist can explain where the cambium came from. But without it, there would be no plants

LEAVES—What are leaves? Each one is a power station. The leaf includes chloroplasts, guard cells, special chemicals, and much, much more. Filled with tubing through which fluids flow, it has five layers of water-proof coatings, and the top coat is akin to varnish.

The location of each leaf dovetails into the others, so that each leaf can obtain as much sunlight as possible. In order to do that, each leaf must be moved into the best position relative to the others. Where are the brains to do this? In the leaf ? In the branch?

Each leaf is a sunlight machine. It takes in sunlight—and, together with minerals and water from the roots, the plant turns out all the basic food used by every plant and animal in the entire world! Without the leaf, we would all quickly perish.

Man makes solar panels to catch the sunlight. These are spread out so each plate will receive sunlight. Imagine how much space the leaves of a tree would need, if they were spread out flat all over the ground? God's way is much more efficient. All the life on our planet is fuelled by solar power!

CHLOROPLASTS—Scientists estimate that over 400 million-million horsepower of solar energy reaches the earth every day. Photosynthesis is the process by which sunlight is transformed into carbohydrates. This takes place in the chloroplasts. Each one is lens-shaped, something like an almost flat cone with the rounded part on the upper side. Sunlight enters from above.

Inside the chloroplast are tiny cylinders that look something like the small circular batteries used in hearing aids and small electrical devices. These are called lamellae, and is actually a stack of several disk-shaped *thylakoids. Each* thylakoid is the shape of a coin. Several of these are stacked on top of each other, and this makes a single lamelium. A small narrow band connects each stack to another stack. They look like they are all wired like a bunch of batteries.

Sunlight is processed by *chlorophyll in* those stacks, and then stored there as chemical energy in the form of sugar molecules. Chlorophyll, itself, is very complicated and never exists outside of the plant, just as DNA and ten thousands of other chemical structures never exist outside plants and/or animals. If they are not found outside, how did they ever get inside?

BLUE-GREEN ALGAE— This is probably the simplest of the plants. Yet its structure, functions, and chemistry is awesome,—and all of it had to be present and functioning from the very beginning.

Blue-green algae produce more oxygen than almost anything else in the world. They are found in oceans, waterways, and lakes. They photosynthesize and respire almost like higher plants. Some of them can fix nitrogen from the air, so that their food requirements are minimal. These algae serve, under the name *plankton, as* the basic food for animal life in fresh and salt water throughout the entire world.

MITOCHONDRION AND ATP—*Mitochondria* within the plant cell are little capsule-shaped containers. They take in sugars, fats and even proteins, which are made elsewhere in the plant, and change these substances into ATP.

Each molecule of ATP is a miniature storage battery and contains electrical power. ATP molecules are stored in the plant and used whenever needed for a variety of purposes—whenever energy is needed. ATP is an amazing substance.

PLANT BLOOD— A drop of blood contains about a hundred million red cells. Each of these small doughnut-shaped discs is covered with one of the largest and most complex molecules in nature: *hemoglobin. Hemoglobin* has been called a "molecular lung," for it is an oxygen processor just as is the lung. Remove the iron from the center of hemoglobin and place magnesium in its place,—and you have chlorophyll, which is so important to the life of the plant.

Are people related to peas? A nitrogen-fixing bacterium, *Rhizobium,* in the root nodules of peas, enables the legumes to make hemoglobin genes. Rhizobium has hemoglobin genes also. What is hemoglobin doing in peas and bacteria!

But that need not surprise you. The water flea, *Daphnia, has* hemoglobin also! Then consider the ice-fish, which lives in antarctic waters averaging 2°C [35.6°F). It has no hemoglobin—but instead has a form of antifreeze which circulates through its veins!

RYE PLANTS—A single plant of winter rye has roots one hundred times greater than all the parts growing above ground. Its regular brown roots grow three miles of new roots per day. In addition, billions of microscopic white root hairs branch out from them, sliding through spaces between grains of soil. Adding these to the already large total, scientists decided that rye adds 53 miles [85 km) of additional roots per day.

SEEDS UNLIMITED—Plants pour out seeds. A single plant of red clover only a few inches tall turns out 500 copies of itself. The weedy crabgrass makes 90,000 seeds on each plant. Pigweed produces a million seeds per plant.

One orchid was estimated to grow 3,770,000 seeds on a single plant. Orchids grow high up in jungle trees, and their seed must find a limb which is wet and the bark slightly decayed. So millions of seeds, as fine as the finest powder float off into the air.

Dandelion seeds come equipped with parachutes. Maple seeds have wings and flutter off like butterflies. Some water plants produce seeds with air-filled floats. When released, they just sail away, as the wind blows them along.

Other plants have pods that snap open and shoot their seeds out as from guns. Witch hazel pods gradually press tighter and tighter against their slippery seeds—until out they pop and travel some distance before landing. As the squirting cucumber grows, its pod thickens inwardly. The fluid center comes under ever-increased pressure till—bang! and the pressure becomes so great that the seeds shoot out like a cork from a bottle.

A small number of dry bean seeds, accidentally left under a concrete sidewalk, will, when they get wet, swell with such power that they will break the concrete.

> Some desert seeds just lie on the ground and refuse to sprout—till a desert rain of a half inch or more occurs. Only a heavy rain will provide them with enough moisture to go through their brief cycle of life. Then they go to work fast!

Scientists tried to figure out a problem here: Why is it these seeds will not sprout if they are only wet from below? Why must they also be soaked from above! The reason is this: The desert soil has too many salts in it—salts that will prevent the seeds from sprouting. So a rain is needed to wash down the salts so that the seeds can sprout and grow.

KNOBCONE PINE SEEDS— The knobcone pine has fire insurance. Unlike most pine trees, which open their cones and let the seeds slide out when ripe, the knobcone holds its ripe seeds sealed inside the cone. This cone is almost as hard as rock and will remain on the tree for as long as 50 years. These cones hug the trunk of the tree, so they are eventually swallowed by bark growing around them. But inside those cones, the seeds are still alive. Even if the tree dies, the waiting seeds continue to be alive. Still more time passes, and then a forest fire occurs.

Since only a fire can release those seeds, they now spring into action! As the fire passes over the tree, the cones explode like popcorn. This explosion flings seeds everywhere, and they take root in the ashes after they have been cooled and wet by rain. In this way, these young trees grow and protect the forest floor from erosion. Later, other trees reforest the area along with them.

TRAVELING SEEDS— Some seeds are inside fruit, and when eaten the seeds reach the ground and sprout. Acorns are carried off by squirrels who know enough to bury them, and then forget where many of them are so they can sprout.

The burdock seed has big hooks that hitchhike on passing animals and people. Seeds of burr, marigold, ticktrefoil, or Spanish needles, travel in the same way.

Other seeds rely not on hooks but sticky surfaces. Still others are coated with oil, so ants carry them off to their underground homes where some of them will sprout.

Then there are the seeds which are part of such contraptions as slingshots, catapults, spring mechanisms, exploding parts, and cannons.

What about the overcoat seed on the wild oat? It has an overcoat called an *awn* which looks like a partly-bent leg of a grasshopper. On warm, dry days, the leg suddenly straightens with such force that the seed is lifted over rough ground and partially burrows itself into the ground.

SMALLEST TO THE LARGEST— One of the very smallest of the seeds, eventually grows into the biggest living thing on earth (and probably the heaviest too). The giant sequoia of the Sierra Nevada range grows over 300 feet [91 m] high, with a diameter which may be 36 feet [11 m]. One tree may contain enough wood to build 50 six-room houses. The bark is two feet [61 cm] thick, and its roots cover 3 or 4 acres [1.2-1.6 ha].

Yet its seeds are little more than a pinhead surrounded by tiny wings.

ROOTS—Green leaves feed the world, but they cannot function without the roots. Each tiny rootlet has a small cap protecting its end as it grows outward. Each tiny cap is lubricated with oil. Continually these rootlets, covered by caps, are pushing through the soil.

Behind them, root hairs absorb water and minerals, which travel up extremely small channels in the sapwood. This fluid moves upward at 200 feet [610 dm] per hour! Up and up it goes, till it reaches the factories in the leaves. Here sugars and amino acids are made, which are then sent throughout the tree to nourish it.

Large amounts of excess water evaporates from the leaves into the atmosphere, which rise upward and form clouds to later fall as rain and help plants, animals, and man.

ULTRA-VIOLET PLANTS—Certain flowers, such as *Jasminium primulinum,* have been found to have hidden patterns, generally on the rear of the flowers, which can be seen only under ultraviolet light. After careful investigation, scientists have decided that certain insects find these flowers by ultra-violet light!

It is known that some insects (how many has not yet been determined) can see ultra-violet light, at least the near ultra-violet spectrum. For example, bees can see UV light. No one has so far been able to figure out how they do it.

TREE PUMP—On a warm summer day, a large tree may pump over a thousand gallons [3785 I] of water from the ground, up through its trunk and branches, and out into its leaves. That is four tons [3.6 mt] of water in one day! Drop by drop, the water is drawn out of the soil by the roots. But it is what is happening in the top of the tree—30 to 100 feet [91-305 dm] up in the air—that causes the water to be taken on up. As water evaporates from the leaves, it produces a negative pressure inside the tree's tubing If you were to cut one of those vessels, a hissing sound—of air rushing in—could be heard. Negative pressures as low as negative 20 atmospheres have been found high in trees. This is what draws the water up the tree.

REPELLING AN INSECT THROUGH ITS STOMACH—Certain plants, including the tomato and potato, have special ways of defending themselves against insects. If a leaf is damaged as an insect begins to eat it, the plant produces a considerable concentration of a substance which causes problems in the insect's stomach so it cannot digest its food. The substance causes the insect's stomach digestive juices—proteinases—to stop flowing! Henceforth, the insect leaves that plant alone.

TITYRA AND CASEARIA —In the forests Of Costa Rica, there is a bird and a tree that work together for mutual benefit. Most birds eat fruit wherever they might find it, dropping the seeds at the base of the tree where most of them die. But the tityra bird consistently depends on the Casearia corymbosa tree for food. In turn, that tree depends on the tityira to scatter its seeds so more Casearia trees will grow.

Two species of tityra birds pluck Casearia fruit—but immediately fly off with the fruit some distance from the parent tree, dropping the seed where it has a much better chance of successful germination and growth.

H.F. Howe, the plant researcher who discovered this relationship, commented that it is clear that without either the bird or the tree, the other would perish.

FIRE SEED—Many trees depend on forest fires to propagate them. They lay there for years until a fire passes through, and then, afterward, they sprout. The lodgepole pine, on the West Coast, has special fire insurance. It produces two types of cones. The first cone opens and releases its seeds at the regular time in the spring. But the second remains unopened, falls to the ground and lies dormant for years. When a forest fire occurs, it shocks those sealed cones into opening. The seeds fall out and a new forest begins growing.

BULL'S HORN ACACIA AND THE ANTS—The myrmecophytes are plants in South America which are inhabited by ants. A species of ferocious stinging ants come to these trees and make their home there. They pierce the thorns to use as nests, and eat small green bumps on the twigs and little brown nubbins on the leaf tips. Thus these ants get both food and shelter from these trees.

In return, they protect that tree from encroaching insects, goats, and other foraging creatures of various sizes. In addition, the ants make regular forays in all directions from their tree—and destroy strangler vines which would kill it, and nip off every green shoot that might threaten to encroach upon the space reserved for their tree to grow and thrive.

To see what would happen to the tree if it lost its ants, scientists carefully killed all the ants on several of these trees, and then made sure that no more ants arrived. Within 2 to 15 months the trees died,—either eaten by foraging animals and insects or suffocated by the vegetation of the surrounding jungle.

MANGROVE'S SALT-FREE DIET—The mangrove tree is one of the few trees that grows in salt water. Its roots suck up the seawater, yet the salt in that water would kill the tree within hours if taken up through the roots and sent up the trunk into the leaves. To solve this problem, the roots carefully filter *out the salt by passing it through special* membranes that remove it.

One species of mangrove does it differently: Partly-filtered sea water is sent up to the leaves, where it passes through small glands on the underside of leaves, where excess salt is taken out and dropped through tiny holes in the bottom of the leaf.

CAP-THROWING FUNGUS—The cap-throwing fungus has a built-in clock mechanism that is keyed to the movements of the sun. Throughout the day it turns with the sun. Then, the next morning at about 9 a.m., it knows that the best time has come to throw out its spores. In response to its light-sensing system, the cap-throwing fungus explodes its top—and hurls out its spores. Upon landing, they are picked up by passing animals and carried elsewhere. A glue coating on the spores aids in this process.

PLANT BLADDERWORT—The common bladderwort (Utricularia vulgarls) lives in ponds. It is shaped like a funnel and spends its time snaring small aquatic insects and crustacea. Its mouth has a hinged trapdoor with a very sensitive trigger. To set the trap, the sac of the funnel is collapsed by pushing all the water out of it.

Along the outer edge of the funnel top are trigger hairs and also a hinged trapdoor. When a swimming insect or plankton touches the hair trigger, the bladder—the inside of the funnel or body of the bladderwort—expands in 1/50th of a second! This produces a strong vacuum which sucks the insect into the funnel. The vacuum pressure thrusts the entire bladderwort forward a distance.

THE FIBONACCI SERIES—Plants and many other things in nature are keyed to various involved mathematical formulas, one of which is the *Fibonacci series*. Leonardo of Pisa, nicknamed Fibonacci (c. 1170-1230 A. D.) discovered this particular formula.

It begins with: 0,1,1,2,3,5,8,13,21,... and runs onward, with each number the sum of the previous two numbers (8 + 13 = 21, 13 + 21 = 34, etc.). This series is to be found in the reproduction of male bees, the number of spiral floret formations visible in many sunflowers, spiralled scales on pine cones and pineapples, the arrangement of leaves on twigs, as well as many other structures. If you were to look downward from above on a tree trunk, you would find that the branches emerge in accordance with the Fibonacci pattern. One will issue from the trunk at a certain point, the next one above it will emerge on a different side of the tree at a point in relation to the series. Gaze into a sunflower head and you will clearly see the Fibonacci series in the manner in which the seeds are arranged; there you see lines spiralling outward. Look sideways at a closed pine cone and you will see the series spiralling around the cone.

MONARCH AND MILKWEED—The milkweed plant produces a latex that is sticky and poisonous. Most birds, insects, and animals avoid it. But the monarch butterfly feeds exclusively on it. Females lay their eggs on the milkweed, and their larvae feed on the leaves. As they do so, they pack away the deadly, active ingredient into special sealed-off body cells. While the poison does the caterpillar no harm, it makes the insect distasteful to predators. If an inexperienced blue jay eats a monarch, it immediately vomits it up, and will never again go near that butterfly.

MONARCH AND VICEROY—The viceroy butterfly looks strikingly like the monarch, but it lacks two special qualities which the monarch has: (1) The monarch has the milkweed latex in its body to protect it against enemies. But the viceroy looks so much like the monarch that predators leave it alone also, thinking it is a monarch. (2) The monarch migrates in the fall to the far south, wintering over in southern California and Mexico. The viceroy dies in the fall.

MAINTAINING BODY HEAT—It is Well known that one of the special qualities of mammals is that they maintain an even body temperature. But certain plants do the same. The *Philodendron sel*loum at certain times maintains a core temperature of 38 to 46°C (100.4-114.8°F], despite air temperatures all the way from 4 to 39°C [39.2102.2°F]. Small male flowers are responsible for equalizing plant temperature. It is thought that the heat helps the plant diffuse scent and attract insects. Perhaps there are other reasons.

There is evidence that some insects have organs which can detect infrared (heat) radiation. At any rate, plant temperature may be one of the factors attracting them to its flowers.

TREE MECHANICS— Auxins are plant hormones which determine growth,—where it will occur on the plant and to what extent. Wherever the auxins flow to, that is where the growth will occur.

In the spring, growth begins in the twigs and progresses down the stem or trunk. Differences in auxin concentrations cause trees to grow toward the light, and help the end of a tree that has been bent over to grow upward.

One scientist, T.A. McMahon, worked out the formula for the general size and height of trees. The mathematical formula goes something like this: "The diameter of trees will vary with height raised to the 3/2 power; that is the length times the square root of the length." This is a lot of complicated mathematics for a tree to keep track of, yet somehow it does it. Here is a little more of this formula: "The mean height trees obtain is only about 25 percent of that which they could obtain and still not buckle. In other words, in regard to buckling, trees are designed with a safety factor of about four."

Another scientist analyzed the knees of cypress trees, and decided that they provide exactly the type of mechanical support an engineer would provide for a tree growing in a swamp.

PREPARING FOR WINTER—Plants know that winter is coming because the weather keeps getting colder. In addition, many, if not most, also measure the length of the day. Many flower plants measure the length of the dark period in every 24 hour day. By this they can know that winter is nearing. Many seeds depend on winter to crack their seed coats enough to soak up water for sprouting in the spring. Many tree buds will not open up until after a certain amount of cold weather. Apple buds need 1,000 to 1,400 hours of near-freezing temperature before they will open in the spring.

DIATOMS—The humble diatom is probability one of the simplest plants in existence. Simple?

It is extremely tiny and mostly made of fragile glass with many little openings, yet it is almost indestructible. It is fireproof, yet makes dynamite. It has explosive properties, yet is used in mines to reduce explosions. It tastes like fish oil, yet is used in toothpaste. It has no apparent means of locomotion, yet it travels around by straining its own cytoplasm through one window and out the other. It looks something like an exquisitely carved pillbox, yet this pillbox duplicates itself by growing a new lid on the box, and then the lid grows a new box.

There are over 5,000 different types of diatoms. All are tiny glass houses; all are intricately marked with design work, yet no two varieties look exactly alike. It is something like an algae, yet decidedly different. Each diatom can comfortably live in a thimble-full of water with 14 million other diatoms.

It moves in the water with the agility of an animal, yet it is a plant which manufactures chlorophyll and produces oxygen and food. But it does not produce carbohydrates, as do other plants. Instead, it produces the oil that give fish a "fishy" smell. Yet its skeleton is used to refine sugar!

Although one of the smallest of the one-celled organisms, the diatom recycles 90 percent of the oxygen we breath, and also provides most of the food for fish and whales. This "simpler form of life" is so complex in construction that it is used to test the resolving power of microscope lenses.

ROSE OF SHARON—This little plant grows in the dry deserts of Palestine and is not actually a rose but a member of the mustard family.

Its scientific name, Anastatica, means "resurrection plant," because when the dried up skeleton of the plant—nothing more than a dried-up ball of twigs—is immersed in water, it opens up and extends its branches like a miniature tree.

It begins to bloom in March and April, and by May its seeds are ripe, but they do not open. They remain dormant, tightly enclosed within little pods or balls. By that time the leaves have fallen off and the dry, hard, twigs of the plant have shrunken together and resemble a closed fist.

But that apparently dead plant is all the while continually measuring rainfall. When some comes, little by little it releases a few of its seeds. Here is how this complicated action takes place,—and all done by a plant that appears to be dead:

The seeds are enclosed in a ball. The first part of a rain causes some of the upper balls to open. If more rain falls right away, some of the peripheral seeds will drop out. If more rain falls rather quickly, some more balls will open and drop part of their seeds. Seeds farther into the center of the cluster of twigs may wait for decades or even centuries to open.

The twiggy mass is so tightly held together that it requires rain to expand it. When that happens, then additional rain can fall on the seed balls and permit them to open and a few seeds to fall. Additional rain and more seeds will drop out. At any point if the rain stops, then the twiggy mass will close up again.

It requires 4 millimeters [.157 in] of rain to open the twig mass, which gradually opens in about 2 hours. When the seeds fall to the ground, they germinate rapidly—in 8 hours—before the earth dries out.

This plant is only found in the driest part of Palestine. In those areas where there is more rainfall, none are found. This is due to the fact that a small gerbil lives in the wetter areas—and relishes Rose of Sharon seeds.

In nature, everything is in perfect balance.

WALKING "SEEDS" AND "TWIGS"—The male flowers in oak trees are called catkins. Sometimes the catkins start walking away! What happens is that a certain caterpillar feeds on catkins until it is so full of them, that it begins looking like them! In this way, it avoids being eaten by birds who are looking for juicy caterpillars, not catkins.

The caterpillars which eat these catkins in the spring, end up looking like them—even to having fake pollen sacks! But those caterpillars of that same species, which hatch out in the fall, also feed in the oak trees—and end up looking like oak twigs! In both cases it is the same type of caterpiller; the only difference is their diet.

DIFFICULT LIVING—Some flowers push their way up through snow and ice, while others lie dormant in the hot sands of the desert for years, and then spring forth and bloom after a rain that may come only once in a decade.

Some bacteria can live in hot springs at a temperature of 175°F [79.4°C], while spores of other bacteria have survived after being exposed to the temperature of liquid air (-310°F [-190°C]).

UNUSUAL PLANTS—Bamboo grows all over the world, yet every so often it dies. No one knows why. When it dies, all the bamboo plants throughout the world also die, even though separated by thousands of miles! Then, all over the planet, new sprouts shoot up and this fast growing plant is seemingly resurrected.

There are several kinds of "air plants" (epiphytes) that get their nourishment from the oxygen, water, and minerals they find in the air around them. The staghorn fern is an example. It grows on other trees, with its leaves pressed against the trunk of the tree to conserve moisture. Beneath the leaves are large masses of roots which extract nourishment directly from the atmosphere.

The great water lily of the Amazon and Indonesia has leaf blades that are five feet in diameter. Some palms have leaves 20 feet [61 dm] long. There are seaweeds that grow 450 feet [137 m] down in the ocean where there is almost no light.

HELICONIUS AND PASSION FLOWER— Butterflies of the genus Heliconius only lay their eggs on the tropical vine, the Passiflora, which is the passion-flower plant. The vine has features which appear to mimic the distinctive bright yellow eggs of the butterfly.

Each species of this butterfly lays its eggs on only one species of passion-flower, so this makes it difficult for the female butterfly to locate the proper plant. For example, on the island of Barro Colorado in Panama, there are 1,369 plant species, but only 11 of them are passion-flower species. So the little butterfly has available to it only a few of all the plants on the island.

Lawrence E. Gilbert has carefully studied the little butterflies. Arriving at a passion-flower, the female must figure out if it is the correct species. Using a specially modified pair of front legs, it "drums" on the surface of the leaf, trying to figure out if it is the correct species. Somehow it is able to identify the plant in this way.

Next, the butterfly must ascertain whether the plant has room for more eggs. If too many are laid, the plant will later be stripped of its leaves by the butterfly's offspring—the caterpillars—and die. The death of that species of passion-flower will bring death to the type of butterflies depending on it.

So the female must next make "an egg load assessment." This is a well-documented occurrence not only in Heliconius butterflies, but other insects as well. As a result of this survey, the female may lay an egg, or may fly off to check out another passion-flower plant. Research studies reveal that very few eggs are ever laid on any one plant. In addition, as part of the "assessment," the female will check on the possibility that the plant might be too young. If the eggs are deposited too early, the hatching caterpillar may devour the shoots before its new leaves appear. The caterpillars will then only have tough old leaves to eat and will die from starvation. A lot of careful, yet complicated, thinking must be done by that tiny insect.

Certain passion-flower species have yellow markings similar in color to the Heliconius eggs. It was found in greehouse experiments that eggs were deposited on 5 percent of the plants which had the yellow markings, compared to 30 percent of those without them.

In another experiment, female butterflies were turned loose in a greenhouse with plants, some of which already had eggs on them and some of which didn't. The egg-free plants had new eggs placed on them 70 percent of the time, whereas only 30 percent of those with eggs had additional ones deposited. In addition, the butterfly took twice as long to lay eggs on that 30 percent of the plants, because it first checked out all the other plants, and finally, in desperation, laid additional eggs on plants that already had other eggs. But when this was done, the new eggs were laid on the plant as far as possible from where other eggs were already on it—to insure that there would be enough food for both clutches of caterpillars when they hatched.

Pretty smart butterflies; too smart for a creature that tiny.

Similar studies of butterflies and plants in America have resulted in similar findings. This would include the swallowtail butterfly and plants of the genus Aristolochia. So there are a variety of other insects which go through the difficult decision making process about plant species, and egg assessment that the *Heliconius* must make.

The Creator's Handiwork

the invertebrates

Designs in Nature

If is easier to show by science that evolution is impossible, than to show how if could have happened. Consider for a few minutes the following facts about invertebrates (animals without backbones). How could any of this have bean caused by the occasional and random effects of harmful mutations—which is the only tangible method offered by evolutionists to produce everything in the world around us:

HERMIT CRAB --This is a small crab which lives in the shallower parts of the ocean. It spends its first year in the ocean as a gill breather. For its second year, it lives on trees and occasionally gets into the water to get its gills wet, although it can breath out of water.

Thereafter, it spends its full time in the ocean, often in rock pools near the ocean's edge. The hermit crab has no shell as do other crabs. Instead, it has to go out and find one. When it finds an empty snail or conch shell, it crawls inside to check it out for size. If it is okay, then it walks around, lugging the borrowed shell on its back. When enemies lurk near, it crawls back into its protective shell. Since its right claw is the largest, it will tuck that in front of it as a protective doorway across the shell's entrance. The left claw is smaller and used to tear up food, which is small plants and animals.

As it grows, it continues to be on the lookout for larger-sized shells. When it changes shells, it moves rapidly! If the size is wrong, it darts back quickly into the safety of its first shell.

The tentacles of the sea anemone are poisonous and sting those that touch it. But the little hermit crab and the sea anemone always know they are good friends. The crab crawls over to a small anemone and pushes on him. Instead of stinging the crab to death, the anemone carefully places its bottom suction cup onto the crab—and off they go, with the crab carrying the anemone around on his shell!

This arrangement helps both of them. It provides even better protection for the hermit crab, and additional food for the anemone. When the anemone catches a fish with his stingers, both share the food. The crab reaches his pincer out and takes part of the catch. When the crab catches a fish, he shares part of it with the anemone. Sometimes the crab will carry two anemones around on his shell!

When he switches shells and finds the new one is better, he nudges the anemone, which knows to crawl off the first shell and onto the second one.

FLYING SPIDERS—Spiders go higher in the sky than any other living creature on our planet. This is part of their way of taking long-distance journeys to new lands.

The mother spider carries her babies in a brown bag. Inside are about 200 baby spiders, each one the size of a dot. Inside the bag they have lots of food in the remainder of the egg. After they are a day old, out they will come from the bag—and immediately all will leave in different directions. If they did not do this, they might begin eating each other up.

(One exception to this is a certain spider which carries her newborn babies on her back for a time before they leave home. They are all crowded together, not in a bag, and do not disturb one another.)

Now, how does the tiny baby spider go about leaving home? That is simple enough, he just crawls up to a high point. It may be a grass stem or the side of a tree trunk, or a leaf on a plant. Then he upends— and off he goes!

Even though only a day old, his little silk factory is in full operational order. Instead of a tail, the spider has a spinerette. Lifting this up in the air, he begins spinning his fine thread which catches in the wind. The wind carries away the thread as the baby keeps reeling it out. Soon enough thread is in the air (about 9 feet [27 dm] of it), and the baby is lifted off its feet and goes sailing!

This thread is actually a liquid that immediately hardens when the air touches it. For its size, the thread is as strong as steel; in fact it is stronger, for it can stretch without breaking.

Where did he learn all this; he was only born that day! But he knows still more: The tiny spider quickly commandeers his craft— and begins steering it! As soon as he becomes airborne, he climbs up on the silk line and walks on that fluttering thing as it is flying high! How he can do this and not fall off is a mystery (how he can even hang on is a wonder). But he quickly becomes master of the airship. Arriving about halfout along the line, he pulls on it, tugs it here and there, and reels it underneath him. In this way, the line now becomes a rudder which he uses to steer up or down! Where did a one-day old, with a brain onethousandth as large as a pin-head, get such excellent flying instruction?

Soon he lands on something, but generally he will only stop long enough to prepare for another flight, and off he goes again.

Scientists in airplanes have found baby spiders 16,000 feet [4,876 m] up in the air! That is 3 miles [4.8 km] high! Eventually the tiny creature will land. It may be several miles down the road, in a neighboring state, or on an island far out at sea. (Spiders are the first creature to inhabit new volcanic islands.)

FRIGHTENING CREATURES— Here is how some harmless creatures protect themselves: When a mynah bird zeros in on a singhalese grasshopper, the grasshopper will show the large eyes on its back, and the bird will fly away in fear.

The British lobster moth caterpillar rises up and appears vicious when attacked. When this does not seem to succeed, it will appear to open wounds on its body, giving the impression it has already been parasitized.

The Malayan hooded locustid will actually open a slit on its body, exposing part of its entrails to indicate it has already been wounded and would make a poor food item.

MORE UNINVITING SIGHTS—When threatened with danger, a spider in Java lies on its back on the leaves— and looks like a bird dropping.

Clearwing moths looks like armed wasps, and so are able to fly during the day as they do, even though other moths only come out in the safety of the night.

STILL MORE SAFETY PRECAUTIONS One moment you see the leaf butterfly, Kallima, fluttering through the air with its bright colors; the next moment it lands on a leaf for safety—and disappears! Upon landing, it folds its bright wings over its back; the undersides of which are the color of the leaf.

The hawk mouth moth looks like bark only if it rests on the sides of trees with its head up; the geometrid tissue moth uses the same hiding trick-but must be turned sideways to give the same effect.

Flata plant bugs will gather together on plant stems—and appear to look like flowers. How can they do that? Since some of them are pink and some green, the pink ones gather in the center, and green ones encircle them. The result is pink petals amid small green leaves.

When certain spiders go hunting for ants, they imitate them as they approach. Ants have six legs and spiders have eight, so these spiders will put their front two legs in the air as if they are antennae.

STARFISH— Some starfish have five legs, white others may have 6, 7, 15, or as many as 50 (the sunray starfish). They have tiny spines on their Each foot has suction cups on which they slowly walk at a fast clip of 3 inches [7.62 cm] a minute or 15 feet (457 cm] an hour. They get water and oxygen through their feet, which have small tubes leading to their body. On each foot is a light- sensitive organ with which it sees.

Starfish are self-regenerating. Fishermen do not like them because they eat oysters, so when they used to catch them in their nets, they would tear them apart and throw them back in the ocean or bay where they were caught. What they did not know till scientists told them was that each leg will grow a complete starfish in a short time! The *Lincklia starfish* can grow a whole new starfish from a piece that is only 1/2 inch [1.27 cm] long.

DIVING SPIDER— The diving spider is also called the water spider. This little creature spends most of his time underwater, yet it breathes air and looks just like a regular spider. Here is a brief look at its remarkable life:

The spider hits the surface of the water and makes a tiny splash, then grabs the bubble produced by the splash, hugs it to its chest against its breathing tubes,--and down it goes into the water! This one bubble will provide it with air for quite some time. The spider will sense when the bubble is becoming stale, and, returning to the surface, it will with a splash get another one.

Underneath the water, the spider can hide from enemies and obtain nourishing food. Finding a small clump of vegetation, the spider will carry down bubbles and store them there. In this way it can stay underwater even longer. Always carrying the first bubble pressed close to its chest, it transports additional bubbles for its new home by holding them between its hind legs.

Aside from a few fish (such as the bubble nest builders), this is the only animal in the world that uses air as a building material. But he uses air for more than a nest; it is also his home. Soon his small tent of air is filled enough to give him oxygen for weeks.

When a male spider dives under, he selects a place for his tent close to the tent of a female spider. Then he builds a corridor between the two and fills it with air. Now they have a duplex apartment. But, standing in the corridor, as soon as he breaks through the partition to the female's apartment, a terrible family argument ensues and both tents are damaged. But he always wins because he is larger, and the two thereafter cheerfully work together to repair the tents. Then they settle down to family housekeeping and the raising of their family.

But diving-spider eggs will not hatch underwater; they need sunlight like all spider eggs. So the mother spins a cocoon around them and floats them on the surface for several days till they hatch. Then the babies climb out of the cocoon boat--and, little mites though they are,--they dive into the water and down to the home tent below the surface.

Eventually the children leave home and make their own family tents.

MALE MOSQUITO— **The** male mosquito lives on plant juices and bites neither animals nor man. While the female mosquito's antennae are difficult to see, the male's looks like a pair of branched feathers. How can he fly with such things on his head? Each antenna is placed in a socket next to a pad made of a special protein. This pad is actually an engine powered by water. When flying, the antennae are flattened against his head. When he lands, he raises them so he can hear. To raise the antennae, a small amount of water is pumped from his body into the pad, which increases its size by 25 percent, causing it to unfold— and lift the antennae!

ULTRAVIOLET WEB—Spiders use ultra violet light to help catch insects. Unlike humans, most insects can see ultraviolet light. They use this ability in direction-finding, to locate the sun when it is hidden behind clouds. It also helps them find certain ultra-violet emitting flowers. The silk spun by spiders, used to make their webs, reflects ultra violet rays from the sun. The garden spider even weaves decorations into its web which increase its ultraviolet reflection capacity. This attracts insects to the web. It is thought that birds, which can also see ultra violet light, are thus warned so they will avoid flying into the webs.

SEA URCHINS—Spiny sea urchins do not like people to look closely at them with a flashlight. They have been known to pick up nearby pebbles and hold them up to cast shadows when flashlight beams shine upon them.

LARGE BLUE—The large blue *(Nomiades arion)* is an English butterfly. In June or July the female deposits tiny eggs on the petals of wild thyme flowers. After hatching and eating some of the leaves, the larva becomes a caterpillar. It is at this point that something unusual happens.

For the first two skin-changes (molts), it feeds on flower heads, but then it becomes restless and begins walking away as though it wants something and is not sure what it is. It generally does not have to journey far, for the female tries to lay her eggs on plants close to an ant's nest.

When it meets an ant, the ant immediately recognizes that it has found a special prize, and strokes the side of the caterpillar. Then from the tenth segment of the caterpillar exudes a sweet kind of honey-dew for the ant.

More ants are called in, and additional milking occurs. The ants are thrilled with the feast, but the caterpillar realizes it is time for action: Swelling up its thoracic segment, the creature rears up on its hind legs— seemingly trying to reach up into the air. At this signal the first ant that found it (always that first ant, we are told), will gently seize and lift the caterpillar while other ants try to help.

Carrying off the caterpillar, the ant heads to its underground nest. The caterpillar is then placed in one of the underground chambers where the young ant grubs are being nurtured.

Now the caterpillar has a new home. It eats a few of the white ant grubs, while giving its honeydew nectar to the ants which they regularly harvest by touching that tenth segment. Scientists have tried to harvest the nectar also, but they have not been able to do it, no matter how they may touch that tenth segment. Only to the touch of an ant's antenna or feet does the pore yield its nectar.

This pattern of life continues all summer and after hibernating during the winter— during the next spring also. then the caterpillar makes a chrysalis. After 3 weeks it emerges as a butterfly. Ants always like to eat butterflies, but they do not touch this one. Why not? It yields no honeydew nectar, yet they do not injure it as they would another butterfly.

The butterfly slowly crawls out through the tunnels to the open air as the ants stand aside to let it proceed. Once outside, it wings its way from flower to flower, and the yearly cycle begins again.

EUGLENA— There are one-celled creatures which have properties of both plants and animals. For example, there is the flagellate, *Euglena,* which, like an animal, can travel around quite rapidly through the water by means of undulating, snakelike appendages. But, like a plant, contains chlorophyll.

GREAT CAPRICORN BEETLE —The larva of this beetle spends the greater part of 3 years inside an oak tree. When fully grown it is 2 1/2 inches [6.35 cm] long and 5/8 inch (1.59 cm] wide. Blind, weak, almost naked, and completely defenseless, the little worm burrows here and there in the oak. Year after year passes, yet that little fellow always knows never to go near the outer part where woodpeckers could get it. But it has no special sense organs to tell it anything. Led by chance alone, it would be sure to chew its way close to and probably through the outer wood, but this never happens. It always carefully avoids the woodpecker zone.

Then the time comes for the larva to metamorphose, and now for the first time it crawls to but a short distance from the outer surface of the oak. Why does it do this, for a woodpecker might now get it?

The blind, mindless worm is soon to change into a beetle, and that beetle will not be able to eat its way through hard wood as the worm can. So the worm comes close to the surface, digs a hole to the surface, makes a chalky doorway, turns around goes inward a fraction of an inch, and then turns around again and faces outward toward the bark, and undergoes the final change.

It turns around and faces outward, but why does it do that? As a soft worm, it can easily change directions in its tunnels, but the beetle will not be able to do so. If it faced inward, the beetle would die. But the worm never makes a mistake. It always faces outward before changing into a beetle.

When the beetle emerges, it simply crawls straight out,. tears out the chalky doorway, and emerges from the oak.

LOCUSTS— There are locusts that have an adult life span of only a few weeks or so, after having lived in the ground as grubs for 15 years.

Once a locust takes off, it flies for long distances. But it does so because the hairs on its head keep it going. As it flies, that bundle of hairs is stimulated by air currents coming from in front, and this excites the locust and it keeps flying. A nerve stimulus is sent from the hairs to its wing muscles, telling them to keep going.

OCTOPUS— The octopus walks around on the bottom of the ocean, but can also shoot through the water by jet propulsion when danger threatens. Each of the eight arms of the largest of these creatures is 16 feet [49 dm] in length!

The female lays 16,000 eggs in clusters of 4,000. To say it another way, she produces 4 strands of eggs, with 4,000 eggs on each strand. Then she hangs them up in a rocky cave and forces water through a jet upon them. This provides them with oxygen.

Carefully she cleans them with her suction cups. There are two rows of suction cups on each arm, so sensitive she can tell what a cup is touching without seeing it. The delicate nerves in each cup, enable her to feel algae and fungus and remove it from each egg. If that were not done, carbon dioxide could not leave the eggs and they would die.

She takes care of her eggs for 2 months and eats nothing during that time. Then they hatch and leave home, crawling or jetting away.

AFRICAN TERMITE—The Trlnervltermes is an African termite which builds mounds on the savanna which are only about 12 inches [30.48 cm] high. But when curious researchers looked inside these termite homes, they were astonished to find that the termites bore shafts into the ground for water,—and that some of these shafts go down more than 130 feet [396 dm] into the earth!

DESERT BEETLES— Flightless beetles (Onymacris plans) from the Manib Desert in southwest Africa regulate their body temperature in two ways; one is by regular body heat control factors, the other is by the elyfra, which is a covering on its back.

Consider the high-tech way the elytra does its work: This elytra, or outer sun shield, absorbs 95 percent of the visible and ultraviolet radiation. But it only absorbs 20 percent of the long-wave infrared rays.

After a cold night on the desert, the morning sunlight is mainly infrared, and this gets through the shield to heat the beetle. But later, in the middle and latter part of the day when the desert becomes hot, the heat mainly comes from visible and ultraviolet radiation, and this is largely shut out by the beetle's elytra.

In this way the beetle keeps warmer in the morning when it is cool, and cooler in the afternoon when it is hot.

Evolutionists say that "warm-blooded animals" (birds and mammals which evenly regulate their body temperature inside) are "more advanced" than the "cold-blooded animals" (reptiles, amphibians, insects, etc.). But is that really so? On a hot summer day we humans would do well to have an elytra over our heads.

ANT CATTLE— Many ants have their own cattle: caterpillars, aphids, or tree bugs. They stroke these creatures, which then exude drops of tasty fluid.

These "dairy cattle" are guarded by the ants, who may herd them into special enclosures they have built for this purpose. Hingston has described how one ant species was observed building sheds for the enclosure of their cattle. When some fencing was damaged, and the cattle began escaping, four ants went after them, turned them around and got them back into the damaged shed. Then, while some guarded the opening, others repaired it.

Other ants herd caterpillars into special reserves where they care for and milk them, and then drive them out to pasture every day so the "cattle" can feed on plants.

CORAL CRAB —Among the corals of the Great Barrier Reef in Australia there are tiny crabs which live amid a certain type of finely-branched coral.

At an early age, a young female crab will settle in a position between several branchlets. The coral senses that the crab is there and henceforth will grow more widely in that spot—thus providing a home for the growing crab. Up and around the crab the branches extend, and move inward and enclose her overhead. The crab is now happily imprisoned for the rest of her life. Food floats in and she lays her eggs and raises her young there. Enemies cannot enter to devour her. The male crab is extremely small and so can easily enter and leave the female's home.

Scientists cannot figure out why the branches always make room for the crab inside, and why they always come together overhead and enclose her. Elsewhere the coral is closer together and does not necessarily come together above open cavities.

AMAZON ANTS —Ants which live in the flood regions of the Amazon basin are careful never to build their nests on the ground, but always in the trees. If they did not do this, flooding would destroy them.

SACCULINA —The Sacculina is a typical crustacean larva which swims in the ocean until it finds a crab. Then it attaches itself to part of the body.

Boring a small hole through a cuticle at the base of one of the crab's hairs, the contents of the larva empty out! A shapeless mass of cells pours down through that hole and into the crab, there to circulate around through its blood vessels. Gradually each cell finds its way to the underside of the crab's intestine. Why does the crustacean suddenly change into separated fluid and enter the crab? How do all the cells know their destination?

In this new location, the cells reunite, attach themselves, and send out roots into the crab's intestine and live on juices from it.

Eventually the tiny organism inside takes another journey. This time it travels backwards up the intestine to the underside of the abdomen. When the crab molts the next time, part of the organism is henceforth on the outside of the crab and part inside. Here it spends the rest of its life, eventually sending larva out into the ocean which swim around as regular crustaceans and begin the cycle all over.

HONEY-STORING ANT —In the Australian desert is a species of ant which will, at random, select certain of its ants and use them as honey pots.

Cells are built for them deep underground and there they live as the reservoirs of the ant hive. Each ant is pumped full of honey to the point that he is an almost **transparent** golden color. The worker ants collect nectar from flowers during the short periods when they flower during rainy seasons, take it home and store it in their honey ants. Each storage ant holds as much fluid as you would find in a grape!

When dry weather comes, the ants go to the honey ants and obtain their food. They would die without this storage facility.

UNUSUAL ABILITIES—A flea can jump 130 times its own height; this requires overcoming a force of 200 g's. Man can only withstand about 82 g's. If a horse could leap as far, in proportion to its weight, as a flea —it could leap over the Andes Mountains in one jump.

Some butterflies can smell a mate several miles away. The male silkworm moth can smell the scent of a female seven miles, yet she is emitting not more than 0.0001 mg [.0000154 gr] of chemical odor.

The trilobite is abundant in the very lowest fossil levels, but its eye is said to have "possessed the most sophisticated eye lenses ever produced by nature," and required "knowledge of Fermat's principle, Abbe's sine law, Snell's law of refraction and the optics of birefringent crystal," according to Levi Setti. "The lenses look like they were designed by a physicist," he concludes. (See the chapter on *Natural Selection* for much more information on the eyes of trilobite and other creatures.)

The honey bee flies 13,000 miles —in order to make one pound of honey.

Cicadas live for 13 to 17 years (all the while sucking juices from tree roots), ticks live 18 years, and nematodes up to 39 years.

In relation to their size, insects have greater strength than do the larger animals. Ants are able to carry fifty times their own weight! A beetle can move a hundred times its own weight!

A snail can pull 60 to 200 times its own weight and lift 10 times its weight! To do as well, a man would have to pull 4 to 13 tons [3,629-11,793 kg] and lift 1,500 pounds [680 kg].

CRAYFISH AND LOBSTER —The crayfish and lobster are remarkably designed. There are two long pincer feet in front of the body, with large pincers on the ends. But they hinder these creatures from moving rapidly when enemies draw near. So, instead, quick, backward movements are made by rapid downward strokes of the abdomen. This drags the entire animal and its pincer feet backwards.

Because crayfish and lobsters live their life moving backwards, they have an unusual internal plumbing system. The kidney is located in front of the mouth, so the gill circulation can carry the wastes away from the body. If the kidney outlet was near the back end as in most animals, the wastes would be carried to the gills. This perfect design enables the crayfish and lobsters to live efficiently, whether slowly crawling forward or rapidly swimming backward.

THINKING BACTERIA —Bacteria can think. Experiments conducted in 1883 by Wilhelm Pfeffer revealed that bacteria will swim away from poisons like mop disinfectant, and toward good food such as chicken soup. When swimming through a partial disinfectant/soup mix, they swim faster. Upon arriving at the good food, they stop swimming and beginning feasting.

INSECTS —The body of an insect is hollow and filled with air sacs similar to those found in birds. This makes each little creature even lighter in weight for flying and jumping. Air tubes extend throughout the body and into the wings, where they form the veins. A hollow tube is the strongest construction possible for a given weight. These tubes in the wings both stiffen the wing and carry air to wing tissues.

Insects have a more rapid nerve and muscular response than do larger creatures. A housefly beats its wings 600 times a second. A dragonfly easily flies 60 miles an hour, but can also stop instantly and go backward or sideways, without changing the position of its body.

A termite queen will lay more than two million eggs in a month's time.

SPIDERS The "orb weaving" spiders build the large circular web with which we are so familiar. Some ground spiders form a flat web, and then a tubular tunnel at one end—or in the middle—in which they live. Others build a silklined tunnel in the ground for their home. Still other spiders carry their babies around in a silken case, until they are hatched. The garden spider places its eggs in a silk cocoon and suspends them in the orb web. Strands of spider web are astoundingly strong and well-made.

A tiny strand of spider silk is used in some large telescopes to enable the astronomer to measure the vast distances of the heavens above him.

OYSTER— An oyster is a soft body covered by a shell. It is a bivalve, which means it has two half shells (2 "valves") which hinge together. The bottom valve is bigger because the body of the oyster is in it. The shells are held together by a strong abductor muscle.

Consider all the complicated things in an oyster:

Between the body and the shell is a special skin called the mantle that produces fluid which hardens into shell. As the soft body grows, the brain sends a message to the mantle to squirt some more fluid. This continues on throughout its 6-20 year lifespan.

The oyster hears by vibrations through the mantle. When it wants to hear especially well, it pushes part of the mantle out into the water. Doing this, it not only hears better, but can also detect light and dark.

On the edge of the mantle there are 2 rows of tiny feelers. These detect light and chemical changes in the water. When certain changes in light or chemical odors occur, the mantle signals the brain: Shut the door quick!

The oyster breaths with its gills and also takes in food the same way, straining it out of the water. Each gill is covered with microscopic hairs which wave back and forth, bringing in water and tiny bits of food. Sticky hairs catch the food, place digestive fluid on it, then pass it over to a little rod which turns round and round. Movement of the gill hairs turns the rod, and it winds the food onto itself. The ball is sent to the mouth and swallowed. Special cells pass through the stomach wall, grab the food, pass back through the stomach walls and take it to all parts of the body.

BOMBARDIER BEETLE —The amazing bombardier beetle *(Brachinus) was* reported in detail in 1961 by Schildknecht in Germany.

Its defense system is extraordinarily intricate, and is something of a cross between tear gas and a Tommy-gun. When the beetle senses danger, it internally mixes enzymes contained in one body chamber with concentrated solutions of some otherwise rather harmless compounds (hydrogen peroxide and hydroquinons) stored in a second chamber. Harmless, that is, when they are not placed together. Yet here they are-stored together—in the same chamber inside the beetle! Chemists cannot figure out how it is done.

The stored liquid was found to contain 10 percent hydroquinones and 25 percent hydrogen peroxide (used in rockets). Such a mixture, Schildknecht reported, will explode spontaneously in a test tube. Why not in the beetle? Apparently the mixture contains an inhibitor which blocks the reaction until some of the liquid is squirted into the combustion chambers, at which time enzymes are added to catalyze the reaction.

The vestibule walls secret these enzymes that produce the explosion: peroxidase causes the hydrogen peroxide to decompose into water and free oxygen; while catalse helps the hydroquinones change into toxic quinones and hydrogen.

At the instant of the explosion, hydrogen and oxygen combine to form water and release energy. The temperature of the discharge rises to the boiling point of water, with enough heat left over to vaporize almost a fifth of the discharge.

An immediate, violent explosion takes place. The resulting products are fired boiling hot at the enemy (at a temperature of 212°F (100°C]). Out goes an extremely hot jet of steam and minute droplets of quinone solution.

A noxious, boiling spray of caustic benzoquinones explode outward. The fluid is pumped out through twin rear nozzles, which can rotate like a B[17]s gun turret, to hit a hungry ant or frog with a bull's eye accuracy. The insect's gun is emptied by four or five little explosions in quick succession. They blast out under high pressure; space rockets work on the same principle.

How did the beetle know that hydroquinone and hydrogen peroxide, when properly mixed, would result in a powerful explosion? How did it manage to manufacture those two chemicals? How does it store them without their exploding in the storage chambers? If "evolution" tried out various alternate chemicals before hitting on the right combination, how did it dismantle the corresponding DNA sequence needed to make each alternate set of compounds? How did it then switch over to a different DNA sequence? How did it make those extremely accurate twin firing turrets? A rifle is useless without all its parts. Everything had to be there in working order for it to succeed.

MILLIPEDE'S DEFENSE —The millipede, Aph*eloria corrugata* shoots hydrogen cyanide at aggressors! How does it not poison itself?

The chemistry involved here is fantastic. On both sides of each segment of its body, subsurface glands produce a liquid containing a complicated chemical compound, *mandelonirrile.* When the millipede is attacked by ants or other enemies, it mixes the mandelonitrile with a catalyst, causing it to decompose to form *benzaldehyde,* a mild irritant, and *hydrogen cyanide* gas—a deadly poison.

Once shot out, the millipede sits there, happily basking in a cloud of lethal fumes, while his attackers flee in all directions. Yet those fumes do not bother him in the least. No one knows why.

SUCH INTELLIGENT CREATURES —Many insects will lay their eggs only on certain species

Worker bees have a special dance to tell the other workers how much food is available, which direction from the hive, and how far away. The entire dance is observed in the total darkness of the hive —yet from it the other bees know exactly how much honey to tank up on to get to the flowers and back, where to go, and how much they will find there.

Ants cultivate species of fungi that are found nowhere in nature apart from the ant colony. The ants prepare compost for the fungus and cause the fungus to produce bud structures which the ants eat.

When bees and birds travel, they know how to orient themselves by the sun. (In addition, according to scientific research, when birds fly at night, they use the stars to guide them.)

The purple emperor caterpillar rests on the midline of the leaf it is eating, then moves *off* the leaf to the stem where it changes to a pupa. It does this somehow knowing that the leaves—and not the stem —will drop off the tree in the fall and it should not be on them for that reason.

FLEA —When a flea jumps, it releases more than 51h times as much energy as the most perfect muscle tissue can generate! How can it do this? Small pads of a natural protein rubber called resilin are in its legs. As the flea slowly pushes down on the pads, it is storing energy-which will be released in 1 /7th the time it took to store it, as soon as it makes its next leap.

SEA SLUG —The nudibranch or sea slug (Eollobidea) is only about 2 inches (5.08 cm] long and lives in the shallow tidal zone along sea coasts. It feeds primarily on sea anemones, —but those anemones are armed with stinging cells which explode at the slightest touch and shoot a dart into intruders. But all this bothers not the sea slug as it chews on them, even though it is one of the most delicate-appearing creatures in the ocean.

The sea slug moves right ahead and eats the anemone, regardless of the darts. It is not bothered by them in the least. Instead of being troubled by the darts, the nudibranch uses them. The little creature has special equipment to store and use those dangerous stinging cells.

Leading from the sea slug's stomach to small pouches in the fluffy spurs on its sides are very narrow channels lined with moving hairs or cilia. These cilia are like small brooms, and they sweep the stinging cells out of the stomach and up the channels into those pouches. Once inside, they are carefully stacked, aimed outward, and stored for future use. Later, when a fish threatens to eat the sea slug, it bites on the pouches-and gets a mouthful of stinging cells which the nudibranch borrowed from the anemone! That is too much for any self-respecting fish, and it immediately leaves.

SPHINX MOTH —This is a true moth, yet to watch it fly, one would think he was looking at a hummingbird! It flies, maneuvers, and feeds like a hummingbird. Approaching the deep-throated flowers, it stands upright and motionless and inserts its long tongue into the flower. This tongue, longer than its entire body, has two grooved halves which suck out the nectar. Without a perfectly-formed tongue, the sphinx moth would immediately die. So the tongue had to be perfectly designed from the very beginning, like all its other body parts. The wings of a hummingbird beat 50 times per second, while those of a sphinx moth are almost as fast: 25-50 beats per second.

SPONGE— The sponge is a creature which lives in many parts of the world, and is regularly harvested in the Gulf of Mexico. This little fellow has no heart, brain, liver, bones, and hardly anything else.

Some sponges grow to several feet in diameter, yet you can take one, cut it up in pieces, and squeeze it through silk cloth, thus separating every cell from every other cell, and then throw part or all of the mash back into seawater. The cells will all unite back into a sponge! Yet a sponge is not a haphazard arrangement of cells, it is a complicated arrangement of openings, channels, and more besides.

Yes, we said they have no brains; but now consider what they do: Without any brains to guide him, the male sponge knows to the very minute when the tide is coming in. Immediately he releases seed into the water and the tide carries them in. The female sponge may be half a mile away, but she is smart enough (without having any more brains than he has) to know that there are seeds from the male in the water. Immediately recognizing this, she releases thousands of eggs which float upward like a cloud and meet the male sperm. The eggs are fertilized and new baby sponges are eventually produced.

THE LASSO MOLD— There are many types of mold in the ground and they are so small that only a microscope can discern them individually. Some of these are predatory molds which capture and feed upon numerous nematode worms which are in the soil.

Some molds have sticky knobs which catch and hold onto the worms until they are eaten. But one, the *Arthrobotrys dacfyloides,* has a very unusual method. It is the cowboy of the microscopic world.

This miniature mold lassos its prey! The mold is in the shape of a thread, and the nematode is shaped like a worm and is much larger. The slender mold senses the presence of a nematode and immediately grows a small loop on the side of its body. As the worm travels along, its head passes through the loop. Instantly —within 1 10th of a second— the loop cells swell and the loop clamps shut on the worm and it is captured and eaten by the mold.

MONARCH AND VICEROY—There are two butterflies which look quite a bit alike. One is the well— *(Danaus menippi* or *Anosia piexippus*) and the other is the viceroy *(Basilarchia archippus).*

The monarch has a disagreeable taste to birds and so they avoid it. But the viceroy although quite delicious, because it looks so much like the monarch, is also left alone.

Yet there is more to the monarch and viceroy story. Although these two butterflies look almost identical to you or me, they are actually quite different. As with many insects, when fall comes, the viceroy dies as cold weather advances. But the monarch is startlingly different. It migrates hundreds of miles to the south!

MIGRATION OF THE MONARCH —While other butterflies live and die within a small local area, the monarch butterfly migrates in the fall to far distant places.

Monarch butterflies leave the northern states and Canada in the autumn and travel southward. Most of them winter in southern California or Mexico. Some flights exceed 2,000 miles [3,218 km]; one butterfly covered 80 miles [129 km] in one day. Arriving at their destination, they settle on sheltered trees in areas where little winter wind will blow. These trees will be the same trees that monarch butterflies departed from that same spring. But it will not be the same butterflies that return to those same trees!

In the spring the monarch heads north on a 2,000-mile [3,218 km] journey. Since these butterflies seem evenly dispersed in northern regions they inhabit, it is thought that each butterfly may return north to the place it left in the fall. Arriving at its summer home, it searches for milkweed plants to eat and lay its eggs on. Later in the summer it dies. Its young hatch, eat milkweed leaves, go through the various stages of growth and then emerge as monarch butterflies. And what do they do? In the fall they head south to that same place that their parents flew from in the spring!

"The butterflies that come south in the fall are young individuals which have never before seen the hibernation sites. What enables them to find these is still one of those elusive mysteries of nature."— *"B.J.D. Meeuse,* Story *of Pollination (1961), p. 171.*

SPIDER LEG PUMPS—Our muscles are located on the outside of our bones, so we are able to bend and extend our arms and legs. But a spider has its muscles underneath its outer bony sheath, so it can only bend its leg muscles! In order to straighten them out, the little creature pumps fluid into its leg—and this straightens out its leg joint hinges! This action is similar to the hydraulic braking system used on automobiles and trucks to tighten brake shoes. The pumping of fluid causes a mechanical movement at a distance.

ANEMONE'S EAR It has Only recently been discovered that the sea anemone has a more complex "ear" than any other creature! It has hearing receptors similar to ours, but it is able to change the range of frequency of those receptors! This enables the anemone to hear a range of high— and low— pitched sounds far beyond that of probably any other living creature.

PARAMECIUM— The paramecium is a cigar shaped microscopic creature which is quite common in pond water. Inside it live numerous green algae. If algae are presented to one without any, it will swallow them and knows to save some alive, which then continue to live inside of it. The algae produce sugar and oxygen through photosynthesis, which the paramecium uses. For their part, they are protected inside the relatively large paramecium.

PISTOL SHRIMP —There are over 2,000 different kinds of shrimp. As with all other species, each shrimp reproduces only its own kind.

As with many shrimp, the pistol shrimp is about 2 inches long and an orange color. It makes a sharp shooting sound with its one large claw. This snapping sound stuns small fish, and the shrimp then eats them. One scientist put a pistol shrimp in a glass jar, and the sound waves from the shrimp broke the jar!

AMAZON ANT— The Amazon ant lives a sophisticated lifestyle. It is not able to feed itself and raise its young. So it goes out and catches other ants to help it with such tasks. These other ants willingly remain and help it perform simple duties which it seems unable to do for itself.

The two colonies of ants live jumbled together, yet they never interbreed and become one species.

ASSASSIN BUG —The female assassin bug has a special way of protecting her eggs. She goes to the camphor plant and rubs the resin of it onto her belly. Then she lays her eggs, and carefully coats each egg with this resin. This coating acts like "mothballs," and keeps ants from eating the eggs!

METAMORPHOSIS —NO scientist can understand the metamorphosis of a butterfly. It is utterly astounding. A butterfly lays an egg and it hatches into a caterpillar. After feeding for a time, that caterpillar shrinks and attaches itself by its own silk cords to a plant stem. Then it remains there for quite some time. Immense changes gradually take place and the caterpillar becomes a hardened chrysalis.

Within this dry shell, the organs of the caterpillar are dissolved and reduced to pulp! Breathing tubes, muscles and nerves disappear as such; the creature seems to have died. Massive chemical and structural changes occur!

Gradually, that pulp is remolded into different, coordinating parts. The creature did not grow, did not mature; it just changed—totally changed! Eventually, out of that chrysalis emerges a beautiful butterfly. Biochemists, biologists, evolutionists all retreat in confusion before the awesome miracle of metamorphosis.

PERIWINKLES —This is a small creature found on the seashore. There are several species of periwinkles, and all are small sea snails of the genus Littorina, and are found in shallow waters along the coasts of Europe and northeastern North America.

One kind of periwinkle is oviparous, that is it lays eggs in which embryos are undeveloped. This is the way that most invertebrates, fishes, many reptiles and all birds produce their young.

Another kind of periwinkle is oviparous, that is it has an embryo which, although it develops within the mother, is separated from her by persistent egg membranes. Many reptiles, one or two snails, some roaches, flies and beetles, and parthenogenetic aphids, gall-wasps, thrips, and some other creatures have their young in the same way.

Yet another kind of periwinkle is viviparous, that is it has an embryo which develops within the mother, and is in close contact with her through a special organ called a placenta. Mankind and nearly all mammals are viviparous.

Thus different periwinkles use one of all three methods of giving birth to their young!

Among the frogs, toads, and salamanders, there are species of each which utilize two or three of these methods of reproduction.

HORSESHOE GRAS— Horseshoe crabs usually live in shallow waters in the ocean. During a monthly highest high tide, they immediately know it is the monthly highest tide, and swim ashore and mate. The female lays eggs which she quickly buries in small holes on that part of the sandy beach washed by the highest of the high tides. She then returns to the sea.

The incubation period of the egg is exactly four weeks, which means the young horseshoe crabs dig out of the sand at the next monthly high tide, when the waters again wash that section of the beach. They are immediately swept into the sea before predators can devour them. How can the horseshoe crab know when that high tide occurs?

Chapman and Lail of the University of Maryland think they may have a solution, but it only adds to the puzzle of how all this could have originated by chance: Horseshoe crabs have four eyes of two types. Two lateral compound eyes are used to see much as an insect sees. The function of the other eyes—two dorsal simple eyes—were never understood until recently. The monthly highest high tide occurs when the sun, earth, and moon are so aligned as to exert maximum gravitational pull on the water. At that same time the moon reflects the most sunlight to earth, including ultraviolet light. These two scientists performed tests indicating that the dorsal eyes are stimulated by ultraviolet light. Does that answer all the puzzles? Not quite.

BACTERIA —Within its chromosomes, a single bacterium has about 3 million base pairs in an exact sequential order. It can double itself in forty minutes so that DNA synthesis is done at the rate of more than 1,000 base pairs per second! How can this "simple" organism be so efficient in operation and yet so complicated in genetic material?

If their divisions continued uninterrupted, the mass of descendents of one bacterium would weigh as much as 2,000 tons [1,814 mt] in only 24 hours.

EXOCULATA SHRIMP —This is no ordinary shrimp! It lives 2 miles down at the bottom of the ocean, in the mid-Atlantic Ridge. Inside this ridge are slow outpourings of gases and lava at superhot temperature. Called "black smokers," these geological formations shoot out black clouds of water which are 660°F. No trace of sunlight ever penetrates this great depth, yet the nearby shrimp have eyes! Trying to figure out why, scientists discovered that that super-heated water actually has a slight glow as it comes out of the ground! It is not much of a glow, so each little shrimp has eyes so large, they are located on its back like tophood headlights! These eyes enable the shrimp to feed within inches of the hot water without getting burned.

COMMON MIME —The common mime is a butterfly that lives on the island of Sri Lanka, off the coast of India. Consider this interesting life history that required a lot of thoughtful planning to originate. We find here five mimic stages in its life:

1— The golden egg is laid on the tender young shoots of a plant of a similar color.

2— The young larva, until it is half grown, is colored brown and yellow, with smeary-looking cream-colored marks with a wet-looking gloss. Always sitting on the upper leaves feeding, it looks just like a bird dropping.

3 — During the second half of its larva stage, it is too big for that ruse, so it changes color to a gaudy black, yellow and red. Creatures that gaudy in Sri Lanka often are dangerous or poisonous.

4 — Then the caterpillar changes into a pupa, and now it looks just like a short, snipped-off dead twig. Now it hangs outward from the plant stem. The base of the pupa appears to grow out of the stem it is fastened to, and the upper end looks like a broken-off twig end.

5 — Emerging as an adult butterfly, it next takes one of two distinct and very different appearances; males and females occurring in both.

(5a) One type is brown with mottled yellow, just like the *Eupioea* butterfly, which is distasteful to birds. (5b) The other type is striped black and blue like the *Danais* butterfly, which also has an unpleasant taste.

When frightened, both types fly like a Mime, but, normally, each flies the slow, graceful way the butterfly they are imitating flies.

LEAF-BINDING ANTS —The leaf-binding ant builds nests out of leaves sewn together. The problem is that it does not have the thread to tie the leaves together. So it produces larvae, then it will go to one of its children and, carefully holding it in its jaws, the adult ant walks over to the leaves. The baby ant dutifully exudes silk, which the adult reaches up and takes and uses to sew the leaves together.

DIGESTIVE AIDS—Vast numbers of one-celled plants (fungi) and animals (protozoa) live in the stomachs of cattle. The part of a cow's stomach where digestion takes place has a volume of about 100 quarts [94.63 liters)—and contains 10 billion micro-organisms in each drop.

Those tiny organisms obtain nourishment from the food eaten by the cow, but at the same time they break down the cellulose in the plants on which the cow feeds. If they did not do this, the cow would die of starvation, not being able to extract nutrition from the food.

Termites have a similar problem and solution. They eat wood, but without certain bacteria in their stomachs they could not digest it. The bacteria digest it for them.

COUNTING ANTS —**Can** ants count? Ants are sent out from the nest to find food and bring it back. When they find a piece that is too large, they go back and get other ants to come back and help them. A scientist carefully cut a dead grasshopper into three pieces. The second was twice as large as the first, and the third twice as large as the second. Then the three pieces were placed in different places. When the scout ant found each piece, he looked it over for a moment, tried to lift it, then rushed off for helpers. Twenty-eight ants were brought back to work on the smallest; 44 on the one twice as large, and 89 on the third. The scout ants estimated it very well!

THE INTELLIGENCE OF A SPIDER —A Spider has very unusual and specialized organs for producing the tiny thread which it uses for so many different things. The spinneret organs of the spider have hundreds of apertures through which silk and glue are extruded. In addition, a special oil gland has to be on each foot so it does not become stuck in its own web.

Spider webs are known to be as large as 19 feet [579 cm) in circumference, yet the silk is as thin as a single molecule. It is said that only fused quartz has a higher tensile strength.

Next time a spider spins a web, watch him closely. First he will make a few radiating lines (threads running out from the center). Then he will make the circle lines. First he will spin the largest circle, and then, one by one, he will make each of the smaller circles. Especially watch him closely as he makes those circles, for they are the ones coated with sticky glue. This is what you will see:

He will swing from one radiating line to a second, spinning out thread for the circle line as he goes. Now comes the special part: As he reaches the second radiating line, he will carefully pause and pluck—yes, pluck—behind him the circle line as a violinist would pluck a string with his finger in pizzicato. Then he will swing across to the next radiating line, reeling out more circle thread as he goes,—and again he will deliberately pause and give that part of the circle a final pluck before leaving it.

Why? Wave motion is involved here. That thread was moistened with his glue gun, but as it comes from the spider it will not catch bugs. What is needed is that pluck, which vibrates the cord—and pushes the glue into separate tiny balls strung out along it! Now it is ready to catch flies and insects; not before. Watch the spider in action as he spins his web and do a lot of thinking as you watch.

BOLO SPIDERS —Did you ever see a boy play endlessly with a lasso? Well, there are spiders that do the same thing. Thinking that it takes too much work to go out and catch some food, certain spiders will sit around and swing a strand of silk with a tiny ball of glue on the end. This will go on for minutes at a time. As a passing insect is seen, instead of jumping it, these lazy Bollo spiders just throw a lasso at it!

Other spiders build a little net the size of a nickel and spend their time trying to throw it over insect pedestrians.

Then there is Dolometes fimbriatus spider. He decided to really do it up right, so he makes little rafts out of silk, climbs in, and then goes canoeing after insects!

SEA CUCUMBER The sea cucumber dwells in the ocean. It catches its food without much trouble, but how does it do it—for it is blind?

This 2-inch [5.08 cm] wide creature lives as much as 600 feet [183 m) deep in the sea, and has 15 million tiny spines on its skin. There are billions of special nerve cells under the skin. These tell it what is in the water all around him. The brown warts on the skin are receptor nerve centers which receive the messages and send them on to nerve networks further down, which in turn are connected to a very tiny brain. Somehow it receives all those signals, unscrambles them, and knows what to do next.

Part of these are motion signals, but others are chemical signals. Extremely minute chemicals in the water warn it in advance of various types of creatures nearby.

There are 25 super-sensitive tentacles near its mouth. These are sensitive to taste and touch. So when it catches something, they tell it whether it is safe to eat!

In addition, the sea cucumber burrows into the sand—and eats that! In the process, it extracts the bits of food in the sludge. What it does not eat is cast out as high-quality dirt; something which earthworms on land also do. Each year, the sea cucumber swallows 200 pounds [90.72 kg] of sand and dirt, yet it only weighs about a pound.

If a fish or crab approaches, his chemical wart system warns the blind creature that an enemy is lurking not far away. The sea cucumber then fires goo quite accurately at the intruder, and the sticky stuff adheres to it like spider webs and it is caught.

But what if a big fish comes after the sea cucumber? Somehow recognizing that it is a larger fish, the little creature does something very different! It forces all its intestines out through its mouth! The fish goes after them and leaves the sea cucumber alone. Then it crawls under a rock and rests awhile as new intestines grow back.

LYCAENIDAE BUTTERFLIES—These butterflies have structures which look like antennae on the hind portion of their wings. Eye spots are there also. When a bird comes along to eat the butterfly, it waves its hind "antennae," and the bird snaps at it. But—at that instant—the butterfly flies off rapidly in the other direction and hides in the vegetation.

CATKIN CATERPILLAR—These little caterpillars hatch out in early summer just when the oak tree catkin flowers open up. They begin eating catkin flowers—and they look just like golden catkin flowers! For two weeks the catkins bloom and during that time the catkin caterpillars stay there and eat catkins, while looking just like them.

Then they spin cocoons and later emerge as light green moths. The moths lay their eggs in the middle of the same summer, and soon caterpillars emerge. But these caterpillars immediately begin eating the oak leaves— and they look like brown oak twigs! (It has been suggested that perhaps the tannin in the oak leaves causes them to look different than the spring caterpillars.)

Then they spin cocoons and later emerge as light green moths. The moths lay their eggs in the late summer, and next spring the young will be golden catkin caterpillars again.

WATER BEETLE —One type of water beetle *(Stenus bipunctatus)* escapes from enemies by discharging a detergent from a special gland. This discharge has two powerful effects. First, it shoots the beetle away from the danger, and, second, at the same time, the detergent weakens water surface tension and the creature chasing the beetle sinks in the water. It took a good knowledge of chemistry to figure that one out. Mankind did not know about anti-surface tension detergents till a few decades ago.

LEAF-CUTTING ANT— This IS a South American red ant about 1/2 inch [.635 cm] long, which is somewhat larger than most ants. Millions of these ants crawl out of their nest in the morning to begin their daily work. Climbing trees, they use their pincers (the mandibles by their heads) to cut leaves into 2-inch [5.08 sq cm] square pieces. Then each ant lifts a leaf overhead and carries it off. (It is for this reason that they are also called "umbrella ants" or "parosol" ants.)

The piece of leaf is much larger than the ant. It should be quite a task just to hoist it overhead and carry it, — but now another ant climbs on top! He is a guard ant, and it is his job to watch for a certain fly that might attack the ant carrying the leaf.

The destination of all these leaves is their "ant garden." Millions of leaves are brought down holes in the ground and carried through tunnels, until finally the ants enter with them into one of many rooms, each the size of a football. Here the leaves are spread out, and special worker ants, which have better eyesight than do the others (needed for the Close exacting work they must do), chew up the leaves and make them much smaller. Next they crawl over the leaves and release a fluid on them which dampens and causes them to decay. In this way, the leaves turn into good soil instead of simply drying up.

Having become good compost, mushrooms always begin growing on it. This is the leaf-cutting ant's garden!

But not only mushrooms, but mildew, rust, and other bacteria also begin growing in the garden. The ants must now carefully weed their garden! They know that everything but the mushrooms must be removed aS these "weeds" will take over. The weeds are carried out through the tunnels and dumped outside.

We are here discussing not human beings, or even dumb squirrels— but ants with brains the size of pin heads! And when they do all this work underground— including the careful weeding, it is all done in the dark. How can they know what to weed out?

The story ends happily enough: the ants live contentedly on the mushrooms, even though a lot of work must continually be done to prepare new gardens and care for them.

Oddly enough, there are *other* leaf-cutting ants which go through the same procedure,—but they weed out the mushrooms and eat the other fungi and bacteria which grows in *their* garden!

BUTTERFLY WINGS —One of the most exacting and meticulous skills in optics technology is ruling a diffraction grating, so that It will split up light rays into component spectral colors. First, an optical surface must be carefully marked with parallel lines in the form of a fine grid. The more lines per millimeter, the better will be the result. Such gratings are used in a variety of delicate optical devices, so one of the challenges of science is to design machines which can scribe ever finer lines, thus producing more precisioned instruments.

But the iridescent butterfly has been turning out flawless diffraction gratings ever since they first came into existence. Billions of copies are produced each summer as butterflies emerge from their chrysalises.

Each butterfly wing is overlaid with countless numbers of extremely small scales, and each one is laid down in exact order in a precise pattern. The scales are shingled on, overlapping each other very slightly. —and inscribed on each scale are fine diffraction grating lines, finely tuned to reflect a certain wavelength of light. Different gratings would produce different colors, yet the large pattern worked out by these gratings is always exquisitely designed by a master Craftsman. It is this that gives many butterflies their exquisite coloring.

That special coloring is scientifically known as "iridescence." It is best seen when the surface is black, so that the diffraction grating can reflect certain colors in their full clarity. The throat of a hummingbird and the male mallard duck are another of the many examples in nature of iridescent coloring. It consists of reflected color; there is no color in the surface itself. Prismatic colors in sunlight are split up and certain ones are reflected, according to the angle of the viewer.

PORTUGUESE MAN-OF-WAR —The man-Ofwar is one of the largest jelly fish in the ocean. Its tentacles hang down a great distance and paralyze smaller fish which get caught in them.

But there is one little fish, the Nomeus, which swims close to the Man-of-War because it is never in danger of being injured by a sting of the large jellyfish. While other fish are instantly paralyzed by those long tentacles, the little Nomeus can swim around and through them all day long and never be disturbed. It is no surprise, therefore, that the little defenseless fish stays close to the Man-of-War.

It should also be no surprise that other fish, intent on eating the little fish, chase him right into the tentacles— where those larger fish are instantly caught.

DESERT ANT —The desert ant (Cataglyphis) Of the Sahara Desert is the fastest-running insect on earth. He can run a yard in one second or 2 miles an hour. Living out in the desert sand, he wanders far from his nest over featureless sand, but he always knows where he is and easily finds his way back home. Most ants have two eyes, but the desert ant has five. The extra three are located in his forehead between and above his normal eyes. With them he sees polarized light, and navigates by seeing features in light which we cannot see. Without his speed and special eyesight, he could never survive under such harsh conditions.

GIRDLER BEETLE— The mimosa girdler beetle knows that it must go to the mimosa tree in order to lay its eggs. Arriving there, 'tt searches for the proper place for the eggs. Eventually it finds what it is looking for: a very small tree branch. Going about a foot or two from the trunk, the beetle carefully cuts a notch in the bark all the way around the tree, for it somehow knows that its particular babies cannot live on fresh mimosa bark; it has to be dead! Who told the beetle that a notch has to be cut around the entire branch in order to kill it?

AWESOME CREATURES —The railroad worm of South America journeys along looking somewhat like a locomotive or a diesel truck. It has a red light on its head and 11 pairs of greenish Eyes.

The Algerian locust protects itself by opening a pore between the first and second joints at the base of its leg,—and shooting a stream of special juice as much as 20 feet [61 dm]!

There is a species of blind termites which has a bi-lobed gland on the head which contains a fluid that solidifies when it comes in contact with the air. Although blind, this termite in some unknown way knows exactly which direction to fire its fluid. The jet stream flies accurately into the face of an invading ant, who immediately leaves.

The china-mark moth is exquisitely designed both in line and color drawings. But that is not why we mention this little creature here. Unlike every other caterpillar in the world, It spends the entire caterpillar stage of its life underwater!

WATER BUG —This little water bug is greenishblack and about an inch long. It brandishes plierslike pincers which it uses to catch its food.

When the female is about to lay her eggs, she goes over to where the male is swimming around and stops him. Then she carefully lays all her eggs on his back! A sticky glue is placed underneath each pinhead-sized egg.

This load presents problems for the male, for now it is easier for him to float to the surface, so he needs to hold onto a water plant for support. As with all water bugs, he must occasionally come up for air. So he crawls up the leaf, catches a bubble beneath his wings, and then crawls back down under the water. There are little holes in his wings called "sphericles;" with these he takes oxygen from the bubble and sends it through special reservoir tubes into his body.

If there were no water plants to hold onto, the male could not carry the eggs for he could not get oxygen. Then he would have to kick off the eggs and they would die.

While he carries the eggs on his back, he massages them with hairs on his hind legs. This stirs up the water and cleans fungus off them. Gently he rubs the eggs several times each day. Every so often, he does "push-ups," and this circulates water around the eggs so they will get enough oxygen.

The male carries them for 3 weeks on his back, and then they are hatched. Why does the female lay her eggs on the male's back? Well, it is impossible for her to place them on her own back, and she dare not place them on a stone or water plant, for then they will be eaten.

TARANTULA SPIDER —**This** large spider has hairs with sharp fishhook barbs. When a snake draws near to strike, the spider knows to pull out hairs and—just as the snake lunges forward, the spider throw them up in the air and jumps back. The open mouth of the snake snaps onto these barbs and he leaves.

The tarantula does not spin webs but lives underground in a room which it lines with silk. Tiny toads 1/10th of its size go into that hole and live there with it. They protect the spider and its eggs from ants. In turn, the spider protects them from the western ribbon snake.

When the snake comes, the toads run together and the spider jumps on their backs— and challenges the snake. Then when the snake gets a mouthful of barbs, he backs out of the hole, and the toads go back to eating the ants. If a toad accidentally gets a baby spider in his mouth, he feels the hooks—and spits it out, unharmed, right away.

WHIRRING WINGS— Who is the mechanical genius that devised the wings of the insect, Glossing palpalis, which beat 120 times a second, and arranged the timing of the beat so that the wing actually rests three-fourths of that time!

Who created the wings of the tiny midge (an insect less than one-tenth of an inch long) that beats over 1,000 times per second!

LEGS OF THE GRASSHOPPER —Scientists have studied the marvelous hind legs of the grasshopper. This little creature can leap about 10 times its body length in a vertical jump, or 20 times its length (almost one meter]39 inches]) horizontally.

The grasshopper only weighs two grams [30.8 g), and its leg muscle is only 1/25th of a gram, so it has a power to weight ratio of 20,000 to one. Its tiny hind leg muscle exerts power equivalent to 20,000 grams for each gram of its own body weight.

ICHNEUMON WASP —Imagine a tiny creature that looks so delicate that the slightest wind might blow it over. Then this little thing lands on a hard tree trunk, and begins thumping with something that looks as delicate and frail as the leg of a daddy-long-legs. Frail? that antennae of the ichneumon wasp happens to be a high-power extension drill!

The drill is about 4 1/2 inches [11.43 cm] long; so long that it curves up and down as the small fly thumps on the hardwood with it. After thumping for a time, the tiny creature somehow knows it has found the right place to start work.

Drilling begins. This little wasp uses that delicate feeler to cut its way down through several inches of hard (hard!) oak wood! How can it do it? No one has any slightest idea. But it does do it.

The second miracle is what the wasp is drilling for— the larvae of a special beetle. How does it know where to start its drill so as to go straight down (it always drills straight down) —and reach a beetle larvae? No one can figure that one out either. Somehow that initial faint thumping gave it the needed information.

The ichneumon wasp (Thalessa) lays its eggs on the larvae of the Tremex. When those eggs hatch, they will have food to grow on. Then, before they grow too large, tiny ichneumon wasps come out through that original hole.

INSECTS AND INFRA-RED —Philip Callahan reports that a number of insects communicate by means of infra-red! They catch infra-red radiation with their antennae and sensory hairs.

In order to send messages by infra-red, the body sending the messages must be warmer than ambient temperature. For example, the corn earworm moth warms its body by vibrating its wings before it initially starts into action for the night. Then it takes off and begins flying. Its body is now warmer than the atmosphere and it will radiate detectable blackbody infra-red. This infra-red signal is modulated into peaks by the flapping of the wings. The signal is strongest from the sides of the moth, and most of the heat is generated by the thoracic (wing) muscles. This produces a directional signal, and is picked up directionally by other moths because they have antenna pits which consist of vectored elements arranged in a 360° circle around a main detector.

That brief description will afford you a hint of the complicated aspects of infra-red signaling, which many insects regularly do. Callahan found by experimentation that the vibration of insect antenna match log periodic emission bands of the micrometer wavelengths of infra-red!

By the way, how can an insect sense heat from another insect 20 or 30 feet [61-91 dm] away? Think about that one for a time.

SURPRISING CREATURES —The grasshopper does not have its ears in the usual place. According to the species, sometimes they are underneath its abdomen, and sometimes in its forearms.

In Java there is a strange earthworm that sings—and even whistles!

The *Difflugia is* a type of amoeba. This tiny creature gathers sand grains, and then cements them together into a house! Using a sticky secretion, it makes a ball-shaped house with a hole in one side. As it travels about it carries its house with it. When enemies approach, the amoeba jumps inside!

BANANA SLUG —This is the longest slug in the United States and the second longest in the world. It is 10 inches long (most slugs are only 1 inch in length) and lives in the Redwood National Park in Northern California.

It has two pairs of tentacles on the front of its head. The upper two pair are longer and are its eyes. They are set high in order to give a better view. Each eye can move around independently of the other. Or, at will, they can periscope down into the head and back out again.

The lower two pair are sensory organs. With these, it can smell. Special sensory cells, similar to those in your nose are on their tips. But sense of touch cells are also on those same tips. So it can touch and taste at the same time.

Each tentacle is less than 1/2 inch (.635 cm) long and is thinner than a pencil lead. If one of the four (two eyes and two taste/touch organs) are lost, it will grow back within a short time, and work just fine after it does!

There is not a bone in its body, yet it has a sharp jaw that can bite off food. There are barbs on its tongue which saw through food, which is then pulled back and down its throat. Behind its head there is a hole which opens to its lungs. The banana slug knows to close it during rainfall otherwise its lungs would drown. Having no arms or legs, it moves by a muscular foot which reaches out and pulls it forward.

A "peddle gland" produces sticky saliva which protects it from sharp objects in the ground beneath it. When an enemy approaches, the tiny creature gives off a mucus that tastes terrible. Another mucus keeps it from losing water through its skin. After climbing up into a tree, it falls out! The sticky mucus helps it return to the ground. It pushes out some sticky mucus from its tail, and then lets itself down slowly from a thin cord of this mucus.

ROTARY ENGINE— One bacterium has small hairs twisted in a stiff spiral at one end of it. It spins this corkscrew like the propeller of a ship and drives itself forward through water. It can even reverse its engine!

Scientists are still not clear how it is able to whirl the mechanism. Using this method of locomotion, it is able to attain speeds which would, if it were our size, propel it forward at 30 miles [48 km] per hour.

Commenting on it, Leo Janos in *Smithsonian* said that "nature invented the wheel." Another researcher (Helmut Tributsch) declared: "One of the most fantastic concepts in biology has come true: Nature has indeed produced a rotary engine, complete with coupling, rotating axle, bearings, and rotating power transmission."

INSECT WINGS —The typical insect wing is a superbly designed piece of flying equipment. It is a thin membrane reinforced with numerous veins which give it a powerful stroke potential in regard to strength, light weight, and carrying capacity.

The wing movement of an insect is complicated, and requires that each tiny wing move up, down, forward, backward, and also twist. Folding and buckling of the wing is also needed during wing operation.

Well, then, just how does the wing do all that and produce any flight at all? It does it by following a figure-eight pattern. Insects fly forward by using this figure-eight pattern. Some can hover using it, and some can even fly backward with it. The trick is the tilt of the wings and the angle of the figure-eight. A few exceptionally good fliers can fly on their sides—or even fly a rotation about their head or tail! This is done by utilizing unequal wing movement.

One scientist, Romoser, noted that the wing movement of insects is so efficient that it produces a polarized flow of air from front to rear during 85 percent of its wingbeat cycle! That is a terrifically high-efficiency air-flow pattern from an up-and-down flap of an insect's wings!

A scientist concluded several years ago that the honey bee has a body too large and heavy for the size of its wings, and therefore it should not be able to fly. We need to tell that to the honey bees. This wing-to-weight ratio is even more extreme in the bumble bee.

The worker honey bee has many duties in the hive and it could not do them efficiently if it had large wings in relation to its girth and weight. So it has small wings—but beats them faster. While some beetles have a wingbeat of 55 per second, the wingbeat of the honeybee is over 200 per second. (The mosquito is 600, and the midge is 1,046 per second—but keep in mind that the mosquito and midge are very tiny, compared with the large honey bee.)

BUOYANCY REGULATORS —Man was able to invent the submarine when he knew enough about structural steel and a number of other factors. A very important principle was buoyancy control. Without a method of taking the submarine up and down at will, it could not effectively be used.

Microscopic radiolarians have oil droplets in their protoplasm by which they regulate their weight underwater, and thereby move up and down. Fish push gas in and out of swim bladders to do the same thing. If they did not do this, they could still swim forward and turn, but they could not swim upward or downward.

The chambered nautilus has flotation tanks in its inner chambers. This mindless creature knows to alter the proportions of water and gas in these tanks, so that it can regulate its depth.

The giant cuttle fish has similar cavities, but they are located in its internal shell, the cuttlebone (the same one your canary likes to eat). When it wants to move upward, the cuttlefish pumps water out of its cuttlebone skeleton and allows gas to fill the emptied cavity. How did it learn to do that?

In each case, these creatures extract oxygen and other gases from the water, and use part of them in these floatation tanks.

PAPER MAKERS— The invention of paper was a major achievement for mankind. But wasps, yellow jackets and hornets have been doing it all along. They chew up old wood and produce paper to make their nests

Hornets, for example, hang their grey-paper nests from trees. The outer covering is many layers of paper, with dead-air spaces in between. This provides heat and cold insulation equivalent to a brick wall 16 inches [40.64 cm] thick.

STRANGE SIGHTS DEEP DOWN — The scarlet shrimp shoots forth a cloud of luminous fluid to blind its assailant with light, while the shrimp escapes in the dark.

The Venus girdle appears to be a long ribbon of light as it moves through the water.

The sea gooseberry is a small creature about 1 1/z inches [3.81 cm] long which shines brightly at night, but in the daytime is a lovely mass of beautiful colors like the colors in a rainbow.

WATER SKATER —These are the little insects which run about on the surface of ponds. Someone finally decided to examine the bottom of their feet with an electron microscope. It was found that their feet have many small pits surrounded by hairs. Inside the pits are air bubbles, and around the pits are the hairs to help hold the bubbles in. The hairs also give the insects traction as they walk and run about on water.

JET PROPULSION— Most large passenger planes today are jet-propelled. Many invertebrates are also. This includes the octopus and squid, which can travel very swiftly by using powerful muscles to shoot out water forcefully.

Jellyfish, scallops, the chambered nautilus, dragonfly larvae, and even some oceanic plankton use jet propulsion to move about.

FIDDLER CRAB —Evidence and testimonies are available that the fiddler crab can foretell cyclonic storms. But no one can understands how the little creature does it.

These crabs live in shallow, water-filled holes a few feet above normal tide level. Several hours before a hurricane strikes, they leave their holes and scurry inland. In this way they escape the destruction that would come if they remained in their little puddles next to the ocean. They have this ability to detect serious storms in advance, whether they be hurricanes, tornadoes, or major wind storms.

FIREFLIES —NO One has solved the mystery of this tiny creature, although scientists have spent years trying to do so. One researcher, determined to discover the cause of the fire in the fly, spent his entire adult lifetime at the task, yet failed to do more than to name the substance responsible. *(Luciferln* [light-bearing compound] it is called.)

The firefly makes light with almost no heat. Yet every other source of light of which we know (apart from certain luminous animals and plants), produces large amounts of heat as well as light, thus wasting a lot of energy when heat is not wanted or needed.

Then there is the signal system used by the firefly and the glow worm. It is well known among scientists that they have a code system of flashes, something like flashed dots and dashes, but no one has broken the code yet. The male (the "firefly") flies through the air, signaling as he goes. Down on the ground the female (called a "glowworm") signals back.

MAGNETIC COMPASSES —It was not until the 13th century that navigators began using compasses, which at first were magnetic needles floating in a bowl of water or oil.

But from the beginning, bacteria have had within them strings of magnetite particles just the right size to make a compass. These guide them back to preferred locations. Keep in mind that, even though a bacterium is quite small, the distances it travels can seem long to it with many twists and turns.

Magnetite is a natural magnetic stone. Particles of it have been found in other creatures as well, and apparently helps guide them in their journeys. It has been found in birds, bees, butterflies, dolphins, mollusks. How did the particles get there?

MONARCH'S HEAT SYSTEM —This IS the Wellknown orange and black butterfly that is so beautiful. Elsewhere we have mentioned how it migrates each winter hundreds of miles to a place far away. But just now let us consider the requirements of its heating system. Doing so will help us to better understand the flying and resting movements of many other butterflies:

The monarch "rests" on a flower with its wings straight out. It does not do this to rest, nor to help it obtain nectar, but to soak up sunlight. Heat from the sunshine is absorbed by its wince, and is then transferred to the thorax (its trunk) and internal organs within ft. When its body temperature is at least 81 °F [27°C], ft is ready to begin flying.

Once in the air, it can still fly when the temperature drops lower, but not below 50°F [10°C]. Its body muscles must be at least 81 °F [27°C] before it begins flying, but once in motion, tiny cells on its wings act as heat collectors and they continue to soak up heat from the sun. Two principles apply here: (1) It is easier to heat something thin, than something thick, and (2) darker wings absorb heat somewhat better than light wings.

Early in the morning, the monarch will climb up on a leaf or flower and angle its wings to get as much sunlight as possible when the sun begins to shine. This little creature knows to angle its wings towards the sun. In this way, they act as "heat sinks" to collect heat from sun rays.

If it is a cool, sunny day and the butterfly has already reached the needed temperature to get started flying for the day, it will only fly short distances and then "stop to rest on a flower." It is neither resting nor looking for nectar, but warming up its body again. Then off it will go again for another short distance. When doing this, the butterfly prefers to land on light-colored flowers, like daisies. In this way heat will also be reflected up from below.

If the sun goes behind a cloud, then the monarch must find some other way to generate heat. So it perches on a flower, closes its wings and makes them quiver very rapidly. This produces friction in its wing muscles—and its body becomes 10°F warmer! It is shivering with its wings closed till it becomes warm enough, and then it will fly again.

When the day becomes hotter, flying can help it cool off for a time, but when the heat increases still more, the butterfly flies to a shady spot, lands, and closes its wings. In this way, even the warm rays reflected by clouds will not be absorbed. The hottest its body can safely be is 105°F [41 °C]. Scientists think that, somewhere in its tiny body, there must be a special thermometer which tells it the temperature. Without that thermometer, it would not know when to heat up or cool off. But even with such temperature information, how would the little creature know what to do to warm up or cool off? Yet it does know, and its life depends on the fact.

PALOLO WORM —This little worm lives deep in the oceans of the South Pacific. It burrows into coral reefs and at certain exact times it reproduces. This is done by breaking off half of its body, which floats to the surface of the ocean! Natives on islands in Samoa and Fiji know exactly when this occurs each year.

CLOCKWORK —When the tide is out, diatoms-among the smallest creatures in the ocean-come to the surface of wet beach sand. When the tide comes in, they go down into the sand again. When these same diatoms are taken into the laboratory, although there is no tidal ebb and flow in that sand, their clocks continue to tell them to go up and down according to the time when the tides are taking place. Figure that one out.

During low tide, fiddler crabs turn a darker color and come out. When high tide arrives, they turn paler and dig down into the sand. Carried off to laboratories, they continue to go through the same cycle of color and digging in accordance with the tides back at the ocean.

CICADA —in 1634, the Pilgrims named this creature the "seventeen-year locust." But the cicada (a sucking insect) is different than a locust (a chewing insect). There are 1, 3, 9, 13, and 17year varieties of the cicada. The 17-year variety is one of the longest-lived insects in the world. This is the story of the 17-year cicada:

The female lays eggs and they hatch in about 1 1/2 or 2 months. The parents die 1 month before the babies hatch, so no information is given them by their parents. Upon hatching, each one drops to the ground and knows to instantly dig in. He also knows to dig down to below the frost line. If he did not do so he would die that first winter. He is called a "nymph," looks like a grub and is 6/100 inch in length.

Having dug into the ground until he reaches a tree root, this tiny creature will spend the next 17 years sucking on sap from that root, using a needle-like tongue to obtain it. During that time, the little creature will molt five times, grow larger each time—and do it all underground.

How does the grub know when the 17 years are up? The answer is simple enough: he has a 17year clock in his tiny head! At a certain time, suddenly all the 17-year "locusts" come out together! They come out after sunset. And they all come out on the same night!

By emerging from the ground at night, birds will not eat them during this especially unprotected time. Underground, below the frost line, how did each one know whether it was night or day? How did each one know that 17 years had passed? How did each one know to come out on the same night as all the others?

It all happens soundlessly. Arriving above ground, immediately they begin climbing trees. Clinging to the bark, they begin their sixth and last molt. The skin splits on their backs, and they crawl out, leaving the old skins behind. They have waited 17 years, and now they wait 2 more days while their wings dry, harden, and strengthen.

Then the racket begins! The male cicadas begin calling with their wings. It sounds as if the woods are full of buzz **saws!** Everyone knows that the 17-year locust has come back again.

The females then make sawtooth marks in trees, and lay their eggs. After 3-4 weeks all the adults die. Several more weeks and the eggs hatch, and the whole 17-year cycle begins over again.

The Creator’s Handiwork

Amphibians and Reptiles

The amphibians Include frogs, toads, and salamanders. The reptiles include lizards, snakes, crocodiles, and turtles. There are astonishing facts about these creatures which clearly prove they could not have been formed by evolutionary processes.

FRESH FROZEN -Some creatures survive the winter by hibernating. Others burrow deep into the ground to avoid freezing temperatures. But there are others which actually do freeze! The painted turtle of the northern U.S., can freeze in the winter and still survive. It can be in water which freezes solid, and as long as less than 54 percent of the water in its body freezes, it will later thaw out and do just fine. As freezing nears, the blood sugar levels in this turtle triples, and certain amino acids, which act as antifreeze preparations, greatly increase in its body. In addition glycerol, another antifreeze substance, triples.

MIDWIFE FROG -Unlike most frogs, the female midwife frog lays her eggs on land close to water. The male midwife frog takes the eggs as they are being laid by the female- and twines the strings of eggs about its hind legs.

He then digs a hole in moist sand or soil, which he does very rapidly. There he sits with the egg string, waiting patiently while the eggs incubate.

Then, at a certain time, he knows to suddenly climb out of the hole and jump into the water and begins swimming energetically. This breaks the egg membranes, and tiny tadpoles scatter in all directions.

GECKO LIZARD- This tiny lizard can walk across your smooth ceiling upside-down without falling off. Scientists could not figure out how the little fellow accomplished the task. Using optical microscopes up to 2,000 diameters magnification, they found thousands of transverse lines running across each of the four finger-like toes on each foot. Well, that gave some information, but it did not solve the problem.

Then the powerful scanning microscope was invented, and it was turned on the foot of the gecko lizard. A series of photographs were taken, each 35,000 diameters or more in magnification. They discovered that each of the "fingerprint" ridges on its toe-was filled with millions of short fibers or hairs; on the ends of each was a tiny suction cup!

This would provide immense sticking power too immense. The poor creature could put its foot down on a smooth surface-and not be able to lift it back up! But the lizard's foot is designed so that the toe joints bend or curl up at the ends. In this way, the gecko lizard can bend up each toe, and unstick them gradually without having to do it all at once.

It was estimated that one gecko lizard has at least 500 million suction cups on his 16 toes How wondrously made are even the smallest of the animal life forms.

Evolution could not enable the gecko lizard to walk on ceilings. Remember that the next time you see a lizard walking on a wall.

SERPENT'S TONGUE -As its forked tongue flickers in and out, the serpent is picking up small particles from the air or ground and transferring them to Jacobson's organ. This is a special structure shaped like a pair of pits in the roof of the mouth, with a sensory organ lining similar to that in a nose,-but much more accurate.

PRODUCING FROGS -A frog lays its eggs, but no frog hatches from the eggs. Instead, a flsh, well, something like a fish—comes out of the egg. It has gills and is entirely aquatic. Remove it from the water where it is swimming and it will quickly die, for it cannot breathe air from the atmosphere.

Soon the tadpole begins to sprout legs. A fish growing legs! In a few days, it undergoes a radical transformation. Its gills disappear, and lungs and other organs are formed. A little longer and the tadpole has become a hog! From then on, it can go on land or into water and is perfectly adapted to both.

Every spring the miracle occurs again. Frogs produce eggs, which become fish-like creatures, which become frogs with lungs.

CHUCKWALLA -The chuckwalla is a desert lizard living in the Mojave Desert in the American southwest.

It is 16 inches [40.64 cm[in length with a creased, wrinkled, baggy hide which looks as if it were several sizes too large. It also has an oversize stomach.

Why is it so wrinkled? At the approach of an enemy the lizard quickly crawls into a sack in the rock. Once inside, it grips the rock, sucks in air, and pumps up its body to as much as 300 percent of normal size. This jams it into the crack so tightly that enemies cannot get it out.

There might not be any rain for a full year, so the chuckwalla is only active in late spring and early summer. The rest of the time it is hibernating. Emerging about March 20, it eats every plant it can find. Beneath all the Baggy, baggy skin along its sides are lymph spaces which it fills with water whenever it can find any. By August its stored water is nearly gone, and it goes into hibernation till the following spring, while living on its food reserves.

The plants it eats all grow on alkali soil, so they are full of sodium and potassium salts. Each summer the chuckwalla eats enough salt to kill it. In its nasal passages there are two bean-shaped glands connected to ducts which run forward to a pool inside the nostril. The glands are a chemistry department which extracts the salts. They flow to the pool, where they are expelled by sneezing.

Because the morning is colder than the evening, this little lizard is a late riser. In the morning it changes to a dark color so it will be able to absorb more sunshine faster. Later in the day, it changes to a light color to help it better reflect the sun's rays.

When the afternoon temperature climbs to 102°F [38.8°C], as it very often does, the lizard craws under a shady rock and pants to cool itself off.

All that required a lot of careful designing by a highly intelligent Creator. And all the design systems were then carefully incorporated into the chuckwalla's DNA coding.

EATING WITH THEIR EYES -Toads and frogs use their eyes to eat with. In swallowing, they close their eyelids, press down with their extremely tough eyeballs, and lower the roof of their mouth against their tongue, forcing the food down and into their stomachs.

HEAT SENSORS -The pitted vipers include, in the U.S., the rattlesnakes and copperheads. These snakes have two small pits or depressions on their heads beneath their eyes. With these pits, the snakes can "see" in the dark, for they sense changes in infra-red radiation aril thus detect very slight differences in temperature.

The crotalid snake has a sense organ on its head which can detect temperature changes as small as 1 /100th of a degree. But consider the rattlesnake: That creature, with its pits, is able to sense a change of 1/600th degree F.

A boa constrictor responds in 35 milliseconds to a heat change of a fraction of a degree.

ALLIGATOR -The alligator pushes together a mound of dirt and lays eggs in it. These eggs have moderately hard shells. Inside each one is a baby alligator which will grow to a length of about 8 inches [20.32 cm]. Then it is time to come out.

But how can it do that? The egg case is too hard to break. So, like many baby birds, the alligator has a special "tooth" on the tip of its nose. Striking it against the egg case causes it to split open and out the baby alligator emerges. Shortly afterward, the tooth drops off.

Where did that tooth come from? To put it there would require thousands of DNA changes. But by the time random evolution accomplished them all, all the alligators in the works would be dead, having not been able to get out of their egg cases.

It is of interest that, although an alligator can close its jaws with a force sufficient to break a person's arm, the muscles that open its jaws are so weak that it is possible for a man to hold the mouth of a full-grown alligator shut with only one hand. (But watch out for that tail!)

REGENERATING PARTS -HOW Can a salamander re-grow an amputated limb? Why is a lizard able to develop a new tail that has been bitten off? Yet many of these reptiles can do this.

Other creatures can do it also. Crabs can regenerate a claw that has been snapped off. If a lobster loses an eye, it will grow a new one.

By the way, if your liver was in good health and part of it was cut out, it would re-grow the lost portion within a few months.

GREEN SEA TURTLE -The glean sea turtle has excellent physiological thermo-regulators. It is able to warm faster and cool slower than any other similar-sized reptile in the works. This trait is needed in the cold ocean waters in which it swims.

How can the turtle become warm so rapidly and cool so slowly? It has the largest difference in warming and cooling heart rate of any reptile. This means that, during the warming process, its heart beats much faster than it normally would. Its cooling heart rate is virtually independent of body temperature,-something that appears to be unique for any vertebrate.

FROG EGGS - When a female frog lays her eggs, they are in a jelly mass which quickly absorbs immense amounts of water. Rapidly, the jelly mass of eggs becomes far larger than the female frog they came from!

PRODUCING MORE REPTILES - Reptiles have a variety of ways of producing young. Skinks, lacertas, boas and vipers belong to groups that have both oviparous (lay eggs) and viviparous (bear young live from placentas) types of members. Still other reptiles, such as sea snakes and certain amphibians, are ovovlparous (have embryos, which develop in the mother but are in separate egg cases).

Some species, such as the adder and the common lizard, lay eggs in warm parts of their habitat (oviparous), but in northern areas will bear their young live (viviparous).

Caecilians look like large earthworms but are amphibians. Some of them lay eggs (oviparous), while others are viviparous and produce milk in the uterus.

The black salamander is viviparous, and nourishes its young, as do sharks, on unfertilized eggs in the oviduct.

At least two kinds of lizards are *parthenogene*tic: the females bear young without having been fertilized.

Two lizards are *hermaphroditic:* two lizards fertilize each other, and then both bear young.

AUSTRALIAN FROG- There is a small Australian frog which has a totally unique method of giving birth to its young. It does not have a placental womb as do mammals, or the marsupial outside pouch that many other creatures in Australia have. And it does not lay eggs in a nest on the ground. Instead it swallows them!

This little creature uses its stomach to hatch the eggs! It uses its stomach both to digest food *and* as a womb!

When this frog becomes pregnant, the stomach stops its digestion functions and ceases to excrete enzymes. Instead, it becomes an incubator, where dozens of baby frogs are hatched.

Soon mama frog has dozens of live baby frogs crawling around in her stomach! Seeing the hole at the top, they crawl up the esophagus into her mouth, and she spits them out. When the last one emerges, the "womb" again becomes a regularly functioning stomach!

GOLDEN TOAD -The golden toad lives in the cloud forest high in the mountains of Costa Rica. Bright orange in cola, this little frog is easy to see when it comes out in the open. Yet, all year long, it is not seen. Then, after the first heavy rain of the spring, the males, which are even more brightly colored, gather in pools of water and sit quietly waiting. Then the females arrive. Thousands of golden toads will be together in a few locations. Within less than a week, mating will be past and they will disappear in the forest, where they will be hidden for the rest of the year. But for a brief time they were all together-in such large numbers that there were too many for their predators to eliminate.

CAMOUFLAGE -The leopard frog lives in moist grass among the edge of ponds, and wears a green coat to blend with the grass, but it also has irregular blotches of brown on its back which are the color of the shadows among the green grasses.

Horned toads in the Southwest have a color so similar to that of the desert sand that the animal is not seen until it moves.

SNAKE EYED Snakes in the viper family do not change focus by changing the shape of their lenses, as do other reptiles. Instead they shift the whole lens farther forward or farther back.

Examination of the retina discloses that these **snakes have twice as many cones as we** do! This means that they can see color far better than people can.

Snake eyes are different from the eyes of any other creature among the reptiles or vertebrates. Even evolutionists admit that the eye had to be newly invented for the snake; it did not get it from anything else.

Vertebrate eyes are like a simple camera, in which light enters the lens, which being actuated by several different methods, then directs it through transparent vitreous fluid to a focus on the retina, the light-sensitive area which covers two-thirds of the rear part of the eyeball.

But in the snake there is an outer "spectacle." Something like a contact lens over the eye, this is the transparent scale that covers each eye. Because the snake must crawl in the dust, and even go down holes in the dirt and between dirty leaves, and between dusty rocks, it needed eye protection. Without that clear, covering scale, the delicate cornea would be damaged and the snake would soon be blinded.

Gradually this outer scale becomes scratched, dimming the snake's vision. But it can sense odors with its tongue, and (in the case of the pit vipers) directional heat on its pits, so it can make it without clear eyesight. Several times a year the snake sheds its skin. At that time it gets a new spectacle, and can see well again for a time.

A snake with transparent scaled Yes, as we have just observed, there are two of them on every snake. Would anyone say it is by coincidence-that they are right over its eyeballs! How could the randomness of "evolution" produce that?

HUNGRY TOADS -if it has no food to eat, a toad can go for a full year without food. It spends most of this time resting to conserve heat and energy.

SALTY CREATURES -Sea turtles and sea iguanas (a mammoth lizard) both have the ability to remove salt from the water they drink. Special glands in their bodies routinely accomplish this task.

DARWINS FROG -This Small frog does something so unusual that Darwin ought to be embarrassed that it is named after him, for it does not help the cause of evolution.

The male has vocal sacs which he uses to sing with, but they are structured in such a way that he can also use them to hold the eggs that the female lays! The eggs go into his mouth and from there do not go into his stomach, but into two channels on the floor of his mouth. These lead into a pouch under his neck which grows larger as the eggs hatch. When the baby frogs are born, they remain there till they pass through the larval stage.

CROCODILE -The Nile River crocodile never bothers the plover, because that little bird walks over to it as it opens its huge mouth with 48 teeth -and cleans them! The bird will fly about its head to catch its attention. Seeing the little bird, it comes out on land, opens its mouth-and the bird walks right inside to give the teeth a good cleaning!

When the crocodile opens its mouth, no water goes down its throat because of a special flap at the back of its mouth. When it closes its mouth, the water continues to run into it because it has no lips and many cracks.

After 30 minutes underwater, all of its metabolism slows down, with the exception of its heart and brain. In this way it can remain underwater longer.

This large creature, which is 18 feet [30.5 dm] long and 1,800 pounds [816.5 kg], has a special transparent eyelid that covers the eyeball when it is submerged. The eyeball is designed with shiny skin behind the retina, in order to reflect light onto the retina. In this way it can see better in the darkness under the water than it otherwise could.

HORNED DESERT VIPER -The Egyptian horned desert viper is 2 feet [61 cm] long and yellowish-brown. It lives in sand which frequently is 115°F [46°C]. Yet if the body temperature of this snake goes over 105°F [40.5°C], it will die. How then does it survive?

In the daytime, it crawls under the sand where it is cooler, remaining there till evening. It has special scales on its body which it opens up and, like little shovels, uses to scoop out sand. As it does this, it throws that sand on top of its body. This snake can do that operation in 2 seconds! Then it crawls under the sand and keeps cool and avoids desert hawks.

Once under, it leaves the last 2 inches [5.08 cm] of its tail above the sand. This tail wiggles every so often, and that intrigues the desert mouse, which the snake then catches.

There is a horn above each eye, which is something like an awning to shade the eye from the sun. But when the snake throws sand up and over its back, the horns keep the sand from falling into its eyes-not only when it is digging, but afterward while it is hiding under the sand.

The sand is too slippery and hot for a snake to crawl through in the regular way. So, the Egyptian horned desert viper crawls sideways through the sand, just as does the sidewinder in the American deserts. It humps its body up as it goes so that only parts touch the sand at any given time. This leaves "J" marks in the sand. the snake looks like it is going forward when it is really going sideways. Who taught these two snakes, so very distant from each other, to travel in the same way?

TURTLES -Turtles have special water sacs at the rear of their bodies. When a turtle submerges, water is drawn into these sacs and then expelled again. Air in the water is absorbed by a special type of "underwater lung" arrangement. In this way, oxygen is supplied to the turtle's body while it is underwater. When the turtle comes to the surface again, it opens its mouth and breathes. That air is taken into its regular lungs to provide a more direct flow of oxygen to its body. So the turtle has two totally different types of lungs!

STICK LIZARD -No, it is not a stick lizard, but it is a lizard with a stick. This is a small lizard in the Near East which likes to make sure a stick is always near for protection. No, it does not beat its enemies over the head with it! Instead, it goes about its business eating and resting in the sun. Then, when an enemy is about to leap upon it, the little lizard grabs that stick- and holds it sideways in its mouth! Who wants to eat a stick; especially one that won't fit in its mouth?

The special enemy of this lizard is the snake, and it has to swallow its food whole. It cannot merely bite off a piece and swallow that, then bite off another piece. Because the serpent cannot swallow both the lizard and that sideways stick, it gives up and glides away.

GREEN SEA TURTLES -The green sea turtle migrates from the coast of Brazil to tiny Ascension Island, 1,400 miles [2,253 km] out in the Atlantic Ocean, and then back. No one has figured out how the green sea turtle knows where to go, or knowing, how it is able to find that tiny island in the middle of the Atlantic.

SEYCHELLES FROG -This little land frog lives on the Seychelles Islands, off the coast of Kenya, Africa. It is 1 inch [2.54 cm] long and light brown with dark brown horizontal streaks.

The female lays eggs on the ground, and the male guards them. When predators come, he lures them away. These frogs and their eggs are never in the water. When the eggs hatch, the father exudes a liquid goo onto his back. Then he hops near and touches the tiny frogs. Immediately they swim up by means of that liquid onto his back. Once on, the father frog can hop around and his babies will not fall off!

They swim around through that liquid on his back for a month. All during that time, his back continues to exude more mucous. During that time, they feed on the yolk in the eggs. They must be in fluid during that time, since baby tadpoles have no lungs as adult frogs do. Instead, their long tails have blood vessels close to the skinwhich absorb oxygen and give off carbon dioxide.

After a month, they jump off his back and hop away. The mucous on the father's back stops coming out and his back dries off.

PIPE SNAKE -The pipe snake of Southeast Asia is somewhat blunt at both ends, hence the name. It is difficult to tell which is the front end.

When an enemy comes, the tail end flattens out, rises in the air -and looks like an angry cobra defending itself. Looking more closely at this "head," we find that it has black and white bars, just like those on the cobra, with a red tip at the end that looks like its mouth! There it is with its "head" raised, seemingly ready to strike, while its body is coiled-and underneath those coils is its real head protected. If the enemy leaves, as much of the time it will, then the pipe snake uncoils and quickly travels to a safer place.

This is not a trait which the pipe snake learned.

It lives in the same regions where the dreaded cobra lives, and it is born with this protective coloration, flattening and other abilities. As soon as a pipe snake is born, it can imitate a cobra.

GLIDING TREE FROG -The gliding tree frog never goes into water, but remains all its life in the trees and on the ground of the Borneo jungle. It has webbing between each toe which it can spread wide like a duck's foot. This helps it glide like a little parachute. With its sticky toes, it climbs to near the top of a tree 140 feet [426 dm] above the ground. Then it sucks in its neck and stomach so that both are concave-curved inward and then it leaps out into the air!

Before jumping it selects a landing spot near the lower part of another tree. As it travels, it has a range finder in its eyes and brain that tell it that, based on the vertical distance to the ground and the horizontal distance between the trees, the diagonal angle of this leap will be 230 feet [701 dm].

Downward it goes, twisting its feet slightly-as a rudder-to help it turn toward the left or right. At the last moment, it tips up so that it will land with its head up on the tree trunk. From there, it jumps a final 6 feet [18 dm] and lands perfectly on the ground.

Yet all this was done in the inky blackness of night inside a jungle, with the overhead foliage shutting out the starlight) The little frog does all that sighting, leaping, and landing in apparent darkness.

Before concluding, let us consider its nest: Baby frogs are tadpoles and must have liquid to swim around in, but this frog never enters the water. So it builds a nest in the trees out of foam! Both the male and female release albumen from their body onto the top of a large leaf, stir it up till it is foamy, then the female lay eggs in it. By the time the eggs hatch, the foam is more liquid, and the tadpoles swim around in it. Eventually they grow large enough-although still tiny creatures-that they jump out of the nest. When they do that, they plunge over a hundred feet to the ground below. Being so light-weight, they land without injury and hop away.

INCUBATING EGGS—Sea turtles and some birds lay their eggs in the warm sand. In this way they are kept warm until they hatch. Some alligators will gather together a mass of decaying vegetable matter, and lay their eggs in it. As the vegetation continues to decay, the temperature will remain warm enough to nicely incubate the eggs.

ALPINE SALAMANDER- Climbing up into the high grasslands on the slopes of the Alps, from 3,000 to 10,000 feet [914-3,048 m] altitude, you will find the Alpine Salamander.

When the female is ready to lay her eggs, she does not do so in the regular manner, for it is too cold outside. Instead, 50 eggs go from the ovaries into the oviducts; of these, two will be fertile. These will hatch and then remain in the female's body, living and growing as they feed on the other 48 eggs in there! How could only two-exactly two-be fertilized, and not the rest, since they were all expelled from the ovaries?

When they finally emerge, they are just like their parents but smaller.

EGG-EATING SNAKE- There are certain snakes which primarily eat eggs. These snakes are about 2 feet tong, have a narrow head and slender body, no sharp teeth, and are not venomous.

These creatures can swallow eggs which are wider than their bodies) It would be equivalent to a human swallowing a basketball!

Locating an egg, the snake coils around it, and then opens its jaw several times to exercise it. Next it begins to swallow that egg! It unhinges its jaw, opens it amazingly **wide, and starts** taking in the egg. This is not easy to do, and the snake must push his head against it for about 20 minutes in order to succeed. It is a close fit!

As the egg enters the throat, the egg begins to crack. This is because there are about 30 teeth in a row along the back of the throat which point downward. The first 17 are knife-like and long; the next several are broad and flat; the final ones are more like stumps. When the egg reaches the back of the throat, the snake begins moving its head forward and backward over the egg, and this causes a sawing action by the teeth on the eggshell.

When the egg breaks, the liquid flows down into the stomach, but in front of it is a valve which admits the liquid- but not the egg shells. The snake then carefully gathers the egg shells into a ball and spits them out.

This snake feeds only for about one or 2 months a year, during egg-laying season. The rest of time it rests or hibernates.

Imagine a creature with teeth in the back of its throat instead of in its mouth!

SNAKE EARS-A special bone is attached to a serpent's jaw. As a result, the snake can hear best when its head is pressed dose to the ground. But when the head is lifted into the air, its hearing is much poorer.

FLYING SNAKE-There is a snake in South America, called the paradise snake, which flies from one tree to another. h is really more of a glide than anything else, for the snake has no wings. As it launches from a tree limb into space, the snake flattens its ribs tremendously and then glides to a landing place. Arriving at its destination, it recoils its ribs in their regular rounded arrangement, and then it crawls away.

FALSE-EYED FROG- The South American false-eyed frog is an interesting creature. Generally about 3 inches [7.62 cm] long, it is brown, black, blue, gray, and white! Drops of each color are on its skin, and it can suddenly change from one of these colors to the others, simply by masking out certain color spots.

The change-color effect that this frog regular produces is totally amazing, and completely unexplainable by any kind of evolutionary theory.

The frog will be sitting in the jungle minding its own business, when an enemy, such as a snake or rat, will come along. Instantly, that frog will jump and turn around, so that its back is now facing the intruder. In that same instant, the frog changed its colors! Now the enemy sees a big head, nose, mouth, and two black and blue eyes!

All of this looks so real-with even a black pupil with a blue iris around it. Yet the frog cannot see any of this, for the very intelligently-designed markings are on its back!

The normal sitting position of this frog is head high and back low. But when the predator comes, he quickly turns around so that his back faces the predator. In addition, the frog puts its head low to the ground, and raises hind parts high. In this position, to the enemy viewing him, he appears to be a large rat's head! In just the right location is that face, and those eyes staring at you!

The frog's hind legs are tucked together underneath his eyes- and they look like a large mouth! As he moves his hind legs, the mouth appears to move! The part of the frogs body that once was a tadpole's tail, now looks like a perfectly formed nose, and it is in just the right location!

To the side of the fake face, there appear long claws! These are the frog's toes! As the frog tucks his legs to the side of his body, he purposely lifts up two toes from each hind foot, and curls them out so they look like a couple of weird hooks. And the frog does all of this in one second!

At this, the predator leaves, feeling quite defeated. But that which it left behind is a tasty, defenseless, weak frog which can turn around quickly, but cannot hop away very fast.

The frog will never see that face on itself, so it did not put the face there. Someone very intelligent put that face there! And the face was put there by being programmed into its genes.

The Creator’s Handiwork

the fish

Billions of fish in thousands of species swim in the oceans, rivers, and lakes of the world. Yet their lives point to the Creator who made them. Come, let us consider the fish. They have an important lesson to teach us:

FISHY DESIGNS -Scientists have tried to figure out the shape of the fish. It is obvious that a fish is shaped in such a streamlined fashion that it will glide through the water with the least effort. But, in addition, it has been discovered that the mouth is located exactly where water, with its oxygen, will be most easily taken in through the mouth. After the gills extract the oxygen from it, this water is then expelled behind the gill flaps at the point where outward pressure will be the greatest to pull the water out of the fish, with the least effort on the fish's part. The eyes are located at exactly that point where water pressure while swimming is zero. This is important, for water pressure on the eye would distort the fish's vision differently at different speeds. The heart is located in a point where outward pressure is strong, so that, after each heart beat (each heart contraction), the heart can easily re-expand before the next heart beat.

MOVING EYES -There are fish which swim horizontally, while the longest sides of their bodies are vertical (sea horses); there are fish which swim horizontally with their longest sides to the right and left (sardines, tuna, salmon, etc.); there are fish which are more roundish (bass); there are also fish with net, pancake bodies -some of which remain vertical all their lives (sunfish), while others later change to a horizontally net position (soles).

Many of the fish which have horizontally flat bodies undergo a strange transformation during their life. They change into true "flat fish," with horizontally flat bodies.

At first, this type of fish will swim and look just like a regular vertical fish. But then one of its eyes will begin migrating to the other side of its head! Imagine the involved process required to do that! Beneath the skin of every fish, reptile, and mammal, there are many muscles, nerves, blood vessels, tones, and other structures. In the midst of all that maze, how can an eye move to the other side of the head? The optic nerve connects that eye directly to a certain point in the brain. How can the eye move halfway around the skull, without its optic nerve being sliced in two by muscles, tendons, and other obstacles it meets?

All of the Pleuronectidae ***(fish*** that swim on their sides), undergo this unusual change. After being born, at first they swim around as do other fish, but after a month one eye begins to move. Meanwhile the body slowly flattens sideways and the small fish, originally a surface swimmer, begins to sink slowly towards the bottom. By six weeks the eye has reached the top of the head, and a week later it is almost next to the other eye! By now the young fish has sunk to the bottom and is lying on what was once its side. That side will turn white and the two eyes will be on the top side.

With plaice, soles, dabs, flounders, and halibuts, it is always the left side that goes down and the left eye that moves; these are called "dexteral fish." But other species (such as the turbot and brill) are called "sinistral fish," and in those fish the right eye travels toward the left eye and away from the right side on which they eventually lie.

Many of these fish have a very special ability to change color in accordance with the sand or mud they are on. If the sand is white with brown and black specks, the fish will look just the same as that sand, and will have the same size, texture and color of markings!

DEEP-SEA FISH- Some deep sea fish have telescopic eyes, set on long stalks. Others are equipped with headlights like a car. These lights are placed in front of curved, glistening reflectors near the eyes and are projected as two beams of light.

Two kinds of fish (photblepharon and anomalops) carry lanterns which are luminous plants with tiny bacteria in them. Just below the eyes are the receptacles for holding the lanterns. There is even a mechanism for turning the lights on and off.

Constellation fish have five horizontal rows of illuminated spots, one above the other. The great gulper eel (Saccopharynx harisonl), 55 inches [140 cm] long, has a flaming red light organ near the tip of its tail.

Some fish have illuminated circles around their eyes and mouths, others glow all over. Then there is the fish that carries a lantern at the end of a long rod above and in front of it.

PORCUPINE FISH -This is a little tropical fish which goes about minding its own business until an enemy , arid then it goes into action with a surprising defense technique. Suddenly through its gills it takes in large amounts of air very rapidly, and as it does so it blows up like a balloon! It has changed from a regular fish to a round balloon fish. Because it has small spines protruding outward all oust its body, when it expands these spines sticking out of the large ball make it a positive menace to any fish that might consider biting in.

CODFISH -The codfish feeds 80-240 feet [183732 dm] deep at the cold bottom of the North Atlantic. There is a whisker under its chin that is made of skin, which smells food. As the fish swims it brushes that feeler along the bottom, searching for small crabs and other creatures.

The codfish knows that it must not lay its eggs where it lives, so it goes to the warmer surface and always lays them amid rich areas of plankton, so the babies will have food to eat. Each codfish lays 4-6 million eggs at a time. Only 1,000 will grow to adulthood, but that will be enough to keep this fish in the ocean, since many of the adults will be eaten before laying eggs.

The codfish is the second most abundant food fish in the world.

STICKLEBACK -The stickleback looks like many other fish in streams and ponds, but it is different in a special way. The male stickleback makes a nest of leaves and twigs, mates with the female, and then remains to guard the eggs till they hatch.

He begins by nosing out a depression in the sand and carrying sand away by the mouthful. Next he digs a tunnel by wriggling under the pile of nest materials, made of twigs and leaves. With the nest ready, he waits for a female. When she arrives, he dances, zigzags, stands on his tail, and turns and swims rapidly toward the nest while she demurely follows. Then he shows her the tunnel, which she enters. He prods her to lay eggs, and then chases her away, lest she remain and eat the eggs.

Facing those eggs, the male then fans his front fins in reverse. To hold still, he swims forward with his tail. The bubbly current brings fresh air to the eggs and helps them hatch rapidly.

As soon as they hatch, the babies are interested in seeing the world, so they start swimming toward the sunlit surface. Immediately, he chases after, and catches them in his mouth. Returning to the nest he spits them one by one back into the safety of the nest. Later, when they are able to care for themselves he leaves.

DECOY FISH -Off the coast of Oahu, Hawaii, lives the care decoy fish. The dorsal fin is the one at the top front of a fish. But this particular fish has a dorsal fin -that looks like a small fish! The fin is shaped like a fish head, with a dot where the eye should be, The fin membrane is notched between the 1st and 2nd spine and resembles the mouth of a fish. The fin has the color of a fish, but the horizontal bottom of the fin is transparent, so it will not appear to be attached to the decoy fish below it.

When the decoy fish sees possible food swimming near, it goes through a special routine to attract it to draw near: (1) The decoys fish's dorsal fin goes up and displays the shape of a smaller fish. (2) Immediately upon raising the lure to view, the fish stops its gill movements, and slows its breathing. (3) The fin lure changes to a deep red color, and a small horizontal area at the base of that fin changes to a transparent see-through band. (4) While the decoy fish remains motionless, it now moves the decoy fin from side to side, and causes that slit (the "mouth") to open arid shut! (5) The other fish draws near, curious to see that inviting small fish. (6) Then, suddenly, the decoy fish snaps its prey in one quick movement. (7) The fin color fades away and the fin is folded down onto the back of the decoy fish.

How could "natural selection" do all of that?

PIPEFISH -This little creature is somewhat like a seahorse, but it is shaped like a tiny vertical pipe. One-fourth of an inch wide and 6 inches [15.24 cm] long, the pipe fish can change color from brown to glean to match the grass it is in.

It has special cells which send a signal to the brain, which then studies the message to determine the exact color of green, etc. Then a signal is sent to the pigment glands in the skin. The dark green pigment gland squirts out some dark green pigment. Or several glands will squirt out a combination of colors to provide an exact color-match to the background! That entire process takes about 20 seconds. Many other fish, as well as some reptiles and amphibians, can do it also.

Ocean currents move and sway the eel grass, so the little pipe fish must move and sway with it also. Sensitive to grass movements, the fish sways back and forth with the grass.

Because the eel grass is vertical, the pipefish swims vertically also, but if it wants to do so, it can just as easily swim horizontally. Only the pipe. fish and the sea horse routinely swim vertically.

Like the sea horse, the pipe fish cannot open its mouth. It only has a small hole opening, so it must suck in its food.

When mating time arrives, the female swims up to the male and lays her eggs in a pouch on his stomach. He carries the eggs till they hatch. The same process occurs with sea horses.

In the case of the sea horse, the female inserts eggs in the pouch of the male, where they are then fertilized, sealed and nourished for six weeks on his blood. The pregnant male then enters labor and 200-300 baby seahorses are born alive. We seemingly have have an almost exact opposite of normal mating among animals!

NILE EEL FISH- The Nile eel fish (Gymnarchus nllotkus) lives in the Nile River in Egypt. This is a fish that is shaped somewhat like an eel. It stores electricity in its stubby tail, and discharges it into the water in controlled bursts.

It is true that there are some marine creatures which use electricity as a means of defense, but the Nile eel fish uses its electricity for a surprisingly different purpose: it sends out quick bursts of electricity as a radar instead! When the echoes come back, it can tell what is ahead, just as a bat does!

This fish sends out these impulses and as they bounce back from solid object, the electromagnetic energy is used as a form of underwater radar. It somehow interprets the reflected signals accurately in its brain, just as bats do with airborne waves, in time to alter its course and so avoid running into things.

One might ask, why does it need this ability when other fish manage not to "run into things"? The Nile eel fish uses its radar signals at night when it is darting backwards) For some reason, it likes to do that frequently, and since it has no eyes in its tail it uses radar in their place.

PLAICE-The plaice fish is so good at camouflage that, if it is placed on a checkered background, it can reproduce a checkered dark-and-light pattern of squares on its back. It will match the exact coloring of the background also.

GRUNION Grunions live in the deep sea and are only seen about once a year when they appear in great numbers. Here is their amazing story:

The female grunions lay their eggs in the sand on southern California beaches exactly 15 minutes after high tide on the night after the month's highest tide. These eggs have to be fertilized by the males within 30 seconds.

As each wave runs back, grunions flop on the wet sand, helpless as fish out of water. There they lay eggs at the edge of the farthest reach of the sea, burying them in sand out of sight of hungry shore birds. The eggs are in no danger of washing away because the tides will not be so high again for another month. They receive warmth from the sun and fresh air through the grains of sand.

When the next high tide comes in, the waters lap up and over these eggs, -and they suddenly hatch out when touched by the salt water. Scientists watching it, say it is almost explosive how the tiny fish instantly hatch and come out onto the surface. The young immediately know that they must get to the sea quickly! The new-born fry are washed back into the sea. No grunions will be seen again for a full year.

Who taught the grunions all this? Who fixed the incubation period to exactly coincide with the monthly highest tide on southern California beaches? Who did this and a million, million other miracles in our works?

TRIGGER FISH -The trigger fish feeds on crabs which swing out with their claws when attacked. But the eyes on this fish are located quite some distance above its mouth, so the claws will not injure them when it goes after a crab.

But every so often a larger fish chases after the trigger fish. Then it uses a different means of self-protection. This fish has the ability to trigger its first dorsal fin (its top front fin), which is shaped like a long sharp spike. When danger draws near, this fish raises the sharp spike to an upright position and locks it in place. Seeing that sharp, raised spike, the larger fish gives up and leaves. Then the trigger fish releases a smaller spine on its back, which in turn is connected by a tendon to that trigger spine; this lowers the spine.

SURGEON FISH -The surgeon fish lives far away in South Pacific reefs, and has a device that is quite similar to that of the trigger fish. This is a sharp, movable spike which, like a switchblade, can suddenly shoot out-out from the side of the surgeon fish. If the enemy fish does not leave quickly enough, the surgeon fish jumps at him and, moving its body and tail in quick jerks, slashes the enemy on the side, cutting him deeply.

When the spike is retracted, it returns into a deep recess within the body and surrounded by a protective sheath.

TILAPIA FISH -The male tilapia fish hatches eggs in its mouth and allows the hatched young to use his mouth as a refuge when enemies draw near. Several other mouth-breeder fish care for their young in the same manner.

This 3-inch [7.62 cm] fish fives in the rivers of Africa. The female scoops a hole with her mouth in the gravel on the river bottom, and then lays about 80 eggs in this nest. The male drops sperm on the eggs, and then darts head-first toward the nest, scooping up a few more eggs with each plunge, until he finally has them all in his mouth. If he misses a few, the female slaps him with her tail, so he will get back to work.

Finally they are all in, and now, crammed with eggs, his mouth bulges. They hatch in about 5 days, but he keeps them in his mouth for about 6 more days. Then they are large enough to take care of themselves. For the first time in nearly two weeks, he is able to eat a meal.

ANGLER FISH -In some species Of angler fish, the female catches the food and feeds it to the male who never eats. The male is much smaller than the female and the two attach themselves together. Then, by a special organ, she feeds him intravenously.

LUNG FISH- This type of fish is indeed a strange one. In South America and Africa are to be found several different lung fish. They live in stagnant pools which dry up in the rainless season. Normally, fish in such pools would die, but not the lung fish. Instead, it simply burrows down into the mud, places a sort of mucilage cocoon around itself, and goes to sleep. Soon it is enclosed in clay that is baked dry and hard as rock! The fish gets its air through a hole which extends to the surface of the ground.

The lungfish has skin glands that produce a varnish during the dry season when the fish is buried in the mud. This varnish exudes out and covers the entire surface *of* the skin. The varnish protects the fish from drying out-and losing the water inside it.

Months later, the rains fall again and the lung fish comes back to life, as it were, and again swims around in its pool of water.

There is no possible way that, at some earlier time, a fish could have evolved this ability! As soon as one tried to crawl into the drying mud, ft would die. Yet evolutionists tell us that this is how all land creatures began: a fish one day crawled out of the water and began walking around with only air to breath. And then it quickly grew legs and other equipment needed to eat, protect itself, and survive on land. Then it passed all these acquired characteristics on to its children.

KNIFE FISH- The black ghost knife fish of South America has the ability to re-grow its backbone, if it becomes severed! This includes the spinal cord within the backbone as well as the supporting muscle structure.

CLOWNFISH -The clownfish Is a very attractive fish that is colored rich cream with rose markings. It is so beautiful that ft is easily seen by predators. But the clownfish is not worried, for it feeds near the dangerous sea anemone, whose tentacles paralyze fish touching it.

When a fish chases after the clownfish, ft dives into the midst of the sea anemone's tentacles without harm! The pursuing fish is caught, and the clownfish darts back out. Thus, each of these very different ocean creatures help one another.

MORE ON THE CLOWN FISH -Every clown fish begins life as a male. Then, if it becomes largest fish in its group, it becomes a female! She is mated by the next largest fish. If that fish is removed, the next largest becomes the dominant male in the group.

AMAZON LEAF FISH -This fish floats down the Amazon River and looks like a dead leaf floating along. When ft sees the food it is looking for, the leaf fish quickly swims after it. Then it begins floating again.

SAND SHARK -The Sand Shark has a totally unique way of raising its young. The female will have a hundred or so eggs stored in the oviduct. The first two that hatch will slowly eat all the other eggs inside the female! Then those two will emerge about a year later, being born alive. At birth, they are fully developed, although still quite small.

RAYS- Some rays are oviparous and lay eggs which later hatch by themselves. But there are other rays which are viviparous and become embyros and grow inside the mother's placenta. About 20 will be born in this way at a time. Some mother rays even produce mother's milk for them (even though they are not mammals), in addition to providing them with egg yolk desserts.

ANGEL FISH-The angel fish (the type you See in aquariums) makes a little concave depression in the sand and there lays its eggs. Both mother and father help watch over the eggs. When they hatch, the parents remain close, and when the little ones wander out of the nest, one *of* the parents will draw near, suck ft into its mouth, then spit ft back into the nest!

DISCUS FISH- The discus fish of the Amazon basin, is a majestic circular fish which looks like a vertical pancake. When its babies emerge from eggs, they come to the parents, both of which extrude a type *of* milk through the sides *of* their bodies which the young eat.

SHARK AND PILOT FISH -The Shark is the terror of the oceans, at least as far as fish are concerned. There are few creatures able to resist him.

A pilot fish is a small brightly-colored fish which accompanies the shark and most often precedes him, as though smelling out the way. The shark obediently follows the movements of his little scout. He never attacks or hurts the pilot fish. So close is this association that the pilot fish will jump into the air after a captured shark when it is being pulled out of the water.

JOURNEY OF THE EELS -Some crabs migrate up to 150 miles [241 km] on the ocean floor. Salmon leave the streams where they were born and years later return to ft same streams to lay their eggs. But consider the eels:

Eels from rivers in Europe and eels from rivers in North America leave their rivers and travel out to the Atlantic Ocean. Then they swim south and in the Sargasso Sea lay their eggs and die. The Sargasso Sea lies in the Atlantic near the equator, and is relatively free of strong ocean currents. It is ideal for the eggs to hatch and an abundance of floating vegetation is there to shield baby creatures the are growing to maturity.

Now comes the amazing part: When Those eels mature, they head north. No one ever taught them what to do; they automatically have thousand of miles of geography in their tiny minds!

Going west, they get into the Gulf Current that passes near North America, and it carries them up adjacent to the northeastern U.S. At this point, half of tire eels leave the others, and head up American rivers and some into the Great Lakes. These are the eels hatched from parents which came from those same lakes and rivers that spring!

The other half of the eels continue swimming with the Gulf Current- and it takes them to Europe, where they go up European rivers into the same streams their parents came from!

None of these eels had ever been there before. Their parents had died down south about the time they were born. This was their first trip up the Guff Current and into those U.S. or European rivers and streams. How could they do know ?

MEDITERRANEAN GOAT FISH This fish has two barbell-little feelers-under its chin. There are millions of receptor nerve cells in each one. The barbels help the fish feel and smell. Swimming in shallow waters, and on sandy reefs, it drags the barbell on the bottom. In this way it can smell and feel tiny sea worms which it then eats.

But other tiny worms try to kill the goat fish! They attach to its skin and begin burrowing in. Now the goat fish is in trouble and needs help right away. So it swims rapidly over to the nearest cleaning station--and this normally goldbrown fish then turns bright reds

The angel fish at the cleaning station recognize this signal, and they swim over to it and immediately set to work digging out the worm attached to its skin. Then they eat the worm, which is their pay for doing the goat fish that service.

The goat fish is able to rapidly change color from a golden brown, to orange, gold, and then bright yellow, as well as to red. For this reason, the ancient Romans would catch and put them in ponds or jars so they could watch them.

EAR STONES - In a cavity on each side of a fish's skull are two chambers, each containing a small stone. These are the ear stones, or otoliths, used by the fish to help them hear sound. But how these strange "ears" work, no one knows. This method of hearing sound is quite different than the one found in land dwelling creatures. How did those stones get inside their ears?

ICE FISH -The ice fish has antifreeze in its blood. This fish lives among the ice floes near the continent of Antarctica. R does fine in water which would chili other fish to death. The water it swims around in normally remains at a temperature of 2°C (35.8°F], which Is only slightly above the freezing temperature of water.

No hemoglobin Is to be found in the blood of the ice fish; instead there is a chemical compound which acts as an equivalent to the antifreeze in your car's radiator in the winter.

GLOBE FISH -This fish will every so often suck in air from its gills -and blow itself up like a balloon until it is almost round. This action frightens away enemies, and at the same time it causes the little ash to rapidly rile to the surface, where it bounces along on the surface, propelled by the wind. That is one way to get away from your enemies!

BUBBLE NEST BUILDERS- The Osphronemidae family of fish can breath through their gills, but they can also obtain oxygen directly from the air. Gulping in air from the water's surface, the male blows bubbles, coating each one with a sticky secretion from his mouth. Blowing them up into a pile, he gradually makes a nest of bubbles. Soon the little raft or floating nest is ready. The female comes and lays eggs, which he catches as they fall and blows into the nest. Two or three days later they hatch while he continues to guard them.

Fish in this family include the paradise ash and the Siamese fighting fish.

SOUND FISH -The trumpet fish toots like a horn; the booming whale lines a variety of songs which can be heard for miles; the taps of the drum fish can be heard 80 feet (18 m] away; the croaking gourami occasionally makes a purring noise; the singing catfish emits deep and penetrating sounds.

ANGLER FISH -Among fish that live deep in the ocean (1,500 feet or deeper), are a variety of "angler fish." These are fish with fishing rods sticking out of the upper front of their heads. A "light bulb" is on the end of some of these rods, while others have no lighting but only a round knob as an end-lure. Molt are broad, soft-bodied, and have a very large mouth.

Some varieties of angler fish live in shallow water near the shore. The shallow angler is a small tropical fish which displays what appears to be a wiggling worm at the end of the pole. Other types of anglerfish display different forms of "bait," such as apparent shrimp or small fish.

The angler fish displaying a 'shrimp' will move it backward in quick, darting movements --just as a real shrimp would do. One with a "fish" will impart a rippling motion to it, as though it were moving through the water on its own.

Occasionally the lure works too well and is nipped off by a fish before the angler fish can swallow him! In such instances, a new lure grows back within 2 weeks.

In recent years a deep-sea angler fish was discovered with the lure hanging from the roof of its mouth! The lure is a light bulb. The fish swims about with its mouth open and small fish enter to examine the light.

ARCHER FISH -This is an attractive fish with most of its body pointed in the shape of a triangle. Many research studies have been made on this fish because it can fairly easily be kept in an aquarium.

Slowly the archer fish will come up to the surface of the water, and then poke the tip of his pointed mouth out of the war. Suddenly a spurt of water shoots out of his mouth and hits a fly resting on a nearby leaf or branch. It falls into the water, and the archer fish swallows it.

It is an astonishing performance. Some complicated equipment was needed in order to do it:

The archer fish has a special mouth which has a groove along its root. When the tongue is pressed up against the back of its mouth, the groove becomes a pea shooter extending from the back of the mouth straight forward.

The gills operate as a pump, while the tip of the tongue is a valve, swiftly opening and shutting, measuring out water bullets rapidly one by one. The pea shooter is not seen, since it does not extend beyond the mouth. The tip of the mouth breaks the surface, and only its puckery lips are observed. Everything else is underwater, including the eyes. Almost motionless, the fish moves into final position, and then the gills clap and the water drops shoot out.

Wait a minute! Any physicist will recognize that there is something wrong here! How can the little fish hit anything- if its eyes are under the surface of the water? To understand this better, take a pencil in your hand and as you watch, push it diagonally beneath the surface of several inches of water. You will see the pencil apparently "bend" as it enters the water. Place a marble on the bottom of a tub of water, and then reach down for it. You will probably miss it at first. The problem here is that sight is passing through two different mediums: air and water, and the defraction from each is different. The archer fish has the same problem. How can he shoot with accuracy when his eyes are underwater? No one knows, but he does it anyway.

The archer fish never misses a little insect within a range of 4 feet [122 cm], and can score hits up to a distance of as much as 12 feet [366 cm]!

We would ask the evolutionists: For how many thousands of years did .archer fish waste their time spitting, trying to perfect their equipment and techniques, while the other fish were having good meals? How could this contribute to their "survival" as the "fittest"? They should have become extinct within a generation a two.

PADDLE FISH -This one could have been called the "scooper fish." The paddle fish has a long, flat bony nose which is 1 /3 of its total length. Using its snout as a shovel, ft goes along scooping up mud and gravel in search of food.

SQUID- The squid can distinguish polarized light, which we cannot see. in addition, ft has a finer detail structure on Its retinas. This would indicate that ft can almost certainly see far better than we can. How can the squid see better than we can, when, according to the theory of evolutionists, ft is supposed to be one of the earliest creatures to have evolved?

CLIMBING PERCH -The climbing perch of Burma often leaves the water, travels inland, and climbs trees!

On each side of its head there is a built-in storage tank. Before leaving the water, the little perch fills these two tanks with water. They are used to keep its gills wet. This water is aerated as it travels overland, so it can stay out of water for a time. But if ft does not find another pool to jump into, then it will limb trees in search of pools of water in the crotches of tree trunks. It needs to replenish ft water in its two storage tanks!

How did this creature ever think up all this, and then make the proper equipment to walk around and climb trees? Why does it even attempt to leave the safety of the water for the dangers of overland travel?

As ft climbs a tree, it will cling to the bark with its gill covers and will use its spiney fins to help ft climb.

Any normal fish that tried to do this would die quickly, so there is no way one could "evolve" into a land-walking, tree-climbing perch!

CLEANER FISH -There are several species Of cleaner fish, as well as a number of species of tiny, beautifully decorated cleaner shrimp which remove the parasites from other fish. In fact, several dozen cleaner relationships have been observed in tropical waters.

A wide variety of parasites get on the fish and eat into their sides and fins. They even get into their mouths. So they go to the "cleaner stations" for help.

Arriving there, the distressed fish give certain signals indicating that they want help. If they do not give these signals, the cleaner fish or shrimp may not venture forth, since normally bigger fish travel around looking for smaller ones to eat.

These signals include color change, an attitude of rest with gills and fins flared, or standing upright -vertically -in the water with head up and fins flapping.

Then the cleaner fish or shrimp goes up to these large fish and begins cleaning along their bodies, and will even enter their mouth. Each parasite they find is eaten as their reward for the help given. Meanwhile, other fish in need of cleaning will actually line up awaiting their turn.

One researcher removed all the cleaner shrimp from two coral heads. Within two weeks he found that there were fewer fish at these coral heads than elsewhere, and those still present showed frayed fins and ulcerated sores.

Scientists are at a loss to figure out how such a symbiotic process could have begun.

SALMON -The tiny salmon is born in a stream somewhere in the Northwest or along the coast running up into Alaska. Its tummy still has part of the yolk sac, and this will provide it with food until it can eat regular food. It hides under pebbles and slowly grows.

Then the small salmon leaves the shallow brook where it was born and swims down into the larger rivers. But that little brook is imprinted on its brain. Its parents were born there; its grandparents, and ancestors all began their lives in that quiet place.

Some scientists think that part of the solution is that each brook has its own odor, and the salmon traces its way back by means of a faint smell emitted by the brook. But even such an answer only adds to the mystery, for the flow of water from a thousand streams should provide only a confusion of intermingled odors, farther down the river systems.

From the shallow stream, the salmon travels till ft reaches a lake and there ft grows big and strong.

When it is 8 inches [20.3 cm], it knows to leave the lake and swim down one river into another and finally to the Pacific Ocean.

Arriving there, it pauses and gets used to a total change: from fresh water to salt water! For a time it swims around in the brackish (half sea and half fresh water) of the bay, and then out it goes into the broad Pacific.

Far and wide it travels in every direction. Time passes. Surely it will never remember how to locate that entrance bay again, much less the tiny stream it was born in. Schools of sockeye salmon are known to travel 9,000 miles [145 m] while in the Pacific Ocean. Always swimming, always searching for food, on and on they go.

While still 9-10 inches [22.8-25.4 cm] in length, our salmon feeds on plankton, which are tiny sea life. As it grows larger, it begins to eat shrimp. Doing so turns its flesh pinkish, although its skin will remain silvery in color.

How long it is in the Pacific varies with different types of salmon. Pacific sockeye remain 4 years before reentering the freshwater rivers.

Our salmon is now quite large. It is 6-7 pounds [2.72-3.18 kg] and 20 inches [50.8 cm] long. Far out in the ocean, the urge comes, and it turns and heads homeward. Of the hundreds of outlets into the Pacific, it heads to exactly the right one. Then it pauses in the brackish water for a few days to adjust to fresh water again. (Which itself is amazing; most fish never can make such an adjustment.)

Scientists think that the salmon locates that entrance river by the sun. It is thought that they can tell direction by the sun even on a cloudy day. Entering the fresh water river, our salmon smells the odor of one tiny creek, its home. Even though thousands of creeks lead into the rivers, and hundreds of rivers lead into still larger ones, our salmon is thought to be able to identity the right one by a tiny chemical odor in the water that registers in its brain -after four years away from that creek. Millions of odors, but the salmon recognizes the correct one. There are special smell detectors in its nostrils, and scientists tell us that the salmon can identify one odor out of a billion other odors! One part in a billion! And it has not smelled that odor since it was a tiny infant!

Up the rivers it goes; from one into another, and then into lakes with many rivers feeding into them. The young salmon selects the right one and goes on. Past the dams erected by modern man it goes, hurling itself time after time up rapids, white water, over boulders, small waterfalls, and manmade "fish-ladders." On and on it swims.

During the entire trip upstream our salmon eats nothing. It lives on body tissue and fat. As a result of not eating, its skin changes from silver to an orangish red. The carotene from the shrimp it earlier ate is now tinting the thinner skin.

Nothing but bears, eagles, and people stop it. On it goes over every barrier. With a good swimming start, ft can clear 10-foot [30 dm] waterfalls, even though ft might take 8 or 9 tries to do it.

Up rivers, lakes, into more, and finally Re-enters its own little stream, the stream where it was born. It has arrived at the same little creek, the same pebbles and gravel.

Now the large fish is tired. The females lay eggs and the males fertilize them with milt. The 10,000 mile [1,6093 km] journey that began 4 years earlier is complete. Exhausted, our salmon floats downstream and dies. It lived a full life and accomplished its task.

The Creator’s Handiwork

the hyrax

In chapter 23, Evolutionary Showcase (p. 776), we learned that, in a desperate attempt to produce a "horse series, " evolutionists decided that the hyrax is the "horse 's direct ancestor. " After completing that chapter, more information has come to light on the hyrax. Since it is alive today, the hyrax has been carefully studied. The data on this little animal is astounding-in two ways:

First, the hyrax could not possibly have evolved from anything else; it has too much high-tech design. It had to be produced by a supremely intelligent Creator.

Second, the hyrax could not possibly be the "ancestor" of the horse, for it has such totally different features. There are 9 species of Hyraxes; 3 are rock hyraxes, 3 are bush hyraxes, and 3 are tree hyraxes. We will here discuss the rock hyrax of Palestine and Syria, but the others have essentially the same features.

To begin with, the hyrax is a very small mammal. It is only 11 inches long and weighs only 9 pounds. In the Bible it is called a "coney" (Proverbs 30:26; the Hebrew word for it means "rock rabbit"). The hyrax looks somewhat like a small brown baby bear, with little round short ears. Its fur is short, coarse, and brown. But that is all it has in common with bears.

Intermingled in its fur are occasional long hairs, called "guard hairs" by scientists. They have a very special purpose, for this small animal must regularly pass through small openings. Before entering an area where it might become jammed and unable to back out, the guard hairs warn the hyrax not to go any farther. That little feature required advance planning, but there is more to come:

The legs of the hyrax are only 3 inches long. Scientists tell us that, in shape, its front legs resemble the bones of an elephant. They also tell us its brain is shaped like an elephant's brain. But those are the only points of similarity to the elephant.

The stomach of the hyrax is shaped like the stomach of a horse. Its feet are flat on the bottom, like those of a horse's hoof. But we will learn below that the foot of a hyrax is very, very different than the hoof of a horse. After carefully studying them, the experts have decided that the front teeth of the hyrax are similar to those of a beaver. The two upper front teeth of the hyrax are like those of typical rodents, such as the rat. When its mouth is closed, those two teeth still show, just as they do on a rat. But there is where the similarity ends.

The hyrax is so unusual in so many different ways. It is not classified with the rodents, but is categorized in its own family. Even those two upper, front teeth are not really the same, for—on a rodent they are flat, with a squarish chisel shape on the bottom. But on the hyrax they come to a sharp point.

Researchers next turned their attention to the upper cheek teeth of the hyrax, and found them to be like those of the rhinoceros. Then they decided to look at its lower cheek teeth—and found they were like those of the hippopotamus! How could the Hyrax have such different upper and lower molars? Yet it does.

Then the scientists examined its eyes, and found they bulge in just the right amount to provide it with a sun-shade. In other words, the hyrax has built-in sunglasses! It lives where there is a lot of midday sunlight, and it needed a way to reduce glare. So the Creator gave it sunglasses. This bulge is in the iris, which produces a sun visor effect, blocking out excess sun rays from entering the retina. This makes a light shadow, so that when the sun is overhead, less light glare enters the eye; but when the sun is closer to the horizon, the little creature has keen eyesight to spot enemies drawing near.

After carefully studying the hyrax (which is a mammal), scientists decided it was like no other mammal in the world! So they placed it in the hyrax family.

But what about those "horse's hoofs" which it has, which make it the supposed "ancestor" of the horse? If you were to sight a hyrax through binoculars, it would appear to be running about on small horse-like hoofs, because they are flat on the bottom. But with that the similarity ends.

Closer examination of those "hoofs," by a competent biologist, shows them to be unlike any other mammal feet in the world! To begin with, each front foot has 4 toes, with short nails. Each nail is in the shape of a semicircular hoof. Each hind foot has 3 small toes, and the middle toe has a curved claw. That claw is used to comb its fur.

But now we come to something totally unique. The hyrax is the only mammal with suction cups on the bottoms of its feet! It is this suction-cup feature, which gives it the appearance of having "hoofs." There are thick pads on the bottom of its front and hind feet. These work like high-tech pavement-gripping tires! The hyrax uses them to grip the surfaces it is running on.

There is a gland in the bottom of each foot that releases moisture. As you know from your own experience with suction cups, they work best after being moistened. Wet a suction cup and press it down-and it can really stick! The moisture helps the foot suction cup to grip tight, for air is trapped inside to form an airtight seal. Once the foot is pressed down, some of the air initially escapes-and the partial vacuum which results clamps the foot to the surface it is on.

With these suction-cup feet, the little hyrax can run up the vertical sides of rocks, or smooth-barked trees. But, wait a minute! If the foot clamps tight to a surface, how can that foot be lifted off again? Once the seal is made, the little creature should not be able to move, much less walk or run.

Fear not; careful preplanning solved all such problems before the first hyrax came into being: A small muscle was placed on the bottom of each of the hyrax's four feet. That muscle can push down—but only in the center of the foot. When that happens, the vacuum is eliminated, and the seal broken. Then the foot can be raised.

When the foot is set down again, the muscle is raised and the vacuum seal is again made. The brain of the hyrax has been designed so that it can send extremely fast signals to those four foot muscles—so that they raise and lower those foot muscles in perfect coordination. Because of this, the hyrax can run very fast. In conclusion, let us consider three additional features about the hyrax:

First, this little fellow is the only cold-blooded mammal in the world! This means that the hyrax constantly changes body temperature in relation to the temperature of the air and surfaces around it. Its body temperature regularly changes 11°F. between night and day. At night, it crawls into rocks, earth, or tree holes and hibernates till morning.

Second, the hyrax has two appendixes. What other animal has that many?

Third, the hyrax has no gall bladder.

After seriously considering the biology of the hyrax, why should anyone be foolish enough to suggest that this unusual creature could be the ancestor of the horse—or anything else?

The Birds

INTRODUCTION

The freedom of the bird! Able to fly so high and so far! Yet it took careful design to make them. There is nothing haphazard about the structure of a bird. Everything had to be carefully thought out in advance. But, all aside from most of those basic marvels, in this chapter we will consider a number of additional ones.

ARCTIC TERN—The arctic tern nests north of the Arctic Circle. When the summer ends, these birds fly south to spend the next half of the year on the pack ice near the South Pole! All year long they are either living in summertime at one of the poles, or traveling between them!

Before returning to the Arctic when the next northern spring begins, they may circle the entire continent of Antarctica. By the time they have returned to their Arctic nesting grounds, they will have completed an annual migration of 22,000 miles [35,200 km]!

BLACKPOLL WARBLER—This little bird weighs only three-quarters of an ounce! Yet in the fall it travels from Alaska to the eastern coast of Canada or New England, where it stops over and gorges on food, stores up fat and then waits for cold weather to arrive.

When the cold comes, the tiny bird heads south. In its little mind, it is planning to go to South America,—but it gets there by first going to Africa!

Out over the Atlantic Ocean it flies at an altitude of up to 20,000 feet [6,096 m] in the air! How can it keep its warmth at such a height? The little wings must beat constantly—yet there is very little oxygen! In addition, at such high altitudes it is more difficult for beating wings to make progress—there is so little air for them to push against!

At some point in its travels, it encounters a wind blowing toward South America; it then turns and heads toward that continent. That prevailing wind tends to be found only at such great heights, but who told that to the little bird?

This journey is about 2,400 miles (3,862 km), over trackless seas, and requires about 4 days and nights of constant flying. No one is there to tell the bird where to go, the height at which to fly, or where to turn. No one is there to feed its tiny three-fourth's ounce body during the trip. It dare not land on the water. Its tiny brain must guide it by day by the sun moving across the sky, and at night by the stars; double navigation!

it seems almost beyond comprehension, yet the little bird does it. And its offspring takes the same trip, without ever having been taught the route or shown any road maps.

RUBY THROATED HUMMINGBIRD This little fellow weighs only a tenth of an ounce. That is all: one tenth of one ounce, and much of that is just feathers.

Yet twice each year this hummingbird crosses the Gulf of Mexico, from North America to South America. Its little wings beat 75 times every second throughout the 25-hour trip. The experts, who have time to figure out the mathematics, tell us this amounts to 6 million wingbeats non-stop! Six million wingbeats in 25 hours with no rest stops.

OTHER MIGRATING BIRDS The golden plover migrates from the Arctic tundra to the pampas in Argentina. That is a long distance! But certain sandpipers migrate a thousand miles beyond the pampas to the southern tip of South America.

Starting in Alaska, the bristle-thighed curlew flies to Tahiti and other South Pacific islands. Such migrations take them across 6,000 miles [9,655 km] of open seas, with absolutely nothing beneath them to act as markers to guide them! How can they do it? And their destination is tiny islands in an extremely large ocean. Men need special navigational equipment to make such a journey.

STILL MORE MIGRANTS—How can these creatures travel such long distances and arrive at the right place? How can they have the stamina to do it? Who taught them what to do, where to go, and how to get there? One thing is certain: other birds did not teach them. This is obvious when we consider the cuckoos and Manx shearwaters.

When the cuckoos of New Zealand travel 4,000 miles [6,437 km) to Pacific islands, they do so having left their recently-born children behind. After strengthening for the trip, the young cuckoos later fly that same 4,000 miles [6,437 km) and join their parents on those islands!

Manx shearwaters migrate yearly from Wales in England—all the way to Brazil. Left behind are their chicks, which follow after they have grown strong enough to make the trip. One shearwater did it in 16 days, averaging 460 miles [740 km] a day. A bird enthusiast became so excited about this, that he took a Manx shearwater to Boston in the

United States, tagged it, and turned it loose. In less than two weeks—12 1/2 days—that bird had returned to Wales, a journey of 3,200 miles [5,149 km].

The young birds have never seen their destinations or been there. They have never been over the route before. No one showed them a map; no one sat down and explained where they should go or how they should get there.

OTHER MIGRANTS—It is well known that homing pigeons will find their way back to where they came from. Taken from their home lofts to any point 625 miles [1,006 km] away, they will return during the daylight of just one day.

Birds are not the only creatures that migrate. Insects such as the monarch butterfly and the locust take long migrations. (When the monarch migrates, different generations do different parts of the complete migration cycle.) Eel, salmon and other fish also migrate, and in most unbelievable and mysterious ways. Whales, porpoises and seals find their way through vast distances of unmarked ocean waters to distant breeding grounds. They do this as unerringly as do the birds which fly overhead to faraway places.

The barn swallow annually migrates 9,000 miles [14,483 km] from northern Argentina to Canada.

A major part of many of these migrations is done at night, and over unmarked water. Each species follows special routes not taken by other species. The birds leave their summer nesting grounds only at certain times. They arrive at certain times. They come back at certain times. Last but not least, they succeed in what they are doing. They do the impossible—and get there!

GUIDANCE SYSTEMS—How do they do it? Scientists are trying to unravel the mystery of migrational flight. They have made a few discoveries, but the discoveries only deepen the mysteries.

The lesser white throated warbler summers in Germany but winters near the headwaters of the Nile River in Africa. Toward the close of the summer, when the new brood of young is independent, the parent birds take off for Africa, leaving their children behind. Several weeks later, the new generation take off and fly, unguided, across thousands of miles of unfamiliar land and sea to join their parents. And they have never been there before!

German researchers raised some of the warblers entirely in a planetarium building. Experiments proved that, within their little bird brains, is the inherited knowledge of how to tell direction, latitude, and longitude by the stars, plus a calendar and a clock, plus the necessary navigational data to enable them to fly unguided to the precise place on the globe where they can join their parental Talk about dogs that travel thousands of miles to their masters; we are here considering birds with the smallest of brains!

Cornell University scientists were able to figure out that the homing pigeon determines directions by observing the position of the sun in relation to the bird's internal calendar and clock.

But that does not solve the problem of how they get home on overcast days. Further investigation disclosed that they have directional electromagnetic abilities also. Tiny electromagnets placed on their heads destroyed this homing ability on cloudy days, but not on sunny days. So they have sunlight and some type of internal magnetic compass as two separate guidance techniques. But what are we talking about here! A pigeon's brain is no larger than a small bean!

STILL MORE ON GUIDANCE—The indigo bunting is a beautifully-colored bird. Before September and April, they eat a lot, gain weight, and, significantly, they start becoming more active at night. Are they taking some time to match information in their genes with the stars they see overhead? If they are a year old, the last time they saw those stars was many months earlier, and those stars were positioned differently at various times of the night.

Then in September and April, migration begins. The little birds will fly as much as 2,000 miles [3,218 km] south or north.

Emlin, a research scientist, took indigo buntings and put them in a cage so that they could see the sky at night. In the fall the birds kept facing south and in the spring they faced north.

Then he took them into a planetarium. Those large dome-covered buildings house very expensive equipment that is able not only to project points of light where the major stars would be on the sky above,—but the equipment can omit various lights. After painstaking work, blotting out certain stars and permitting others to shine, it was learned that the small birds were being navigated by the northern polar stars. This includes Polaris (the north star), the Big and Little Dipper, Cassiopeia, and Cepheus.

In one experiment, he had the north star moved into the western sky, and the birds began facing west. This and similar activities demonstrated the importance of that single star over any other single star in the northern sky.

Then he took a dozen baby indigo buntings, which had never seen the night sky before, and set them out in cages. At first, they did not seem to know directions, but two weeks later, and thereafter, they did. Within two weeks something had matured in their brains and certain inherited knowledge became available to them.

How then does the monarch butterfly navigate as much as a 1,000 miles every spring and fall— when he has a brain far smaller than that of a baby bird?

Before concluding this section, it is of interest that the indigo bunting changes the color of its coat each fall from blue to brown. In the spring it changes it back to blue. Researchers found that the change was due to a change in the length of the day. As it shortened in the fall, something within the brain of the little bird told it to change the color of its feathers ! In the spring, longer days triggered it automatically to return to blue. So, in addition to their other abilities, these little birds automatically time the length of the daylight hours!

EMPEROR PENGUIN—The emperor penguin lives 35 years, and is the largest of about 12 species of penguins (all of which stay close to the south polar waters).

Near the end of May—when the horrors of an Antarctic winter are about to begin—the emperor penguins decide that it is time to travel overland onto the Antarctic ice pack for some distance, and then lay their eggs, incubate, and hatch them! This will be done in the middle of winter near the South Pole, with its perpetual darkness, terrible cold, and fierce wind storms! The penguins will encounter —110°F (-80°C] temperatures, plus some of the worst weather on earth.

Swimming through the frigid ocean waters past ice floes, the penguins head toward the shelf of ice. Sighting it, they leap up and land right on it. That is no easy task, since sighting an object out of water—from underwater—cannot easily be done.

Then they begin their march inland. Sometimes walking, sometimes sliding on their bellies, onward they go for many miles. Arriving at a desolate place—that is frankly as desolate as all the other places on the journey,—they stop and the female lays one egg onto the males feet. He quickly covers it with a fold of feathery fur skin and keeps it warm. For 64 days he stands there, living on body blubber and eating nothing. At the beginning, the female held it briefly, but soon she leaves and he cares for them. She spends the next 2-3 months feeding in the ocean. About 100 penguin males will be in each group, standing a few feet apart, hatching eggs on their feet.

Soon after the babies hatch, the females return. But how do they know where to return to, across the trackless wastes of that white land? This is another great mystery. If you or I tried to do it in the perpetual darkness of an Antarctic winter, we would get lost in the wind and storms. When the females return, the males have lost 20 pounds]9 kg], and now they go to the ocean and feed. The females remain and each gradually regurgitates a stomach-full of food for their little ones.

By bearing their young in the winter, the children can be young adults within six months. They need summertime in the Antarctic Ocean to get ready for the soon-coming long winter.

PTARMIGAN—The willow ptarmigan can change its color at will to fit the environmental background. Other creatures, such as the arctic fox, chameleon, iguana, flounder, and reef fish do it also, but in other ways.

PIGEON SORTING—No, people are not sorting pigeons; the pigeons themselves are doing the sorting. Pigeons at Japanese Deer Park, California, have been trained to sort electrical parts. They are able to do it faster, better, and longer than people! The problem is that people rapidly become bored with the task.

HORNBILL—The hornbills of Africa and Asia have large bills with what appears to be a small horn, parallel to the bill, lying on top.

A pair of hornbills find a hollow tree and they make a hole in the side. Then they bring clay and wall up the opening until the female can barely squeeze through. Inside, she continues to wall up the opening to only a narrow slit, using more mud which the male brings her. Through this opening the male feeds her 30 times a day as she incubates the eggs and after they hatch. Soon he is bringing her food 70 times a day! When he no longer can bring enough food to supply their need, she breaks out the mud door and flies out. The 3-week-old babies then set to work and patch up the hole again with mud! Both parents now bring food to the young. Three weeks later, the little ones break down the opening and fly out.

QUETZAL—The quetzal is the national bird of Guatemala, and is, indeed, very beautiful. It is a foot long, with two 2-foot [61 cm] tail feathers!

It lives on fruit which grows on the sides of trees. Much of the time it hovers as it eats the fruit. But whether it hovers or lands, when it is time to leave the fruit on the side of the tree, the bird goes through a special procedure to do so.

The problem is those long tail feathers. It cannot just fly off or it will trip over the feathers or they will get caught on something. So it flies backwards several feet away from the branch, and then hovers for a moment, flies forward and leaves.

When it is time to make a nest, the quetzal female prepares it a foot deep in a rotten tree with nice soft rotten wood inside. After making the nest, the male helps incubate the eggs. But once again, he has that beautiful long tail to contend with. He solves the problem by pulling his long tail up over his head, and then flying backward into the nest!

When the babies hatch they cannot digest fruit until they are a month old. The parents automatically know this, and only give them grubs during that first month. This may seem a little matter, yet if the parents gave them the wrong food, the babies would die and within one generation there would be no more quetzals. So from the very beginning, quetzals have known what to do.

Three years after birth, the males grow their nice long tails.

HERRING GULL—Herring gulls have bright red markings on their bills. One researcher (Tinbergen) discovered that hungry chicks instinctively peck at anything red. When they peck at the mother's beak, they receive food. But they will even peck at a red spot on a piece of cardboard.

Owls—Owls have soft down on their feathers so they can fly noiselessly, since their diet is primarily mice and rats. Their eyes are unusually large so they can see well at night. In the darkness, the retina (black portion in the middle of the outer eye) becomes very large. If it were not for owls, the world would be overrun with mice and rats.

The head of an owl can turn around in almost a complete 360° circle, without moving its body in the slightest. Then suddenly it snaps its head back around and begins again. In this manner, it appears to be turning its head endlessly around and around.

ANTING—There are 200 different types of birds which rub ants on the underside of their flight feathers. They crush the body of the ant and a special acid comes out —formic acid—which is colorless and has a strong odor.

This acid helps keep lice off the wings, but also softens and tones the flight feathers. When the wing beats up, the barbs on the feathers become unhooked; when the wing beats down, they become hooked again. Ten times a second this hooking and unhooking occurs. The acid keeps the feathers in better condition.

Birds begin "anting" 2-3 days after leaving the nest, but there is no indication that they are taught to do it.

Many species will sit on the ground near an ant nest. The ants, concerned to protect their nest, climb up on the bird's feathers and there release formic acid, which drives off mites and most other tiny pests.

EYESIGHT—An OWL Can See 100 times better than man at night. The golden eagle can see a rabbit at two miles.

HAWKS AND THE WARREN TRUSS—Go into a modern wide warehouse having no central posts, a flat roof, and no drop ceiling to cover the supports and gaze upward. You will probably see a Warren truss above your head. Look at the best of the modern bridges, and you will see it again. Draw two parallel horizontal lines, one above the other. Between the two lines draw a straight —not curved—zig-zag line back and forth (at 45° angles from the horizontal lines) from top to bottom. You have designed a Warren truss. It is full of triangles.

That is the design of the bone structure of hawks. It is the lightest, strongest engineering structural design known.

Animals generally have hollow bones to give them more strength with less weight in those bones. Bird bones must be especially light and strong, so, for added strength, they will have struts built into their thinner bones. But hawks need especially strong bones. They must climb quickly, drop at high speed, and carry heavy weights. So they have the best-designed bones: they have Warren trusses in them.

It cost modern mankind millions of dollars and untold thousands of man-hours to invent the Warren truss. And here the hawk had it all the time! These excellent inner diagonal struts which connect the load-bearing bony beams, give them maximum strength with the least possible bone fiber.

WINGS—Flight requires two forces: lift and push. Lift gets the plane off the ground and keeps it in the air; push moves it forward. Lift comes from the wings, and push from the propellers.

On the forward edge of a bird's wing are specially-designed feathers, called primaries. The air flows up and over this leading edge of the wing, providing partial lift. The downstroke of the wing movement provides the rest of the lift. But on the upward stroke of the wing, the primaries move upward and backward, providing push. So birds have the equivalent of both wings and propellers.

FEATHERS—A feather grows from pin feathers, and when it reaches adult size it becomes lifeless. A feather from a wing or tail will have a shaft with branches. Each branch is called a barb. Each barb has branches called barbules. These barbules overlap one another and are hooked together with tiny hooks and eyelets. It is this automatic hooking mechanism which renders the feather useful for flight.

The feather is the lightest, strongest thing in the world. Or, to put it another way, it combines the least weight with the most air-resistance of any object in the world.

When a bird molts, it drops feathers from both wings symmetrically. Thus the balance is more easily preserved than if one wing lost more feathers than the other. In this way each bird can at all times protect itself and obtain food.

Birds frequently preen their feathers. It is important that they do this, for in this way they clean, oil, and rehook feathers. Birds of the heron family accumulate a coating of slime on their feathers. To clean it off, a feather is plucked from one of three special patches of feathers on the body. Then the heron crushes it into something like talcum powder. The powder is then applied to the feathers, and it absorbs the slime. After this is done, the feathers are combed out using a special toe. As with most other birds, oil from a special oil gland is also placed on the feathers to condition and waterproof them.

TEMPERATURE GAUGES—The beaks of the malle bird, the brush turkey can tell temperature to within half a degree Fahrenheit. A mosquito's antennae can sense a change of 1/300 degree Fahrenheit. A rattlesnake can sense a change of as little as 1/600 degree Fahrenheit.

EGGS—Which came first the chicken or the egg? We have all heard that question before. But it only sounds simple because we have heard it before; the truth underlying it is still profound. Before an egg could exist, there had to be a perfect chicken. Before there could be a perfect chick, there had to be a perfect egg. Without eggs, no chickens could survive more than that first generation. So the answer is a simple one after all: They all had to be there together at the very beginning! On the first day that a chicken existed, it had to have the full potential of perfect egg-laying ability.

But there is more to eggs than appears on the surface:

(1) The shell has to be strong enough to resist accidental breakage, yet fragile enough that the chick can get out of it. (2) As the chick grows inside, more and more water accumulates. The egg must lose the right amount of water through the shell so that the chick does not drown, does not dry out, and has enough water for its needs. (3) The original size of the egg must match the size of the chick just before hatching. (4) Gases from inside must be able to get out through the shell. (5) There has to be a special membrane which separates the chick from its wastes. (6) There has to be a second special membrane which allows it to breathe air in some way from the outside. (7) Waste products from the chick must be in the form of insoluble uric acid, not the soluble kind produced by amphibians and mammals. (7) The egg must be fertilized before the shell hardens. (8) The chick must be given a small hammer to chip its way out of the shell, and the sense to use it at the right time.

What are the chances of all that happening by the random events of "evolutionary progress"? None; none at all. Yet everything had to be just right when the very first hatching occurred!

Well, here are a few more facts about this "simple subject" of eggs:

The chick has to be able to breathe inside the shell, so the eggshell has 10,000 tiny holes in it for this purpose. You need a microscope to see them. Under the shell there are not one but two tiny membranes, with tiny holes in them also.

The baby chick needs oxygen, but first it must grow something that can take in that oxygen! For the first several days, it has all the nourishment and oxygen it needs inside the yolk. Two blood veins gram out of its body and branch out into hundreds of tiny capillaries. They grow around inside of the shell, just below the two membranes—and they attach to the lowest of the two. By the 5th day, they are fully in place. The heart is pumping, air is going through the 10,000 holes, through the membranes, and into the veins.

The "law of diffusion" operates here. Because there is lots of oxygen on one side of the skin or shell, and a small amount on the other side, the gas wants to get through to equalize. So oxygen passes through the shell and to membranes and into the veins and gives oxygen to the chick! This matter of the "simple chicken egg" is becoming more complicated all the time! And it is all supposed to have evolved by chance? But, by the time evolution got around to getting started on developing the egg, all the birds in the world would be dead. And by the time it got ready to figure out how to make birds successfully grow and hatch from eggs, all the eggs would have rotted.

The baby chick uses 61/2 quarts, or 1 1/2 gallons [6.15 liters], of fresh oxygen while he is inside the shell. He gives off waste gas (carbon dioxide)4 1/2 quarts [4.26 liters] of it—while he is in the shell. It goes out by diffusion; there is more inside than outside, so the gas leaves, and plants use it to give us more oxygen.

Interestingly enough, when the chick first begins, everything he needs is inside the shell except, after the first few days, the oxygen. The yolk becomes food for the baby. On the 5th day, 2 veins go into the yolk and branch out. This brings food from the yolk to the chick.

As fat inside the yolk is used up, it is replaced by water vapor. That water vapor must go, for it is a waste product. From the chick it goes out through veins to capillaries just under the shell—and then out by diffusion through the shell.

But what takes the place of that water vapor? Oxygen and other important gases enter through the shell. This air goes into the little sack at the blunt end of the shell

As the chick grows, the sack grows also, until it is 15 percent of the egg. This is important, for when the baby chick is 20 days old, it is so big it can no longer get enough oxygen from capillaries under the shell The chick is in serious trouble! It will soon die before hatching! But, no, instead at that crucial time, the chick jerks it head—and punctures a hole in that air sack! It finds air—and now it begins using his lungs for the first time!

But why is it that the chick always grows with its head facing toward that sack? If it faced the other way, it would not punch that hole in the sack—and the chick would die from lack of oxygen. But the head is always faced the right direction.

Six more hours of air is given to the chick by punching that hole in the sack. But then another crisis comes! The air from the sack is about used up,—and a second time it has run out of oxygen! Now, in a last desperate attempt—it hits the shell above its beak—and a small hole is made. Air comes through! Now the chick begins in earnest to punch a hole in the shell itself. Pecking on the shell, it breaks through—and still more air flows in.

But this final rescue would be impossible were it not for a small pointed object on the top of the chick's beak. This is a tiny "egg tooth" which looks like an upside-down "W'. Now the chick must work to get out of the shell, and that very work strengthens its little body. Soon it is out, and a few days later the egg tooth falls off, for it is no longer needed.

BIRD SONGS —Bird songs require special body parts. The organ which produces the song is the syrinx. It is located at the lower end of the trachea (whereas our larynx is positioned at the top part of the trachea). Because it is at the bottom in birds, the length of the trachea can be used as a resonant organ to reinforce the sound, and the throat can be used to modify the tones. Because birds do not have facial sinuses to produce resonance, if their syrinx was—like ours—at the top part of the tracheas, we could hardly hear their songs.

FEEDING NICHES— Birds fill different "niches" in the scheme of things. Each type of bird has a special place where it feeds which is somewhat different than most other birds. Because of this, there is very little competition among the various birds. Consider this:

Creepers feed on the bark, going up. Nuthatches feed on the bark, going down. Woodpeckers feed on the trunk and branches, digging in.

Chickadees feed on the smaller twigs. Kinglets feed on the smaller twigs and foliage. Warblers feed on the ends of the twigs and in the air.

BODIES OF BIRDS —Each bird has the type of feet it needs. Land bird have short legs and heavy feet; wading birds have long legs; swimming birds have webbed feet; perching birds have slender legs and small feet; scratching birds have stout feet and moderately long legs.

Each bird has just the type of beak it needs. Seed eaters have short, blunt beaks; woodpeckers have long, sharp beaks; insect-eating birds have slender beaks; ducks and geese have beaks fitted for gathering food from the mud and grass; hawks have hooked beaks.

Birds are designed for lightness, since most of them fly, and many need buoyancy in the water. The bones are hollow and filled with air. There are large air sacs in the body. Feathers enclose more air spaces. All the air inside a bird's body is heated 10-20°F above that of a human body. This heated air gives added lift and buoyancy to the bird.

Because the air in a bird's body is lighter in weight than anything else, birds balance by shifting their air load! A bird is able to automatically shift air from one body air sac to another, so that it can maintain its balance while flying. If a bird did not do this, it could not maintain its balance in flight.

A bird has rib muscles just as we do, but it also has flying muscles also. When it is resting, a bird breathes by its rib muscles as other animals do. But when it flies, the rib muscles cease operating-and the ribs become immobile. This is because the strong flying muscles must have a solid anchorage on a rigid bony frame. How then does the bird breathe while it is flying? The wing muscles cause the air sacs to expand and contract, and this provides oxygen to the bird in flight since its lungs are not operating properly due to locked ribs. It took a lot of thought to design that!

Birds that feed out in open fields will tend to be more brilliantly colored. This is because they can see their enemies at a distance. Birds living in the woods and thickets will tend to have protective coloration, since they cannot as easily escape from enemies.

Water birds spend much of their time floating on the water, so they have thick, oily skin and a thick coat of feathers which water cannot penetrate. Diving birds have a special apparatus so they can expel air from their bodies. In this way, they become heavier and can stay underwater more easily.

PARROT BEAK —Parrots can move the upper jaw separately from the skull! But they need to be able to do that, for in this way they can use the jaws as pincers to grip and climb up and down, as well as in obtaining food.

CROSSBILL —The crossbill is a bird with an unusual shape to its bill. The two parts cross somewhat like curved scissors. But why? The crossbill feeds on pinecone nuts, and it uses its bill to open the pine cones. Of all the birds, only the crossbill is able to open an pinecone and eat the nuts inside it.

DUCKS —Have you ever wondered how a duck obtains its food? Along the edges of its spoonshaped bill are small teeth. The duck reaches down to the bottom of the pond and feeds on the mud. It squirts mud through its spoonbill mouth, and as it does so the small teeth strain out small creatures which it eats. The mud is spit out.

DOUBLE-COLOR BIRDS—When, in the fall, the new feathers appear on many bright-colored birds, the tips of the feathers are dull in color. During the winter, these dull tips wear off, and when spring and mating season arrives, these same birds now have brilliant plumage colors.

HONEYGUIDE—The African honeyguide is a small bird which leads people and animals to bees' nests. When it leads a badger to the nest, the badger tears open the nest and both enjoy the honey. But the honeyguide also leads the Boran people of Kenya to the honey nests also. Having found a nest, it will, through flight patterns and calls, alert a Boran to send a group to follow the bird to a honey site. But the Borans initiate the search as well as the bird. They will whistle to call the honeyguide. Arriving, it will lead them by flying a short distance and waiting for them to come. Arriving at the honey nest, they always leave some honey for the honeyguide. Scientists have even seen the honeyguide scouting out bees nests at night, so it could promptly lead a group to it the next morning!

WATER OUZEL—The water ouzel is a regular songbird that flies underwater!

The water ouzel (pronounced oo-zul) looks like a normal bird, such as a robin. It has no webbed feet, no fins. There is nothing different about its appearance in any way from normal song birds.

But, flying to a rock on the edge of a river, it will jump right in and begin flying with its wings under the water! The water can be swift, white water, swirling over rocks, but it matters not. The water can be cold also! This small bird will dive into ice cold water in the creeks and rivers in the high country of the Sierra Nevada range. But, wherever it may be, the ouzel is quite at home in the water.

After flying for a time, it will land on the bottom and turn the rocks over with its beak and toes to feed on various water creatures that are uncovered. Then it will fly up out of the water again.

When it is time to prepare its nest, the water ouzel flies into a waterfall and makes its nest on living moss on a rock. Spray from the waterfall keeps the moss wet and well attached to the rock. So the nest has a secure foundation. Each time the bird goes to or from its nest, it goes through that waterfall!

WHITE-COLLARED SWIFT—The white-collared swift is found in the Mexican jungle and, like the water ouzel, also flies through waterfalls!

This small bird looks and lives totally unlike the ouzel, yet also regularly lives behind waterfalls for protection. It also makes its nest there. It drinks from ponds while it is flying but never goes into them. Instead, it flies over a mile up into the air and eats tiny flying insects and aphids, often being blown by 60-mile-per-hour [96.5 kph] winds.

The white-collared swift is a powerful flyer and can go 80 miles [129 km] per hour. In many ways, this swift is completely unlike the water ouzel, but in one way it is very similar: It builds its nest behind waterfalls. But, in addition, when not nesting, the white-collared swift continues to make its home behind waterfalls when not nesting; something that ouzels do not do.

SNAIL KITE—The snail kite is a hawk like bird which lives in the southeastern U.S. swamps. It soars over the swamp looking for large snails, called "apple snails." Every so often one rises to the surface for air. Swooping down, it seizes the snail before it sinks again, and carries it off to a tree limb where it proceeds to eat the snail. But the shell is strong and the kite could not eat it except for the fact that the curve of the kite's bill exactly matches the curve of the snail's opening!

SUGARBIRD—Here is a bird that depends on one bush for everything. The sugarbird lives in the mountains of South Africa, and has a 4-inch [10 cm] body, and a 10-inch [25-cm] tail.

The protea bush, growing on those same slopes, is large-about 7 feet [21 dm] tall and very bushy. The sugarbird goes to its pink flowers and sips the nectar. It also eats bugs, flies, and worms that come to the flowers.

The bill of the bird is long, round and narrow— just right for sipping the sugar water in the flower. A problem is that the flower, which is also long and narrow, curves downward. But the bill of the bird has exactly the same angle of curve, and it is also a downward curve! So the sugarbird need only go up to the flower and reach down in and take the nectar.

But more than a long, narrow, curved bill is needed. There is also a pump in the bird's throat, with a pipe leading from the pump to the bill. That pipe is its tongue which it twists into a pipe shape.

Both the bird and the bush are obviously designed for one another.

But there is more: The sugarbird makes its nest in the protea bush, but only makes its nest when the bush is blooming throughout the summer. In this way, the bird can feed nectar to its children. Along with grass, the nest is made from dead protea bush twigs which the bird finds underneath the bush.

Inside the stick nest, the bird places soft, white fluff for the baby birds to sit on. Where does that fluff come from? It is dried-up petals which earlier fell from the protea bush.

For its daily drink of water, upon arising, the bird obtains water from the leaves. The same dew which fell on the bush at night also provides enough wet leaves that the bird takes its bath by flying into the branches and shaking itself. As it does so, water showers down upon it, providing it with a morning shower bath!

Occasionally the bird must search elsewhere for food, but that does not happen very often. For the most part, the bush provides for all the needs of the sugarbird.

CANADA GEESE—As do a number of other creatures, the Canada goose mates for life. As the geese are flying in "V" formation, if one mate goes down from sickness or injury, the other will go down with it and stay with it till it is able to fly again.

When landing on the water, these large birds lift their wings at the last moment to cut speed, and then run on the water for a distance, and then alight on it. Taking off, they begin running on the water again as they pick up speed for flight.

The first day the goslings are hatched, the female leads them immediately into the water. The male goes ahead and beats on the water with its wings to frighten away enemies.

When they migrate, Canadian geese fly in the long "V" formations you have seen in the sky in order to reduce air resistance on the entire flock. The leader meets the full force of the wind, so they take turns leading. Scientists now know that they navigate by the stars.

SNIPE—The snipe has two special feathers that jut out at right angles when it makes a dive, resulting in a loud buzzing noise. The snipe only makes this buzzing sound on two occasions: (1) when it is ready to mate, and (2) when a storm is coming that will hit later that day or night. For this reason the snipe is sometimes called the "weather bird" or "barometer bird."

OILBIRD —In the deep, dark caves of northern South America is to be found a strange bird. The oilbird (Steatornis caripensis) gets its name from the natives that rob its nests, boil the squabs for their high oil content, and then store and use the oil to flavor their food.

A major part of the life of this bird is spent in total darkness in those caves. The young are hatched in total darkness, fly around in the caves without hitting the walls or other birds, and eventually emerge with their parents during the night to search for tropical fruits.

How can this bird fly around the cave without striking something? The answer is that it uses sonar. The oilbird emits distinct evenly-spaced clicks. The return time for the echo tells the bird what is in front of it—which is not only boulders and cave walls, but other flying birds as well!

No one ever taught the oilbird how to do this. It was born with the ability. When scientists plugged the ears of two of the birds, they found that they collided with the walls, thus proving that sonar was being used.

SUNBIRD—The sunbird of Africa has metallic colors: blue under its chin, bright red on its chest, and shining black feathers on its back.

This 5 ½ Inch [14 cm] long sparrow-sized bird hovers as it takes nectar from flowers in African jungles. Its wings beat 50 times a second, so you can see that the sunbird is somewhat like the hummingbird.

Its bill is 2 inches (5.08 cm] long and slightly curved to match the flowers, with a special tongue which curie and sucks out the sugar water. When it encounters extra-long flowers, the bird pokes a small hole at the base of the flower and sucks out the nectar. A built-in pump is in its throat to draw the nectar up its bill and down into its stomach.

It pollinates flowers with its feathers. Just as bees do, the sunbird only goes to one species of flower at a time; in this way cross-pollination is insured.

When the sunbird arrives at the African mistletoe flower, it has to tell the flower to open up! If the bird did not do so, that flower would always remain clod. Carefully, the bird puts its long bill inside a slit in the flower. This triggers the flower,—and it opens immediately, shoots out its anthers, and hits the bird with pollen all over its feathers. Then the bird goes to the next mistletoe and pollinates it, repeating the process.

Evolutionists declare that all flowers were made millions of years before insects and birds. But if that was true, then the flowers had to wait millions of years before being pollinated.

EAGLES, HAWKS, AND BUZZARDS—These large birds have to be able to see very well, so they have been given excellent eyesight. They can climb high in the sky—as much as a mile up— and then as they ride on thermals (rising warm air currents), they gaze down and are able to see a mouse or a rabbit on the ground.

Their brain causes the eyes to be able to zoom in and make things look closer, or zoom out and see regularly when they land in a tree or on the ground. If that did not happen, they could not see things less than 40 feet [122 dm] away.

In the morning they do not leave the tree they roosted in during the night until it warms up. Then they fly off on rising air currents—and soon they look like gliders, floating in the sky.

PIGEONS AND DOVES—When their young hatch, both parents produce a milk in their throats, and open their mouths. The baby doves and pigeons (squabs, they are called) reach into their parents' throats and get the milk that is there. Here is how it works in more detail:

Having eaten grains out in the field, a special enzyme made in the throat is also swallowed. It digests the food in the stomach, softening and turning the grains into a thick, white milk that looks like cottage cheese.

As the parent stands before the squabs, it opens its mouth wide, and a special pump turns on, pumping up the milk into its throat. A baby sticks its head into a parent's mouth and sucks it in. They continue to eat in this way for at least a week, and then are ready for grains and worms.

But first they must have that milk or they will die. There was no time for the milk to slowly "evolve" over thousands of years.

Four days before the babies emerge, both the mother and father somehow know that the egg is about to hatch. This excites them and they stimulate the gland in their bodies that produce that milk. By the time the squabs have come out of the shells, there are lots of enzymes, and milk production begins.

WHIPPOORWILL—The whippoorwill is the well-known southeastern U.S. bird which flies at night. There are bristles on either side of its beak, and these can feel the bugs as it flies. Quickly, turning its head, it eats them.

The whippoorwill is one of the only birds that hibernates. It remains through the cold winter and sleeps. While its body temperature is normally 104°F (40°C), it drops 40°F during hibernation to 60° (15.51/2). When the temperature goes down to 38°F (3.3°C) and stays there a few days, then the whippoorwill searches for a place to hibernate between some rocks and begins its long sleep.

A whippoorwill only needs 1/3 ounce (9.36 g] of food to keep it alive and well during the approximately 100 days it hibernates. During that time, no breathing or pulse will be detectable.

Not only can the whippoorwill take the cold, it can withstand terrific heat. When the weather becomes too hot, the whippoorwill slows its body rate (breathing, heart rate, etc.) to 1 /30th that of normal. So, both in summer and winter, the Whippoorwill adapts by slowing its metabolic rate.

KIWI—The kiwi bird is the national bird of New Zealand, and is the smallest bird in the world that does not fly. It has "hair" instead of feathers; actually they are pinfeathers. Short stubby wings balance it as it runs. This little bird is dark brown, nocturnal, and catches and eats earthworms by smelling them. The kiwi has the best sense of smell of any bird in the World.

EGYPTIAN VULTURE—The thrush throws snails on a rock to break them open, but this is not considered tool-using, since no in-between object was employed to open the snail shells. But the Egyptian vulture does use tools. It is one of the few tool-using birds known to mankind.

The Egyptian vulture is about the size of a raven, and it eats the eggs of other birds-especially large ostrich eggs. The eggs of an ostrich are so large and strong that they cannot be opened by pecking them.

In the Serengeti! National Park in northern Tanzania, the Egyptian vulture (Neophron percnopterus), has been photographed throwing rocks to break ostrich eggs so the bird could eat them. Various species of birds may be standing nearby, wishing they too could eat some of the egg, and will watch the Egyptian vulture in action, but will never try to do what it does. They seem not to be able to understand how it accomplishes the eggbreaking, but they know !t can do it.

Seeing the egg, the Egyptian vulture goes into action. It hurries here and there, searching for a rock of just the right size. Picking up a stone in its beak, the vulture raises its head as high as possible and then throws the stone at the ostrich egg. Sometimes two birds will take turns throwing stones at an egg. When rocks were not nearby, the vultures will range as much as 50 yards [46 m] away looking for them. These birds have been known to hurl stones as large as a pound in weight. About 50 percent of the time the vulture hits the target directly. Crack/splash! It is dinnertime.

Checking this out, scientists found that the Egyptian vulture will hurl stones at anything that is egg-shaped, regardless of the size; but it will ignore anything not egg-shaped.

Other tool-users include chimpanzees which occasionally use sticks as tools to dig termites and ants out of their nests. A Liberian chimpanzee was observed using a rock to pound open a palm kernel. A small finch in the Galapagos Islands uses a cactus needle to dig worms out of holes in wood. Several other examples of tool-using animals are known.

COWBIRD—It is well-known that the cowbird in America, and the cuckoo in England, lay their eggs in other birds' nests. In one research study, young male cowbirds were only paired with song-less female cowbirds from another locality, where the cowbird song is distinctly different. (Keep in mind that only male cowbirds sing; the females do not sing.) Soon, the young birds had totally reworked their songs to match that distant area,—even though the females had not once uttered a single note! How can you teach a person to sing a new song, if you never sing it to him? Additional research indicated that the females taught the new singing style to the males using only motion and touching. The scientists are still trying to figure out that one.

MARVELOUS HUMMINGBIRD—The Peruvian marvelous hummingbird—truly is marvelous! It has iridescent green, yellow, orange, and purple feathers which glint in the sunlight as it flies and hovers over flowers. While most birds have 8 to 12 tail feathers, the marvelous hummingbird is unique in having only four. Two of those four are long, pointed, thorn-shaped feathers. They are 6 Inches long, which is 3 times longer than the birds body. On the end of each of these two long narrow feathers—is a large, wide fan! Their surface area is almost as large as the hummingbird's wings! With such feathers, the little bird should hardly be able to fly, yet it can—and for a special reason: The marvelous hummingbird has complete control over those two feathers! At will, it can bend and tilt them in any direction. In flight it uses them to help maneuver, at rest, it can move them in various directions. During mating season, it signals with them. They are like little semaphores.

HUMMINGBIRD—The ruby-throated hummingbird beats its wings at an incredibly rapid speed: 50 to 70 times a second! It requires an immense amount of energy to do that. If a 170pound (77 kg] man expended energy at the rate of the hummingbird, he would have to eat and digest 285 pounds [129 kg] of hamburger or twice his weight in potatoes each day in order to maintain his weight. In addition, he would have to evaporate 100 pounds [45 kg] of perspiration per hour to keep his skin temperature below the boiling point of water.

PALM SWIFT—The ways that different creatures live is incredible. No two seem to be exactly alike—and some are so very different as to be astounding.

The palm swift lives in Africa and, with its long, narrow wings, can fly 70 miles [112.6 km] per hour. It flies as much as a mile high in the sky eating bugs flying in the air. A sensitive barometer is in its brain, and it can know when storms are approaching. When that happens, it will fly at right angles to the storm and thus avoid it.

The palm swift only lands on trees or buildings—never on the ground. With its weak legs, it would have to climb a tree to take off!

This swift builds its nest in the sand palm tree. Using sticky saliva, it glues some of its feathers to the back side of a palm leaf. Then it will lay its eggs, catch and glue them to the feathers! What a strange nest; always on the verge of falling to the ground, but never doing so. Next, the bird climbs onto the leaf! Digging its claws into the palm leaf, it covers the eggs with its body and incubates them!

Researchers trying to figure out this strange procedure, decided that the wind blowing the palm leaves back and forth, substitutes for turning the eggs! After 19 days, the eggs hatch.

But now, more problems! Now the emerging babies will fall out of the nest! But no, instead, each of the tiny chicks digs its claws into the leaf and hangs on! Although each baby is born with weak legs, yet it has strong claws. The parents feed them for a week, and then the babies crawl to the stem of the leaf where they are fed a couple more weeks. Then they fly away.

WOODPECKER—The redheaded woodpecker spirals up the tree trunks. It pecks, then listens for a grub moving or turning. If no sound, it moves on.

The woodpecker also pecks for three other reasons: to send messages to other woodpeckers, to store acorns and other nuts in holes, and to dig holes for a nest. These nesting holes are 1 foot [30.48 cm] deep and 5 inches [12.7 cm] wide. After vacating them, more than 30 other species of birds will later use those holes for nests.

The woodpecker has extremely strong neck muscles. It tenses them and they vibrate. When it pecks, it aims straight down, perpendicular to the wooden surface. If it did not do this, the offset pressure would tear its head off.

The woodpecker has special spongy bones to protect its brain, and its bill is stronger than that of any other bird.

WOOD DUCK—The wood duck makes its nest in a hole 40 feet [122 dm] up in a tree! The female lays eggs, but does not set on them until they are all laid. In this way they will hatch at the same time.

She pulls feathers from her chest to line the nest, and then while setting on the eggs her body temperature—94°F [34°C]—is exactly the amount of heat needed by the eggs. The male feeds her while she is setting on the eggs.

As the time nears for the eggs to hatch, she peeps to the un-hatched chicks. They peep back. She quacks some more. She is telling them that she is their mother and that they must listen to her and obey her when she warns of danger. Researchers have proven that if she does not do this, they will not obey her afterward.

One day after they are hatched, they leave the tree! They must do this for their safety. But they are not only very tiny (only 3 inches (7.62 cm] long), but they are also a foot [30.5 cm] deep down inside a hole that is 40 feet [122 dm] up in the air!

That second day after they are hatched, the mother flies to the ground and calls up to them. They obey her voice and, one by one, jump out of the nest and down, down to the ground far below they fall.

How do they do this? The little creatures are covered with down, but have no feathers yet. Using their egg tooth with which to grip the sides, they crawl up to the entrance of the hole. Then out they go! Because they are so light, they land without being hurt. If they did not jump they would die, for she never goes back up there again to feed them.

BLACK SKIMMER—This is a sea bird which does literally that: it skims over the surface of the water. The top of its bill is 4 inches (10.16 cm], but the bottom half is 41/2 inches [11.43 cm]. The skimmer uses it as a fish trap.

While flying over water, the skimmer drops to about 6 inches above the surface, and lowers its bottom bill so that it is dragging in the water. There are special nerves in the lower bill, so the bird can always know how much of it is dragging in the water. With this automatic depth gauge, the lower bill is kept exactly 4 inches [10.16 cm] in the water. As soon as it touches a fish, the upper bill shuts and catches it.

Flying at 20 miles (32 km] per hour and striking its bill against a fish should break the bird's neck! But this does not happen, for it has very powerful neck muscles. As soon as it strikes a fish, its tail automatically goes down, slowing it to 10 miles (16 km] per hour.

In addition, the continual wear on that lower bill should cause considerable damage over a period of time, but instead that lower bill is constantly growing to compensate for the fact that it is continually being worn down! (Only the lower bill keeps growing; the upper one does not.)

In addition, this bird saves 50 percent of its flying energy, because there is very little wind next to the water.

Because it has a 4-foot (12 dm] wingspread, it only needs to slightly flutter its wings in order to keep flying steadily. That is important. If it had shorter wings, it would have to flap them—and the wings would dip into the water, quickly slowing the bird.

With this creature as with all the others, everything was obviously thoughtfully planned out in advance.

The skimmer is the only bird in the world with cat eyes! The pupils of its eyes are like vertical narrow slits, and after dark they widen so it can see the fish at night. According to evolutionary theory, this proves that the skimmer must be closely related to cats! Except for its eyes, it surely does not look like a cat.

When a fish is caught, it is taken back to the babies who grab it out of their parent's mouth. But they could not grab the fish if their bottom bills were like those of their parents—longer on the bottom. So the baby birds have the same size bills on both top and bottom. Later, when they are ready to fly and catch their own, the bottom bill grows a half-inch (1.27 cm] longer. When is that time? Exactly 6 weeks after birth,—and right on schedule the bottom bill grows longer by just the right amount at the right time!

MORE ABOUT BIRDS—During World War I, parrots were kept on the Eiffel Tower to warn of approaching aircraft long before they could be heard or seen by human observers. The parrots had far better hearing than the people did.

A young robin will eat the equivalent of 14 feet [43 dm] of earthworms a day.

In the 1840s, pigeons would carry European news from ships approaching the U.S. to newspapers along the Atlantic coast. In spite of having traveled all the way to one or more European nations and back, those pigeons still knew where home was and how to get to it.

The albatross has the largest wingspread of all: 10 to 12 feet [30-37 cm] from tip to tip. When a young bird leaves the nest, it may not touch land again for 2 years. Day and night it glides above the ocean, occasionally landing on the water.

With few exceptions, birds do not sing on the ground. They sing while flying or while sitting on something above the ground. Exceptions include the turnstone and some American field sparrows.

The African eagle swoops down at more than 100 miles [161 km] per hour, and can suddenly brake to a halt in 20 feet [61 dm].

A parrot's beak can close with a force of 350 pounds [159 kg] per square inch.

Every bird must eat half its own body weight every day in order to survive. Young birds need even more.

The ancient Vikings from Norway navigated on the ocean with ravens. Releasing them one by one, the men watched to see where they would go. If the raven flew back to where it came from, they continued sailing west. If it flew in a different direction, they would change course and follow its flight path in search of new lands. They knew the raven could sense distant land better than they could. Stories passed down from generation to generation from Noah's time may have encouraged them to try releasing ravens in the ocean—and they found it worked.

When a woodpecker beats on a dry, resonant branch of a tree to talk to other woodpeckers in the vicinity, the duration and rhythm of the drumming tells whether what species it is, and whether it is a male or female. Then another woodpecker, by pecking on a branch or hollow tree, replies and tells what it is.

The hoatzin when full grown is about the size of a medium turkey, but has claws on its wings. Not long after birth—while still naked and without feathers—it uses those claws to crawl up, down, and along tree branches!

The yolk of a bird's egg is connected to the shell by albumen "ropes." When the mother bird begins incubating the egg, these ropes break. Because of this, the mother bird must rotate her eggs every so often. If she does not do this, the yolks will not remain in the center while the chicks are forming, and they will die. Yet the mother bird knows to do this. How long did it take for mother birds to learn that, while, for thousands of years beforehand, all their unhatched chicks repeatedly died?

BIRD NESTS—There are probably as many different nests as there are birds; here are a few to think about:

The weaverbirds of Africa weave grasses and other fibers into hanging nests. A variety of weaving patterns are used.

Social weavers build woven apartment houses, with thatched roofs 15 feet [45 dm] across. They locate strong tree branches and build the roof, then groups of individual pairs gather under that roof and make their own family nests. Before it is finished, over a hundred nests may be housed under one roof. (When necessary, they add—on to the diameter of the roof.)

The tailorbird of southern Asia sews leaves together, using threads it obtains from cotton, bark fibers, and spiderwebs. Carefully punching holes along the edges of the leaves, it then pulls the thread through it all and laces it up like shoes. The end is knotted, or spliced to a new piece so the sewing can go on. The result is a big leaf cup, and all of it done by the bird using its bill.

The swift of Southern Asia makes its nest out of saliva. Gradually layer after layer is built up until a cup-shaped nest is attached to the sides of a cliff. The famed "bird's nest soup" of Southern Asia is made from these nests.

The nest of the peduline tit is rounded with a small entrance hole and appears to be made of felt. A skeletal structure is first made of woven grass, then overlaid with downy plant fibers pushed through the grass mesh. Finally still finer fibers are pushed into the larger fibers. These nests are so beautiful and sturdy that they have been used as purses or even as children's slippers.

The horned coot locates quiet water and then builds an island! The bird laboriously carries over and piles up about 2-3 feet [61-91 cm] of small stones until it dears the surface of the water; then a nest is built on top, using vegetation. The bottom of the stonework may be as much as 13 feet [40 cm] in diameter. More than a ton of stones may have been carried in for the project!

MALLEE FOWL—The mallee bird lives in the Australian desert and does not appear to be anything special, until you take time to watch it carefully. Having done so, you are stunned with what you learn.

In May or June, the male mallee bird makes a pit in the sand with his claws. He continues until it is the right size: about 3 feet [9 dm] deep and 6 feet [18 dm] long! Then it is filled with vegetation of various kinds—anything that will rot. But leaves from the mallee bush are especially used, hence the name given to the bird.

As the heap decays, it produces heat. The male waits for warm rains. When they come, the rains soak up the vegetation and start it heating. Soon it is up to over 100°F [38°C] at the bottom of the pile. The bird waits until it is down to 92°F [33°C]. It continually it tests the sand with its amazing beak.

If the female tries to lay eggs on the pile before it is 92°F, the male will chase her away. He has a thermometer in his beak, and knows exactly how warm it is,—so well in fact, that he can identify temperature to within half a degree!

When the right temperature is achieved, he calls his wife and she lays an egg on the dry leaves. Every day she returns and lays another egg, until about 30 of them are there. The male then covers them with sand and uncovers and turns the eggs every other day.

The sand holds the heat in, especially at night when the temperature drops to 50°F [10°C]. But at night he tests the temperature within the sand, and if it becomes too cold, he piles on more insulating sand. The next day, he will test it again and take off extra sand. If he did not do this, the nest would get too hot. He cannot let the eggs overheat even a half degree!

This goes on for 7 weeks until the first chicks hatch. Each chick comes out of the egg, using its egg tooth,—and then crawls out of the sand rapidly, in spite of the fact that it may have to go up through as much as 2 feet of sand!

Arriving at the top, it is fully able to fly and is on its own. Neither mother nor father give it any attention, training, feeding, or care from the moment it is ready to hatch, onward. When it grows up, it does just as its parents did.

How can the offspring know to do the complicated procedures that its parents did, if it never watched them or was taught anything by them? Even Isaac Asimov is astonished:

"The chick of the mallee fowl never knows either of its parents. As soon as it burrows out of the mound in which its mother built her nest, the chick is able to fly and is left entirely on its own. No mother mallee has ever been seen with a brood."—Isaac Asimov, Asimov's Book of Facts (1979), p. 118.

PETREL—The black-rumped petrel is 2 feet [6 dm] long with a wingspread of 4 feet [12 dm]. An ocean bird, it is also called the "Peter bird," or "little Peter," because from shipboard, it appears to walk on the water. Flying low and slowly over the surface with its feet down, it is looking for fish, and so only appears to be water walking. It has a nesting pattern that is totally unexplainable by any theory of evolution:

The black-rumped petrels know at nesting time to migrate from wherever they are in the broad Pacific—to the Hawaiian islands. How they get there is a mystery, but they do it.

Arriving, they go to Haleakala, the highest mountain on the island of Maui, Hawaii. This mountain is said to have the widest crater of any volcano in the world. These petrels nest in that extinct crater. The problem is that it is 10,000 feet [3,048 m] up! Their nest is built higher than any other ocean bird nest in the entire world.

The female lays only one egg, and the reason is simple: it requires so much energy for the two parents to bring just one chick to maturity! They set on this egg longer than is done for any other bird in the world: 55 days.

It takes 3 weeks just for the egg to form within the mother! This is because the yolk in the egg must be so rich. The baby will have to live on that yolk for 55 days. She lays the egg, and the male sets on the egg for 2 weeks. During that time she is down skimming the surface of the sea eating fish. Then she flies up and sets on the egg for the next two weeks while the male goes down to the ocean to eat.

There is not much oxygen at that high elevation, and it is very dry. Both factors could injure the chick within the egg. This is because most eggs absorb oxygen and emit water through tiny holes in the shell. But this egg shell has fewer holes in it than any other bird eggs! In fact, it has just the right amount of holes to let the water vapor out in the proper amounts—not too much and not too little.

Yet there are fewer holes in the egg, and the thinner air at that high altitude ought to mean less oxygen to go into the shell. But it is a scientific fact that oxygen travels through eggshell faster at high altitudes, and gases come out faster also! So this egg has, in all respects, been designed in advance for high altitudes. "Designed in advance," that is, because if it were designed later on, all the petrel chicks would have long since died in their shells before the design was properly worked out.

After the chick is hatched, it stays in the nest for 4 months! The great horned owl cares for its chick for a full 5 weeks, and that is considered a long time. But the petrel is fed by its parents for 4 months! This is because it grows so slowly.

The parents fly down to the ocean and catch fish and small squid and bring it up to their chick. But the problem is that they are simply unable to provide their infant with enough food. —Why should that be a problem, since it is only one chick? Watch birds in your backyard: both parents are continually flying to and from the nest bringing food to their babies. But the nest of the petrels is 10,000 feet [3048 m] in the air, in a very wide crater, with sides that drop off at an angle thus increasing the distance to the bottom. Beyond the foot of the mountain, there is additional travel time to the ocean—which is the only place that petrels can obtain their food. The parents have to fly so far to bring food to their chick, that they simply cannot bring it enough nourishment as it grows larger. Thus we encounter another insoluble problem. But it also has been solved.

The mother and father petrel produce a special oil in their stomachs. It is a rich red oil, and is nutritionally packed! As they are down skimming the ocean surface and eating to the full, their bodies make this concentrated oil out of much of the food they are eating. Arriving back at the nest, they regurgitate this oil and feed it to their baby, along with some fresh fish or squid.

The Creator's Handiwork

The Marsupials and Mammals

Introduction

MONGOOSE

The mongoose is a favorite family pet in Asia because it is such an effective snake killer. About 3 feet [9 dm] long, the mongoose weighs about 10 pounds [4.5 kg]. It has short legs, yet is a fast runner and quick in movement. This little creature is gentle around people, and was clearly designed to protect them from poisonous snakes. Even if a cobra bites a baby mongoose, the venom will not bother it. Venom antibodies are in mongoose body, blood, and nerve cells. Although it may never have seen a dangerous snake until fully grown, yet a mongoose will instantly know to attack and kill that snake, and how to do it.

CATS' EYES-The eyes of a cat, and many other animals, are able to see well when it is too dark for humans to see hardly anything. One reason is the reflective layer of cells, just below the light receptors in the retina. As it enters the eye, if a particle of tight (called a photon) misses a light receptor, ft is reflected back-from the back side through the light receptor cells for a second chance to be seem The eyes of animals, with such a reflective layer, shine in the dark when a flashlight is turned toward them. Most of these are animals which are nocturnal; that is, they prefer to be active at night.

BATS-Bats are classified as mammals and are the only flying mammals in existence. They sleep during the day in caves and come out at night to hunt for food.

Specialized features enable the bat to fly, yet all those features had to be placed there together in the beginning. Its pelvic girdle is rotated 180° to that of other mammals. That means it is backwards to yours and mine. The knees bend opposite to ours also. This is ideal for bats, but an impossible situation for evolutionary theory to explain. The pelvis, legs, knees, and feet of a bat are structured so that they can sleep, while hanging upside down at night from rocks and trees.

Young bats have special infantile teeth with inside tooth hooks on them. These allow the immature bats to hold onto the thick hair on their mother's shoulders. Without those juvenile teeth, few bats would survive to adulthood. It would be equally hazardous to the bat race if the babies lacked the instinct to grip the fur with their teeth.

The sonar abilities of bats surpasses man's copy of ft. In a darkened room with fine wires strung across it, bats fly about and never touch them. Their supersonic sound signals bounce off the wires and return to the bats, who then make use of echolocation to avoid them.

(There is a true bird, the oilbird, which flies in and out of dark caves using similar echo-location structures. Using sonar, porpoises and whales do the same thing in the water.)

Bats have complicated flaps of skin around their nostrils, and special structures in their ears, which they use to emit and receive high-frequency sound waves. The bat emits bursts of sound of frequencies up to 32,000 per second. Yet we cannot hear these sounds, or anything else above 12,000 waves per second. We can be thankful that we cannot hear those sounds, for it would make a terrible racket all night longs

This sonar system of the bats is more efficient and sensitive, ounce for ounce, watt for watt, than man-made radar and sonar.

Using their echo location method, bats easily find flying insects in the dark, and thousands are caught every nights A bat will catch hundreds of soft-bodied, silent-flying moths, gnats, and other insects in a single hour.

The bat, *Nlctophllus* geoffroyl, can detect fruit flies 100 feet [304 dm] away by echo location. It will catch as many as five in one seconds

Another species of bat, the horseshoe bat of Europe, has elaborate "leaves" on its nose, which act as a horn to focus its orientation sounds in a narrow beam. Turning its head from side to side, the beam sweeps out, scanning the area before ft.

Incredibly, another species of bat uses its sonar to locate fish underwater) This type of bat only eats fish and can locate them below the surface of the water with its sonar!

There is a problem of physics here: Although this bat has a well-developed system of frequency-modulated ("FM") sonar, sound loses much of its energy in passing from air into water, and from water into air. The high-pitched sounds must go from the air into water, echo off the fish, return through the water, then into the air and back to the bat. How can these bats locate underwater fish using this system? Apparently they succeed by flying close to the water as they emit their bursts of sound.

The bat is able to hear sound frequencies of 150,000 cycles per second, whereas man can only hear 15,000 cycles per second. The bat emits sounds of 70,000 cycles per second, at a rate of 10 impulses per second while at rest, and up to 100 impulses per second when in flight.

High-frequency waves are transmitted through the mouth (or nostrils in some bats) from a specialized larynx, and the echoes are picked up by large and specialized ears.

A special, small muscle is in each outer ear. These muscles contract-and automatically shut the ears just before ft emits a sound, and then open them to receive the echo! That is high-tech! Imagine trying to coordinate those ear muscles with 100 squeaks per second made by the mouth!

The randomness *of* harmful mutations is supposed to have made all that?

This sonar has marvelous discriminatory capacities, but why this is so is not understood by researchers. In a bat swarm, cave, or out in the night air, a bat can identify its own sound-from among thousands of sounds emitted by other moving bats! It has the ability to detect its own signals even though they may be 2,000 times fainter than background noises!

Before leaving the bat, consider the arctiid moths. This small moth avoids being caught by bats by producing sounds which are believed to confuse the echoes which return to the bats!

POLAR BEAR-The polar bear has special coarse pads of fur on its feet to keep them from freezing as it walks on the ice. They also enable it not to slip. Nine feet [29 km] tall and weighing 1,000 pounds [454 kg], it can easily run 18 miles per hour on ice.

Diving into the ocean, R swims in water that is extremely frigid. Because it contains salt, ocean water does not solidify into ice until it is 26°F [2°C]. So it is very cold water! Yet the bear has no difficulty maintaining a body temperature of 99°F [37°C]. In addition to excellent fur, he has an inner 3 inch [7.62 cm] layer of fat. This fat not only keeps him warm, but helps him keep his 1,000 pounds [454 kg] afloat.

GIRAFFE-Charles Darwin wrote in his Origin *of the* Species, that the giraffe was just a regular animal that grew a long neck to reach the higher branches. Poor Charlie did not know much about giraffes! There is far more to a giraffe than merely "a long neck"!

The giraffe has the most powerful heart in the animal kingdom. This is due to the fact that it has double the normal blood pressure. This high blood pressure is required to pump blood all the way up to its brain.

The giraffe's blood pressure is two or three times that of a healthy man, and probably is the highest in the world. Because the giraffe has such a long neck (10-12 feet (30-37 dm] in length), its heart must exert an immense force to pump blood through the carotid artery to the brain. The giraffe's heart is huge; it weighs 25 pounds [11 kg], is 2 feet [61 cm] long, and has walls up to 3 inches [7.62 cm] thick.

In contrast, the brain of any animal is a very delicate structure and is not able to stand high blood pressure. What happens when the giraffe bends over to take a drink from a pond? Obviously, we hate here an impossible situation. High pressure is needed to get blood to the brain, yet that very pressure should destroy the brain when it lowers its head to the ground.

Four carefully thought-out design factors nicely solve this problem: (1) The giraffe has in his jugular veins a series *of* one-way check valves. These immediately close as soon as the head is lowered! But there is still a large amount of blood in the carotid artery; too much. (2) That extra blood Is immediately shunted to a special spongy tissue, located near the brain and filled with small blood vessels, which absorbs it. In addition, (3) the cerebrospinal fluid, which bathes the brain and spinal column itself, produces a counter-pressure to prevent rupture or capillary leakage. Last but not least, (4) the walls of the giraffe's arteries are thicker than those of any other mammal.

SURVIVAL OF THE FITTEST

The theory of evolution is based on the idea that, in any given environment, only a certain organism will succeed and all others will fail and die out.

The monkey is said to have developed a tail so it can climb trees better, but the gibbon, manx cat and bear climb trees and they have no tails. The domestic cat climbs trees and has a tail, but does not use n for that purpose.

The horse has uncrowned teeth, long legs, and a bushy tail so it will be "fit for survival." The cow grazes in the same field and has crowned teeth, shorter legs, and a tail with a tuft on the end, and does just as well.

Why does the female duke of burgundy butterfly walk on six legs, while its mate only walks on four?

Evolutionists say that plants evolved berries to aid seed distribution by animals. Why then are some berries poisonous?

The queen ant produces worker ants which are sterile and thus unable to pass on improvements to offspring-nor receive them from their ancestors) How then could the worker bee evolve? The queen produces all the bees. (More on this in chapter 40.)

Cats descend trees tail first, but leopards survive just as well as the only member of the cat family that descends head first. Why then did the others "evolve" the pattern of going down tail first?

Evolutionists maintain that feathers evolved for the purpose of flight. Why then do such birds as ostriches and penguins not fly? How can bats fly, when they have no feathers?

Why do insects and birds which are in identical environments-have different colors?

BEAVER-The American beaver dams up the water to form artificial ponds, and prepares fortresses in them in which it can over winter with its family.

These dams are not essential to the beaver's existence, for there are beavers in Europe which do not go through all the complicated procedures required to make dams; they just do not make them at all.

Cutting down trees, the beaver limbs them and uses them to build a dam. In order to get trees from a farther distance, it builds canals to float the timber down to the pond it is making. Sometimes large stones are placed as part of the foundation of the dam. In the course of time, the dam may stretch to as much as 300 feet [914 dm] in width, and be from 6 to 8 feet [18-24 dm] in height.

The weight of water in these dams can be considerable, so the beaver will, when it thinks it necessary, prepare an upper and lower dam to take pressure off the main one. In this way, if too much rain falls, the main dam is more likely to be protested. The lower dam catches the overflow and covers the base of the larger dam, and thus partially counterbalances the water pressure in it.

The upper dam is higher up in the valley above the main pond. The beaver senses when there is likelihood of flood problems, and it is then that this earnest worker constructs the higher one. The upper dam will always be constructed oversize, in order to hold an extra amount of water; more than would normally flow into it.

The beaver's lodge is made in the main pond and is placed half in and half out of it, with two entrance holes, leading into tunnels usually 7-10 feet [21-30 dm], which open under water. The lodge has a low dome on it, with walls 4-5 feet [1215 dm] thick, made of earth, mud and sticks. The dimensions inside it is about 7 foot by 8 feet [21x24 cm] by 1 foot, 4 inches high [40.64 cm]. -Just the right size to keep the beavers warm in wintertime.

BLUE WHALE-The largest creature which has ever lived on our planet-is still alive: the blue whale. It can reach a length of 100 feet [30 m] and weigh up to 170 tons [154 mt]. That is 340,000 pounds [154,224 kg], or the weight of 2,267 people weighing about 150 pounds [68 kg] each. This fantastic creature has seven stomachs and eats a million calories a day. Its tongue, alone, weighs more than an elephant! It has eight tons [7 mt] of blood and a 1,000-pound [453 kg] heart to pump it. Lastly, the blue whale is one of the longest-living animals, for it can live 120 years.

KANGAROO -The marsupials are the pouched mammals. Two of the best-known of these is the American opossum (the only marsupial in North America) and the Australian kangaroo.

An egg develops inside the mother marsupial, and when it is born it is no larger than a bean! It is blind, deaf, hairless, and looks somewhat like a tiny worm. A newborn opossum is smaller than a honey bee, and six will fit in a spoon. There are 12-15 in each litter.

Emerging from the birth canal, this baby ought to drop onto the ground and die right there. But no, it holds tightly to the fur of its mother, and slowly crawls a sizable distance over to the pouch. We are told that the mother often does not even know when her baby is born, so she does nothing to help it in its journey.

Moving slowly, it makes the trip with difficulty, but eventually it arrives and crawls into the pouch. Why does it know to hang onto the mother and crawl to the pouch? How does it succeed in doing it? How can a worm successfully accomplish the task?

Down into the pouch it goes, and there it fastens onto a nipple. Having done so, the nipple enlarges, locking the little creature tightly to it. There it remains for many months in its warm, safe home as it eats and grows. A wombat will remain thus attached to its mother for half a year until it grows to the size of a mouse.

The red kangaroo (Megalela rufa) can make two kinds of milk simultaneously: milk suitable for the new-born young in one gland and, in the other gland, milk for a young kangaroo that is already out hopping along beside it much of the time! The two kinds of milk differ considerably in nutritional proportions.

Aard Wolf-This is the South African "earth wolf." It looks like a regular wolf, but only eats insects! It loves termites and will eat 200,000 of them in one night!

With its long tongue, it can lick above its eye or under its chin. A sticky saliva is on this tongue, and the wolf uses it to catch the insects-and clean its face afterward. At night when the termites come out of their rest, the wolf catches and eats them, and claws into the nest as well. Its teeth and fangs are used only to protect itself against other animals which might try to attack ft. Otherwise, it does not use its teeth for any foods

Oryx-The oryx is an antelope which lives in the hot deserts of Africa and Arabia. It has long curved antlers and travels in herds of 6 to 12 animals. But when it is time to bear young, several herds will unite for greater protection, with about 60 animals in each herd. The oryx has its young only during the rainy season. If it did not do this, it would not have enough water to nurse its babies properly.

It lives in the desert where the heat can rise to 110°F [43.3°C]. A thermostat is in its nose and as the temperature rises, the oryx gets hotter and it begins breathing more heavily to cool its blood. That nasal thermostat is used to increase blood how to many small nasal veins where the blood is air-cooled before going to the brain. Most animals only have one artery to the brain, but the oryx has several.

CAMEL-The camel was designed to live where there is little food and less water. It has one of the most efficient water conservation systems of any animal. The camel can go two weeks without water. Both the large bowel and the kidneys conserve water in the body.

The camel's digestive system extracts 40 times as much water as does the digestive tract of a cow. Its kidneys are far more efficient in water removal than are other animal kidneys. Even its nose is designed to catch and condense water in air about to be exhaled. When food is scarce, the camel can change part of its wastes back into usable protein! Last, but not least, the camel can readjust its body temperature by a full 12°F! Few animals could survive such a temperature change inside their bodies.

LEMMINGS-These look like short-tailed relatives of the field mice. They live on the bare tops of mountains in northern Europe and also on the Arctic tundra.

Every so many years, their numbers grow to such an extent that there is not enough food for them all. When this happens, suddenly they will march to the sea. Hordes of them will swim across rivers, travel across plains, and climb over mountains. On they go until they reach the ocean. Plunging in, they begin swimming, and soon drown.

This is an emergency means of keeping down the population. It is necessary to protect the environment from contamination from dying mice..

PROPORTIONAL FACTS-An animal's proportions required advance planning, for its structure and shape has to match its size and weight. If a fly was the size of a dog, its legs would be crushed. If a dog was the size of a fly, it could not maintain body heat. No insect the size of a man could, in earth's gravitational field, walk, fly, run, or even crawl an inch.

All things being even, a small animal must have a faster metabolism than a large animal. Otherwise it will not be able to replace all the energy it is so quickly using up. A shrew or hummingbird must constantly be eating or either will die of starvation within a short time, while a large animal could go without food for longer periods.

WONDER NET-Many creatures have the "wonder net." This is a special arrangement of blood vessels that some animals use to conserve heat.

A man standing with his bare feet in cold water would not survive long, but a wading bird can stand in cold water all day, and the whale and seal swim in the arctic with naked fins and flippers, continually bathing them in freezing water.

All such warm-blooded creatures have to maintain a steady body temperature. Yet how do they avoid becoming sick when the cold continually presses against their thinly-insulated extremities?

They use what scientists call the "countercurrent exchange." It is a method of heat exchange used in industry. In animals it is called *rete Irablle*, or "wonder net." The blood in one vessel flows in the opposite direction to that of an adjacent vessel, and in this way warm blood passes on its heat to the colder blood. It is similar to a double layer of circulating blood.

SLOTH-The sloth has no soles on its feet, for it does not need them; it hardly ever stands on the ground. Spending most of its life in the trees, it likes to hang upside down from the branches! In order to rest, move, and sleep suspended from trees, several factors in a sloth need to be different than other mammals. Yet, because it has them, it is obvious that the sloth can only be happy when hanging upside down from trees.

Here is another example of careful design: All other mammals have fur which hangs downward from the top, but the hair of the sloth has a part running along his bottom sides, thus causing the hair to hang opposite to the other mammals. In this way, rain runs right off this upside-down creature.

FEET, SMELL, AND TEETH-The horse has a single hard hoof so it can run on the hard ground of the plains. The cow has a split goof, so it can walk on much softer ground without inking in. Its two hoofs spread and give better support. The caribou's hoof is even wider, so it will not sink into the snow. But during the winter, the inner part of the hoof shrinks; leaving a sharp outer edge which prevents slippage on the ice.

Night animals will not be able to see as well, so they have a better sense of smell than most of the animals roaming about in the daytime.

When a squirrel, rat, or beaver wishes to cut something with its chisellike front teeth, the lower jaw is slid forward. In this position, its grinding teeth will not meet. In order to grind up what it has cut off, it slides its jaw backward again. In this position, the cutting teeth fit into a vacant space behind the upper incisors, and the grinding teeth match each other.

POLAR BEAR-The polar bear has a head shaped in such a way that its eyes, ears, and nose remain above water as it swims. The feet are much larger than those of other bears, so it can walk on snow. There is webbing between those large feet, so it can swim. The soles of the feet are covered with hair, which prevents slippage on the ice.

RAT-The rat has 16 teeth; 12 molars to grind and 4 front incisors to bite food, crack hard corn, and chew through wood. the top two front incisors go behind the bottom front teeth. The very hard outer tooth coating, called enamel, is found only on the front of the incisors. Therefore the back sides of them are ground down by the top teeth to a razor-sharp edge.

Engineers at General Electric Corporation wanted to design self-sharpening saw blades. So they studied a rat's front teeth in order to figure out how to do it in the very best way. Then, on a metal lathe, they copied the design and prepared a saw blade that has the same angle in relation to the metal it is cutting. As it slices through the metal, small pieces of the blade are cut away by the metal, thus always keeping the blade sharp. That self-sharpening blade lasts six times longer than any other blade they had previously been able to make. All because researchers studied the front teeth of a rat.

RIBLETS-You do not know what a riblet is? It is not an animal. Airlines in the United States are saving $300,000 a year because of riblets. Here is the story behind them:

Scientists at NASA tried to figure out how certain water creatures could swim so rapidly. They studied porpoises and sharks for months. The friction of the porpoise's body as it moves through the water ought to be great enough to slow it quite a bit. Yet the amount of drag that should be present-simply was not there! Given the drag of the water and the amount of flipper motion, something was enabling the porpoise to swim much faster through the water than it ought to be able to swim.

Then the experts figured it out: riblets. These are small triangular-shaped groves on the outer surface of the porpoise's skin. They are also found on fast-swimming sharks, but never on the slow ones. These grooves run from front to back. As the water touches the body, it is carried along in those riblets, and this reduces the amount of frictional drag as the large creature swims rapidly through the water.

NASA's Langley Research Center developed the riblets and tested them in wind tunnels. They then asked 3M Company to manufacture riblets in large, flat vinyl sheets. When these sheets were placed on the outside of large airplanes, the resulting savings were immense. It now costs airline companies a lot less in fuel to fly a jet liner a given distance.

MOLE-The mole is. not blind, but has good eyes although often hidden by fur. It may not run very well, but it surely can digl A mole's front feet are small spades, with well-designed claws on the ends. Its nose and tail have special nerve endings which can strongly sense vibrations. These vibration sensors obviously were carefully designed, for they have thousands of parts. With them, a mole can actually hear worms and grubs crawling several feet away in solid dirt. The mole is not mining the ground, but is eating the grubs which destroy the plants.

HYENA-When they are not running from lions, packs of spotted hyenas in Africa spend their time watching vultures! They in turn watch the hyena packs. When either finds a dead animal, all gather and eat it together without disturbing one another.

The hyena has a strong stomach acid that is able to digest the most rotten meat, without becoming sick. Yet that strong acid never injures the wall of its stomach.

WEIGHT LIFTERS-A female chimpanzee can lift 1,260 pounds [571.5 kg] with one arm, whereas a man of the same size could only lift about 1/6th as much.

The hero shrew of Uganda, Africa, measures only six inches [15 cm], yet it can support a 160 pound [72.5 kg] man on its back. No human could survive under a proportionate load.

MANATEE-When Columbus came to America on his second trip (in 1493), he saw mermaids and said they looked ugly. What he saw were manatees. These are the large "sea cows" which feed on vegetation in rivers not far from the ocean. This giant mammal stands on its tail in the water and walks around! Seven feet (21 dm] tall, it weighs 1,400 pounds [635 kg], and balances on its tail.

LIGHT SLEEPERS -The giraffe only sleeps half an hour every 24-hour day. The tiny shrew (the smallest mammal in North America) does the same. All other mammals and most other animal life need much more sleep.

OXPECKER-The oxpecker bird lives in Africa and lands on the necks of various grazing animals and drills out burrowing insects and cleans wounds. When it lands on the neck of the giraffe it has a field day. The animals welcome the oxpecker bird for he helps safeguard their health.

PRONGHORN ANTELOPE-The pronghorn antelope in western U.S.A., can run 50 miles [80 km] an hour. It lives where there are hot summers and cold winters, so it has short fur and long guard hairs. In the summer the guard hairs stand up, and in the winter they lay down flat and seal over the fur beneath, keeping it warmer.

The pronghorn has a special signal system that can be seen by other antelope two miles away. A special muscle in its rump pulls white hair over brown hair; a raised, shows brown hair. At a distance, the sudden change to white hair and then back to brown looks like a flashing mirror. This warns other antelope of danger; coyote packs are approaching! One antelope signals and others signal; then all run. As they run the signal keeps flashing on and off for a short time.

HIPPOPOTAMUS-The hippopotamus is the second largest land animal in the works (next to the elephant). It is 14 feet [43 dm] long, 41/2 feet [14 dm] tall, and weighs 4 ton [3,628 kg]. But in the water, it only weighs 116th as much: 1,200 pounds [544 kg].

During the day it sleeps in the river, or walks around underwater, as fish clean ticks and bugs off its skin. At dusk it comes up on land and nightly consumes 150 pounds [68 kg] of grass, traveling as much as 20 miles [32 km] to do so.

SEA OTTER-The California sea otter is a playful creature. It is also a tool user. When it finds a clam or abalone shell for dinner, it picks up both the clam and a stone from the ocean bottom and carries both to the surface. Then, leisurely, it floats on its back and cracks the shell open, using its chest as an anvil. Placing the clam on its strong tummy-the sea otter hits it with the stone, opening it.

SPRINGBOK GAZELLE - The Springbok gazelle in the Kalahari Desert of Africa is only 3 feet [9 dm] high, but every so often will spring 10-12 feet (30-36.5 dm] straight up! It does this to look for enemies at a distance. This would be equivalent to a 6-foot [18 dm] man jumping 24 feet [73 dm] high.

One guard will spring up periodically, looking for lions and leopards, while others in the herd feed. A white patch on its tail goes up when it spots enemies, and off it runs. Then all the others speed away at 60 miles [96.5 km] per hour.

DESERT BURRO -The desert burro in the American southwest lives in the heat all summer long. Four feet tall, it normally weighs 300 pounds [136 kg], but can lose 75 pounds [34 kg] of water before needing a drink.

Normal blood in mammals is 97 percent water. The desert burro can lose 30 percent of the water in its blood without hurting it. It has special blood cells and a strong heart. If a man lost 6 percent of the water in his blood, he would fall unconscious; 10 percent and he would have a heart attack and die.

MARMOT-The marmot is like a woodchuck, but instead is a "rock chuck." It lives under boulders so bears will not get it. When the time comes to dig its den for a long 9-month hibernation in the cold country it lives in, the marmot must know the soil and terrain well. If it makes its winter home in the wrong place, water, draining in, may flood and drown the little creature in the spring before hibernation is ended. The marmot's den is 20 feet [61 dm] below ground, sometimes with a 300-foot [914 dm] tunnel leading to it. So it always stays in high ground, and away from depressions or ravines when digging its winter home.

MAMMALS FROM REPTILES -Any classical evolutionist will explain that mammals descended from reptiles. Consider some of the many differences:

1- The basic structure of mammals is quite different than that of reptiles.

2 - Reptiles breathe in a totally different manner than mammals, for reptiles lack a diaphragm.

3 - Mammals primarily excrete urea, whereas reptiles excrete uric acid.

4 - Mammals have fur (although some, such as whales and elephants have relatively little); reptiles have scales.

5 - Mammals have much larger brains than reptiles have.

6 - Mammals maintain a constant body temperature, but reptiles do not.

7 - Mammals produce milk, but reptilian infants must get their nourishment from the egg.

8 - There are important vertebral differences between mammals and reptiles.

9 - Mammals have different blood. Theirs is nucleated and markedly different in several ways. The blood of reptiles is un-nucleated.

10 - Mammals have three ear bones, whereas reptiles only have one. The inner ear of mammals is much more complex.

11 - Mammals have a palate separating the mouth from the nose cavity; reptiles lack it.

12 - Mammals consistently have a single dorsal aorta (their largest artery). Reptiles have two. How could one circulatory system change into a different one?

13 - Mammals have a complex set of teeth, including temporary infantile ("milk") teeth. Reptiles have single peg-teeth.

COW-There are millions of milk glands in the udder of a cow. Each day it drinks 25 gallons [94.6 liters] of water and produces 5 gallons [18.9 liters] of milk.

People have one chamber in their stomach; cows have four chambers. Grass is ground up by the back grinder teeth and is then swallowed. That grass enters the first chamber (the "rumin"), which is 3/4's of the total stomach area. This holds lots of water. Food churns and ferments at body temperature [102°F; 39°C]. The heat multiplies bacteria which make B vitamins, which help the cow make milk.

There are also many protozoa in the stomach. They were in the water and grass that was eaten. The protozoa are killed by strong stomach acid in the fourth chamber-and become protein for the cow and its milk.

The food now passes into the second chamber (the "reticulum"), where a muscle pushes it back up the throat and the cow, lying on the grass, chews on this "cud" with its mouth. This breaks it up even better. Once again it is swallowed.

Now the cud is sent down to the third chamber (the "omassium"), where moisture is squeezed out of ft. From there it passes into the fourth chamber (the "abelmasson"), where strong acids break the food down for digestion in the intestines. Gallons of water are poured into this fourth chamber.

How could such a complicated stomach mechanism ever evolve?

POCKET GOPHER-This little fellow has big cheeks with pouches in them, which extend from below its eyes down to its shoulders. This is its grocery sack, in which it pokes carrots, potatoes and other food which it finds. It will chew and swallow that food later.

The gopher digs long shallow tunnels, each of which may extend 50 feet [152 dm] or so. When it goes down into its hole, it seals the entrance to keep snakes out. With its long sharp claws, it can dig rapidly. Because the wear on those claws is terrific, they need to be fast-growing. So its front claws grow 20 inches [50.8 cm] a year.

Crawling around through the dirt is hard on eyes, but the gopher has no problem. There is a gland near each eye which produces jelly. This coats the eye, and when it blinks, the dirt falls off. Then the eye is reooated by fresh jelly.

But the gopher does more than crawl,-it runs through its tunnels. And it runs both forward and backward! As it runs backwards through the dark, curving tunnels, it raises its tail and feels the sides,-and never runs into the wall!

The gopher can both bite and dig at the same time,-and do it without getting dirt in its mouth! This is because its lips are closed behind its teeth.

ELEPHANT- MUCH could be said about the elephant, for it is a large subject-in more ways than one. Its fantastic trunk can pick up an immense log, a tiny child, or a pin! It is also used to hose itself down with water or dust, or scratch its back with a stick! The elephant has a very slow metabolism and heartbeat, yet can outrun a man. Its cooling system is in its large ears! Each ear, weighing over 100 pounds [45 kg], are filled with many small blood vessels. To conserve heat, the ears are held close to the body, and to cool off they are held outward. On very hot days they are flapped.

KOALA-This is a 2-foot-tall [62 cm], 20 pound [9 kg] marsupial, which is the Australian "teddy bear." It spends its entire life in the tall eucalyptus trees, eating eucalyptus leaves.

As with other marsupials, baby koalas are born looking like tiny worms, then crawl into the mother's pouch. Six months later they emerge and are 8 inches [20.32 cm] long. At that time they crawl out and onto their mother's backs and remain there for another six months!

All the food and water of this animal come from eucalyptus leaves (the leaves are 65 percent water). No other animal dares to eat those leaves, for they are poisonous if swallowed. But the koala has a special stomach acid which neutralizes the strong chemicals in eucalyptus oil.

The koala has a special intestine which is able to digest the leaf cellulose. Tiny one-celled protozoa provide the needed digestion. Passing into another chamber, strong acids digest and eat the protozoa.

It is said that man is the ruler of the world "because he has an opposable thumb." The little koala bear laughs at that suggestion, for he has an opposable thumb on each foot,-and two of them on each hand!

With but two exceptions, the pouch of every marsupial opens towards its head. The exceptions are the koala and the wombat, which open to the rear.

RIVER OTTER- The otter may be slow on land, but is one of the fastest mammals in the water. The otter has 36 special whiskers attached to nerve pads in its cheeks. As it swims rapidly through muddy water, it can sense the faint shock wave sent out by a passing fish. From that sensation, the otter can tell what type of fish it is and where it went!

Even if the fish is resting, it will emit electrical currents which the otter can sense. **With its paws, the otter** digs for crayfish, and can locate them by sensing their body electricity. When the river is covered with ice, the otter will go up beneath the ice and breathe out, and then take the air back in and breathe out again. This keeps melting and weakening the ice. Soon it can break through.

SLOTHS AND ALGAE- In the South American jungles can be found the three-toed sloth and the two-toed sloth. A certain green algae gets onto the coat of the three-toed sloth and lives there. This is helpful to the sloth for it turns him green and hides him from enemies. He looks like a clump of leaves.

In the same forests live the two-toed sloth. A brown algae likes to make its home on him-and turns him the brown color of the tree bark he lives on! He looks like a piece of tree hanging down from a limb.

The difference lies in the structure of the hair on the two sloths. The transverse cracks in the first type of hair seem to attract green algae, whereas the longitudinal grooves in the second type of hair are more favorable to brown algae.

ANTELOPE SQUIRREL- This little desert squirrel lives in the Sonoran desert. When it is hot outside, the squirrel goes down into its underground tunnels to cool off. It has special skin inside its nose that senses moisture. As the little squirrel exhales air, this nasal skin soaks up most of the moisture in that exhaled air-and puts it back into its body! Certain other animals, such as the camel, do this also.

STAR-NOSED MOLE- This little mole has a star the size of a dime on its nose. With that star it is able to sense vibrations in the ground or in the water. As it digs, this mole stops and listens. It can hear the vibrations of an earthworm or similar creature, and identify the direction it is coming from. The mole obtains both its food and water from earthworms.

As with other moles, the star-nosed mole has sense organs in its tail that enable it to run backwards through the curves and sharp turns of tunnels, without colliding with the walls.

Also, as do other moles, the star-nosed mole has a sonar similar to bats. Opening its mouth and emitting a high-pitched squeak, as it runs forward through the tunnels, the returning echoes are sent to its brain, where they are interpreted and tell it what is ahead in the darkness.

KANGAROO RAT- The kangaroo rat (Dipodemys microps) of the American southwest, is able to live on the leaves of the saltbush, Atriplex, which most other creatures avoid. The outer layer of these leaves is very salty in contrast with the tasty inside portion of the leaf. The little rat has special teeth, with which it is able to shave off the salty outside portion of the leaves before eating the inside part.

WHALE-Evolutionists maintain that the whale is descended from land animals. They say this because it is warm-blooded and nurses its young with milk. But those are among the few things which whales have in common with mammals on the land!

The whale has no neck to turn its head, and, because its eyeball is fixed, the whale must move its entire body to shift its line of sight. Its eyeball is ideal for seeing underwater, whereas land animals generally cannot do so. A special sclerotic coat protects its eye at great depths underwater.

Whales produce excellent sonar. They have the ability to detect objects miles away through echolocation. Not only can they locate distant objects, but they can tell if they are neutral, friend, or enemy. According to the evolutionary theory of similarities, creatures with sonar and radar are all related; in other words, one is ancestral to another. So the whale, which according to the theory came from a mammal that crawled into the water,-must have descended from the bat!

The whale's nose and mouth are structured so that no water enters the body under the pressure of fast swimming or depth diving.

Its forelimbs are jointless paddles or flippers; there is no fossil evidence that they evolved from animal arms.

Except around the nose, the whale lacks the hair and fur that land animals have. Instead, it has thick layers of blubber to keep it warm. It has no sweat glands.

The ears of a whale are designed remarkably differently than land animals. Sound is carried to the eardrums through a tube from a point beneath the surface near the eyes. It can hear other whales at a great distance.

The whale has special breathing equipment so that it can remain underwater for as long as two hours. Which land animal did it inherit that ability from? While down at great depths, its body can withstand immense pressure that would crush any land animal that tried to go down there.

The outer skin is marked with lines not found in land mammals. These lines help streamline water flow, giving it maximum speed for the least effort.

In the mouth of the baleen whale are unique horny plates with fringed edges, that permit it to strain out ocean water-and catch tiny plant and animal plankton-the smallest creatures in the ocean-for food.

The windpipe and gullet separate at about the same point in land animals, but in whales the two are located differently so the baby whale, as it nurses, will not get milk down its windpipe and choke. If a whale choked underwater, it would cough and that would carry enough water down its windpipe to kill it.

PRAIRIE DOGS- Daniel Bernoulie was an 18th century physicist who first stated the principle that the pressure exerted by a moving fluid decreases as the fluid moves faster. *Bernoulie's princi*ple may sound complicated to you and me, but prairie dogs understand it well.

These little creatures admirably apply this principle in making their underground tunnel cities.

The burrows have two openings, one at ground level, the other located on a raised mound. They work hard to make that second opening higher than the normal ground level.

Having done this, the Bernoulie principle takes effect and nicely aereates their burrows with fresh air.

ARCTIC HARE- When you follow the tracks of the arctic hare in the snow, they will lead on for a distance and then stop. The tracks end! Did it take flight?

Carefully examining the track, you will see that the hare has doubled back on those same tracks. Following it back, you will find that after about a fourth of a mile, the doubling back tracks end entirely. The hare is gonel

Scanning about, you will see that, 12 feet [37 dm) away, the tracks begin again, leading off in a different direction. Who taught the arctic hare to do that?

PORPOISE- The bottlenosed dolphin is also called a porpoise. Some scientists and naturalists call it by the one name and some by the other.

The porpoise has a special valve in its air hole which closes when it submerges. In this way, no water goes into its lungs. Lacking that single feature, the porpoise (and all whales) would quickly die for they could catch no food without drowning.

Coming to the surface, it exhales 90 percent of the air in its lungs, whereas people only exhale 15-20 percent. This enables the porpoise to remain underwater longer.

It has 40 special valves in its bronchial tubes, and these close so the air in its lungs cannot escape while it is underwater, opening its mouth and catching and swallowing fish.

Porpoises do not breath automatically as we do, and so they cannot sleep as we do. Each breath of air must be purposely taken. If they became unconscious, they would fall to the ocean floor and perish.

Porpoises get hot while swimming but they cannot sweat or pant, so there are extra blood vessels in their flippers and tail which, through heat exchange, release heat off into the water.

As with whales, there are stripes or corrugations etched into the skin of porpoises that enable it to swim faster with the same amount of effort than they otherwise could. Accuracy in directional swimming is also improved by this means. The resultant reduction of water resistance makes it possible for porpoises to sustain speeds that are about ten times more than otherwise would be possible with the same muscle power.

Porpoises are very powerful creatures and crush vicious barracudas with one snap of their jaws, and kill deadly sharks merely by ramming them with their snout. It is sonar that enables them to be able to plan at a distance and win the battle with those terrible creatures. Yet porpoises are intelligent enough to know that man will not hurt them (?), and they have never been known to attack people.

You have probably read that careful research indicates that the porpoise is the most intelligent water creature in the world, and probably equal in intelligence to the larger dogs. Dogs, in turn, are more intelligent than most any other animal. Chimpanzees are considered the most intelligent of the animals.

Porpoises use sonar (sonar = "sound navigational ranging") to locate food and enemies. They emit high-pitched squeaks, which rapidly travel outward, bounce off fish, reefs, and other surfaces, then return. Porpoises can even measure the size and distance of the fish with this technique. They probably can identify them as do whales with their sonar.

Porpoises have a special region in their head which contains a specialized type of fat. Scientists call it their "melon," for that is its shape. Because the speed of sound in the fatty tissue of the melon is different than that of the rest of the body, this melon is used as a "sound lens" to collect sonar signals and interpret them to the brain. It focuses sound, just as a glass lens focuses light. The focused sound produces a small TV screen "sound picture" in the porpoise's mind-showing it the unseen things ahead of it in the murky water.

It has been discovered that the composition of this fatty lens can be altered by the porpoise in order to change sound speed through the melon-and thus change the focus of the lens to accord with variational factors in the surrounding water!

There is also evidence that tie composition of fat varies in different parts of the melon. This technique of doublet lens (two glass lenses glued together) is used in optical lenses in order to overcome chromatic aberrations, and produce higher-quality light lenses. The porpoise appears to be using a similar principle for its sound tense system!

The Creator's Handiwork

man

INTRODUCTION

The evolutionists fell us that man is the product of chance. Random action of chemicals produced living creatures; random changes In those creatures produced more creatures; random changes in later creatures ultimately produced man. That is how the story goes.

Man talks about exploring outer space. In this chapter we will briefly look at some aspects of inner space-inside you. Everything within your body is a wonder, an absolute miracle of structure, function, and design. We could fill 100,000 large volumes with the amount of information known by modern science about the human body. Although the following is but the briefest of overviews, as you read each point, think to yourself: "How could it happen by chance?" and then settle it in your mind: "It couldn't happen by chance! It was done by the Creator God!"

1 - BONES

Bones are the framework for your body. If you did not have them, you would lie nearly motionless on the floor like a jellyfish. Your 206 bones are all perfectly shaped to do the right job and in the right way. Each bone is somewhat different from all the others, yet perfectly designed for its task. It is connected in just the right way to perform its functions.

Your finger joints move like a door on its hinges, so are called hinge joints. Your shoulders and upper legs have ball-and socket joints, so they can turn in every direction. How could such a joint make itself by chance? You would have a difficult time working and surviving without that special joint in your shoulders and legs.

Strong, fibrous bands, called ligaments, hold your joints together, and each moving joint is lined with a membrane that secretes a fluid (synovial fluid to keep the joints "oiled" and working smoothly. The ends of each joint has over it a plate of very smooth cartilage to provide a slick surface for rotation.

Inside the bones is a spongy material called marrow. This design provides great strength, yet makes your bones much lighter in weight. Since the area inside the bones is a highly protected area, the red marrow within it contains special cells. Those cells manufacture one of the most important substances in your body: red blood!

Everyone knows that there are only 2 bones in your head: your skull and your jaw. But did you know that, at birth, you had many bones in your head? They were all movable so your head could squeeze through your mother's birth canal. Later, they fused together. Everything was planned, carefully planned.

Your spinal bones are another total marvel. The spine is divided into a vertical stack of bones (vertebra), all carefully connected, with a central vertical hole. Through that hole a cable of nerves-your spinal cord-runs down the middle, with horizontal outlets in the vertebra so nerves can pass outward to various body parts. How could that complicated arrangement invent itself?

2 - *MUSCLES*

Hold your hand out in front of you and look at it. Move the palm up, then down, and around. Then rotate it slowly from one side to the other. There is hardly a movement that you cannot do with it. Notice that those motions involve your forearm and upper arm. From your shoulder down, all the muscles and bones are working together with your hand as it undergoes various movements. Place your left hand on your right hand, as you move the right hand. Feel the bones and muscles beneath the skin responding to the messages sent from your mind. Look at your hand carefully as you move your fingers in every possible way. Do it again, but this time with your other hand on your wrist, and then your forearm. Rotate your hand again, with your other hand on the forearm bones. Feel the radius and ulna bones turning over on one another as you do it.

Now, within your shoes, wiggle your toes.

Stand up and, with your hands on your hips, slowly walk across the room. As you go feel the bones and muscles moving in perfect coordination. Notice how your legs and body do what is needed to keep you balanced as you walk.

What is this amazing machine called the human body! It is astounding!

Your muscles are attached to your bones at exactly the right places where they will give the best leverage. That took thinking! Downstairs in your family workshop, make a couple bones and several muscles, ligaments, tendons, and all the rest, and then figure out the best place to locate the ends of the muscles in order to obtain the best leverage. Oh, you say, you don't know how to make a muscle! Well, no one else can either. That which intelligent human beings cannot do, random actions of molecules are supposed to have accomplished.

One end of each muscle (the insertion) is attached to a movable bone, the other (the origin) to a less movable one. Muscles are elastic and work in pairs: Most body movements require several pairs of muscles working together. When you bend your elbow (flexion), you can feel the muscle in your upper arm grow hard and thick as the muscle fibers shorten to bring up the forearm. At the same time, the contrasting muscles, those on the back of your upper arm, are lengthened and they pull against the front ones. Now reverse the process (extension) and your arm is extended outward again.

You have two types of muscles: voluntary (skeletal, or straiteal) muscles, and involuntary (smooth) muscles. The voluntary ones change body positions and only work when you want them to; the involuntary work automatically. Work automatically! How can a muscle work "automatically"? Well, they do anyway. These involuntary muscles control motion inside the body, circulate the blood, move food along the digestive tract, make eye adjustments.

Highly-trained scientists and technicians have invented cameras with automatic focus and aperture control. But your eye has always done both functions automatically. Obviously, a highly skilled Person produced that eye. The focusing makes adjustments in the lens system; the aperature determines the size of the hole through which light enters the optical instrument. Yet in your body, it is all done "automatically." literally thousands upon thousands of other adjustments are also made in your body automatically! Thousands are made each minute in each cell in your body. (See chapter 11, Cellular Evolution, for much more on this.)

3 - CIRCULATORY SYSTEM

If I tried to put an ad in the newspaper announcing houses that come with self-manufacturing plumbing and electrical systems, they would tell me I was writing science fiction, and refuse to print it. If I tried to have it printed in a science magazine, they would laugh in my face. But that is what your body does. Before you were born, it constructed its own plumbing and electrical system-and more besides.

Your body is filled with plumbing; in fact, with several totally different plumbing systems. These include your circulatory system, which sends blood all over your body, your urinary system, which purifies the blood, and your lymphatic system, which carries on additional cleaning actions in body tissues. There are also compact plumbing systems in the liver, kidneys, mammary glands, skin sweat and oil glands, and the endrocrine glands.

Your circulatory system is composed of a blood pump (your heart), and the plumbing (blood vessels) needed to carry fluid (blood) throughout your body.

The structure of the heart is another great marvel. It is perfectly designed for what it must do, and is the hardest working muscle in your body.

In the wall of the right atrium of the heart is a small spot of tissue. Called the sino-atrial (SA) node, approximately every second this tissue send out a tiny electrical signal which special nerves quickly carry throughout the heart muscle in the right ventricle. The message it sends is: "Beat!" Instantly, a second node, the atrioventricular (A V) mode (bundle of His) is alerted and relays the message on to the left ventricle: "Bead"

And your heart beats! Moment by moment, day by day, year by year, it keeps beating. How thankful are you for that beating heart?

The heart is a powerful pump that drives 5 to 6 quarts [4.7-5.7 liters] of blood per minute through several miles of tubes in your body. During active exercise, this can go up to 20 quarts]19 liters]. Consider the complicated, yet efficient design of the pump:

Blood from all parts of your body returns through the superior and inferior vena cava (the largest veins in your body) and enters a "waiting room," the right atrium (right auricle), ready to enter the right ventricle. When the next heart beat occurs, the ventricles squeeze. The load of blood already in the right ventricle is squeezed out into the pulmonary artery (and is sent to the lungs for oxygen). None of that blood flows back into the ventricle, because the semllunar valve guards the exit. That same squeeze brought the waiting blood from the right atrium through the tricuspid valve into the right ventricle. That valve keeps it from flowing back into the right atrium.

Blood returning from the lungs passes through four pulmonary veins into the left atrium (left auricle). A mural (bicuspid) valve guards the entrance into the left ventricle. Then comes the next heartbeat which sends that blood into the left ventricle,-a split second after the blood in the ventricle has been squeezed out through the semilunar valve into the aorta (the largest artery in your body).

The blood in the aorta goes to all parts of your body. From the aorta, that crimson stream is carried to still smaller arteries, and thence into arterioles. These flow through capillaries so tiny that the blood cells must pass single file. As they do, oxygen and nutriments pass across into the cells, while carbon dioxide and wastes leave the cells and pass out into the capillaries. Still other wastes pass out into the lymph vessels to be carried away. From the capillaries, the blood passes into venules, then into veins, then into the inferior or superior vena cave, and back to the heart. Random activity of molecules is supposed to have invented all that? Why, the organism would be long dead before "natural selection" ever got started trying to figure out such complication! Natural selection is simply random activity, and nothing more; it does not have the brains to accomplish anything worthwhile.

Your blood cells are very complex. In chapters 10 and *11 (DNA* and Cells), we discuss part of the immense requirements needed to invent blood and other body cells. There are different types of blood cells; each one is vital and each one contains hundreds of key factors needed for life. Complicated enzymes must be present to prodace the crucial ingredients in those cells.

One cubic centimeter-smaller than a drop of blood contains an average of 41/s-5 million red *blood cells*. They wear out in less than a month, and more are made in the red bone marrow. That same cubic centimeter of blood contains 7,0009*,000 white blood cells,* and increases to 15,00025,000 when infection occurs. There are several types of white blood cells. That same cubic centimeter of blood contains 250,000-500,000 *blood* platelets *(thrombocytes). If* you cut your finger, these are used to quickly clot the blood so you will not bleed to death.

The above description is over-simplified in the extreme. But it is enough to take one's breath away! A Powerful, and extremely intelligent Being created you!

In addition to the blood circulatory system, there is the lymphatic system. If all your body were removed except your lymph vessels, the complete three-dimensional form of your body would still be there. That is how many lymph vessels there are in your body! Your lymphatics are used to carry away additional wastes from your cells.

4- DIGESTIVE SYSTEM

For a moment, let us consider your digestive system, a complicated structure that harmful mutations, assisted by random actions ("natural selection") is supposed to have developed Of course, evolutionary processes would have had to produce it within a few days or your first ancestor would have starved to death very quickly.

Evolutionists say that, given enough time, anything can be done. But that is not true. (1) Given enough time, randomness only increases confusion. (2) In relation to living creatures, all the complicated organs had to be in place-fast!

In or near your mouth are teeth to chew food, a tongue to move it around, and seven different salivary *glands to* produce saliva to predigest part of that food. Any one of those items would be impossible for chance to invent. It is only their great ignorance that enables people to glibly speak about how "evolution operates by mutations and natural selection." Anyone who takes time to study into the multitude of nerves leading to the tongue will be dumbfounded with amazement. All those nerves were needed, for you were purposely designed to be able to think in words and then speak them with your tongue.

From the mouth, the food is sent to the back of the throat where it passes through the swallowing *mechanism. How* may ages did it take for natural selection to figure out that you needed to swallow food without choking to death instead? Until that happened, food would all pass into the lungs instead of into the stomach!

Another little detail: Your *pharynx not* only contracts so you can swallow food properly, it also connects through *eustachian tubes* to each ear. Without those tubes, changing air pressure would quickly destroy your hearing!

Passing down the 10-inch [25 cm] esophagus, the food arrives at your stomach. The cardiac valve guards the top end, and the pyloric valve the bottom end of your stomach. Both are ingeniously-designed spincter muscles.

Within the stomach, the digestion begun in the mouth continues on. Signals are sent to the stomach wall, and its excretes an acid so powerful that it can digest meat! Why then does it not digest the stomach and everything inside your body? No one has ever satisfactorily explained that question. Next the stomach begins churning back and forth, mixing the contents with *hydrochloric* acid. All the while, the pyloric valve remains closed.

Then, something tells that valve to open, and the contents start entering the small Intestine. The upper 10-12 inches [25-30 cm] of it is called the duodenum. Within that short length of tubing, bile pours in on signal from the gall bladder. (It was oil in the food which triggered that signal.) The wall of the duodenum also signals the pancreas on the other side of the body to quickly send over some pancreatic juice. Still other types of juices come from the wall of the duodenum. All of those juices work to break up fats, proteins, sugars and starches into still smaller particles.

The food gradually moves downward through the small intestine, which is 11/z inches wide [3.8 cm] and 23 feet [7 m] long. Throughout its entire length, little fingers protrude from the walls. These are called villl. In the center of each is a lymph channel (lacteal), with blood capillaries surrounding it. Between the villi are additional intestinal juice glands. The villi absorb the nutriments and send them into the blood stream.

You could not design a more efficient way to do it if you tried, yet evolutionists say it all happened by chance. When asked how that could be, the reply is always the same: "long ages of time, long ages of time; anything can be done if given enough time." How did we live during all those "long ages" until our villi were invented?

The *liver is* generally classified with the digestive system, but it accomplishes a wide range of tasks. Aside from your skin, this is the largest gland in your body, and one of the most astonishing structures in your body!

The liver literally performs thousands of different functions! It is amazing how such a small organ can do so many things. Here are a few of its major activities: (1) It is a collection and filtration plant, carefully removing a variety of substances from the blood. (2) Working with waste products and nutrients brought to it in the blood stream, it manufactures literally hundreds upon hundreds of different chemical substances. Among these are bile, glycogen (stored sugar), and blood clotting aids and preventatives. (3) Since it does so much, how can the liver find room to store anything,-yet it does. It is a warehouse and stores iron, vitamins, copper, amino acids, fats, and glycogen. (4) It is a heating plant, producing more heat than anything else in the body except the muscles. (5) It is a waste disposal plant. Like the *kidneys,* it filters all your blood, removes certain waste products, and sends them off for excretion. Aside from your blood cells, the liver and kidneys are the major detoxification points in your bogy.

We will discuss the pancreas later.

6 - RESPIRATORY SYSTEM

Here is another miracle system. Air enters your nose and passes down to that same *pharynx* again. But this time, the swallow mechanism is not in operation, so the air goes directly downward into the *larynx,* past your *voice box,* and into the *trachea,* which then divides into the two *bronchi,* which then lead through the *bronchioles* into tiny air sacs called *atria.* Think of two trees with their branches continually rebranching until finally they end-in grapes! That is the appearance of the bronchi, bronchioles, and atria. Tiny projections, called *alveoli,* protrude outward from each grape-like atrium into the lung. It all does look very much like a bunch of grapes! The plan is to exchange oxygen for carbon dioxide-as much as possible and as quickly as possible. There are over 400 million alveoli; each one is closely connected with blood and lymph vessels, nerves, and connective tissue.

That is what, on the inside, your lungs look like; From the outside, the lungs appear to be two cone-shaped organs, nicely designed to fit the space in your chest. Your left one is not as large, in order to make room for the heart just below it. Your lungs hold about 31/z quarts [3.3 liters] of air, and are remarkably like air bellows, partly filling, partly emptying, partly filling, partly emptying; this goes on constantly, night and day. It should not take long for such action to wear a hole in the side of the lungs, but instead they are wrapped inside the *pleural cavity.* Moist fluid is exuded by the walls of the pleural membrane, which provides a slippery surface for the lungs to move against.

Please remember that, throughout this chapter, you are observing only the barest outline of the body systems. It is similar to lifting the top off the central processing unit of a home computer, letting you gaze within at the electronic boxes and cards neatly stacked inside,-and then concluding that you understood the complexity of a computer!

Several lengthy books could easily be written about each italicized word in this chapter.

6 - URINARY SYSTEM

Your *kidneys* are the primary filtration and removal plant in your body. They are your blood cleaning organs. Most of your kidneys consist of *nephrons. Each* one is a capillary cluster with a coiled tube attached to it. There are over a million of them in your kidneys! As the blood passes through the capillary cluster, water and waste products filter through the capillary walls and into those tubules. Most of that waste water is cleaned and returned to the blood. Your kidneys, then, are like a million little thinking machines, each one of which knows just what to remove from the blood and what to leave in it.

The waste fluid drains out into a collecting basin in each kidney called the *renal pelvis.* From each one, a tube leads down into the *bladder.* When the bladder fills to about 200 cc [12.2 cu inches], it sends a signal to the brain to void the *urine.* How can a bag send a signal? How does it know to do it at the right time?

7 - ENDOCRINE SYSTEM

The *endrocrine glands* are located in various parts of the body and pour their *secretions* directly into the blood stream. They produce chemical substances which speed up or slow down the activities of various body organs. These substances, called *hormones,* also affect each other's actions. Each endocrine gland is a fantastic organ for what it can accomplish, especially in view of its small size.

1 - The Thyroid Gland. The thyroid is in the center front of the neck, and looks something like a butterfly with wings 2-3 inches [5-7.6 cm] wide. It is just behind your voice box. The thyroid secretes *thyroxin (thyroxine),* and regulates the rate at which the cells burn food. Thus, it regulates *metabolism.* If too much thyroxin is sent out into the blood stream, all body activities are speeded up, and the cells burn food so rapidly that the body uses up its daily supply of nourishment and draws on the stored reserves. If the thyroid does not secrete enough of this hormone, the cells burn food too slowly. this interferes with body development and slows body activities.

How can the extremely small amount of thyroxin sent out by this gland get to each of the billions of cells in your body, and affect them? In what way does that fluid signal them to speed up or slow down? All this is a great mystery. Thyroxin is almost pure iodine.

2 - The Parathyrolds. Four small glands, each the size of a pea, are the *parathyroids.* There are two of them on each side of the thyroid. These extremely tiny organs secrete a hormone (parathormone) which regulates the amount of calcium in the blood. The amount of calcium in the blood directly affects nerve and muscle irritability. Too little, and muscle spasms and convulsions bring death within a few hours. Too much, and the body uses up calcium faster than it can get it from ingested food, and calcium will then be drawn from the bones and they will become soft and eventually break.

All the hormones are utterly mysterious, yet we all take them so much for granted. They are miracles; describable, but inexplainable. Each endocrine gland is as truly miraculous as any miracle found in the Bible. The endocrines are blessings to mankind sent from the same Source as all the other miracles.

3 - The Adrenals. Also called the suprarenals, these two glands are at the upper end of the kidneys. Each one is so tiny it is the size of the last joint on your little finger. Each adrenal gland is really two separate endocrine glands because its two parts produce different hormones.

The central part (the medulla) secretes the hormone *epinephrine (adrenalin), which* brings many body processes into action quickly. This is the "fight or flight" hormone. It makes the heart beat faster, raises blood pressure, increases muscle power, and makes blood clot more rapidly. -A tiny amount of fluid from part of a large bean can do all that? Emotions of fright, anger, love, grief, or pain signal the epinephrine to be sent out.

The outer part (the cortex) secretes several hormones. One of these, cortin, regulates the behavior of salts and water content in the body. Certain male and female hormones are also secreted by the adrenal cortex.

4 - The Pancreas. When the duodenum signals it to do so, part of the pancreas sends secretions to the duodenum to aid in the digestion of food. Yet another part of it contains the islets of *Langerhans, which* secrete *Insulin.* This regulates the amount of sugar in the blood. If too little insulin is sent out, sugar accumulates and the kidneys try to get rid of it through the urine.

5 - The Pituitary Gland. The pituitary is often called the "master gland." It is located in one of the safest places in the body: the center of your skull. Attached to the base of the brain in the region back of the eyes, it is only about the size of a pea, yet it secretes more potent hormones than any other gland. How can it do that when it is one of the smallest of the endocrine glands? It has two **parts, the anterior** lobe and the posterier lobe.

The posterior *lobe* secretes two hormones: The first of these, vasopressin affects the smooth muscles, raises blood pressure by constricting blood vessels, and stimulates the reabsorption of water in the kidney tubules, thus affecting water balance. The second, oxytocin stimulates contractions of the uterine muscles.

> The anterior lobe of the pituitary secretes several hormones. One regulates the thyroid, another controls the adrenal cortex, another stimulates sex and mammary gland activity, and another regulates growth of bone and fibrous tissue. It is the pituitary anterior lobe which determines how tall you will become. It is also decides how much pigment you will have in your skin.

6 - The Gonads. The gonads are the reproduction glands: the testes in men and ovaries in women. The testes secrete male sex *hormones (androgens), which* includes testosterone. The ovaries produce estrogen *and progesterone*. These **hormones are powerful in their effects** on the body, yet they come from small glandular organs.

7 - The Thymus. The thymus lies behind the breast bone (sternum), but its purpose is still not clearly understood. It apparently has something to do with attaining sexual maturity, for it atropies following puberty.

8 - The Pineal Gland. The peneal is attached to the brain and is another endocrine puzzle. Apparently it has some effect on growth. Tumors on this gland in children accelerate sexual growth.

9 - Other Hormones. The stomach wall secretes a hormone, gastrin, which affects the blood vessels and secretions of the stomach glands.

At the beginning of the small intestine, the lining of the duodenum secretes two hormones: Secretin stimulates the pancreas to send pancreatin, a digestive fluid to the duodenum wall for excretion into small intestine. A second hormone signals the gallbladder to contract and send gall into the small intestine.

The placenta is also a temporary endocrine gland which excretes hormones to regulate and maintain pregnancy.

8 - THE NERVOUS SYSTEM

There are several other complicated body systems, such as the skin and the reproductive system, but we will conclude this chapter with the nervous system.

Without nerves, your body could not send, relay, or receive any signals. Without nerves, you could not think or even live. A large part of your nerve activity is done without your conscious thought, and is called the autonomic nervous system.

Did you know that the best way to build a telephone switching station is to send in several dump trucks with sand, dirt, rock, and odds-and-ends junk? Then send in a bulldozer to scatter it around a little. After that leave it for several million years and return-and you will have a complete switching station, ready for operation? Well, that is how evolutionary theory would build one.

But within your body is a switching station and far more: a complete electronic computer system operated by something equivalent to an Intel chip 500,000. (As these words are being written, the largest home computers are Intel 486 in capacity.) Literally millions of connections are to be found inside just a pinhead of space in your brain. Main cables flow out from the brain and down through your spinal column, and then out to various parts of your body. And all that is supposed to have come about by chance?

Through a network of wires, messages come into the central switchboard, where the necessary connections are made to direct them out to the right places. Your nervous system is organized to bring messages into a center which relays them out to certain parts of the body. The brain and the spinal cord are the switchboard, and the nerves are the wires that carry incoming and outgoing messges. The deference is that thinking is a part of your switchboard system.

Your brain weighs about three pounds. It is similar to a bowl of jelly, yet it is the most fantastic creation in our world. The largest part is the cerebrum which fills the upper part of the cranium. Next is the cerebellum, located below the cerebrum. The third major part is the *brain stem,* with its pons and medulla.

The cerebrum is the main brain and is divided into two halves, one on either side, called hemispheres. The outer part is the cerebral cortex. This is soft grayish matter filled with nerve cells. Beneath it is the white matter, which has the nerve fibers, or "wiring," leading out from the gray matter. The cortex or "gray matter" is heavily wrinkled. That is done to give it a much greater area. If it was flattened out, it would cover a surprisingly large area. Some centers in the cerebrum think, some are memory. Others are related to hearing, sight, movement, and speech.

Directly beneath the left and right cerebral *hemi*spheres, and covered by them, are two other centers: the thalamus and the *hypothalamus. The* thalamus is a relay station; receiving impulses from every part of the body, it sends them to exactly the right part of the cortex. The thalamus also interprets sensations, and tells the brain whether they are pleasant or unpleasant. The main job of the *hypothalamus is* to regulate the action of various body organs in order to maintain normal conditions. For example, you shiver when you are cold because of the hypothalamus.

The cerebellum maintains body balance and coordinates groups of muscles. It is because of the cerebellum that you can walk across the room, or reach down and pick up a book. Skill in sports is related to good cerebellum connections.

At the top of the brain stem is the *midbrain,* which is an important reflex center. A reflex is an action that takes place automatically when something happens. If you look into a mirror and shake your head, your eyes will keep looking forward. It is the midbrain that tells them to do that.

The pons is the bridge between the cerebral cortex and the cerebellum, carrying messages from one to the other.

The medulla is just below the pons and is on the very bottom of the skull. It connects the brain with the spinal cord. It also controls certain factors on its own. One of these is the amount of carbon dioxide in the blood. The medulla, in some mysterious way, knows that percentage,-and then sends out signals instructing you to breath faster or more deeply. It also guides the rate of heartbeat. It even affects the muscles in the smallest arteries. The spinal nerves from the two halves (hemispheres) of the cerebrum cross over in the medulla before proceeding on down to the body.

The spinal cord is a long mass of nerve fibers reaching down through the central holes in all the vertebra in your spine. The spinal cord does two things: (1) conduct impulses from the brain to the body, and (2) operate as a reflex center apart from the brain. When you touch something hot, the spine sends the message to move your hand back quickly. That arrangement was wisely planned, for the nerve impulses warning of terrible danger did not have to travel as far before a message could be sent back to take proper action.

You have different types of nerve cells; we will not take the space here to describe them. Suffice to say that they are extremely complicated. Each nerve connects with thousands of other connections in nearby cells. The result is a massive electronic circuit board arrangement,-and all connected to part of a thinking mind.

The major nerves for your body exit the brain and travel down through the spine and then go outward at various points. There are 12 pairs of cranial nerves and 31 pairs of spinal *nerves. The* cranial nerves attach directly to the brain, and most of them carry impulses to and from the brain and various structures about the head (sensory organs, swallowing, speech, hearing, sight, tongue, jaw, etc.). However, other cranial nerves connect with organs in the thorax and abdomen.

The spinal nerves are attached to the spinal cord, and carry impulses from the skin and some internal structures to the central nervous system.

But now, forgetting all the rest; let the evolutionists satisfactorily explain the brain, the nerves, and and spinal cord-on the basis of random actions ("natural selection") and harmful accidents ("mutations"). We await their reply.

CONCLUSION

We have not taken space in this chapter to discuss the sense organs, and they are just as wonderful, if not more so, than some of those we have already discussed.

The eye we discussed in some detail in chapter 13 (Natural Selection). The ear has some of the most delicately complex structures to be found anywhere in the body. For example, consider this: Blood bathes every part of your body, and flows next to and into every cell,-with one exception: the cells in the ear which are involved in hearing. Why is that? If blood capillaries flowed next to those particular cells, you could not hear properly! You would hear the faint beating sounds of the blood rushing along as it is pushed by the heart pump. So, instead, fluids containing no blood are sent that final short distance to bathe, nourish, and clean those hearing cells.

That was done by chance? There would be no reason for random activity to do that.

Why do you have eyelashes? They keep dust out of your eyes, but are in no way needed for survival. A thinking Creator would bestow eyelashes upon His creatures; the chance workings of so-called "natural selection" would never produce these perfectly-located little helpers.

Why do you have odor-detecting cells in your nose? Why can you taste with your tongue? Why does food itself have built-in flavor? The food and your tongue were designed for one another!

> There are three semicircular canals, shaped like small horseshoes, that are close to each ear. Each is partly filled with fluid that is set in motion by head or body movements. Sensitive nerves send signals from this fluid to the brain. Without those structures and those signals, you could not maintain body balance; you could not stand up without falling down. Think about the semicircular canals for awhile; how could they arise by merest chance?

Everything is a miracle; an absolute miracle. It all came from a God of miracles; your heavenly Father. He made you for purpose: to live a good, clean, unselfish life. He alone can help you live such a life. Come to Him just now; tell Him your needs. Let Him give you forgiveness for the past, and help for the present and future. He is waiting, just now.

The Creator’s Handiwork

More Wonders of Nature

INTRODUCTION-

The French physicist, ReneAntoine de Reaumur (1683-1757) was so impressed by the geometrical perfection of the hexagonal cells made by worker bees in their beehives, that he urged scientists throughout the world to adopt the cross-sectional measurement of this six-sided cell as the fundamental unit of measurement) So flawless, so perfect is this cell, and so uniform is it in size throughout the works, that de Reaumur declared it to be the ideal worldwide basis for measurement. There is nothing— anywhere on earth—that man makes, de Reaumur said, which has the consistency of dimension to be found in the cell of the bee.

What is this astounding creature that it is able to combine both complexity and perfection of design? Let us consider the bee:

BEE COLONY—Bees live in colonies, called a swarm, and may number from 10,000 to 60,000 or more individual bees. Considered singly or together, they are a masterpiece of creation.

Although they all came from eggs of the same queen, there are three different types of bees in the hive, and each knows exactly what its task is. There is the queen (female), the drones (males), and the workers (undeveloped females). Interestingly enough, the queen does not rule the colony) No one rules it! Each one does its job as if it had gone through a training school, graduated, and then had work supervisors to guide and keep it at its work. Yet the bees live and work with no schools, managers, or supervisors.

BEE STINGER— People fear being stabbed, so they leave the bee alone to go about its work. A bee's stinger is a spear located on its rump. A bee's stinger has nine barbs on each side and is split down the middle. The two halves slide back and forth on each other. This double spear is enclosed in a sheath worked by strong muscles. The two halves slide back and forth with a pumping action.

When the spear enters flesh, the barbs hold fast. A bee is so lightweight that it cannot get a good hold on that which it stings. But the stinger does it for the bee. It pumps itself in.

When the bee tries to pull away, it is fatally wounded. Bees are not anxious to sting people. They only do so when frightened or angry. (If you are stung by a bee, scrape the stinger off immediately, for it is attached to a muscle that continues pumping after it is in your skin. By acting quickly, you will reduce the amount of poison that enters the wound.)

BEE EYES —A bee has five eyes. There are three small ones in a triangle on top of its head, and a large compound eye is located on each side of its head. Each compound eye is a marvelous interconnected arrangement of thousands of single eyes placed close together. With their eyes, bees can distinguish blue, yellow, and ultraviolet.

The bee is largely guided by what is called "the polarity of light." The eyes of the bee operate something like a compass, for they are sensitive to the polarity of sunlight. Waves of light, streaming from the sun in all directions, travel directly outward; each beam in a single direction. As the earth turns on its axis, each animal and insect views this direction of light from a constantly changing angle from sunrise to sunset. That tiny angle of each shaft of sunlight is analyzed by the eye and brain of the bee, telling him directional information: where the sun is, where the bee is, and where the hive is. Because of certain information given it back in the darkness of the hive, it also uses sunlight to tell it where its food is!

BEE WINGS—The bee has two pair of amazingly efficient, powerful wings that work too well to have occurred by chance. The bee has a large, bulky body with wings that seem too small to match it.

Why are the wings so small? They are small because the bee has many duties to do inside the hive and it could not do them if it had wings that protruded out the back far enough to properly bear its weight in flight. As a result, scientists have concluded that the wings of a bee are too small for it to fly! Bees laugh at this, for they fly anyway —the equivalent of thousands of miles in their brief lifetime.

The solution to the aerodynamic design of the bee's wings is this: The larger front wing on each side has a ridge on its trailing edge with a row of hooks on it. These hooks attach to the rear wing when in flight. In this way four small wings on the ground convert into the equivalent of two large wings when flying! Upon larding, the two wings are unhooked and again overlap, greatly reducing their size) How is that for wing design?

In addition, the honeybee wing beats a fabulous 200 times a second. This is extremely fast in view of its large size. The mosquito is 600 times a second, but it is so much smaller than the bee. Some small beetles beat as fast as 55 beats per second, but that hardly compares with the honeybee. Yet the Designer saw that the honeybee would need its larger size in order to carry so much special equipment around with it, while needing small wings for its many crowded duties inside the hive.

The wings, and muscles attached to them, have been so carefully planned that in flight the wings move in a figure eight design, which makes it possible for the bee to go any direction—up, down, sideways, backwards, forwards, or any combination of those directions. It can remain motionless, hovering before a flower as a hummingbird does. It is all keyed to a figure eight wing motion, and when the shape of the figure eight is changed by the muscles which control the set of the wings) the wing beat changes from up, to down, to sideways, etc.

This arrangement of muscles and wing structure is complicated in the extreme, yet the result is one of the most efficient flight systems on earth!

When the bee arrives at the flower, it is able to crawl inside. If it had fixed wings like a dragonfly, it could not do so. But instead, it has wings that quickly fold together—and into the flower it goes!

BEE ANTENNAE -—There are two slender, jointed feelers which are attached to the head of the bee. Such exquisitely tiny things surely cannot fulfill any useful purpose. But wrong again! On the top of each of those little threads, which the bee uses to smell and touch with, are miniature sense organs. Down the center of the antennae a nerve passes from that detection device to the brain of the bee, relaying information.

Bees talk to each other by several methods, one of which is their antenna. They will touch them together and thus communicate. Special warnings of danger and other messages are communicated in this way.

BEE MOUTH —In front of its head are four structures which are two jaws. In front and between them is a tongue. This tongue, or proboscis, is a flexible tube which the bee uses to suck up water, nectar, and honey into its mouth. It can be shortened, lengthened, and moved in all directions. When not in use, it is curled up under the head.

The jaws are used as pliers to grip with. In addition to holding onto leaves and petals, the jaws mainly work with wax and pollen.

Peer closely into the face of a bee as it works on clover blossoms, and wonder how those tiny mouth structures can do all that they have to do. Think of how perfectly they are designed, and the delicate nerves attached to them.

BEE LEGS The bee has three legs on each side of its thorax. Each leg has five main joints, plus tiny segments that make up the foot. With five joints, each leg can twist, turn, and move in just about any direction needed. The very small parts of the foot are exactly suited for standing and walking in relation to the bee's size and weight, even when fully loaded with pollen, nectar, honey, or wax.

The honey bee has sharp tips on its claws on each foot, to enable it to walk along on any rough surface. Between its claws it has a little pad or cushion called the pulvlllus that enables it to walk on smooth, slippery surfaces, such as glass. That is a well-designed foot!

The bee is continually using its legs and feet to clean off its body and work with pollen and wax. On two of its legs are "pollen baskets," but more on that later.

When the bee inserts its head into flowers, the antennae frequently become coated with bee glue or other substances—It is very important that the bee have some way to clean its antennae. On the front legs is a movable piece of tough tissue, which can be raised like a lid, making an opening. On the edge of this opening are short, stiff hairs. The bee bends an antenna toward the left, opens the leg gate, inserts the antenna, closes the gate, and then draws the antenna back and forth between the stiff hairs. Quickly and simply, that antenna has been thoroughly cleaned! Then the other antenna is cleaned.

How did evolution produce the tiny, specialized equipment needed for that task, and then teach the bee how to go through the process?

HEAVY FREIGHT TRANSPORT —These Little black-and-yellow balls of buzz are amazing creatures. A drop of honey is a high-octane fuel that gives the bee power to go from flower to flower. The bee must tank up with exactly the right amount of honey when it leaves the hive and travels to the flowers. If a mistake is made, it will not return alive. —More later on how it knows how much honey to take.

A bee is the only flying creature built to carry heavy freight. It has storage space and lifting power to transport syrup, pollen, and varnish. It easily manages heavy airborne cargoes. Everything else that flies—birds, bats, insects—carry only themselves through the air, except for relatively light mail, such as twigs and worms which birds carry in their beaks occasionally.

Men build small cargo planes and giant ones. Some carry passengers, while others carry heavy freight, such as jeeps and trucks. But all of them only carry a pay load of about 25 percent of their weight. In contrast, a bee can carry a cargo almost equal to its own weight; an almost 100 percent pay load!

Man-made planes have powerful wings for lifting, but there is no power in those wings to move forward. They can lift only when engines drive the plane forward fast enough to make suction on their top surfaces. The bee has short wings on a fat body, but it can move up, down, sideways, or hover. It does not have to move forward for its wings to lift. It needs no propeller nor jet, for its wings provide both lift and power!

SCOUTS— Now it is time for our bee to go out and gather some honey. But where will it go? How does it know where the flowers are? It is vital that this information be obtained, for it needs to know how much honey to tank up on for the flight.

The bees do not leave the hive to bring back honey until they know the kind of flowers, and the direction and distance to those flowers. Somebody must give them flight instructions. This will not be the queen, for she never issues an order. Entirely preoccupied with laying eggs, she knows nothing about flowers, pollen, or nectar. She might spend an entire year in a hive, and yet go out into daylight only twice in her life. The job of gathering nectar and pollen belongs to the worker bees.

(The worker bee inherited all its knowledge from its mother, the queen. Yet she knows nothing about the abilities and duties of a worker bee.)

Bees are marvelous honey-gathering workers and they should not spend their valuable time looking for honey. So, instead, they send out a few of their number—the scouts—to survey the territory for miles in every direction. These scouts bring back immediate reports on the prospects for honey. Availability of nectar this morning will be different than yesterday afternoon—or later this morning or afternoon. Scouting continually goes on, and report are continually being brought back to the hive.

Perhaps a dozen bees will leave the hive and fly off in different directions. Scouting the countryside, they fly around in the vicinity of the hive in ever-widening circles. The honey may be near or some distance away. The scouts may have to search across miles of countryside. When one of these scouts returns, it will tell the others exactly what kind of flowers are open, and give them a compass bearing for the direction, and also announce the distance to the spot. Many other creatures can communicate, but few can tell it with the clarity of the bee.

Wait a minute! We are talking about insects with brains as big as pin heads! How can they learn such information-or impart it to others? How can all this knowledge of how to fly, clean antennae, make honey, bee bread, bee cells, and all the rest;—how can all that knowledge be in those tiny pinheads? How can they all work together, with no boss to organize and tell them what to do? This situation of the bees is becoming more impossible, the more we learn about it!

But it is so! The bees do all the above and much, much more. And they do it regularly, day after day, month after month, year after year.

BEE DANCE—The Austrian naturalist Karl von Frisch, spent most of his adult lifetime studying the bees. He learned so much that he is well known among scientists for his investigations.

Von Frisch placed dishes of nectar in certain locations. When the bees came to them, he would paint marks on their backs. Back at the hive, he would then study how the returning scouts "talked" to the other bees, in order to tell them where to go to find that honey!

From his experiments von Frisch learned that the bees could distinguish certain colors —including ultraviolet (but not red or infrared) —which they communicated with one another by means of a dance on the honeycombs. He discovered that the nature of this dance and the vigor with which it was done—told the direction and distance of the food dish, and even how plentiful or scarce was the food supply. It was von Frisch that discovered that it was polarized light in the sky that the bees used to tell directions. It was his research that opened up entirely new vistas of information in regard to the language of the bees.

As mentioned earlier, the bees do not go after the honey until they are first told the kind of flowers, direction, and distance to those flowers. How are they to learn that information? The bees are all descended from the queen, yet she knows nothing about gathering honey, having never done it. All she does is lay eggs. It is the worker bees that must locate and gather the nectar and pollen.

When a scout strikes it rich, the little bee fills its tank, packs its baskets, and returns with the news. Immediately, there is excitement among the waiting bees and they are anxious to learn what has been discovered. So anxious are they that they often crowd too near, and the bees closest to the scout have to push the others back to give the scout room to explain!

Now the time has come for the scout to tell what has been found:

Climbing onto the side of a comb, first, the scout begins with a weaving dance, veering to this side and then to that as it goes. By this the scout is telling the others, "There is plenty out there!" The amount of weaving back and forth reveals how much abundance is at that certain location. The direction of the weaving walk tells the angle of polarized light from the sun to that flowery location.

Seeing this weaving dance, the bees crowd up excitedly, touch the scout with their antennae to pick up the odor of the flowers they are to look for, and then fly off.

But if the treasure is a long way off, and if it is only a single tree or a small patch of flowers, —then the dance is different. The information must be much more carefully given since the bees might get lost searching for those flowers.

So the scout, instead of weaving, runs along a straight line, wagging its abdomen as it goes. At the end of the line (which is only an inch or so, since there is not much space cleared in the crowd), it turns left and walks a partial circle back to the starting point. Then it runs straight forward again along that same line, circling right this time back to the starting point —where it does it again!

Its dance communication forms a figure eight, with the cross points of the "eight" at the center. That gives the direction of the nectar in relation to the sun. As the bee dances on the wall of the honeycomb, the position of the sun is always down. If the bee moves up the comb wall at 19 degrees to the left of vertical, that means the honey source is located 19 degrees to the left of the sun. This information can be given even on a cloudy day, since the bees are able to see ultraviolet light, and UV light from the sun penetrates the clouds. Imagine that! This tiny creature can sense the slant of UV light on its body!

The straight line points directly at the flowers.

The speed with which the speaker circles tells the distance. The farther off the flowers are, the more slowly does the scout circle back. If it makes 10 circles in 15 seconds, the flowers are about 300 feet [914 dm] away. If it returns in slow motion (two circles in 15 seconds), the flowers are around four miles [6.4 km] away!

The wagging of the abdomen tells the amount of honey or pollen that is available at that specific location. If it shakes vigorously, the supply is abundant. If it shakes lazily, there is only a little, and just a few bees should go. In that case, the others will wait for another scout's arrival.

So there is a round, weaving dance to indicate nearby nectar, and a tail-wagging figure-eight dance to indicate distant nectar. There is more to it than the simplified description given above, but this should be enough to afford you an idea of the bee dance.

And it is all done in the dark, for the scout gave them that information in the darkness of the hive, not outside in the sunlight!

Very specialized information about distance, quantity, exact location, and type of flower—is all given in the dark to bees who are obtaining those facts in the dark! Yet life and death to the bees and to the hive depends on their obtaining the correct information! Before departing, they must fill their honey bucket with just the right amount of fuel—not too much or too little. Yet how can they learn anything in the dark? There is no ordinary light, and no ultraviolet light in the hive, and they are not able to sense infrared light from the heat of the moving body of the bee weaving before them.

A 1990 Princeton research report disclosed that bees can detect tiny movements of air around their bodies. It is thought that, perhaps, by detecting air movement, bees are aided in "hearing" the bee dance as it is performed. It is thought they "hear" the sound movements with organs located at the base of each antenna. But more than air movements are needed for the bee to grasp the waggles, speed of walk, directional angle, and other factors involved in the complicated bee dances. So the mystery remains.

NECTAR AND POLLEN- In order to properly understand the work of the honey bee at the flower and in the hive, we need to understand what it does with the nectar and pollen:

As it goes from flower to flower, the bee cross-pollinates the flowers. It somehow knows that, at any given time, it must only go to flowers of the same species. Why would it know to do that? Yet because it does, the flowers are cross-pollinated. If that one factor was missing, after several years there would be no more flowers for the bees to obtain nectar and pollen from.

In the chapter on plants we have discussed many of the ways in which plants put their pollen on bees and other insects. Bees and flowers must have been brought into existence at the same time. They could not live without one another.

Ants are not interested in pollen, but would like to have the nectar. Yet they do nothing to pollinate flowers. Ants cannot make pollen mush as can the bees, but they like nectar. They lick sweet juices off leaves, sap coming from a wound in a stem, and sweet syrup exuding from other insects. Ants would take nectar from flowers if they could, but the Designer of the flowers placed ant barriers to keep them *off.* Bristles will be erected which act like barbed-wire entanglement. Some flowers defend nectar with gummy places, for no insect can walk if its feet are stuck. Others dangle flowers from shaking, slippery stems, which knock *off* an ant before it can get to the flower. Ants are not concerned, for they have many other sources of food. Thus the nectar and pollen is saved for the bees and those other insects which do pollinate flowers.

In the iris, the bee must pass the projecting stigma and brush some pollen on it. After the bee has passed, the stigma springs back in place. Its weight pulls down the anther, thus giving the bee a shower of pollen onto its back, to carry to the next flower. In the mountain laurel, the anthers are held in pockets. When the bee enters, the anthers are released. The filament snaps upward, and it is showered with pollen.

The milkweeds have their pollen in masses shaped like saddlebags. When the bee arrives, its feet become tangled in it and part of it is carried about for hours, pollinating other milkweed flowers. The horse balm has four small petals and one larger one. The bee lands on the large petal and immediately slides off. Coming back in a second of stamens hanging from overhead, and pollen falls on the bee.

The lady's slipper lets the bee enter, but once inside the bee is trapped, for the entrance door has closed. There is one way out: a small opening at the back. Crawling through it, the bee must brush against the pistil and then against the stamens.

The worker bee gathers not only nectar but pollen as well. There are bristle-like hairs all over its body to initially catch the pollen. (Drones are not hairy, since they have no need of a hairy coat to collect pollen.) Worker bees do not mix different kinds of pollen together. Each kind is stored separately. Bees that gather honey one day may gather pollen the next, but they do not mix their honey and pollen gathering. Flowers would not otherwise be properly pollinated.

The honey bee gathers pollen as well as nectar, for the pollen is part of its food. But how can it carry pollen back to the hive? Simple; the bee was given specially designed legs for this purpose!

This marvelous flying machine has three places for storing cargo. One is the tank inside its body, which it fills by sucking up nectar syrup through a long tube from the inside of the flower. The other two are baskets on its hind legs for carrying pollen. Who ever heard of a plane carrying freight on the landing gear? But the bee has been doing it for thousands of years.

The bee also carries freight in only one direction. Outward bound, it needs only a speck of honey for fuel, enough to reach the goal, where it can find plentiful stores of honey and refuel. Honey is so powerful that a pinhead-sized speck of it will whirl the bee's wings for about a quarter of a mile.

At the flower, the little bee sucks in nectar and collects pollen. To collect honey, a bee dives into a flower, scrambles around, rolls over like a child playing in the surf. The splashing throws pollen grains all over its body, where they stick to feathered hairs.

But when the bee specifically is after pollen, it does not have to jump around inside the flower; its body picks up pollen just by brushing past the pollen boxes that are usually held out in front of the flower on long, thin stems.

After getting the nectar, pollen will cling to the hairs on its legs and body. Most of this, the bee transfers to its pollen baskets. Pollen baskets! Yes, pollen baskets. These "baskets" are composed of a peculiar arrangement of hairs surrounding a depression on the outer surface of the hind legs. Look at bees as they buzz from flower to flower, and you will see that some have a small yellow ball on the front of each hind leg, while others have a large ball.

In addition, the bee carries around with him several tools. There is a tool to put the pollen into the baskets. On the middle pair of legs at the knee is a short, projecting spur, used to pack pollen into the pollen baskets. On the inner part of the hind leg are a series of side combs used to scrape the body hairs of the bee—and gather together chunks of pollen. The combs are used to give final collection to the pollen and then put it into the baskets; the spurs are used to pack it down in!

So then, the worker bee has four different types of tools to help him stow away pollen into the pollen baskets: (1) Long hairs on the front pair of legs remove pollen from its mouth and head. (2) The middle pair of legs scrape pollen off the thorax and front legs. (3) The stiff comb hairs on the third (rear) legs comb the abdomen and also take the accumulated pollen off the middle legs, and then push it into the baskets. (4) Finally, the spurs go to work and pack it down tight.

In the process, the pollen is moistened by the bee in order keep it from blowing away or falling out in mid-air. It also has to be evenly balanced with the same amount of pollen in each basket.

This entire process had to be carefully thought out in advance, and structures had to be predesigned, built into the bee, and knowledge given to that bee!

The legs of a honey bee provide a complete set of tools for collecting, shifting, packing, and storing heaps of pollen! Without that collected pollen, the bees could not live, for it is an important part of their diet.

GETTING A LOAD— Watching the little worker, this is what you will see:

The bee leaves the flower, and, while hovering in mid-air, or swinging below the flower and hanging by one claw, it combs its face, the top of its head, and the back of its neck with its front legs. Even the bee's eyes collect pollen, as hairs grow out of the eyeballs! The bee has a specially soft brush to remove that particular pollen.

A reverse gulp brings up a speck of honey from the honey tank to moisten the pollen. The middle legs scrape off the middle of the body, reach up over the back. Rapid combings and passings to the rear get the pollen onto the hind legs. The scrapings are caught in a comb with nine rows of bristles.

Immediately, the bee doubles up its legs, —and a huge rake passes through the rows of bristles, pulling the pollen into a press made by the knee joint. When the bee bends its knees, the jaws of the press open; when it straightens its leg, the jaws close, and the pollen is pressed and pushed up into the pollen basket—that shallow trough in the middle of the hind leg.

To hold the load securely, there are many curving hairs around the edges of the basket. There is also a single rigid hair in the center of the basket. This makes it possible to build twice as big a load.

As the pollen ball grows bigger and bigger, the curving hairs surrounding it are pushed apart, and the load mounts above them. The long, rigid hair in the center gives the load a solid core to build on. Farmers use the same principle when they put a pole in the center of a haystack so later winds will not knock it over.

If the nectar is flowing strong and anthers are bursting with pollen, a bee can suck up a load of syrup in a minute. It can build two big, bulging loads of pollen in the baskets on its hind legs in three minutes. Considering all the procedure the bee had to go through to do that,—that is fast!

Often it may carry water in its honey tank, if the hive is thirsty. It may scrape resin off sticky buds and twigs, especially, poplar, horse-chestnut, willow, and honeysuckle buds, and load this into the pollen baskets. This resin will be made into varnish to coat tree hollows, making all surfaces perfectly smooth, even at the points where the hive is attached. resin is used also to stop up cracks and crevices.

When it is finally loaded up, the honey bee will fly home at 14 miles [22.5 km] an hour with a tank of nectar inside, and two bulging bags of yellow pollen swung below.

When the worker is ready to return to the hive, fully loaded, it makes a "bee line" home! It goes in as straight a line as possible to the hive. This bee line proves that the bee is fully aware of directions at all time. Navigational information is continually being fed into its brain through its several eyes, just as, on a ship at sea, a sailor keeps checking the compass and using the sextant to get their bearings.

All this knowledge and equipment came from the DNA code placed by the queen bee in her eggs. Yet she is not passing on information that she does, for she never goes out and gathers any nectar and pollen, nor does she make any bee bread, wax, nor cells. Not once does she ever dance the honey dance or even bother to watch it being done. Yet she is the one that passes along all the coding for all the parts**,** processes, and accomplishments of all the bees in the hive.

Researchers at Princeton University thought they might be able to outsmart the bees, but how well and how long, they were not certain. After the bees learned where their food source was, the scientists moved it 50 meters (656 yd] farther away from the hive. They were surprised to find that it took the bees less than one minute to find the moved food. So they moved it again, this time a second precise 50 meters [656 yd] farther away. It still took the bees less than a minute to locate it!

But then the scientists discovered the bees were smarter than they were) The bees were apparently carrying on advance research into the research habits of researchers) When the researchers moved the honey source a third time,—the bees were waiting at the exact location it was to be moved to—before the researchers arrived with the food!

HONEY FACTORY— Bees have two stomachs: They have a special "honey stomach" that is entirely separate from their own food-digesting stomach! Each bee carries the nectar gathered from the flowers in this honey stomach.

While the nectar is in a bee's stomach, certain chemicals are added to it as the bee flies around! Arriving back in the hive, the bee places the nectar in honey storage cells. The water in the nectar evaporates and the chemicals change the nectar into honey. Workers then put wax caps on the honey-filled cells.

This honey contains levulose, dextrose, other sugars, dextrines, gums, vitamins, proteins, calcium, iron, copper, zinc, iodine, several enzymes, and other nutritional factors.

To prove that a bee never digests its food alone, but rather that the whole hive digests the food together, scientists fed radioactive honey to six bees in a hive of 24,500. After two days, all the bees in the hive were radioactive. That was the result of having passed honey from mouth to mouth for processing.

(Bees do not suck honey from flowers; they suck nectar. Nectar and honey are chemically distinct. Honey is much more concentrated, and is nectar, plus added chemicals from the worker bee's stomach.)

GLUE FACTORY-- Bees also make "bee glue." This is called propolis. They obtain the raw materials from the sticky covering on special plant buds. There are certain things on which they place this bee glue. One is mice!

If a mouse gets into the hive, the bees sting him to death. But they do not drag him out of the hive for he is too heavy, so instead they coat him with bee glue. This forms an airtight sack around him so no odor or contamination will come from his decaying body.

The glue is something like a cement, and the bees normally use ft to repair cracks in the hive.

WAX FACTORY-- Down on the abdomen of each worker bee, there are four little pockets. Here is where the wax is made! Wax! You mean that they make that, too? Yes, the little bees make everything they need, and almost the only raw materials for all their productions come from what they find in flowers!

When the bees decide to start making wax, they get hot! First, a cluster of bees gathers together in a large pendant mass, their wings buzzing rapidly. They hang vertically from one another, and this seems to stretch their bodies. After 24 hours, each one begins sweating wax! A white substance begins coming out of their pores. This is called "wax scales," and each bee removes it with a special tool! This is a pair of pincers found on one knee joint on each side of its body.

Each bee generally makes eight flakes of wax at a time. This wax is taken off, and chewed in its jaws. It becomes a soft paste which can be easily molded into the six-sided cells. This wax is only made when the bees need wax to build a honeycomb.

Soon, wax scales litter the floor below the hanging bees, and other bees regard it as loads of stacked lumber: they pick it up and use it to make the comb and cells. Skilled chemists have never been able to match the quality of beeswax! This special wax contains a variety of special substances, and has a higher melting point (140°F [60°C]) than that of any other wax known in the world.

This high melting point enables the bee hive to withstand a lot of heat without softening and flowing, ruining all the cells.

As if that is not enough, the bees also make a second type of wax, with a different chemical formula. This very special wax is used to seal over the top of cells in which eggs have been placed by the queen. Why is a special "cap wax" needed? The cap wax permits air to pass through so the larva will not suffocate.

How long did it take for evolution to come up with cap wax? Before that time, all the bee larva died. As with all other plants and animals in the world, every little detail is crucial in the life of the bees.

BABY FOOD FACTORY-Bee bread is a highly nutritious food, made from pollen by the bees. Worker bees, upon emerging from the comb, must eat bee bread so their glands will produce food for the queen and the developing larvae. Older worker bees only need honey for their food.

What made the difference? Scientists decided there must be additional nutritional factors in the bee bread. After careful study, they better understood the bread-making process. As the bees collect the pollen, they add secretions from special glands to it-even while they are out in the field collecting pollen! They also add microorganisms which produce enzymes which release a number of important nutrients from the pollen. Other microbes are added to produce antibiotics and fatty acids in order to prevent spoilage. At the same time, unwanted microbes are removed. If you have ever made bread, you know it requires special attention. In addition to the other ingredients, the bees also add a little honey here and nectar there, and a little more honey and nectar so the bread will stick together just the right amount!

A sophisticated knowledge of microbiology, nutritional chemistry, as well as general biochemestry was needed, in addition to some high-tech equipment-all located inside the bee!

ROYAL JELLY FACTORY- When it is decided to produce a queen instead of merely a worker bee, the bees have a way of doing ft.

Young worker bees make a special substance in their bodies which is called "royal jelly." It is regularly fed to all their grubs for the first 48 hours after they hatch from eggs. Royal jelly is a creamy substance, rich in vitamins and proteins. It is formed in ductless glands in the heads of young worker nurse bees.

When a queen is desired, royal jelly is fed to a grub for five days instead of only two. In all other cases, royal jelly is fed to the grubs for only 48 hours, and then an exact (exact!) 50-50 mixture of honey and pollen (called "bee bread") is fed to those grubs for an additional three days.

So a five-day diet of royal jelly is given to a grub which will later mature into a fully-developed female-a queen bee. But the two-day diet of royal jelly, followed by a three-day diet of bee bread, is given to the other grubs. They will later develop into an undeveloped female-a worker bee. (Worker bees are also called neutral bees.)

SILK FACTORY- After the grub is sealed into its wax cell, the larva spins a silk cocoon for itself. How does it know to do that? When it later emerges as a bee, it can never again make silk. That ability was only there while it was needed.

HIVE AND CELLS- There is also a hive and cell factory. That is also made by bees, using material from within the hive!

Out in the wild, the hive with its cells will be built in a hollow tree. But if the queen with her swarm of bees is placed in a man-made square beehive, they will produce honey for people.

Whether it be in a tree or in a square hive, the worker honey bees make some beeswax and shape it into a waterproof honeycomb. The honeycomb is a mass of six-sided compartments called cells. As soon as the workers have completed a few cells, the queen lays eggs in them. The workers keep making more honeycombs with their cells, and the queen keeps laying more eggs.

All the while, thousands of other bees are busy flying out of the hive, gathering nectar and pollen, and bring it back to the hive. This provides food for the adult bees and their babies. It also provides the raw materials with which the bees manufacture honey, glue, wax, royal jelly, bee bread, honeycombs, and cells.

The cells containing the eggs and developing bees are kept in the most protected part of the hive-near the center. That area is called the "brood nest." Around it, more cells have been made and pollen has been stored in them. Above the pollen cells, more cells have been built, and nectar has been placed in them. Enzymes from the bees gradually change that nectar into honey.

Each six-sided cell is a work of perfect craftsmanship) The bees have no architects to help them, no drawing boards, no blueprints, no compasses, or rulers; but the job is well-measured, strongly made, and flawlessly executed.

Did you know that the wax structures in the beehive have been reinforced? Wax is reinforced by drawing long thin threads of varnish through it! The wax hardens around the threads, like concrete reinforced with wire.

Cell walls are only 1/350th of an inch [.007 cm] thick! This would make a sharp top cell edge, even for bees' feet,-so the top edge is given a final extra coating of wax to thicken it, giving it a rounded coping, and bringing it up to 1/80th of an inch [.03 cm] in thickness.

Fluid materials pushed together from all directions form into six sides. That shape makes them cling the closest together without spaces between. Bees crawl into the cups and press them into shape-each one the size of an adult bee.

The structure of the honeycomb is astounding. Only three shapes could possibly be used: the triangle, the square, or the hexagon. Any other shape would leave wasteful open spaces between the cells. Testing out the three, we find that the hexagon holds more honey in the same space than the other two. It also uses less wax to construct, and the shared sides require even less wax. After calculus was invented by Isaac Newton, scientists discovered that the shape of the cell is still more marvelous: The cap at the end of each cell is a pyramid composed of three rhombuses. Complex mathematics reveals that this shape requires less wax than any other, and it enables the cells to be butted up closely against one another, with no loss of space. So we have here a ten-sided prism.

AIR CONDITIONING -Maintaining temperature control in the hive is equally amazing. The bees have air-conditioned hives! They keep the hive at a constant 95°F [35°C]. When the weather is cold, the bees congregate at the center of the hive and generate extra heat by increasing their metabolism. How they do that? By breathing faster! Other bees collect all over the outer walls and provide insulation to the hive! If the weather remains cool, the bees in the center rotate with the bees on the walls.

When the weather becomes too warm, some of the bees go to the entrance and begin rapidly fanning their wings. This brings in cooler air from the outside into the hive. If the weather becomes still warmer, other bees fly out of the hive and bring back water-and wet the inside of the outer walls of the hive! At that point, the fanning of the other bees rapidly cools the walls as the water evaporates.

What bee is smart enough to figure out all that?

QUEEN BEE- Yet another factory is the queen herself: she is an egg factory!

She walks around all day laying eggs. That is all, just laying eggs. Helper bees follow her, feed her (she works so hard, she must be fed constantly), go ahead of her to get empty cells ready, follow after and feed the grubs, and later cap grub cells when the feeding time expires and cocoons are to be formed.

If the queen is not in the hive, all the workers become excited and disorganized. When she leaves the hive, bees follow her out. More on that later. They have reason to be excited. Without her, the hive of bees will soon perish.

DRONE -This is the male honeybee. These are clumsy creatures and somewhat larger than workers. They sit around all day and are totally dependent on the workers, which even have to feed them!

Their most striking feature is their large eyes. They have 13,090 little eyes in each compound eye globe; which is more than twice as many as the 6,300 which worker bees have. Why do drones have such large eyes? One would think that the workers would reed them more; they do so much work. But a little thought reveals that worker bees have so many other functions which they must do, and so many chemicals which they must produce in their heads, they do not have space for larger eyes. In contrast, during the mating flight the drones must not lose track of the queen as she flies up into the sky.

Drones have no sting and do no work. Drones develop from unfertilized eggs. Their only task is to mate with a young queen. Before mating, that young queen can only lay drone eggs. The queen need only be fertilized one time-and she will be able to spend the rest of her life laying worker eggs which, with royal jelly, can be turned into queens.

If something happens to the laying queen, the workers can easily use diet (royal jelly) to change a baby worker into a queen, which will lay drone eggs until she has mated. The arrangement is a perfect one. It is perfect because it was carefully thought out before any bees existed.

WORKER BEES-The worker bees are well named. They work hard during their brief lives. The youngest clean empty cells, care for the young, help build the comb, and take care of nectar.

When a worker is 10-14 days old, it begins flying to the fields where it collects nectar, pollen, and water for the young in the hive. The worker lives about 6 weeks during the busy summer, but several months during fall, winter, and spring when it has less work to do.

Several guard bees stand at the entrance. Any creature not belonging to the nest is not permitted entrance, with the exception of drones. The guard bees smell every bee that enters.

Ventilation bees stand at the entrance and fan air into the hive to aerate it. (In case of a grass or forest fire, all the bees fan their wings in an effort to save the hive.)

In the winter, the workers gather over the honey cells and move their wings to produce heat. When the temperature reaches 50-60°F [1015.5°C], they stop heating the hive till the temperature drops again. (In the summer, the brood area temperature will rise to about 93°F (33.8°C.)

EGG To LARVA- Worker bees place a little royal jelly in the bottom of a cell. The queen then lays a pearly white egg in it. The egg is as big as a dot over an "i." Three days later a small wormlike larva crawls out of the egg, but it remains in the cell. Worker nurses immediately begin feeding it: royal jelly for 48 hours; after that the 50-50 honey/pollen mixture called beebread. Scientists tell us that, while the nurses are feeding the larvae, each larva is fed over a thousand times a day! They eat and eat and grow rapidly.

Five days after the larva hatches, the workers place a wax cap over its cell. Inside the cell, the larva spins a cocoon and changes into a pupa, which then develops into an adult bee. A full, mysterious metamorphosis-with all its complicated chemical changes-takes place at that time in the body of the creature. (The larva and pupa stages of honeybees are collectively known as the

Twenty-one days after the egg was laid, the adult bee chews off its larval skin and bites its way out of the cell. (Twenty-one days: 3 as an egg, 6 as a larva, and 12 as a pupa.) It immediately begins work, without ever having been taught what to do.

I say "immediately begins work;" what do you think its first untaught duty is? As soon as the bee emerges from the cell, it turns around and cleans up that cell! Once done, the new member joins the colony in all its' varied work. How does a newly-hatched bee know that its first duty is to clean up its cell and get it ready for the next generation? Where could that knowledge have come from? How can it know what to do after that?

Everywhere we turn in nature, we find the guiding hand of a super-powerful Intelligent Being. And throughout it all, we see so many evidences that that Being is kind and loving.

OCCUPATIONAL SELECTION- How does a bee decide what it will do? There are a variety of different activities that worker bees are involved in; what determines the adult employment of each newborn worker bee? One researcher was very patient. He glued tiny, numbered, color-coded tags to the backs of 7,000 living honey bees! His objective was to figure out how the bees decided their lifetime work.

Typically, the queen bee mates with over a dozen mates before settling down to a year or two of continuous egg-laying. In one study, the queen was only allowed to mate with a "guard bee" and an "undertaker bee" (whose job was to dispose of dead bees). The discovery was made that, 8 times out of 10, bees do what their father did. So that aspect is another result of DNA coding. The mating with a variety of bees means that the queen will lay eggs for all types of worker occupations.

NEW QUEEN- in some unknown way, the workers select certain larvae to become queens. The old queen is becoming feeble or disappears, or may have left with part of the hive. For this purpose, a larger cell is made to house the future queen.

About 5 1/2 days after hatching, the queen larva becomes a pupa, and 16 days after hatching, she emerges as an adult. But the workers ignore her as long as there is a laying queen in the hive. The young queen will fly away—swarm—with some of the bees, or will fight to the death with an older queen, or the older queen will swarm with part of the hive. (Just before swarming occurs, several worker bees will leave as scouts in the hope of finding a location for a new hive.)

When two queens fight, they are able to sting repeatedly. Only the queen has a smooth stinger, able to be used without injuring herself. (The worker bees have barbed stingers, so each sting brings death to the worker. The drones have no stinger.) When the fight begins, one or both queens will often sound a high, clear note as a battle cry. The sound is made in anger by forcing air through ten little holes in the side of the queen. The sound is a signal to the entire hive. Everyone stands back and waits for a single queen to emerge.

Often the older queen wisely leaves, taking part of the bees with her, as soon as she learns that a new queen is in the hive.

At swarming time, the hive becomes terribly excited. All work stops. Out of the hive shoots a terrifying ball of, say, 35,000 bees. After swirling around crazily, it heads off. Landing on a tree limb or the side of a tree, it waits while scouts search out a location for a new hive. Then it flies there, makes wax, and begins building the new hive. In the midst of such apparent confusion, why would the bees give any attention to what returning scout bees have to tell them? It truly seems impossible that returning scouts would even be noticed.

The new queen then has a mating flight with one or several drones, and, after fertilization, will return to the hive a half-hour later, ready to lay worker eggs for the rest of her life. She may live as long as 5 years, or as little as a year.

Every day she may lay 2,000 eggs (more than the weight of her own body!), more than 200,000 eggs each season, and up to a million eggs in a 5-year lifetime.

(The mating flight of the queen does not occur until the scouts return to the waiting bees, and the entire swarm has then moved to the new location. But while the swarm is waiting in a tree for the scouts to return, they can easily be persuaded to move into artificial quarters-such as a bee hive, -merely by shaking the swarm, with its queen, into the container.)

SOLITARY BEES- We have told you about the "social bees" which make beehives. There are also "solitary bees" which live alone. We will not take the time to describe these, but included among them are carpenter bees which build nests in dead twigs or branches, leaf-cutter bees which cut pieces of leaves and pack them into small nests in tunnels, miner bees which dig tunnels in the ground, mason bees which build clay nests in decaying wood, or on walls or boulders, and cuckoo bees which lay their eggs in other nests.

Each of these five types of solitary bees lead very unusual lives. For example, the female of one species living in the ground always builds an underground nest next to another female bee. Tunnels connecting the two are then made, so they can visit and socialize from time to time.

Sometimes they even lay their eggs near each other and raise their young together. Often one female bee will baby sit both sets of young while the other goes shopping for groceries.

ANATOMY LESSON-In review, consider some of the special parts of a worker bee:

(1) Compound eyes able to analyze polarized light for navigation and flower recognition. (2) Three additional eyes for navigation. (3) Two antennae for smell and touch. (4) Grooves on front legs to clean antennae. (5) Tube-like proboscis to suck in nectar and water. When not in use, it curls back under the head. (6) Two jaws (mandibles) to hold, crush, and form wax. (7) Honey tank for temporary storage of nectar. (8) Enzymes in honey tank which will ultimately change that nectar into honey. (9) Glands in abdomen produce beeswax, which is secreted as scales on rear body segments. (10) Special long spines on middle legs which remove the wax scales from the body. (11) Five segmented legs which can turn in any needed direction. (12) Pronged claws on each foot to cling to flowers. (13) Glands in head make bee bread out of pollen. (14) Glands in head make royal jelly. (15) Glands in body make glue. (16) Hairs on head, thorax, and legs to collect pollen. (17) Pollen baskets on rear legs to collect pollen. (18) Several different structures to collect pollen. (19) Combs to provide final raking in of pollen. (20) Spurs to pack it down. (21) Row of hooks on trailing edges of front wings, which, hooking to rear wings in flight, provide better flying power. (22) Barbed poison sting to defend the bee and the hive. (23) An enormous library of inherited knowledge regarding: how to grow up; make hives and cells; nurse infants; aid queen bee; analyze, locate, and impart information on how to find the flowers; navigate by polarized and other light; collect materials in the field; guard the hive; detect and overcome enemies; -and lots more!

How can a honeycomb have walls which are only 1/350th of an inch [.007 cm] thick, yet be able to support 30 times their own weight?

How can a strong, healthy colony have 50,000 to 60,000 bees-yet all are able to work together at a great variety of tasks without any instructors or supervisors?

How can a honey bee identify a flavor as sweet, sour, salty, or bitter? How can it correctly identify a flower species and only visit that species on each trip into the field-while passing up tasty opportunities of other species that it finds on route?

All these mysteries and more are found in the life of the bee. A honey bee averages 14 miles [25.5 km] per hour in flight, yet collects enough nectar in its lifetime to make about 1/10th of a pound [.045 kg] of honey. In order to make a pound of honey, a bee living close to clover fields would have to travel 13,000 mites [20,920 km], or about 4 times the distance from New York City to San Francisco)

NO EVOLUTION- With all this high-tech equipment on each bee, surely it must have taken countless ages for the little bee to evolve every part of ft. Yet, not long ago, a very ancient bee was found encased in amber. Analyzing it, scientists decided that, although it dated back to the beginning of flowering plants, ft was just like modern bees! So, as far back in the past as we can go, we find that bees are just like bees today!

ONE FLAW- In all the above, we find absolute perfection in design and execution. But there appears to be one flaw: Why was the queen bee given a smooth stinger so she could sting repeatedly, while the worker bee was only given a barbed stinger-with which he can sting but once?

Evolutionists point to that "flaw" as evidence that there was no preplanning in the life and work of the honey bee.

But it is not a flaw. The queen can repeatedly sting so only one queen will emerge as the new queen. But the worker bee can only sting once when you come near his hive. Would it be wise planning to have each worker bee able to sting repeatedly? If you are stung by five bees, you can quickly remove the stingers and neutralize the wounds with mud or dampened charcoal. -But what if each of those five bees had stung you 10 or 15 times? You might die.

No flaws. When the Creator does something, He does it right.

2 - THE PALOLO WORM

At random, we will select one of the hundred or more creatures briefly mentioned In an earlier design chapter, and give It a fuller discussion. The astounding fact Is that the startling information below on this tiny deep-sea worm could be matched by extended write-ups on any one of thousands of other living creatures.

The palolo worm is totally incredible. Randomness could only rearrange; it could never produce something new. Neither natural selection nor mutations could invent the palolo worm.

Palolo worms live in coral reefs off the Samoan and Fijian Islands in the southern Pacific. Twice a year, with astounding regularity, half of this worm develops into another animal with its own set of eyes, floats to the surface on an exact two days in one or the other of two months in the year, and then spawns!

Yet these worms live in total darkness and isolation in coral holes deep within the ocean,. have no means of communicating with one another, nor of knowing time-not even whether it is night or day! How can they know when it is time to break apart for the spawning season? *Here Is the story* of the palolo worm:

The Palolo worm *(Eunice vlrldis)* measures about 16 inches (41 dm] long. It lives in billions in the coral reefs of Fiji and Samoa in the south- western Pacific. The head of an individual worm has several sensory tentacles and teeth in its pharynx. Males are reddish-brown and females are bluish-green. These worms go down into the ocean and chew their way, head-first, into deep coral atolls, and riddle ft with their tiny, isolated tubes. They also burrow under rocks and into crevices. Once settled into their new homes, these creatures catch passing food-small polyps with their "tails," while their heads are buried inside the coral or between rock.

The body of one of these worms is divided into segments, like an earthworm's, and each contains a set of the organs necessary for life. But reproductive glands only develop in rear segments.

As the breeding season nears, the "brain" of the little worm, inside the coral, decides that the time has come for action. The back half of the palolo worm alters drastically. Muscles and other internal organs degenerate, and the reproductive organs in each segment grow rapidly. Then the palolo worm partially backs out of its tunnel, and the outer half breaks off. By that time, the outer half has grown its own set of eyes. Once separated from the rest of the worm, the broken-off half, swims to the surface. (Down below in the coral, the "other half" grows a new back half and continues on with life.)

On reaching the surface, the free-swimming halves break open and their eggs and sperm float in the water and fertilization occurs. The empty skins sink to the bottom, devoured by fish as they go. Soon, free-swimming larvae develop and, becoming full-grown palolo worms, they sink deep into the ocean and burrow into the reefs.

We have here a creature which stays at home, while sending off part of itself to a distant location to produce offspring. That is astounding enough. But the most amazing part is the clockwork involved in all this! The success of this technique depends upon timing. If the worms are to achieve cross-fertilization, they all must detach their hind parts simultaneously. So all those worm segments are released by the palolo worms at exactly the same time each year!

Swarming occurs at exactly the neap tides which occur in October and November. (Some of the spawning occurs in October, but most in November.) It occurs at dawn on the day before and the day on which the moon is in its last quarter.

Suddenly, all the half-worms are released into the ocean. Swimming to the surface and bursting open, the sea briefly becomes a writhing mass of billions of worms and is milky with eggs and sperm.

The timing is exquisite.

People living in Samoa and Fiji watch closely as these dates approach. When the worms come to the surface, boats are sent out to catch vast numbers of them. They are shared around, festivals are held, and the worms are eaten raw or cooked. In Fiji, the scarlet aloals and the seasea flowers both bloom. This is the signal that the worms are about to rise to the surface!

Then, each morning, the natives watch for the moon to be on the horizon just as day breaks. Ten days after this-exactly ten days-the palolo worms will spawn. The first swarm is called *Mbalolo lailai* (little palolo), and the second is *Mbalolo* levu (large palolo). On the island of Savaii, the swarming is predicted by the land crabs. Exactly three days before the palolo worms come to the surface, all the land crabs on the island mass migrate down to the sea to spawn.

Throughout those islands, the natives know to arise early on the right day. An hour or so before dawn, some will begin wading in darkness, searching the water with torches for evidence of what will begin within an hour. Even before the night pales into dawn, green wriggling strings will begin to appear in the black water. Flashlights reveal them vertically wriggling upward toward the surface. Shouts are raised; the palolo worms have been seen!

People who have been sleeping on the beaches awake. Gathering up their nets, scoops, and pails, they wade out into the water. Dawn quickly follows, and now the number of worms increases astronomically! Billions of worms have risen and are floating on large expanses of the ocean's surface. The sea actually becomes curded several inches deep with these tiny creatures,-yet only a half hour before there were hardly any, and absolutely none before that for nearly a year. The people ladle them into buckets, as large fish swim in and excitedly take their share.

People **a**nd fish must work fast; an hour before there were none,—and already the worms are breaking to pieces. As their thin body walls rupture, eggs and sperm come out and give a milky hue to the blue-green ocean. Quickly, the empty worm bodies fall downward into the ocean and disappear.

Within half-an-hour after the worms first appear, they are gone,-and only eggs and sperm remain.

Scientists have tried to figure out how the palolo worm calculates the time of spawning so accurately. But there is just no answer. The worms cannot watch the phases of the moon from their burrows. They are too far down in the ocean to see light or darkness, or note the flow of the tides. The only solution appears to be some kind of internal "clock"!

But wait, how can that be? An internal clock would require that the action be triggered every 365 days, but this cannot be, since the moon's movements are not synchronized with our daynight cycle, the movements of the sun, nor with our calendar. As a result, the moon's third quarter in October arrives ten or eleven days earlier each year, until it slips back a month.

Nor can it be that the worms in their holes are somehow able to judge the phase of the moon by its light, for they spawn whether the sky is clear or completely overcast.

Well then, it must be that the worms send signals to each other through the water! But that cannot be, for palolo worms on the reefs of Samoa split apart at exactly the same time as the worms at Fiji-which are 600 miles away! If some kind of signal could indeed be sent over such a vast stretch of the ocean, it would take weeks to arrive.

Indeed, the timing appears to have been predecided for the worm. There is no celestial or oceanic logic to ft. The Pacific palolo spawns at the beginning of the third quarter in October or November, whereas the Atlantic palolo - near Bermuda and the West Indies- also spawns at the third quarter; but always in June or July instead of October! (Far away from both, a third pololo worm also spawns yearly at the beginning of the third quarter in October or November.)

At any rate, the advantages are obvious. All the eggs and sperm are together for a few hours, and a new generation is produced. Some other sedentary sea creatures also reproduce within narrowed time limits. This includes oysters, sea urchins, and a variety of other marine animals. But, with the exception of the California coast grunion, none do it within such narrowed, exacting time limits as the palolo worm.

***3 - PORTRAIT* FROG**

For our third exhibit in this chapter, we will review a living creature discussed In an earlier design chapter: the false-eyed frog, also called the portrait frog.

First, we will reprint our earlier write-*up on this humble creature, and then we will consider the implications:*

FALSE-EYED FROG- The South American false-eyed frog is an interesting creature. Generally about 3 inches [7.62 cm] long, it is brown, black, blue, gray, and white! Drops of each color are on its skin, and it can suddenly change from one of these colors to the others, simply by masking out certain color spots.

The change-color effect that this frog regular produces is totally amazing, and completely unexplainable by any kind of evolutionary theory.

The frog will be sitting in the jungle minding its own business, when an enemy, such as a snake or rat, will come along.

Instantly, that frog will jump and turn around, so that its back is now facing the intruder. In that same instant, the frog changed its colors!

Now the enemy sees a big head, nose, mouth, and two black and blue eyes!

All of this looks so real-with even a black pupil with a blue iris around it. Yet the frog cannot see any of this, for the very intelligently-designed markings are on its back!

The normal sitting position of this frog is head high and back low. But when the predator comes, he quickly turns around so that his back faces the predator. In addition, the frog puts its head low to the ground, and raises hind parts high. In this position, to the enemy viewing him, he appears to be a large rat's head! In just the right location is that face, and those eyes staring at you!

The frog's hind legs are tucked together underneath his eyes-and they look like a large mouth! As he moves his hind legs, the mouth appears to move! The part of the frogs body that once was a tadpole's tail-now looks like a perfectly formed nose, and it is in just the right location!

To the side of the fake face, there appear long claws! These are the frog's toes! As the frog tucks his legs to the side of his body, he purposely lifts up two toes from each hind foot-and curls them out so they look like a couple of weird hooks.

And the frog does all of this in one second!

At this, the predator leaves, feeling quite defeated. But that which it left behind is a tasty, defenseless, weak frog which can turn around quickly, but cannot hop away very fast.

The frog will never see that face on itself, so it did not put the face there. Someone very intelligent put that face there! And the face was put there by being programmed into its genes.

Well, there it is. And it is truly incredible. How could **that small,** ignorant frog, with hardly enough brains to cover your little fingernail, do that?

Could that frog possibly be intelligent enough to draw a portrait on the ground beneath it? No it could not. Could it do it in living color? No!

Then how could ft do *it on its own back?*

There is no human being in the world smart enough-unaided and without mirrors-to draw anything worthwhile on his own back. How then could a frog do it?

It cannot see its back, just as you cannot see yours. The task is an impossible one. And, to make matters more impossible, it does it without hands! Could you, unaided by devices or others, accurately draw a picture on your back? No. Could you do it simply by willing colors to emerge on the skin? A thousand times, No.

"Portrait frog"! This is the motion-picture frog! And the **entire process occurs on its back** where it will never see what is happening! And it would not have the brains to design or prepare this full-color, action pantomime even if it could see it.

Someone will comment that frogs learn this by watching the backs of other frogs. But the picture is only formed amid the desperate crisis of encountering an enemy about to leap upon it. Only the enemy sees the picture; at no other time is the picture formed.

All scientists will agree that this frog does not do these things because of intelligence, but as a result of coding within its DNA. How did that coding get there? It requires intelligence to produce a code. Random codes are meaningless and worthless. Codes producing ordered structures and designs never arise through random activity. They require intelligent planning. Genetic codes within living creatures are the most complicated of all, and are far above the mental capacities of humans to devise and fabricate.

The facts are clear: God made that frog, and He made all other living creatures also. Only His careful thought could produce and implant those codes and **the physical systems** they call for.

There can be no other answer.

Remember the honey bee and all its technology, equipment, and know-how. Consider the palolo worm and its astonishing ways. View the portrait frog, which not only can produce the image of a large rat's head, but even move its body in such a way to simulate motion by the rat!

Yet the frog can see nothing of what it is doing. A man can never learn a skill If he can never see whether he is succeeding in utilizing the skill properly. The term for this is educational feedback. The little frog never has any feedback. Yet it executes the function perfectly each time. And it does it on but a moment's notice. Instantly, the fully-formed picture is there, and it is set in motion.

God made the honey bee, the palolo worm, the portrait frog- and everything else In our world. May we acknowledge Him, honor Him, and serve Him all the days of our life. He deserves our truest, our deepest worship and service, for He Is worthy.

He is our Creator.

MORE WONDERS OF DESIGN # 1

An unforeseen delay of over a year occurred before the printing of this set of books. During that time, additional research studies in natural history were made. Just prior to publication, these nature nuggets were placed in three additional chapters, each one located just before the allocated table of contents for each of the three books.

Every fourth chapter in the main text of these books is filled with natural wonders. The following design factors found in nature are additional evidence that God created this world and everything in it. They provide the thoughtful reader with powerful evidence for Creation and against evolutionary theory.

It is obvious that the wonders in our world were made by the Creator.

MATHEMATICS OF A SWIFTLET'S CLICKS

Swiftlets are small birds that live in southeastern Asia and Australia. They make their nests far back in dark caves. It is not difficult for an owl to fly through the woods at night, for a small amount of light is always present and owls have very large eyes. But the situation is far different for a swiftlet. There is no light in caves! And swiftlets have small eyes! How then is this little creature able to find its way through a cave, without running into the walls? Yet he does it.

Designed with fast-flying wings, such as swallows and swifts have, the swiftlet flies at high speed into its cave. Somehow it knows which cave to fly into. But, once inside, there is no glimmer of light to guide it. Yet rapidly and unerringly, it flies directly to one tiny nest. Arriving there, it is confronted with hundreds of nests which look exactly the same. How can it know which one is its own? Nevertheless, flying at top speed, the bird flies across even the largest cavern in only a few seconds-and then lands at the correct nest.

Part of the mystery is solved when we consider that the swiftlet has been given a type of radar (sonar) system. But this discovery only produces more mysteries. As the little bird enters the cave, it begins making a series of high-pitched clicks. The little bird has the ability to vary the frequency of the sounds; and, as it approaches the wall, it increases the number of clicks per second until they are emitted at about the rate of about 20 per second. The time required for the clicks to bounce off the wall and return reveals both the distance to the wall and its contours.

Scientists tried to figure out why the clicks vary in frequency as the bird gets closer to the wall. After applying some complicated mathematics, they discovered that the tiny bird-with a brain an eighth as large as your little finger-does this in order to hear the return echo! The problem is that the click must be so short and so exactly spaced apart, that its echo is heard by the ear of the bird-before the next click is made. Otherwise the next click will drown the sound of the returning echo.

FOG-DRINKING BEETLE-How can a wingless beetle, living in a desert, get enough water? This one does it by drinking fog.

Onymacris unguicularis is the name of a little beetle that lives in the rainless wilderness of the Namib Desert, close to the southwestern coast of Africa. This flightless beetle spends most of its time underground in the sand dunes, where temperatures remain fairly constant. But when thirsty, it emerges from its little burrow and looks about. There is no water anywhere; rain comes only once in several years. The little fellow is not discouraged, but climbs to the crest of a sand dune, faces the breeze, and waits. Gradually fog condenses on its body. It just so happens that this beetle is born with several grooves on its face. Some of the water trickles down the grooves into the beetle's mouth. Happily, the little fellow goes searching for dry food and then returns to its burrow for a nap.

ELECTRICAL IMPULSES OF KNIFE FISH- The Amazon knife fish is a strange looking creature. It has no fins on the side, top, or tail; all its fins are beneath it-in one long, single wave of fin from front to back! Indeed, this eight-inch fish has no tail at all. The fish looks somewhat like a sideways butterknife, which narrows to a spear point at its hind end.

Its one, long ribbon-like fin undulates from one end to the other-something like millipede legs which move it through the water. As it travels, it can quickly go into reverse gear and swim backwards with that fin.

But the most unusual feature of this little fish is its lateral line. This horizontal line of cells on its side is an electrical generating plant, producing impulses which are sent out into the water to both one -side and the other. These 'impulses bounce off objects and quickly return where they are sensed by other receptor cells in its skin. The voltage of these cells is low, only about 3 to 10 volts of direct current. Yet the frequency of the impulses is high-about 300 a second. As these impulses go outward, they create an electrical sending/receiving field of signals, which tell the fish what is around it-in front, to the side, and even to the rear.

But imagine the problems which ought to occur when two knife fish come near each other! Both fish are sending out signals, and the resulting incoming confusion of patterns would be expected to "blind" both fish. But, no, the Designer gave these fish the ability to change wavelengths! As soon as two knife fish draw near to one another, they immediately stop transmitting impulses for a couple moments, and then both switch them back on-but this time on different frequencies to each other!

UNDERGROUND FLOWERS-We all know that flowers never grow underground; but here are two that do:

There are two Australian species of orchid which, not only produce flowers under the earth's surface,-but the entire plants are there also! The only exception is a tiny cluster of capsules which is occasionally pushed up to disperse the dustlike seeds.

How can these plants live underground? Both species feed on decaying plant material in the soil, breaking it down with the aid of fungi. They do all their growing and blooming beneath the top of the soil. Their flowers are regular orchid flowers!

The first, Rhizanthella gardneri, was discovered by accident in 1928 by J. Trott, a farmer who was plowing a field near Corrigin, western Australia. The second, Cryptanthemis slateri, was found by E. Slater in 1931 at Alum Mount in New South Wales. The little plants keep so well hidden that few have ever been found since then.

KNOWING WHERE TO JUMP-Gobies are small fish which, during low tides, like to swim in rock pools on the edge of the ocean. One species, the Bathygobius, enjoys jumping from one tidal pool, over rocks exposed above the water, into another rock pool on the other side. Researchers finally became intrigued by this habit and decided to investigate.

They discovered that this little fellow always jumps just the right amount, at the right place, and in the right direction-without ever landing on rock! How can this fish know where to leap out of the water, and in what direction? It cannot see from one rock pool to the next. Surely it does not have the locations and shapes of all the rock pools pre-memorized in its tiny head! Although much of the area around a pool is exposed rock, with no nearby pools beyond it, yet the Goby always jumps at exactly just the right place. The scientists have guessed that, perhaps, when the tide earlier came in and covered all the rocks, the fish swam around and memorized all the bumps and hollows on the rock, and thus later know where to do its jumping. But, if that was true, then the mystery would only deepen even more. How could this very small fish have enough wisdom to go about in advance and learn all that?

VARIETIES OF ROSES-In chapter 13 (Natural Selection) we discuss the wide range of possibilities to which each natural species can be bred. Because of this, large numbers of subspecies can be developed. The making of new subspecies is not evolution.

An example of this would be the rose. More than 8,000 varieties of rose have been developed for garden cultivation, yet all of them are descended from only a few wild forms. Although roses have been cultivated by the Persians, Greeks, Romans, and Europeans, there were only four or five rose types by the end of the 18th century. This included the dog rose, musk rose, and red Provins rose.

Modern varieties, such as the hybrid tea rose (single-flowered) and floribundas (clusterflowered), began to be bred only around 1900, after the European species were crossed with cultivated oriental Chinese imports.

MIGRATING LOBSTERS-Spiny lobsters live and spawn near coral reefs of the Bahamas and the Florida coast. But each fall, the lobsters know that it is time to leave. Storms occur throughout the year; yet, for some unknown reason, at the time that one of the autumn storms stirs the waters, the lobsters quickly know that migration time has come. Within a few hours they gather in large groups.

Then they form into long, single-file lines and begin marching out into the ocean. They always know to move straight out, and not sideways. As they travel on the sand, each lobster touches his long antennae on the rear of the one in front of him. There is no hesitation about these marches; the creatures gather and immediately depart. As they go, they travel surprisingly fast, yet maintain their alertness. They can never know when their main enemy, the trigger fish, or another predator may suddenly dart down through the clear waters. Indeed, the lobsters are easy to see, for the tropical sands beneath them are often white.

When a trigger fish does arrive, the lobsters instantly go into action. They form into circles, with their pincers held outward and upward in a menacing gesture. When the trigger fish, decides it is not worth getting pinched and leaves, the spiny lobsters reform into a line and continue their march. Finally, they reach a lower level and remain there throughout the winter. Since less food

is available during the winter months, at these lower levels the colder water temperature helps slow their metabolism and they go into semihibernation until spring returns. Then they march in lines back to their summer feeding grounds. Who put all this understanding into the minds of the little lobsters? Could you train a lobster to do all that?

POP GOES THE MOSS-The various sphagnum mosses (the kind you purchase at garden supply stores as mulch) grow in peat bogs. These mosses have a special way of ejecting their seeds.

In the final stage of ripening, the spore capsules shrink to about a quarter of their original size, compressing the air inside, and reshape into tiny gun barrels, each with its own airtight cap. Each barrel is very small-about 0.1 inch in length.

Then the cap breaks under pressure, and the trapped air escapes with an audible pop, firing the packet of spores as far as 7 feet. How could this tiny plant devise a battery of natural air guns to disperse its dustlike spores?

Evolutionists glibly tell us it all happened "by accident." But, first, it could not happen by accident. Only a fool would believe that (and the Bible defines a "fool" as one who does not believe in God [Psalm 14:1; 53:1]). Second, it could not even happen by human design. It would be impossible for a person to get a plant to do the things these little mosses regularly do in the process of preparing their seeds, packing them in for firing, and then shooting them off.

SPIDER MAKES HIS DOOR-Although only an inch long, the female trap-door spider makes excellent doors and latches. After digging a burrow six inches deep into soft ground, she lines the walls with silk, and then builds the front door.

This is a circular lid about three-quarters of an inch across. A silken hinge is placed on one end, and gravel on the bottom. In this way, as soon as the lid is pulled over, it falls shut by its own weight. The top part of the door exactly matches the surroundings; and, because it just happens to have a carefully made bevelled edge, the door cannot by the closest inspection be seen when closed. Throughout the day, the door remains shut, and the little spider inside is well-protected from enemies. When evening comes, the door is lifted and the little creature peers out to see if it is dark enough to begin the night's work.

With the door open wide, the spider sits there, with two front feet sticking out, awaiting passers-by. When an insect happens by, the door is shut and lunch is served.

Sometimes the spider locks the door. This is especially done during moulting time, when the door is tied down with ropes of silk. The males build similar tunnels.

FAST-GROWING TREES-It is always a marvel how a tiny seed can grow into a mighty tree. But, although it takes time for a tree to grow, some trees grow very rapidly.

The fastest-growing tree in the world is the AIbizzia falcata, a tropical tree in the pea family. Scientists in Malaysia decided to measure how fast one could grow, and found it reached 35.2 feet in 13 months. Another in the same region grew 100 feet in five years. The Australian eucalyptus is also a speedy grower. One specimen attained 150 feet in 15 years.

BABY GLUE GUNS- Ants have discovered that babies make good glue guns.

The green tree ants of Australia make their homes out of living leaves. Several workers hold two leaves together, while others climb up the tree trunk carrying their children (the little grubs which will later change into adult ants). Arriving at the construction site, these ants give their babies a squeeze, and then point them toward the leaves. Back and forth they swing their babies across the junction of the leaves, and out of the baby comes a glue-like silk which spot-welds the leaves together. It looks as if a white, silken network is holding the leaves together. When the building project is finished, the ants move into their new home. Perhaps they thank their young for providing the nails to hold the house together.

MILKING THE TREES- That is what they do in Venezuela: milk trees.

The South American milk tree (Brosimum utile) belongs to the fig family and produces a sap that looks, tastes, and is used just like cow's milk. Farmers go out and collect it. The trees are easy to care for; it is not necessary to chase after strays, string barb wire, round up the herd and put them into barns at night, or teach the young to drink out of pails.

RUNNING ON WATER- How can a skimmer—the little rove beetles which glide effortlessly over a water pond—run across the surface of the water?

It is now known that they are pulled by the surface tension of the water ahead of them. But how can this be, for is there not just as much surface tension in the water behind them? No, there is not. These little skimmers can only travel as fast as they do-because they lower the surface tension at the rear of their bodies in a very special manner. There is a small gland at the back end of their abdomens. A tiny amount of fluid from that gland is placed on the water as they run along. This fluid lowers the water's surface tension! But the surface tension ahead of them remains high-and it is an obscure law of physics that this difference tends to pull them forward!

Seriously now: What self-respecting beetle would be able to figure out the complex chemical formula for that fluid, much less planning how to restructure its body in order to manufacture it in the gland it is produced in? How would he know enough about physics to understand, in the first place, what he was trying to do?

Or could you, with your large brain, restructure your body? There is hardly a boy in the land who would not like to have the muscles and endurance of the tiger, but he cannot do it.

If we cannot change our bodies, why should anyone imagine that animals can do it?

MORE ABOUT CLOWNFISH-In chapter 24, we discuss the astonishing activities of the clownfish, which lives amid the stinging tentacles of the anemones without ever being injured by them. Scientists have puzzled over this for years. It has recently been discovered that the answer is that other fish have a certain chemical in the mucus covering their bodies which, when touched by the arm of an anemone, causes its stings to discharge. Clownfish lack this chemical, and are thus able to live amid those tentacles, and let the anemone defend them.

In addition, in the reefs off Australia and New Guinea, the clownfish protects the anemone. The butterfly fish is in that region, and-also lacking that chemical-it is able to bite off parts of the anemone. But when it swims near, the little clownfish comes out and attacks it, driving it away. In this way, the clownfish protects the anemone which protects it.

FISH THAT BUILD NESTS-Some fish are born in nests. The labyrinth family (which include the Siamese fighting fish) are air-breathing fish. They build nests in vegetation near the surface. Sticky bubbles are blown by the male, who places the eggs in the nest and watches over them until they are born, and thereafter for a time.

The stickleback fish also builds nests. The male collects pieces of aquatic plants, and glues them together with a cement secreted from its kidneys. Placing the plant mass in a small pit in the sand, it then makes a burrow or tunnel inside, where the eggs are then laid.

Other fish form depressions in the sand and remain there to care for their young after they hatch. But no other nesting material is used.

Nesting, whether done by birds or fish, is actually a very complicated pattern. It is not something that a weak-minded bird or fish could ever have thought up by itself. Yet most birds and some fish regularly do it.

It is of interest that, even if a solitary bird had actually stumbled upon the idea of making a nest, that bird would not have taught it to its babies. So the pattern would have stopped right there. Just as there is no way that the pattern could be started, there is no way it could be passed on to the next generation. "Oh," someone will reply, "the information simply passed into the genes." Not so, any good scientist will tell you that there is no such thing as inheritance of acquired characteristics.

STICK-BEATING BIRD-No, this isn't a stick beating a bird, but a bird beating with a stick. The huge black palm cockatoo of northern Australia enjoys screeching high notes and whistling low ones to its neighbors. It wants everyone to know it is there. Yet even this is not enough to satisfy it. To insure that no rival cockatoos enter their territory, breeding pairs signal their ownership of a territory by breaking off a small stick with their claws and beating it against a hollow tree.

HEAD-DOOR FROGS-Some Mexican tree frogs use their heads to survive. Called helmet frogs, they have bony crests on top of their skulls. When drought begins, these little frogs climb into tree trunks or into holes in bromeliads (plants of the pineapple family) that grow high in trees.

Once inside, they use the tops of their heads to seal off the entrance! Then they just sit there till rain falls again. Little water is lost through their head, and it makes an excellent camouflage at the doorway to their home.

MILKY WAY CAVES- The fungus-gnat of New Zealand lives in dark caves. You can find them there by the millions. Each of these little insects first makes a horizontal maze, which looks something like a spider web. Then it drips down several dozen mucus threads, which hang downward from its nest. Each of these threads has globs of glue at several points on the thread-and those threads glow in the dark.

Entering one of these caves and gazing upward, you will see the steady, unblinking light of millions of stars overhead. Some seem slightly closer, and some farther away. Everywhere you look above you, the stars shine.

SKIN BREATHERS-Most amphibians breathe with gills when they are larvae in the water, and later with lungs when they become adults and live on land. But there are also land-living, cavedwelling, tree-climbing, and water-living species that do not breathe through lungs or gills. Instead, they breathe through their skin!

An example of this would be the frogs of the genus Telmatobius. These little frogs live underwater in lakes in the high Andes. That water is cold! Yet these frogs, having no gills or lungs, are able to absorb oxygen from the water through their skin.

EGG PRODUCERS-Some people wish each hen in their chicken yard would produce at least one egg a day. But some creatures can do better than that. A single female cod can produce six million eggs in one spawning. A female fruit fly is far too small to do as well as the codfish but, even she can lay 200 eggs in a season in batches of a hundred at a time.

Yet there are creatures which can produce far more eggs than that. These include the corals, jellyfish, sea urchins and mollusks. The champion is the giant clam. Once each year, for 30 or 40 years, it will shoot one thousand million eggs out into the water. This is 1,000,000,000, or a full billion.

The largest litter produced by any placental mammal is that of the Microtus, a tiny meadow mouse living in North America. This little creature can give birth to 9 babies at a time, and produce 17 litters in a breeding season. Thus it is capable of producing 150 young each year.

MOST EXTENSIVE MINER-The Russian mole rat is a champion burrower. In its search for underground bulbs, roots, and tubers, it excavates long tunnels that include resting chambers, food storage rooms, and nesting areas. Scientists excavated one tunnel system in the former Soviet Union and found it was 1 ,180 feet in length. They calculated that it took about two months to construct.

The Russian mole rat is blind and digs with its teeth, not with its claws. It rams its head into the soil to loosen it as it chews out new tunnels. Every so often, it comes to the surface and makes a mound of earth from the tunnel. The longest tunnel had 114 interconnected mounds. If that little rat can do that, just think what you can accomplish!

CHILDREN'S CHILDREN-The greenfly is a live-bearer insect, which means it does not lay eggs but brings forth its babies live, as mammals do.

But the greenfly does it a little differently. During the summer months, when there are lots of food plants in leaf, she produces eggs within herself which are self-fertile; that is they were never fertilized by a male. In addition, all her eggs will hatch into females. But there is more: Each of her daughters will automatically be fertile, so that daughter will, in turn, be able to lay fertile eggs.

MORE ON THE KANGAROO-In chapter 32, we discuss the kangaroo. But here is more information:

After being born, the baby kangaroo journeys to its mother's pouch and begins nursing. After about 9 months it will begin climbing out of its mother's pouch and begin feeding. But, at times, it will jump back in and continue taking milk. Then, at 10 months it no longer jumps in, but remains with its mother and reaches in from time to time to take more milk, until it is 18 months old.

There are two striking facts about this: (1) The mother frequently has already given birth to another tiny baby which is also in the pouch nursing, so she will have a baby and an adolescent nursing at the same time. (2) The teat giving milk to the infant produces different milk than the one which the older one drinks from! It matters not which teat it is; the older one will always receive a different composition of milk than the baby kangaroo is given. The tiny infant has very different nutritional needs. But the question is how can the mother vary the type of milk which is given, at the same time, to both an adolescent and an infant kangaroo?

An example of this is the red kangaroo, which provides milk both to a tiny joey attached in the pouch to a teat, and also to a large joey which has left the pouch. The older one is given milk with a 33 percent higher proportion of protein and a 400 percent higher proportion of fat.

IDENTICAL QUADRUPLETS EVERY TIME The female nine-banded armadillo is a common armadillo, which ranges from the southern United States to northern Brazil. It only bears identical quadruplets. This means that all four babies in each litter come from one egg, which split after fertilization. So each litter is always the same sex.

FRIGHTENING THE ENEMY-Evolutionists tell us that creatures in the wild think through the best ways to avoid being attacked, and then develop those features. But, of course, this cannot be true. There is no way an animal can change its features, or through "inheritance of acquired characteristics," give them to its offspring. But the myth is adhered to, because the obvious explanation is unwanted. The truth is that a Master Designer provided the little creature with what it needed.

The Australian frilled lizard is about 3 feet long. When an enemy draws near, this lizard raises a frill which normally is flat along the back. This frill stands out in a circular disk which can be 2 feet across. How did that frill get there? Did the lizard "will it" into existence? Did it tinker with its own DNA? How does it know to use it to frighten enemies?

The lizard adds to this immense, apparent increase in size by opening its mouth, which is bright yellow inside. By now, the situation is surely looking worse, as far as the predator is concerned. Then, to settle the matter once and for all, the lizard gives a terrible hissing sound and slowly moves toward the enemy. By that time, the troublemaker generally decides to leave.

BABY NURSERY-The eider duck sets devotedly on her eggs without eating anything. When they hatch, she leads them down to the pond. Entering it with her newborn there are often many other ducklings already there that are supervised by one or two adult females, some of which are not mothers. She leaves her brood with them, and departs to find food. Because some of the food is in deeper waters, she may be gone for several days. Upon her return, she, at times, will help take care of the nursery while other mothers leave.

The French word for "nursery" is crèche (pronounced kresh). When animals care for their babies in nurseries, scientists call it a "crèche." Some eider duck crèches have been counted at over 500. If marauding gulls appear, the adult females sound an alarm, and the young gather close about them. If the gull tries to catch one, the adult will try to grab him by the legs and pull him down into the water. As for the chicks, they only need protection from these adult nursery attendants, for they are well-able to find food for themselves.

In South America, the Patagonian cavy (which is somewhat similar to the guinea pig) is also initially cared for in a crèche of babies hidden in a tunnel by the rocks. One of the fathers cares for the group till the mothers return from feeding. Upon her arrival, she gives a call and out come about a dozen cavies. She sniffs among them, until she finds her two, and then leads them away. More babies are dropped off, and more mothers return for theirs. The babies remain in the nursery tunnel, guarded by an adult above. Adults never use the tunnel, although they initially dig it for the nursery.

When bats return to their caves after feeding, they must find their own within a nursery of a million or more baby bats! Each mother flies in and lands close to her own. Then she calls for several seconds and her baby gives an answering squeak. Formerly it was believed that they merely nursed whatever baby they landed near. But genetic tests established that it was their own. How they find their own child in such an immense nursery is astounding. After nursing her own, she flies off to another section of the large cave, hangs from the ceiling, and sleeps for a time. Then she flies off to obtain more food to feed her only baby.

VISION SKIN-DEEP-Some insects can see light through their skin, even when their eyes are covered. Experiments were done on moth and butterfly caterpillars, when their eyes were covered. There are other insects which also have this ability.

In addition, they often have eyes in very unusual places, as we discuss in chapter 16.

SUNGLASSES TOO- Yes, even sunglasses existed in nature before man began using them. Seabirds, such as gulls, terns, and skuas have built-in sunglasses. All day long they have to search for food, as they glide above the ocean's surface. Staring down into the waves for fish, the glint of sunlight on the waves reflects up into the eyes. The solution is sunglasses, which they have.

The retinas of these birds contain minute droplets of reddish oil. This has a filtering effect on light entering the eye, and screens out much of the sun's blue light. This cuts down on the glare, without lessening their ability to see the fish near the surface.

FLICKER'S LONG TONGUE-In chapter 28, we discuss the woodpecker. Here is additional information on his amazing tongue, and that of the flicker:

Woodpeckers like to eat beetle grubs. Cocking their heads to one side and then another, they carefully listen for them. When the grub is heard chewing its way through the wood-which it does most of the time,-the bird swiftly bangs on the tree with its sharp bill, drilling a hole as it proceeds.

Then it reaches out its enormously long tongue. How can a tongue be four times as long as the beak, when the beak itself is very, very long? It took special designing; accidents could never have produced the tongue of the woodpecker.

This tongue is attached to a slender bony rod housed in a sheath which extends back into its head, circles around the back of its skull and then extends over its top to the front of the face. In some woodpecker species, it also coils around the right eye socket.

Then there is the American flicker. This woodpecker-like bird is equally amazing. The tongue is so long that, after reaching around the back of the skull, it extends beyond the eye-socket and into the upper beak. Here it enters the right nostril so that the bird can only breathe through the left one. Flickers use this tongue to extract ants and termites after drilling for them.

But a tongue is not enough. The flicker must put something on the tongue to deal with those ants. Its saliva, wetting the tongue, does two things: First, it makes it sticky, so the ants will adhere to it; and, second, the saliva is alkaline, to counteract the formic acid of ant stings.

The evolutionists will tell us that all this came about by slow, laborious chance. But, obviously, such complicated structures and functions could not develop by accident even once in millions of years. -Yet in the world we find six others, totally different creatures which use this long, sticky tongue method to catch ants: the numbat, a marsupial in Australia (which is something like a small antelope); the aardvark in Africa; the pangolins in Asia and Africa (which are covered with horny plates, so they resemble giant moving fir-cones); and three very different anteaters of South America: the gazelle-sized giant of the savannahs, the squirrel-sized pygmy which lives in the tops of forests, and the monkey-sized tamandua which lives in the mid-tree levels.

As usual, the evolutionists have no answer. To make matters worse, paleontologists tell us that they can find no fossil evidence of any antiquity to explain these matters to us. In other words, there is no evidence that the woodpecker, flicker, anteater, and the others evolved from anything else.

JOURNEY TO THE UNKNOWN-In chapter 28, we consider the marvel of bird migration. Here is yet another example:

The bronze cuckoo of New Zealand abandons its young and flies to its off-season feeding grounds, located far away. After the babies hatch, they become strong enough to fly. But they have never seen their parents and have no adult bird to guide them. Added to this is the fact that, when their parents left New Zealand, they flew to a place where no other bird in New Zealand flies to. So, as soon as these babies are strong enough for vigorous flight, what do they do? Why, they fly after their parents-and take exactly the same route. Here is the story:

The young set out each March on a 4,000-mile migration from their parents' breeding grounds in New Zealand. They fly west to the ocean's edge and keep going. How would you like to do that? The Pacific is an incredibly big ocean.

With no bird to instruct or guide them, these young birds accurately follow the path of the parent flock over a route of 1,250 miles of open sea. Arriving in northern Australia, they turn north, fly to the ocean's edge-and start off again. Arriving in Papua New Guinea, they head off again. This time they fly the gruelling distance to the Bismarck Archipelago.

Just one slight error in direction, and they would die. Why? Because not one of the birds can swim.

AMAZING HOUSE OF THE TERMITE

Termites build their homes of mud. Their homes are amazing structures, as we will learn below. Yet those large, complicated buildings are made by creatures which are blind. They have no instructors to teach them, and they spend their lives laboring in the dark. Nevertheless, they accomplish a lot.

Termites, of which there are over 2,000 species, only feed on dead plants and animals, and have very soft bodies which need the protection of strong homes. And the houses of some species are among the strongest in the world.

It all starts with two termites-a king and Queen. They burrow into the earth and lay eggs. For the rest of her life, the Queen will continue to lay eggs. Gradually, an immense colony of termites comes into being. Working together, they construct an immense turret of hardened mud that reaches high above ground. In northern Australia, in order to keep the termite tower cool, each of these tall spires is made in the form of a long, upright, rectangular wedge. Each side may be 10 feet across and 15 feet high, while only a couple feet thick at the bottom and Quite thin at the top. So the wedge points upward. The narrow part of the termite tower lies north and south; the broad side is toward the east and west.

The colony is Quite cold by sunrise, but their home Quickly warms up because the morning light shines on its broad east face. Then comes the hot, midday sun. But now the narrow edge of the nest faces its burning rays. In late afternoon, as everything cools, extra sunlight falls on the termite's home to help keep it warm through the night.

The lesson here is that it is well, in hot areas, to build one's house with the long side facing east and west.

But how can a blind termite, working inside the darkness of mud cavities, know which direction to face the tower towards? Would you know if you were as small, and weak, and blind as the termite?

Scientists have decided that the termites use two things to aid them in orienting their homes: (1) They use the warmth of the sunlight. But it takes more than the sun circling overhead; intelligent thought about how to place the slab tower in relation to that moving orb of light is also needed. Frankly, the termite is not smart enough to figure it out.

(2) The termite builds in relation to magnetic north. Experiments have been carried out, in which powerful magnets were placed around a termite nest. The termites inside were still able to face their towers in the correct direction, but they no longer placed their nests inside in the right places. So they use solar heat to orient the direction of the tower, but magnetic north to tell them where, within the darkness of the tower, to place the nests of their young.

Termite homes, located in tropical areas, have different problems. There is too much rain and the little creatures could be drowned out, and their homes ruined by the downpours. If you were a blind termite, how would you solve that puzzle? The termites do it by constructing circular towers with conical roofs, to better shed the water as it fails. One might consider that a simple solution. But if you were as blind as a termite, with a brain as big as one, how would you know how to build circular towers or conical roofs? Moreover, the eves of those conical towers project outward, so the rain cascading off of them falls away from the base of the tower. That takes far more thinking than a termite is able to give to the project.

When these termites enlarge their homes, they go up through the roof and add new sections; each section with its own new conical roof protruding out from the side. The tower ultimately looks like a Chinese pagoda.

The bellicose termites in Africa are warlike, hence their name. In Nigeria, they build an underground nest containing a room with a huge circular ceiling, large enough for a man to crawl into. It is 10-12 feet in diameter and about 2 feet high. It is filled with vertical shafts down to the water table. Termites go down there to gather moist dirt to be used in enlarging their castle. "Castle?" yes, it looks like a castle. Rising above the termite-made underground cavern is a cluster of towers and minarets grouped around a central spire that may rise 20 feet into the air. In this tower is to be found floor after floor of nursery sections, fungus gardens, food storerooms, and other areas, including the royal chambers where the king and Queen live.

The entire structure is so large that-if termites were the size of people-their residential/office building/factory complex would be a mile high. Could mankind devise a structure so immense, so complicated? Yes, modern man, with his computers, written records, architects, and engineers could make such an immense building. But how can tiny, blind creatures-the size and intellect of worms-manage a proportionally-sized process, much less devise it?

Before concluding this section, let us view the air conditioning system used in this colossal structure. If you have difficulty understanding the following description, please know that, generation after generation, blind termites build this complicated way-and the result is a high-quality air conditioning system:

In the center of the cavernous below-ground floor is a massive clay pillar. This supports a thick earthen plate which forms the ceiling of the cellar, and supports the immense weight of the central core of the structures built in the tower.

Down in this basement cellar, the tiny-brained termites build the cooling unit of their Central Air Conditioning System Processor. This consists of a spiral of rings of thin vertical vanes, up to 6 inches deep, centered around the pillar, spiralling outward and covering the ceiling of the cavernous basement. The coils of each row of the spiral are only an inch or so apart. The lower edge of the vanes have holes, to increase the flow of air around and through them. The sides of these vanes are encrusted with salt.

These delicate and complicated vanes, made of hardened mud, absorbs moisture through the ceiling from the tower above. This decidedly cools the incoming air, making the cellar the coldest place in the entire building: The evaporating moisture leaves the white salts on the vanes.

Heat, generated by the termites and their fungus gardens in the tower, causes air from the cellar to rise through the passageways and chambers linking the entire structure. But, as any college-trained civil engineer would know, the cooling system is not yet complete. A network of flues must be installed to take the hot air down to the cooling unit in the cellar. Yes, the ignorant, blind termites also provided those flues! From high up in the tower, a number of these ventilation shafts run downward. As they go, they collect air from the entire tower and send it down, past the floor plate, into the cool cellar. As heat is produced in the various apartments of the tower, the air flows downward through the flues, drawn by the coolness of the cellar beneath.

The heat exchange problem has been solved, but there is yet another one: gaseous exchange. .

Air may be flowing throughout the cellar/tower, nicely cooling it, but carbon dioxide must be eliminated. The problem here is that no casual openings to the outside are permitted. The termites have only a few tiny entrances to the outside world, and carefully guard each one against their many enemies. Yet they must somehow refresh their air. Ask an engineering student to solve that one. He has enough equations, calculators, and material specifications that he ought to be able to provide you with a workable answer.

But those blind termites, the size of very small worms, were applying the solution before your engineer was born, the first college was built, and the first books were invented.

The flues are built into the outer walls of the tower. The lining of the flues, facing the outside of the structure, are built of specially porous earthen material. During construction, the termites dig small areas-or galleries-out from the flues toward the outer surface of the outside walls. These galleries end very close to the outer surface so gases can easily diffuse through the earth. As the stale air travels slowly through the flues, the carbon dioxide flows out and oxygen flows in. By the time the air has arrived at the cellar, it has been oxygenated and refreshed. In the cellar it is cooled and then sent back up into the tower! Any thinking human being could, without advance training, use the above guidelines to work out an excellent air-conditioning system for a house. The only basic requirement is moist heat in the upper part of the building. Engineers today call their modified versions "passive air conditioning," but the termites have used it ever since they came into existence.

With this system operational, the termites are able to keep their fungus beds permanently between 30°C and 31°C, exactly the temperature the fungus need to grow and digest the food the termites give them.

At this point, you might wonder why those termites cultivate such fungus beds. While many other termites go out and eat wood, which microbes in their stomachs digest for them, the bellicose termites only eat fungus (they lack those stomach microbes). So they cultivate gardens of manure in which fungus grows. The fungus grows best within a very precise temperature range of 30-31°C. However, the processes of decay in the gardens produces a lot of heat (for it operates somewhat like a compost heap). If you think about that awhile, you will realize that this frail termite, which cannot live outside his termite house, needs his fungus gardens, and yet, without complicated air-conditioning, cannot maintain those beds. The termite colony needs everything just right to begin with.

We have here another "chicken-and-the-egg" puzzle. The world is full of them; they are all solved by the great truth that God is the Creator. Nothing else can explain those puzzles.

More Wonders of Design - # 2

EAR MUSCLES OF THE BAT-We mention the bat in chapter 28, but here is more information about this incredible creature:

Although they have good eyesight, it is well-known that bats fly by sonar. They emit high frequency sounds which the human ear cannot hear. The returning echo of those sounds places "sound-print" pictures in their minds. Using this technique, a bat can "see" and catch a tiny, fast flying insect.

But there are more wonders here than we would otherwise have imagined: A bat can vary the pitch of that sound. The higher it is, the smaller the surface its echo can reveal. Some sounds are so high that they can enable the little bat to detect the presence of a wire no thicker than a human hair stretched across its pathway.

Then there is the intensity of that sound. The louder it is, the more distant the object that can be detected. So these calls are generally loud; so loud, in fact, that they would strike our ears as though they came from air-hammers, except that, by design, they are so high-pitched that we cannot hear them. God designed these noises, as loud as a pneumatic drill, to be in a range which would be soundless to us.

But wait! If it is necessary for a bat to make such a loud sound, in order to have it echo back from a distant object,-how can the bat possibly hear the echo with its ears, in the midst of all the racket it is making with its mouth?

This is a good question, for it would, indeed, be a very real problem. The ear of the bat was designed to be extremely sensitive, so that it can hear very faint sounds. Yet just a few of its screams would quickly deafen it! The Designer solved this problem also: There is a special muscle in the middle ear of the bat. It is attached to one of three tiny bones which transmits the vibrations of the eardrum to the tubular organ in the skull that converts them into nerve signals sent to the brain. Just as each scream is on the verge of being emitted, this muscle instantly pulls back that bone, so that it does not transmit sound from the outer ear to the inner ear. The eardrum is momentarily disconnected! Then, after the scream is ended, that muscle relaxes-and the bone moves back into place, and faint sounds can be heard. This back-and-forth motion of that bone occurs more than a hundred times a second! And it always occurs in perfect alignment with the sending of the super-short screams.

But there is still more: The faster these sounds are emitted, the more up-to-date information the bat will receive. Fast reception of information is especially needed when the little fellow is flying around the curves inside the cave, or is flying among the branches of a forest. Some bats can send out 200 quick screams a second. Each sound lasts only a thousandth of a second, and each is spaced just the right distance from the other so that each echo is clearly heard.

Talk about the amazing honeybee; who designed the bat! This creature is astounding. Frequently in this set of books, it is stated that Creation is a proven fact, not a possible alternative theory as some suggest. It is the laws of nature and the things of nature which prove Creationism; no other possibility could suffice. God made us. Accept the fact, for it is true. Not to accept it is to lie to yourself, and soon you are enmeshed in a habit of believing fanciful, foolish theories which, in reality, are obviously wrong.

GREENHOUSE PLANT-The fenestraria is not a plant in a greenhouse, but a plant which makes its own greenhouse.

Located in the southern African deserts, the fenestraria grows underground and only a small transparent window is exposed above the surface. This window is made of translucent cells and has two layers. Scientists were amazed to discover that the outer layer blocks the most damaging ultraviolet rays of the sun, and the inner layer reduces and diffuses the light to a safe level for the green photosynthetic tissue of the buried plant. How could the plant know how to do all that? Frankly, it couldn't.

Do you want to design a better greenhouse? Go study the fenestraria. Someone may eventually do it, and produce far more efficient greenhouses than we have today.

THE HOMING ANT -In the Sahara Desert there are great areas of trackless sand. How could you travel on it and know where you were going? If you were less than an inch tall, how could you do it and find your way home again? Well, the little *Cataglyphis* does it every day. This is a tiny ant which lives in that great desert. Making its home in a little nest below ground, where it is safe from sand lizards and birds, the tiny ant remains there till afternoon.

By that time, all its enemies have fled to shade rocks or burrows to escape from the burning heat, and the little ant ventures out to find its lunch. At about the same time, hundreds of these little ants crawl out of tiny tunnels and scurry off in search of dead insects. For an hour or so, they run here and there, zigzagging across the hot sand dunes. What they do must be done quickly-before they are overcome with heat.

As each ant travels, it pauses every few seconds, raises its head and moves it around. Then it dashes off in a new direction. Eventually, meal hunting time is over and the little fellow must return to its nest with the collected food.

But where is the nest? How can the little creature possibly know where it is located? Yet, without a pause, the tiny ant sets off in a certain direction-and runs straight for a distance of up to 150 yards exactly to its nest hole!

After making careful observations, researchers concluded that it was during that moment of head lifting and turning that the ant oriented itself. The scientists rigged mirrors which gave a false impression of where the sun was located-and, at the end of the food-gathering trip, the ant was not able to find its way back to the nests. Obviously, this means that the little ant, with a brain smaller than a grain of sand, was constantly memorizing directional locations as, every few seconds, it looked up and then started off in a new direction. And it was able to use the angle of an ever-moving sun as the norm for making those decisions.

BIGGEST SEEDS IN THE WRONG PLACE - The largest seed in the world is not, according to scientists, where it is supposed to be. The double coconut (coco-de-mer), *Lodoicea maldivica, is* a palm tree, the seeds of which require up to 10 years to develop before they are ready to grow into **a new palm tree.** They look like two coconuts joined together, and weigh up to 45 pounds.

In the wild they grow on hilltops in the remote Seychelles Islands. But researchers are baffled by their location on hilltops. How did they get there? Did the 45-pound coconuts roll uphill? The wind surely did not blow them up there. One would *expect* them to keep traveling farther and farther downhill, with each new generation. No known native animal or bird would be capable of carrying them up there. To add to the mystery, these coconuts sink in the water, so how did they get to the Seychelles Islands in the first place?

DOZING MOTHS-The bogong moth lives in Australia. In the springtime the little caterpillars feed on the grassy pastures of southern Queensland and New South Wales. Soon they pupate and become little greyish-black moths. But by now it is summertime and hot. What is a poor little moth to do in a place like that? I am not sure I would know, but the little moth does.

Instead of waiting around long enough to die in the heat, the little moths begin a long journey. Northward they travel to the Australian mountains. Each year they take exactly the same route that their ancestors took in previous years. Yet, just like their ancestors, they themselves have never before taken that trip-for they were born the same year they took it. Arriving at the foot of the mountains, they begin flying up and up the slopes, until they arrive at nearly 4,000-foot elevations. Some go on up to 4,500-foot locations.

The moths have arrived at piles of immense granite boulders near the summits. They alight on the boulders-and crawl into shady cracks. Packing close together, they look like tiles on a rooftop. In this high, cold place they go into a state of suspended animation, and remain there until the fall when they will return to lower elevations and lay their eggs next spring in the sand. Then they will die, and a new generation of moths will emerge in early summer-and soon thereafter wing their flight to the high northern mountains.

LIVING WITHOUT WATER-In chapter 12, we mention a plant in Israel which can live without water. Another is to be found in America. It is called the bird's-nest club moss. This little plant can survive for several months without moisture of any kind. In a drought it rolls into a tight ball to minimize the area exposed to drying winds and sun. As the water leaves the cells, it turns pale. When the plant is dampened, it unfurls and becomes green within 15 minutes.

PRAIRIE DOGS' VENTILATION SYSTEM- Prairie dogs are small, rabbit-sized rodents with short legs and small ears. They live together in very large social communities on the grasslands of the American West.

Working together, they build underground houses which are 90 feet long, with many side rooms. It is all something of a complicated apartment house. But the ventilation is crucial; how are they going to get the air moving through it? How would you do it? Admit it; using only natural materials found on a prairie, neither you nor I would probably not know.

But the prairie dog does it anyway-and quite successfully. Each tunnel has two openings, one at each end. But they are not constructed the same way. One opens flat on the surface of the prairie. The other rises up through a foot-tall chimney of mud and stones. Why does the prairie dog arrange the openings that way? He does not know why; he just does it. The Master Programmer coded it into his DNA to build his house that way; just as He coded his fur to keep him warm, eyes to see with, and ears to listen to what goes on around him.

A marvelous design factor is in that foot-tall chimney. Wind moves faster a little above ground than it does at ground level. With one chimney, the air inside the apartment house is sucked out, and fresh air is drawn in through the lower entrance. But with no chimneys-or with two, the air inside would remain stagnant.

MAKING BIRD NESTS-It is not easy to place sticks together and get them to "stick together." Try it sometime. Watch a bird do it, and you will note that the little creature works at the placement of every twig-until thoroughly satisfied. Yet how can a bird know, just by looking at it, when the location of a stick is satisfactory?

The larger nesting birds tend to make rough stick nests. But many of the smaller ones make delicate cup nests. Inside a twig cup, a lining of softer material is placed. This might be dried grass, or something similar. Thrushes use mud, the bearded tit prefers flower petals. The house wren values pieces of sloughed snake skins. The honey guide of Australia plucks hair from the back of horses. Some birds grow special soft feathers on their chest, which they pluck off to line their nests. This has the double advantage of permitting their bare chests, which will be above the eggs, to keep those eggs warmer.

Hummingbirds use spider's silk. They build their nests while hovering over them, since the nest is too delicate for them to alight on till it is completed.

The swifts have a special problem. Although very fast fliers, their feet are poor and they rarely land on a branch-or anything else other than their nest. How then can they build their nests? How would you do it if you had to remain in the air all the time?

First, the swift collects twigs by flying at a branch and breaking off a piece in flight. Then it flies to a wall and attaches it, using saliva. The swift has been given amazingly sticky saliva! Outside the body, it acts like a fast-drying glue. More sticks are brought, and soon the nest is made. That is how the Asian chimney swift does it. The American palm swift uses-not twigs-but cotton, plant fibers, hair, and feathers. The African palm swift only uses saliva throughout the operation.

These are called "palm swifts," because they attach their nests to the underside of palm leaves. But what keeps the egg from falling out of the palm leaf when the wind blows? No problem; the bird glues the egg into the nest!

The cave swiftlets of Southeast Asia also build with saliva-but they make much larger saliva nests. These nests are deep within dark caves, and may be attached to horizontal ledges, the vertical sides of the caves-or even to the overhead roof!

How can a bird make a nest out of saliva? How would he know how to form it in the right shape as he prepares it? "Easy," you say. Well, try dripping saliva onto a dinner plate-and make a bird nest out of it! Here is how the bird does it:

First he flies to the side of a cliff and repeatedly dabs saliva onto the wall in a half-moon shape of what the wall-side part of the nest will look like. Then he dabs more and more, and slowly builds it larger and larger. Gradually, he moves the sides inward-and produces a perfectly formed nest with a cup-like top! One nest takes several days to make; and when completed, it has the inside of the cup just the right size to hold two eggs. And that is exactly how many the swiftlet always puts into the nest.

20-MINUTE PLANT-The Stinkhorn fungus Of tropical Brazil is one of the fastest -growing organisms in the world. When the fungus is ready to begin growing, chemical changes in its cells permit them to absorb water rapidly.

It pushes out of the ground at the rate of an inch every 5 minutes, and grows to full size in 20 minutes. This growth is so fast that a crackling sound can be heard as the water swells and stretches its tissues.

As soon as full size is achieved, it begins decomposing at the top. Flies are attracted and, crawling over the surface, collect spores on their feet which they carry elsewhere.

MITES IN THE EAR -What is as Small as a mite? These creatures are so tiny that one of the places they live is inside the ear of the moth. Entire colonies of mites will live inside a moth's ear. Separate parts of the ear are used for egg laying, stacking their refuse, and feeding.

But there is a problem: These little creatures so fill the moth's ear that he can no longer hear properly with it. But he needs his ears, and with mites in both of them, he wanders around erratically, and would be caught by bats.

The solution is simple enough: The mites only live in one ear! In this way the moth can hear well enough to go about his business-with less chance of being eaten. Thus the mites keep themselves from being eaten by bats.

But, who told the mites to do that? Surety no mite could be smart enough to figure that out. The brain of a mite would be smaller than the smallest speck you have ever seen.

MADE FOR EACH OTHER- It is an intriguing fact-and one evolutionists would prefer to ignore-that living things are often designed with one another in mind. Without the one, the other cannot survive. How then could they originate in the first place, if they had to begin together? What outside Power did the designing? The plants and animals themselves surely did not confer together before they existed and figure it out.

Stanley Temple, an American biologist working in the Indian Ocean island of Mauritius, noticed in 1970 that the seeds of the Calvaria major tree, although fertile, had not germinated for 300 years (the age of the youngest specimens still growing). Noting that the large, wingless bird, the dodo, became extinct about that time, Temple brought in some turkeys-in the hope that they could do what the Dodo probably had done: swallow the seeds, thereby removing their hard outer coat and enabling them to germinate.

He fed some of the seeds to domestic turkeys, collected the seeds when they had passed through the birds' digestive system, and planted them. For the first time in three centuries, Calvaria major germinated, producing healthy new plants.

DUET BIRD SINGERS-Did you know that some birds prefer to sing together? The bou-bou shrike lives throughout tropical Africa in thick forests, where they can only see a few feet at the most. A pair may not be far apart, but they cannot see one another.

The song of this bird is exquisite. It is clear, flute-like, with a long melodic pattern. Yet, the truth is that it is two birds singing, not one. One bird starts the song and then, it will suddenly pause and the other will add a note or phrase, and then the first bird will instantly take up the song again. Back and forth it will go-and yet it sounds as if only one bird is singing! There is not the slightest hesitation or pause anywhere in the song.

The two birds are a mated pair. Scientists tried to study this in detail with tape recorders and sonograms to analyze the sounds-and then made the discovery that there are many other duet-singing birds in the wild. In a square mile of South American rain forest there may be as many as a dozen different species of birds singing duets. This is how they keep track of the location of each other in those dense jungles.

Yet it is obvious that the birds did not devise this. The intellectual requirements for such a procedure are too great. It would be with the greatest of difficulty that you and I could sing such a duet together, even if we were the best singers in the world. The cue and mental requirements for such instant stopping and switching over from one bird to the other, at random points here and there in **the song are astounding.** It **has been** discovered that each bird in the pair knows the complete, complicated song and, if solitary, can sing it alone. But that cannot explain how they can know to instantly stop-so the other can sing part of it-and then return to the other.

In the darkness of night in the forests of Europe, the tawny owl also sings in duet. Its famous *towhit to whoo* call has been heard by millions of Europeans. Yet few realize that it is two birds uttering the call! One owl sings the *to-whit,* and then, the other owl instantly gives the *to-whoo.* It all sounds as if it is coming from one bird, but the call is being made, alternately, by a pair of owls.

COLD LIGHT- Most of the energy used to light a light bulb is wasted, since it is changed to heat. It takes energy to produce light, scientists cannot fathom how lights in nature operate so efficiently. The man who ever solves this problem will be a millionaire overnight, but, so far, no one has been able to do so-even though fireflies and other creatures do it all the time.

For example, the tropical firefly, Photinus, makes light with 90 percent of the energy used for that purpose. By contrast, only 5.5 percent of the energy used to power an incandescent bulb emerges as light; the rest is wasted as heat. The glow of a firefly contains only 1/80,000 of the heat that would be produced by a candle flame of equal brilliance.

If an ignorant speck-brained firefly can do that, why cannot man do it? If a thinking man cannot do it, then what reason do we have to think that an "accident" did it for the firefly? The firefly is enabled to do it because of the advance planning of an Intelligence far greater than that of mankind.

WATER ON FIRE -In the clear waters of the San Blas Islands, located in the Gulf of Mexico near Panama, you will find that the ocean sometimes sparkles with fire.

What you see are tiny fire-fleas. Each is a small crustacean about the size of a land flea, but with shrimp-like bodies. The sudden spurt of light in the dark water so startles a predatory fish that, even if it has already snapped up the fire-flea, it may swiftly disgorge it in fright. These little creatures also use their light to locate and attract one another, much as fireflies on land do.

One type of firefly makes equally-spaced spots of light as it swims. Another only flashes as it swims vertically to the surface, ever flashing faster as it nears the water line. Yet another flashes synchronistically as the males, several feet apart, move through the water flashing together in precise unison.

FISH THAT FLIES-Everyone has heard of the flying fish, but it is still a very unusual creature. Flying fish do not actually fly; they glide. First, they leap into the air at speeds up to 20 m.p.h. Then, using their wide pectoral fins as wings, they begin their glide. Because they usually remain close to the water's surface, they flick their tails occasionally to produce extra thrust and keep them going longer.

Flying fish have been known to soar as high as 20 feet and travel as far as 1,300 feet in one glide through the air.

OCEAN SOUNDS-There is more noise in the ocean than merely the lap of waves. You can dive down into the sea and not hear these sounds. This is because the small plug of air in your outer ear blocks them out. But, upon lowering a hydrophone (an underwater microphone) into the ocean, you discover that the ocean is full of sound.

Triggerfish grate their teeth together, sea horses rub their heads against their back spines, and pistol shrimps dislocate their claws when enemies draw near-and the resulting noise sounds like gunshots. When a conger eel prepares to atack a spiny lobster, the lobster rubs its stony antennae along a toothed spike that is on its head between its eyes. A rasping noise is made, and all the spiny lobsters in the area quickly jump into their holes.

PORPOISE TALK-Porpoises (also called dolphins) seem to talk more than anyone else living in the ocean. Which is quite a thought.

Scientists have studied them in aquaria and in special shallow-water locations off the coast of the Bahamas. Porpoises have a vocabulary of about 30 different vocalizations, but they can also change the significance of each by the body position at the time the sound is made. A certain sound made while nodding the head will have a different meaning than when not nodding it.

Each porpoise has a "signature whistle," which' is his unique call identifying himself. Another porpoise only uses that call to catch the attention of the owner of that special whistle.

All of these sounds are totally different than the sounds they make when they send out sonar (underwater radar). That system is discussed in chapter 32 and is used to locate distant objects.

A third way in which porpoises communicate is by ultrasonic sounds which people cannot hear, but which certain electronic equipment can receive and record. A fourth way is by touching (nudging, stroking, and smacking) one another.

SONGS OF THE HUMPBACK-The porpoises click and make high-pitched sounds. But the whales sing. Would you like to hear a whale sing? Recordings of these sounds can be purchased from wildlife organizations.

The humpback whale is the greatest singer of them all. Its songs consist of vast roars and groans, interspersed with sighs, chirps, and squawks. That description may not sound very exciting, but their songs are interesting to listen to. And they go on for quite some time. Each song can last 10 minutes or so. Once completed, the whale will repeat it again-and again-for hours. Each year the songs change somewhat, as the whales experiment with changes in the tunes. We have learned a lot about these songs, but no one yet knows why these whales sing.

BLASTS FROM THE BLUE WHALE-The largest creature in the world is the blue whale. Some have been measured at 100 feet in length. It has the largest lungs and vocal cords in the world and makes the most noise. Blasts of 188 decibels have been reported. This would be equivalent to the, Saturn five rockets which launch the space shuttle. But these sounds are extremely low in range. Scientists believe that the calls of blue whales can be heard by other whales a thousand miles away.

GROWING DOWN- Most creatures grow up, but there is a frog which does the opposite. The paradoxical frog (pseudis paraobxa) becomes smaller as it "grows up." Living in the South American tropics, the tadpoles grow to as much as 10 inches in length. But, when this particular tadpole turns into a frog, it shrinks drastically.

During this process-as do other frogs-the tail is absorbed into the body. But when the change is completed, the paradoxical frog is only 3 inches in length.

Why should this frog be so different than the others? Evolution could have no answer. The difference is one of design, and only design. Any student of DNA well-knows that hundreds of interrelated genes, located in different chromosomes, would be involved. Chance could not change them, without producing a monster which would be dead at birth.

WASPS TO THE RESCUE-Several species Of birds in South America (caciques and oropendolas, for example) and weaverbirds in Africa like an especially protected location in which to build their nests. So they first go searching for the homes of the dreaded wasp. No one wants to live near them! It will surely be well-protected from all their enemies,-but what about the wasps?

Once found, these birds build their nests close to the wasps' nests. Yet, oddly enough, the wasps do not at all mind having these birds nesting in the trees just above their own nests. But let another bird even get near, and the ferocious wasps buzz toward them threateningly.

When the nests are constructed, the birds settle down to raise a family. Then an enemy draws near to raid the nest, and instantly the wasps fly out and go after him. The wasps have decided to protect not only their own nests but those of the nearby birds also.

Scientists are still trying to figure out why wasps attack other birds but protect these certain ones.

JUMPING FROGS IN MANY COUNTRIES-

Mark Twain once wrote about a jumping frog. There are frogs all over the world, and all of them surely can jump! Pick up a frog and look closely at it. These little creatures are excellently designed for jumping. Yet they could never work out the design themselves. It had to be done for them. The back legs, folded into three sections, provide the leap; the front legs are the shock absorbers when they land.

The small North American frog, Acris gryllus, can jump up to 6 feet, which is 36 times its own 2 inch length. Many other frogs can jump somewhat shorter distances. For a man to do this, the world's champion human jump would be about 215 feet.

EGG TIMERS- Mallee fowl of Australia lay eggs at random times throughout the summer since, when each hatches, it is a fully-formed small adult; well-able to fly off and take care of itself.

But many birds which nest on the ground cannot do this. Their chicks are born very feeble and must be given much care and a lot of food. It would be very difficult if the eggs hatched and matured at different times. For example, the female quail does not begin to incubate her clutch of a dozen or so eggs until the entire number have been laid-which may require two weeks. Then she begins setting on the entire lot at the same time.

Who told the mother quail to do this? Her parents surely didn't. Yet quail regularly do not set on the eggs until the entire clutch has been laid.

But that is not the end of the matter. The little quail sets on so many eggs that the ones on the outer part of the nest do not receive as much warmth. Also she has to regularly turn the eggs, or the membranes within them may adhere to the shell. So many factors are involved that, as hatching time draws near, some eggs are not as well-developed as others.

How can this problem be solved, so that all the chicks will come out of their shells at about the same time? Another miracle; listen to this:

Scientists have discovered that, as hatching time nears, the unborn chicks begin to signal to one another. If you put a doctor's stethoscope to an egg at this time, you may hear clicks coming from within. The neighboring eggs can also hear them. If they have not yet reached the clicking stage, the sound of neighboring clicks stimulates them to speed up their development! Researchers played recordings of the clicks to batches of eggs-and thus induced them to hatch well before others from the same clutch, which had been kept alone and in silence.

BIRD BONES-In chapter 28, we discuss the amazing structure of birds. Here is more information on its bones:

Evolutionary biologists tell us that birds have evolved their bones until they are now very lightweight. But birds cannot change their bones any more than you or I can. Also, if birds cannot fly with heavy bones; how did they survive before they invented lightweight bones for themselves?

Those bones are truly unusual: They are so lightweight that a bird's feathers weigh more than its entire skeleton! That is quite a thought, considering how lightweight a feather is.

The bones are very nearly hollow, with internal struts and honeycombed air sacs to provide them with unusual lightweight strength. Modern airplanes are built in a similar manner, but only after very careful planning by intelligent men.

During flight, air flows into the sacs in the bones-and then to the lungs. This enables the bird to have a much larger supply of fresh oxygen as it flies. Even the beak is modified to save weight, and is constructed of lightweight horn with no teeth.

A golden eagle is a large bird; yet, although having a wingspan of nearly 8 feet, it weighs a total of less than 9 pounds.

DEVELOPMENTAL AGES AT BIRTH- Each animal is born in just the best way. Some creatures, like baby mice, will have a longer time to grow-since they are born in a cosy, hidden nest. So they come forth blind, hairless, and unable to walk.

But other creatures are born into a harsh environment, and must be able to travel as soon as they arrive in this world. The guinea pig and agouti has no nest, but lives on the surface of the ground. So their babies are fully formed, fully haired, and can run as soon as they are born.

Calves of the wildebeest, in east Africa, are born while the herd is migrating, and can stand up and trot after their mother within five minutes of dropping to the ground.

SMALLEST MAMMALS-The Creator can make things in miniature. The smallest mammals are the 3-inch Etruscan shrew, which only weighs about 0.09 ounce, and the 6-inch Craseonycteris *thonglongyai bat,* which weighs even less: about 0.06 ounce. How can all the dozens of specialized organs, found in every mammal, be included in these tiny creatures? It is, indeed, a great marvel of wisdom and craftsmanship.

BABY DISCOVERS ITS NOSE- Females live together in groups and cooperate in caring for the baby elephants, while the males spend their time alone, wandering about. The little elephants are cared for by all the adults in the group. If anything happened to the mother, the others would raise her little one. In the care of so many protective adults, the youngsters happily romp about and play.

Researchers who watch elephant herds, have found that when an elephant is only a month or two old, it begins shaking its trunk, wondering what this strange thing is. It will shake its head and notice how the curious object flaps back and forth. Sometimes the baby trips over it. When the baby goes down to the watering hole, it awkwardly kneels down and tries to sip with its mouth. At about the age of 4-5 months, it discovers that water can be sniffed up into its trunk, and then can be blown out into its mouth. That discovery not only enables it to get a drink faster but can lead to more fun: Baby finds it can blow water on the other elephants.

Why is the learning process so slow for an elephant, when some other creatures are immediately prepared at birth for life's crises? This is no failure in design. The baby elephant has many protectors and a long childhood before it will becomes an adult. There is an abundance of time for it to learn as it grows, so this factor was wisely provided for in the design blueprint.

PROLIFIC BUNNY RABBITS—Female rabbits can breed when 4 months old, and every 30 days produce up to nine babies. During the spring and summer, one can bear six litters. In three years time, if there were no losses, one pair of rabbits could produce 33 million! Many young children would probably be happy if that happened. There would be enough bunnies for all of them!

BIGGEST CONVENTION OF THEM ALL-The largest gathering of mammals, held anywhere in the world, convenes every summer on the Pribilofs, an island group in the Bering Sea off Alaska. Each year 1.5 million Alaskan fur seals assemble, and produce half-a-million pups.

But it was a planned gathering. Seals on land are relatively defenseless, so they gather together in order to have better protection from their enemies.

WHEN ENEMIES CALL A TRUCE- The Rufous woodpecker of India and southeast Asia likes to eat ants. Those stinging tree ants, in turn, occupy themselves with vigorously attacking every intruder that comes near their nest.

But, surprisingly enough, when it comes time for the rufous woodpecker to build a nest, it temporarily makes peace with the ants.

The awesome fact is that this woodpecker flies to the football-size nest of stinging tree ants, tunnels in, lays its eggs there, and then settles down and incubates them-all the while with stinging ants all about it!

The utterly impossible occurs. No one can figure it out, including the scientists. The thought of a woodpecker setting on its eggs in a nest of stinging tree ants-has the experts stumped. Or treed, should we say.

When the little birds hatch, the dutiful parent feeds them till they are able to fly away. Throughout that time, it has not eaten one of the ants in that nest, nor have they disturbed it during its nesting season (although they attack anything else that comes near their nest at that time, as well as at any other time).

And then what do you think the woodpecker does? It flies off-and again does as it did earlier-eating ants in their ant nests.

SPIDER SILK-There is much more information on spiders in chapter 16, but here is more about spider silk:

Most spiders are such tiny things. Yet every one of them can produce a variety of different silk. Some of it is thin, some of it thick. Some is designed for temporary scaffolding, and Mme is stronger than steel of comparable weight and is heavy-duty building material. It is the strongest of all known natural fibers.

How can a little spider make this silk? It is a marvel. Yet each spider can and does make different kinds of silk! It can automatically turn off one spigot flow of this strange liquid (which, on contact with air, instantly changes into an elastic solid) and turn on a different type of liquid. At any given time, every spider can produce several different types of silk. The type it produces will be exactly the right kind for the job it is immediately working on. Watch an orb (circular) spiderweb in the making. The little spider begins with one type of silk for the initial construction, and then switches to another for the circular, sticky part.

This silk is actually a liquid protein that is squeezed from little nozzles at the rear of the abdomen. It hardens upon meeting the air. Spiders use silk for all kinds of purposes: egg-sac cases, the lining of nests, woven tents for their babies, safety lines when they jump, circular webs, trapdoor wrappings and hinges, non-circular webs, and airplane lines which carry them to distant areas-and across oceans.

GUARDING A SHRIMP-Some people have guard dogs, but there is a shrimp which has a guardfish. The goby *(Cryptocentrus coeruleopunc*tatus) is a 6-inch fish which lives in the ocean. It acts as a sentry for a tiny shrimp, called the snapping shrimp, with which it shares a burrow on the seabed.

The shrimp makes the burrow, and keeps it clean. The fish, in turn, has the better eyes of the two and guards the shrimp when they are outside the burrow.

When the entrance to their burrow becomes clogged with rubble, the shrimp comes out to clean the entrance and the area around it. It uses its claws like a mechanical digger. While it is working, the goby is on guard duty. It is nearby watching for enemies. Yet it remains close enough that one of its antennae touches the shrimp at all times. The moment the goby senses any danger, it wriggles its body. Instantly the shrimp jumps back into the burrow, and the goby immediately follows. Who told the shrimp and goby to work together like that?

MAGNETIC PIGEONS-Of course, we have all heard about the phenomenal homing abilities of pigeons. Ancient Roman emperors would use them to send messages across long distances. These birds tend to stay at home, not traveling more than a few miles from it at a time. Yet, if taken to a distance of several hundred miles, they will be able to find their way back home-and do it within a few hours.

Careful experiments have shown that homing pigeons take note of geographical features below them; and, when leaving their home, they initially circle overhead to get their bearings, and then head *off* to feeding locations not far away. So visual observation is a factor. But birds carried hundreds of miles away cannot see the ground from the air, and will soon travel over terrain they have never before seen. So how do they find their way home?

Birds were fitted with glasses which prevented them from seeing the ground, and yet they found their way home anyway. Obviously, sighting the land below them was not the key. There is good evidence that the birds check the angle of the sun as they fly. Yet, on overcast days, they still find their way home.

Then researchers took birds to a distant location on overcast days, tied tiny magnets to their heads, and turned them loose. They could not find their way home. So the answer is a combination of all three: visual observations of the ground, the angle of the sun, and mental readings of the location of the magnetic north pole. But, of the three, the magnetic readings are the most important for distance flying. This is a feature which does not change.

The small magnets on their heads were strong enough to keep them from sensing earth's magnetic pole. But how are they able to sense earth's magnetism? This is not known, but it has been discovered that birds are born with a tiny piece of magnetic rock in their heads! This is a little magnet in their brains. Where did that particle of rock come from? How did it get inside their heads?

Everything in nature about us is filled with mysteries, which can only be explained by the presence of a Creator who made everything.

MORE WONDERS OF DESIGN #3

LATERAL LINE OF FISH-As fish speed through the water, not only must they see ahead, they must also be able to watch what is coming toward them from the side. It is the lateral line which is their sideways "eyes." In fact, it is equivalent to a whole row of eyes! And it operates something .like radar. But, instead of sending something out to bounce back, the lateral line constantly senses pressure waves. This line was mentioned in chapter 24, but here is more information on this natural wonder:

Many fish have a horizontal row of cells midway on their sides. This line of cells is frequently a slightly different color, so you can often see it on fish that you view in an aquarium. These special cells sense pressure differences in the water. The lateral line senses the presence of a fish coming from the side, and sends messages to the fish's brain. A map is "seen" in its tiny brain. Scientists, testing the power of this line, have discovered that a fish can even tell whether the oncoming creature is a friend, enemy, or a prey to be caught.

PATTERN FOR A PALACE-Earlier in life, Sir Joseph Paxton was the head gardener to the duke of Devonshire at Chatsworth. Paxton was the first person in Europe to successfully transplant and grow the giant South American water lily, Victoria amazonica. The leaves of this plant are up to 7 feet across, and Paxton was astounded by the fact that a child could walk on them. How could this be?

Carefully studying the plant, Paxton found that it was the arrangement of the ribs beneath the leaf's surface which gave it such immense structural strength. Years later, in preparation for the Great Exhibition of 1851, Paxton stepped forward and declared he could design a durable glass house of mammoth size; and he did it. Applying the principles revealed in the supports of that water lily leaf, he built the Crystal Palace-a vast structure of glass and iron-in Hyde Park, London to house the complete exhibition. The ribs and struts of the roof of that immense building were copied from the water lily. (Moved after the exhibition to south London, the structure withstood the elements for nearly a century, but was destroyed by fire in 1936.)

BIG SEEDS AND LITTLE-All the genetic information needed to produce an entire plant or tree is to be found inside its seeds. It is a miniaturized marvel. Of the regular plants, the orchid has the smallest seeds in the world. They are about 0.01 inch long and so light that a million of them weigh only 0.01 ounce. Each orchid seed capsule holds up to a 20,000 seeds. .

The giant double coconut of the Seychelles is the largest seed, and weighs up to 45 pounds.

EUROPEAN EEL RETURNS HOME- The Sargasso Sea is an immense patch of water in the tropical Atlantic, which is filled with a variety of seaweed and small creatures. It lies between Bermuda and the West Indies.

Among those who journey here are small eels. Upon arrival, they seem to know exactly what to do. Going to a depth of about 1 ,300 to 2,500 feet, they lay their eggs and then leave. The parent eels do not see their young and never give them any training. Soon after, the parents die.

In this deep, 20°C cold, the eggs hatch into slender, transparent eels that look different than their parents. Even their fins are located in different places. Because of where the eggs were laid, the young are gradually carried eastward at a depth of 700 feet into the Gulf Stream. Northward it takes them, and on and on they are carried.

Scientists have dropped labeled logs into the ocean where the eggs are laid, and ten months later they arrive off the coast of Europe. The little eels make the same trip but, for some unexplained reason, do it in a year-and-a-half. But these little creatures are not logs! When the wood reaches Europe, it just keeps sailing on past down the coast. But when the eels reach that large continent, they know to go up just certain rivers, into certain tributaries, and thence into certain lakes the very ones their parents used to live in. Arriving in those lakes, the young will know to depart through certain streams, and finally go back to the same brooks where their parents lived for several years!

But let us return the time they arrive off the coast of Europe. When they reach the edge of the continental shelf, which may be several hundred miles from land, their bodies begin changing. Until now, they have not needed complicated swimming gear, for they were carried along by the Gulf current. But now, at just the right time, their bodies change. But why are their bodies triggered to do it just then?

Their leaf-shaped body narrows, they shrink a little in length, and grow pectoral fins. Soon they look like their parents, but are a little smaller and still transparent. With this change completed, something inside tells them they must invade Europe. They also know that they have so much work ahead of them for awhile, they must stop eating.

Some go into Britain, others into the Baltic, still others up the rivers of France, and others go through the Straits of Gibraltar into the Mediterranean. Some go all the way to the Black Sea. Arriving at their appointed place by the coast, they know that they must now enter fresh water-and keep going. Swimming up the rivers, they remain within a yard of the bank, thus avoiding the rapid current out in the middle. Because they are transparent, they are unnoticed by most predators. Stubbornly persistent, they avoid waterfalls by wriggling through the sodden vegetation on the banks. When they enter lakes, their sensitivity tells them which feeder river to journey up.

After they have been in fresh water several months, they begin eating again. Now they grow to their full adult size and opaque appearance, with yellow backs and sides. They remain in these streams for several years, moving to lower, warmer streams in the winters and higher again in the summers.

Scientists have caught eels in a Scandinavian estuary, tagged and released them in another over a hundred miles away. Within weeks they had returned to their original feeding grounds. Others have been caught and taken several hundred yards away arid placed on the ground. They always know which direction to wriggle-in order to again return to the stream. This they do even when a rise in the ground obstructs their view and they have to wriggle upward to get over it.

After the males have been in the rivers for three years, and the females for eight or nine, they again change-this time from yellow to black.

Very soon they will need to be as dark as possible in order to remain hidden. Their eyes enlarge-because, to do what is ahead of them, they will need much sharper vision.

And now, something tells them that the time has come.

Down they go-from stream to lake, and from lake to river; downward, onward-until they reach the sea. When placed in a pond at this time, they will wriggle out of it and cross dew-drenched fields in order to reach rivers that will take them to the ocean. They know they must return to the sea. But there the track was lost; what happened to them then? Recently, scientists embedded tiny radio transmitters beneath their skin. We now know that, arriving at the ocean, they swim away from the European coast in a north-westerly direction at a depth of about 200 feet until they reach the continental shelf. The seafloor then drops to 3,000 feet, and they quickly dive to about 1 ,400 feet. Then they swim away to the southwest.

A map of the Atlantic Ocean reveals that such a course will take them back to the Sargasso Sea where they were born so many years before. Six months later, their tiny radios shows them reappearing in the Sargasso Sea-3,500 miles from their little river streams.

But how did they know where to go? Even if they did know, how could they find their way to that location through oceans-which to them are uncharted. "Uncharted," I say, for people may have charts; but the wildlife does not. How then can they know where to go and how to get there? , Regarding the second question, researchers tried a number of experiments-and found that the eels may be guided by the stars in their initial ocean travels, as they swim near the surface till they reach the continental shelf. But what is their means of guidance after that? Try diving down to 1,400 feet into the ocean, and then figure out where to go. It is pitch black in those depths, and you could not see a compass even if you had one in your hand. Do they detect very low frequency vibrations from the waves overhead? Yet passing storm fronts bring continual confusion to wave motion on the surface.

So, arriving in the Sargasso Sea, they have now laid their eggs. Their young, when hatched, will never be taught by them the journey they must make, for no adult eel has ever traveled from the Sargasso Sea to Europe, or, arriving there, initially swam up its rivers. It is a trip that only their babies will make.

After so many years absence, the parents have returned to their birthplace. They have spawned and now they swim away and die. They have come to the end of their journey.

THE FIRST BALLOONS-Scientists tried to figure out how a pine tree in Scotland could be pollinated by another in Norway, on the other side of the North Sea. But experiments revealed that this was being done.

Analyzing pine pollen, they discovered that pine pollen can travel these immense distances on the wind because of a very unusual structural feature: Each pollen grain is buoyed up by two microscopic-sized balloons. Who decided to put those balloons on the pine seeds? Did the pines get together and vote that they would all change their pollen? If the pines did not do it, then who did? DNA studies reveal it could not have been a random change; it had to be planned by Someone, who then structured the DNA to make pollen that way.

TAILOR AND WEAVERBIRDS- The Indian tailor bird uses spider silk to sew the nest together! How could it possibly learn how to do that? After making a cup of living leaves, still on their stems, the bird holds some spider silk in its bill, pierces the leaf, and draws the silk through it. It finishes by tying a knot at the end of the silk. Can you tie a knot in a thread from a spider web? You can't do it? Then how can a little bird do it? Repeating the operation many times, the nest gradually takes shape as the two leaves are sewn together. Both the weaverbirds of Africa and the icterids of Latin America go a step further-and actually weave their nests. They make a fabric of grasses as they interlace the weft spears in and out of the parallel warp blades. The result is grass cloth! The fibers used are long creepers, thin rootlets, grasses, reeds, or strips torn from broad leaves, such as the banana.

In order to weave their nests, these birds need to know two complicated skills: weaving and knotting. Without a knot, the initial woven part will immediately come undone. If you were a bird, how would you tie a knot in a stem? Here is how the bird does it: First it flies with a long piece to a tree branch where it wants to make its nest. Then it holds part of it down on the branch with one foot. Next, with its beak it passes the end around the branch, threading it through the other, and pulls it tight. A series of half hitches are then tied at the end of this knotted end. By now, are you becoming confused? The bird isn't.

The bird then begins threading one strip beneath another that runs across it diagonally or at right angles. This is not easy work, but the bird persists. It never gives up. After each threading, the strip is pulled tight. If the strip is long enough, the bird will reverse direction of weaving and loop the strip back and interweave it parallel with itself. This looping-back procedure adds to the strength of the nest.

The result is woven nests which dangle from the tips of branches. These nests are not only single rental units, but also apartment complexes! Many of them have separate rooms in them-all carefully woven together.

"It's really nothing at all; just a product of random evolution," someone will say. Well, then, try making an apartment house out of woven grass! If you cannot do it, how do you think that tiny bird ever figure out the process, especially considering two facts:

(1) No one on earth ever taught it how to do such a process. Scientists took weaverbirds and raised them from incubator hatchings. Then they turned them loose in aviaries with trees and grasses. The birds knew how to make their woven nests.

(2) The brain of that bird is as small as the tip of your little finger, and could not grasp the instruction anyway. If you take exception to that conclusion, go out and catch a bird and teach it how to make knots and make interwoven nests. Many of these nests have waterproof roofs. How would you waterproof the roof of a woven grass circular bird nest? The bird does it by using wide strips of leaves on the top, and then carefully overlaying them so the water will run off.

When all that is done, there must be a way to keep out snakes. How would you accomplish that? Some species add entrance passages, which are long, woven, curved tubes. Seeing them, snakes give up and depart without trying to steal the eggs.

If, after constructing a nest, a weaverbird decides that it is not well-made, what does the little bird do? By that time our little craftsman must laboriously unravel it all and start over because there is not enough raw material around since other weaverbirds have taken their share. Carefully taking its nest apart, the little fellow puts it all back together again!

MOVING SLlME- The slime mold is an unusual life-form. Separate mold cells live on rotting wood. When the time comes for reproduction to occur, the cells push together and form a single organism. Where there were millions of separate creatures, now suddenly there is one. Scientists are trying to decide the trigger mechanism that tells the cells when to push together. Thousands of neighboring mold cells form a single unit about 2 inches across.

This strange new creature-which was not there before-looks something like a jellied slug. But, to add to the mystery, it can now move even though the separate cells could not. In the few hours that it exists, it moves about 12 inches toward the light.

Arriving at a new location, which will be more favorable for the growth of the stalk, it sprouts up, forms spores, and the wind carries them away. When they land, they form separate stationary cells.

As soon as the spores depart, the parent organism dies.

AFRICAN HONEY GUIDE- This bird is the size of a robin and lives in east Africa. Although it eats all kinds of insects, it is especially fond of honeybee grubs. But getting them is not so easy. The wild bees of Africa are dangerous, and live in secluded areas. Although the honey guide has a way of finding them, it does not dare enter the hive

unaided. Even if it could drive off the bees, its slender, delicate bill could not penetrate their nests, which are in hollow trees or clefts of rocks. So it gets a friend to help with the task.

In northern Kenya, for example, men from the Boran tribe make money selling honey. A tribesman goes out into the countryside and claps his hands, whistles in a certain way, or blows across a snail shell or through a seed with a hole in it. If a honey guide is not far off, it will generally appear very quickly and sing a special chattering call which it never otherwise uses. When sure that the man's attention has been caught, it flies off with a low swooping flight which is easy to follow. As it flies, its tail feathers are spread wide, so that the white outer feathers are clearly displayed. The man follows, whistling and shouting to let the bird know he is coming.

Then the bird disappears for a few minutes, and then returns, perches, and calls for the man to come. As the two travel together, the bird gradually lands on lower and lower branches until, after about 15 minutes, its song changes to a low, less agitated one. It repeats it two or three times, becomes quiet, and flies over to a perch where it sits quietly. As the man approaches, he can see that the bird is sitting very close to the entrance of a bees' nest.

A stream of bees is moving in and out of the nest, and the man carefully draws closer and sets a small fire just upwind from the nest. This stupifies the bees and he opens the nest and extracts the combs, dripping with rich deep-brown honey. He hangs up part of the honeycomb for the bird. The bird flies to the remains of the nest and eats the fat, white beegrubs, and also some of the honeycomb wax. The honey guide is one of the only animals which can digest beeswax.

Scientists have spent months observing the honey guide in action. Disguised in animal skins, so it will not see them, they have found that this little bird knows the location of every beehive in its territory-and frequently checks to see their condition. On cold days, it hops up to them and peers in. On hot days, it notes the general amount of activity, as the bees go in and out. When the bird begins to guide the man, and then disappears for 15 minutes, it has flown off to be sure it is leading the man to a good, active hive. Then, after leading the man to the nest, if he does not immediately set to work to open it, the honey guide gives its special call and sets out to lead the man to another nest.

Who taught the honey guide to lead people to bees nests? Who taught it the procedure to follow? Who gave it that low, swooping flight and the white signal feathers in the tail? Who told the bird to be quiet when it comes close to the nest-so the bees will not sting it to death? Who gave the bird the ability to digest beeswax?

The honey guide also leads animals to bees nests. The ratel is a badger-sized animal that is actually an African skunk. Also called the honey badger, it has black underparts and white on top, and likes honey. The honey guide behaves in the same manner with the ratel that it does with a human. Arriving at the nest, the ratel sprays the area beneath the nest with a fluid which stupifies the bees, and then the rateI sets to work. It is both a powerful digger with strong forelegs, and narrow enough that it can squeeze into small openings. Soon it has the nest torn open, and it takes its share and leaves some for the waiting bird.

FALLING LEAVES-Why do broad-leaf trees in colder areas shed their leaves in the fall? They do it in order to survive the winter. Much of the water in the ground will, at times, become frozen, so the tree would not be able to draw it up the trunk. Since the leaves need-and lose-more water than other parts of a tree, their absence in winter allows the tree to conserve moisture. Trees covering an area of 100 square feet need more than 20 tons of water a day to thrive. The same number of non leaved trees need only a fraction of that amount.

But coniferous evergreen trees, such as the pine and fir, can survive the winter without shedding their greenery because their narrow needles are so very small and lose very little water through evaporation. Those needles often have a glassy layer that helps reduce loss through evaporation.

The broad-leaf trees shed their leaves in the fall and the leaves cover the ground, protecting it from winter's ravages. The ground does not freeze as hard beneath those leaves. The conifer sheds its needles also; but, since they rot more slowly, they also protect the ground.

FLASHING TREES OF MALAYSIA-In Malaysia and Borneo at dusk, the fireflies come out for several hours. You can journey out in the evening into the mangrove swamps, and you will see a remarkable sight. Scattered flashes begin to blink among the trees. Arcs of light appear as fireflies move across one's line of vision. Minute by minute, their numbers increase. Gradually the lights gather on the limbs and branches of a certain tree, and soon the entire tree sparkles and flickers. Then, as you watch, the confusion of flashes begins to resolve itself into a steady onoff pattern of light-as thousands of fireflies coordinate their light show and blink on and off together.

Not all the mangrove trees are used by the fireflies for this purpose. Some have tree ants which eat insects which land on them. The fireflies know to avoid such dangers, and only go to safe locations to perform their displays.

Researchers have decided that the pulse rate of flashes is so rapid that the fireflies could not possibly coordinate it visually. Instead, they must have some kind of internal metronome which beats so accurately that, once they are locked in together, they can continue on in perfect unison.

To add to the problem, their pulse rate of flashing varies slightly with the temperature (the colder the evening, the slower the rhythm), yet each firefly, in his little body computer, duplicates this factor also. By coordinating their flashing, the light from these creatures can be seen a quarter mile away.

A WORLD OF INSECTS- Biologists tell us that, without insects, we could not survive on this planet. The great majority of insects help, rather than harm, both us and our food supply. And there surely are a lot of insects out there!

An acre of average pastureland contains an estimated 360 million insects. There are about 1 million different types of insects. At least three-quarters of the known animal species in the world today are insects. There are more than a million insects for every man, woman, and child. The world's insect population weighs about 12 times as much as the total human population.

We are told that if the spiders were to disappear, the people would be gone within five years. One reason is that spiders are outstanding insect hunters.

TIMING THE FIRE-The fungus Mycaena luxcoeli, which grows on the Japanese island of Hachijo, can be seen in the dark from 50 feet away, gleaming like little lanterns.

There is a bay near Parguera, Puerto Rico called Phosphorescent Bay, which has the glow of millions of tiny marine plants called Pyrodinium. Another puzzle is this: Why do all these glowing plants-as well as the glowing insects and fish too-only glow or sparkle at night? Obviously, the glow is only useful in the dark, but how can the Pyrodinium, which is a type of plankton can be smart enough to only glow at night? (Plankton consists of the smallest plants and animals in the ocean; it is that which makes ocean water greenish.)

A Designer is doing the thinking, and the glowing plants, insects, and fish only do what they are instructed to do.

FISH: BIG AND LITTLE-The Great Designer was not limited when He planned for fish. The largest is the whale shark at more than 60 feet in length. The whale shark is a placid creature, feeding on plankton.

The smallest fish in the world is the dwarf pygmy goby, a freshwater fish found in the Philippines. It can be less than 0.3 inch long when fully grown, is about 5 billion times smaller than the whale shark. Yet it has all the vital organs that the whale shark has. (Whales are larger still, but since they are mammals, they are not classified as fish.)

PROTECTING THE NEST-The Mexican fly, Ufulodes, lays a batch of eggs in clumps on the underside of a twig, then moves farther down the twig and lays another clump. But this second batch has no eggs in it. It is a brown fluid with smaller, club-shaped kernels. This fluid neither hardens nor evaporates, but remains liquid for the three or four weeks till the eggs farther up the twig hatch. Along comes an ant, searching for food, and runs into the brown liquid. Touching it, the ant jumps back, cleans itself frantically and leaves.

The blacksmith plover lays its eggs in the hot savannahs of east Africa, where there is little vegetation to shade them. In the heat of the day, the plover does not set on the eggs, but instead stands with outstretched wings to shade them from the sun.

In Australia, a jabiru stork gathers food in the morning and late afternoon. During the hot midday hours it occupies itself flying to a pond, filling its beak with water and then spraying the water on its eggs to cool them off.

NATURE'S WATER TANK- In chapter 19, we discuss frogs which apparently have been in rocks for a very long time. Frogs can survive a long time in suspended animation, if they have water and are in a watertight place.

In central Australia, there is a little frog which lives in non-watertight locations for 5 or 6 years without water. The water-holding frog (Cyclorana platycephalus) comes out of its underground den when it rains. Immediately it eats and then drinks water. Rather quickly it absorbs a lot of water as much as 50 percent of its own weight. During this time it feeds and mates. The eggs, laid in pools, hatch quickly, and the tadpoles grow rapidly. Within a few weeks-faster than most species of frog-they too are frogs. Then all the frogs burrow into dens in the sand beneath this desert country .

No more rain will fall for years. The frogs then wait, without moving. Five or six years later the rain may return, and out they come again.

RICH NOURISHMENT-The milk given to a baby elephant seal pup is one of the richest, most nourishing milks to be found anywhere. It is 12 times as rich in fat and 4 times as rich in protein as the best Jersey cow's milk.

Why is the milk so rich? The answer is that the pup will only receive milk for three weeks. Once again, we see evidence of careful advance planning.

As soon as the pup is born, it begins guzzling milk. At birth it weighed about 40 kilos. Within a week, it puts on another 9 kilos. After 3 weeks, it has tripled or quadrupled its weight. Much of the increase in weight was added blubber. But now, suddenly its food supply is cut off.

The mother has not eaten for those three weeks, and must return to the sea for food. Unlike the whale, she is not able to nurse her baby in the ocean where her own food is to be found, and so the pup henceforth will be on its own.

After the departure of its mother, the little seal will stay on the beach for another 6-8 weeks, eating nothing, developing organs,-all the while living off the blubber made by that three-week milk supply.

If it is a male, when the little seal grows up, it will be the biggest of all seals: 14 feet long and weighing 2.5 tons!

LOOKING YOUNG- The axolotl salamander of Mexico can for years look like an adolescent; that is, if it stays in water. It keeps its feathery external gills and a larval, tadpole-like shape. But it can also breed, as though it were an adult.

But if the year comes that the water in the pond dries out, then the axolotl will very quickly grow up. It will change into a salamander and its gills will disappear. In their place it will have lungs.

OUTWITTING THE MILKWEED-Most everyone leaves the milkweed alone. This is because, when damaged, it immediately exudes a milky sap which has a bitter taste and clogs the stomach. Even cows, deer, and horses avoid it. But certain creatures, which could not possibly figure out such devices by themselves, know how to outwit the milkweed.

Certain beetles, landing on a leaf, immediately bite through the midrib. The latex, flowing from the wound, drips to the ground. Beyond it, the beetle eats the tender leaf.

Some caterpillar species not only sever the midrib veins, but also gouge out a circular trench on the underside of the leaf, with only a few bridges holding it together. Then they feed inside this area.

The caterpillars of the monarch butterfly feed on the milkweed without taking any of these precautions. They have a genetic immunity to the poison of the milkweed. More than this, as they eat it, some of the poison is stored in their tissues. This poison remains, even after they change into butterflies. If a bird tries to eat them, the taste is so bad that it never again bothers a monarch.

BIG-MOUTHED PIGEON-The green imperial pigeon can unhitch its lower beak and expand its mouth not only vertically but horizontally. Having done this, it can then swallow a nutmeg that is slightly larger than its own head! The seeds remain in its gizzard for a long time while the rind is dissolved off and the insides digested.

RUNNY-NOSED BIRDS- That is what seabirds are always like: runny-nosed. This is because they have special salt-processing glands in their heads. The glands discharge a highly concentrated salt solution into the nostrils, from where it drips back into the sea. With such a built-in desalination plant, seabirds never need to drink fresh water. They extract all they need from seawater.

Without such a system, no bird could live in the oceans and seas. Large doses of salt are poisonous, leading to dehydration, overloaded kidneys, and a painful death.

But wait! If birds have such a simple, highly successful system for eliminating salt from drinking water,-why do we not copy it? The problem of extracting salt from seawater is one of the leading challenges of mankind. Fresh water is urgently needed all over the world. Transporting it is less of a problem than extracting the sea salts from it. The problem is the high cost of the desalination plant. Yet, not only is the system used by birds a proven success, but it is also extremely miniaturized, and costs the bird nothing. It requires no fuel oil, high-voltage electricity, coal, or propane.

If a bird can do it, surely we can make equipment that do it also. Any competent evolutionist will tell you that the bird did it totally by accident. Then, by careful thought, we ought to be able to do it just as efficiently and inexpensively.

CHOPSTICK FINGERS-The aye-aye is a rare lemur that lives on the island of Madagascar. The middle fingers on its front paws are so thin and elongated that they resemble chopsticks. The aye-aye uses them to eat with-by dipping them one at a time into the pulp of fruit, and then lifting the finger to its mouth and sucking off the juice. It drinks water the same way. Its other food is wood-boring insects. The aye-aye chews through the wood till it reaches the insect, which it then pulls out with one of those long fingers.

RADAR JAMMING AND STEALTH PLANES As the little bat flies through the darkness, its sonar squeaks giving its brain a picture of what is ahead as it searches for flying insects.

But the moth (apparently, all moths) can hear its high-pitched squeak from 100 feet away. This is an advantage, since the bat can only receive echoes from 20 feet. Intercepting the bat signals, which tell it that the bat is drawing near, the moth knows that it must suddenly go into a free fall. Why does it know that a bat squeak means imminent death? Once a moth is swallowed by a bat, it cannot warn its offspring. Until it is swallowed, it cannot know the danger is there.

But now the little moth is falling for its life, and its only hope of safety is to suddenly drop to the ground. But the bat may catch the falling moth in its sonar. Going after the moth, the bat comes closer. But the moth resorts to aerobatics, and flits this way and that. It only has a few feet to go before reaching the protective ground.

Some tiger moth species have a sonar jamming device. This is an ultrasonic sound that throws the bats off course. Using some of the techniques employed by the millions-of-dollars stealth plane, the tiger moth makes it to safety—as the bat heads off toward where he thought the return echo was coming from.

Can the U.S. military use a cheaper stealth bomber? (It is presently the most expensive plane in the world!) Go to the tiger moth and ask him . how he does it. He never paid a dollar for his equipment. He didn't think it up either; it was given to him.

IMPRINTING-Imprinting was first named and described by the Austrian naturalist, Konrad Lorenz. Certain animals will go to the first fair-sized, moving creature they see after being born. It is usually their mother, but it could be another animal or even a human being.

Because of this trait, ducklings automatically follow their mother to the pond and swim after her. They followed the first large moving thing they saw after being hatched. Among mallard young, imprinting occurs precisely between 13 and 16 hours after coming out of their shells. People who have raised waterfowl have discovered that, if the ducklings first see their green rubber boots, they will thereafter follow those boots until they grow into adult ducks.

The imprinting cue can be a sound instead of a sight. In chapter 28, we mention the fact that the mother wood duck speaks to her young while they are still in their shells. Then when they hatch, she jumps out of the hollow tree, high above the ground, where the nest is located-and calls to them from the ground. In response, the tiny things jump out of the hole, fall to the ground and follow her into the pond. This is also the result of imprinting. Earlier, back in the hole, it was too dark for them to know what she looked like, but they knew her voice.

Greylag geese, rails, coots, and domestic chickens respond with visual imprinting cues.

In Africa, the female ostrich lays the eggs and the male sets on them. When they hatch, the young imprint to the father. As he travels across the fields, they all follow him. When other orphaned young see him, they hurry over and follow him also. Observers have seen male ostriches with as many as 60 young; by their age differences, they show that they are from at least 3 or 4 different broods.

Then there are baby shrews. They are born in litters of 6 or so. After imprinting to their mother, they remain close by her side. When danger threatens, she sounds an alarm and begins running. Instantly, one seizes the fur at the base of its mother's tail, gripping it firmly in its jaws. Just as quickly, another baby does the same, and within a few seconds, the wild train of shrews is running away at full speed-all connected. It looks like a furry snake gliding fast through the grass and brush. As they go, they keep in perfect step. Even if you were to pick up the mother (which you will be wise not to do without very thick gloves), the babies would continue to hang on. Arriving at a place of safety, the mother signals again and the train uncouples and they return to foraging for food.

In South Africa's giant Kruger National Park, there is an elephant that thinks it is a buffalo. In the early 1970s five baby elephants, raised by a veterinarian, were released in the park close to a herd of buffalo.,

Game rangers later reported that one of those young elephants had imprinted upon the buffalo.

It had Joined the herd and was adopting buffalo habits. Traveling in a herd of 20 buffalo, the elephant has been seen drinking with them at a waterhole. A herd of elephants draws near and the elephant runs off with the buffalo. It has also been seen trumpeting and bellowing in an effort to drive lions away from a waterhole where its family of buffalo are watering.

MORE ON THE HUMMER-Elsewhere we have a lengthy section on the marvels of the hummingbird. In it, we tell about the twice-a-year migration of the ruby-throated hummingbird, each of which is a nonstop 500-mile flight between North America across the Gulf of Mexico to South America.

But it has recently been discovered that the ruby-throated hummingbird is not able to make that trip. It is just not possible, scientists have concluded. We know they must be right, for they used the latest equipment, metabolic studies, and computer analysis. The ruby-throated hummingbird is only 0.1 ounce in weight, and the conclusion of the experts is that it cannot possibly store the amount of nourishment required for the trip. Metabolic tests reveal the bird is simply too small to carry enough fuel.

Of course, the little bird does not concern itself with the announcement that the scientific world has declared it cannot cross the Gulf of Mexico. It just keeps doing it anyway-twice each year. Fortunately, the scientists have not yet applied their metabolic tests to migrating butterflies. It is probably best that they not do it. The news might frighten the poor creatures into no longer migrating. Using their own wing power, many species of butterflies can travel up to 600 miles without a refueling stop. Some have even been known to fly 'right across the Atlantic Ocean from North America to Europe, backed by the driving force of prevailing westerly winds.

THE NOSE HAS IT -The dog has an amazing sense of smell. This makes up for their poor eyesight. A dachshund, for example, has about 125 million smell-detecting cells in its nose. A human being has only 5 million. A German shepherd dog has 230 million, making its sense of smell more than a million times more sensitive than a human's. A bloodhound has a sense of smell which is equal to that of the German shepherd. There must be genetic factors in the odors we produce. George Romanes, in 1885, showed that skilled tracker dogs could differentiate between anything, except identical twins. To the dog, the twins smelled exactly the same.

By the way, dogs also have good hearing. They can hear high-pitched sound frequencies of up to 40,000 vibrations a second. A human being can not go beyond 20,000 vibrations per second.

EARS ON ITS FEET -In chapter 16, we discuss the amazing ichneumon fly, which walks on the bark of trees-and somehow knows just where to

begin drilling for wood wasp larvae inside the tree. We noted with amazement the mystery of how this tiny creature is able to know where to begin drilling, and then is able to actually do it-using what appears to be a delicate, long antennae to do it. But now we know how it locates the larvae; the ichneumon can hear and smell through its feet. Yet that solution only leaves us with more mysteries. How can this creature hear or smell a creature so far below it in solid wood? For you to do it would be equivalent to walking on the ground and hearing/smelling a gopher digging nine feet below you!

MELON OF THE PORPOISE-The porpoise also has a sonar system. He is discussed in chapter 32. Here is more information on that system:

A porpoise needs to be able to make special sounds, but how can he make them underwater? We cannot talk underwater, so how could a porpoise do it? He doesn't; instead, he produces soar clicks by forcing air through special passages and sinuses in his head. These are focused into a beam of sound which flows out in front of him. The oval, fat-packed organ-called the melon-which forms a bulge on his forehead, does the focusing. Without the carefully-shaped melon, the porpoise could not use sonar.

As many as 700 clicks a second are made by the melon, which is a sound lens producing a sonic "searchlight," with which the porpoise scans the oncoming water path. Using these sounds, the porpoise is able to tell the distance to an object, its shape, texture, and movement. Scientists have found that a porpoise can tell the difference between a tin can full of water and one that is empty, and also between rock in the distance and flesh.

CIRCULAR FLIGHT OF THE PUFFIN-They may fly in circles, but they are not confused. Puffins spend most of their time fishing in the open seas of the north Atlantic, but each spring they nest. Within a space of two or three days, a million and a half puffins arrive at the island of St. Kilda in the Scottish Hebrides. No one can explain how these little birds-vast numbers of them scattered all over the ocean-know to arrive together at the same time to this small island. How can the bird even find its way across trackless oceans to this one tiny spot in the seas?

But, at the same time, the greater black-backed gulls arrive also. They also come to nest, and eat puffins.

The little puffin-which is a very colorful bird nests in holes on the steep grassy cliffs of the island. They are safe until they flyaway from the entrances to their holes.

But they must fly in order to feed while setting, and later when the chicks hatch. At this time of year, there is an abundance of fish in the ocean about them, but getting safely to it and back is the problem. Once they arrive out in the open sea, they not easy to catch, for they are swift in the air, turn quickly, and have strong wings. Even if a gull outmaneuvers them, they can escape by diving below the surface of the water where the gulls cannot follow.

But during the trip to the ocean they are vulnerable, and on the way back, laden with fish for their young, they are also easier to catch. So the black-backed gulls wait for them in the air above the cliffs. Their goal is to catch a solitary puffin. If you were a small-brained puffin, how would you solve the problem? Frankly, you are a very intelligent human being-and you probably have no answer either.

Could some highly-trained design engineers come up with a plan as good as this one:

Scientists have discovered that, when animals are in herds and fish in schools, it is difficult for predators to catch them. The large numbers of moving objects tend to confuse the eye, and render it difficult to focus on one and catch it. The puffins apply this principle in a mind-boggling solution which no puffin-alone or in committee with others-would ever be able to devise.

It is time for the little puffin to leave its nest, fly into the air and go out to sea to catch fish. Up into the air it goes-and overhead quickly flies into a gigantic living wheel!

Above this immense cliff, where all the puffins in the Atlantic breed each spring, is a huge aerial ring, half a mile across, filled with tens of thousands of puffins. All day long they fly in this circle above the cliff. Upon departing from its hole, a puffin immediately flies up into this circle and begins flying the giant wheel. At a random point out over the ocean, with a quick sideways dive, it leaves the wheel and quickly drops to the ocean's surface. Now it begins feeding, and here it is safe from the gulls. For its return flight, it cruises along the ocean's surface until it nears the cliff, then quickly flies up again into the wheel, and flies the great circle route back to a point above its nest, and then rapidly drops to the entrance hole of its nest.

What astounding planning! Scientists have observed that gulls rarely catch puffins circling in the wheel, and mainly catch those who are too slow in getting into it. The number and density of those flying in the wheel make it too difficult to catch one. Of course, the whole arrangement requires that the puffins all arrive and leave that island at about the same time. The entire pattern all works together, and took careful advance planning. That planning was done before gulls started catching puffins, otherwise there would be no puffins today. If this sounds like a farfetched story, go to the St. Kilda Island and watch the puffins flying in the wheel-and see for yourself how well this remarkable arrangement works.

SOMETHING TO THINK ABOUT

Within these three volumes, we have provided you with thousands of details pointing to the existence and workmanship of the Creator. Evolutionary theory falls dead before such a wealth of information. But there are also facts about the living of our lives which also point to the existence of God, His guidance, and intervention in the affairs of men.

Scientists tell us they cannot measure data indicating relationships with the Creator. Yet there is a lot of it available, and it clearly points in one direction. For example, which group of people are the most interested in preserving the life of the unborn? It is the Christians. Other groups, in general, are far less concerned about whether abortions are carried out. Which group generally has happier lives? It is the Christians, and it matters not whether theirs is a life of poverty or wealth. Which group has the greatest peace of heart? It is the Christians. Which group commits the fewest felonies and major crimes? It is the Christians.

Everyone knows that adultery, crime, or murder by a Christian pastor is far more likely to be given space in the media than if committed by an atheist. Why? It is the rarity of the event which makes it so newsworthy. As usual, it is not the dog biting the man which is published, but the man biting the dog. A genuine Christian does not do improper acts as often as the average person.

So the facts can, indeed, be quantified. They are there. It is the believers in and worshipers of the Creator God which consistently have contented, happier, more caring lives. Problems enter the lives of all, but it is the Creationists who are the most peaceful, the most obedient to right principles, and the most stalwart in their defense.

For a few minutes, let us gather together some data on how men face oncoming death. With an open mind, consider the facts for yourself. Except for unusual divine intervention, we will all die. That includes you; within a few years you will be dead. The way a man faces death is but a reflection of his entire way of life and all his past experiences. A man living for himself is terrorized by the approach of death, but a man who has personally experienced the presence of God realizes that death is not an enemy to be feared.

We are not here discussing something imaginary. The facts consistently bear out the fact that it is the leading atheists, the most blatant haters of God-who are the most terrorized as death approaches. In contrast, as we will see below, those who have loved and served the God of heaven have an amazingly peaceful certainty that the future will be far better than their present life.

Experience after experience can be collected and quantified. The results of such research, revealed throughout these three books, indeed confirm these facts of nature that we have found: There is a God; He created the earth, sea, and sky. He also made us. We can only be happy as we love Him and obey His laws. In doing so, we become ennobled with better principles, live far happier lives, and are ready when death nears.

Yet, although we rarely mention it to others, this is exactly what we want to know: how to face *death.*

A group of American soldiers were gathered for the last time for entertainment in England. The next morning they were to ship out. One man stood to thank their British hosts, and then, as an afterthought, said to them: "Tomorrow morning we will cross the channel to France. There we will go to the trenches, and very possibly, of course, to death. - Can any of our friends here tell us how to die?" There was silence in the room.

When it comes, death frequently comes suddenly and unexpectedly. It is today that we must prepare for what will come as a certainty for tomorrow. The preparation can indeed be made.

The following pages may be among the most important you will ever read.

On a dark afternoon in September 1583, in a stormy sea near the Azores, the *Golden Hind,* commanded by Sir Walter Raleigh, sailed close to the *Squirrel,* a smaller vessel commanded by Sir Humphrey Gilbert. The captain of the *Golden Hind* cried out to Gilbert, who was sitting in the stern of his vessel with a book open in his hand, and urged him, for his safety; to come aboard the larger vessel. This Gilbert refused to do, saying he would not leave his companions in the *Squirrel.* Then Raleigh heard him call out over the waves, "Heaven is as near by sea as by land."

Conditions rapidly worsened; and, at midnight that night, those on the *Golden Hind* saw the lights on the smaller vessel suddenly go out. And, in that moment, Gilbert and his ship were swallowed up by the dark, raging sea.

Death can come suddenly for every one of us. But how many are ready when death draws near?

On her deathbed, *Queen Victoria* told those around her that she loved God and was His little child, so she was ready to die. Then she called for the hymn to be sung:

"Rock of Ages, cleft for me. "Let me hide myself in Thee."

For decades she had ruled the British Empire, but when death approached, all she had was God.

And that is the consistent pattern with those who have made peace with their Creator and love and serve Him. Here is how Christians die, as revealed in their dying words:

***Brownlow North* (1875),** a profligate nobleman who became a preacher: " 'The blood of Jesus Christ His Son cleanseth us from all sin.' That is the verse on which I am now dying. One wants no more."

***John Nelson Darby* (1882):** "Beyond the grave comes heaven. Well, it will be strange to find myself in Heaven, but it won't be a strange Christ--One I've known these many years. I am glad He knows me. I have a deep peace, which you know."

Charles Wesley, author of over 4,000 published hymns: "I shall be satisfied with Thy likeness. Satisfied!"

***Charles Dickens* (1870)**, the famous author: "I commit my soul to the mercy of God, through our Lord and Saviour Jesus Christ."

John Quincy Adams: "This is the last of earth. I am content!"

Benjamin Parsons: "My head is resting very sweetly on three pillows: infinite power, infinite wisdom, and infinite love."

***Henry Moorhouse* (1880)**: "If it were God's will to raise me up [from this sickbed], I should like to preach from the text, John 3:16. Praise be to the Lord."

***Earl Cairns* (1885),** lord high chancellor of England: "God loves me and cares for me. He has pardoned all my sins for Christ's sake, and I look forward to the future with no dread."

Bishop Joseph Lightfoot, after having several Scriptures read to him, he was asked what he had in mind. In utter calmness of spirit, he replied: "I am feeding on a few great thoughts."

***Sidney Cooper* (1902),** member of the Royal Academy of Science in London: "I have full faith in Thy atonement, and I am confident of Thy help. Thy precious blood 1 fully rely on. Thou art the source of my comfort. I have no other. I want no other."

***Lord V.C. Roberts* (1914)**, who died in France while telling those gathered by him of the importance of their studying the Bible: "I ask you to put your trust in God. You will find in this Book guidance when you are in health, comfort when you are in sickness, and strength when you are in adversity."

***Catherine Booth,* wife of the founder of the Salvation Army: "**The waters are rising, but so am I. I am not going under, but over. Do not be concerned about dying; go on living well, the dying will be right."

***William Pitt* (1778),** Earl of Chatham, statesmen, orator, and prime minister: "I throw myself on the mercy of God through the merits of Christ."

Edward Perronet, pastor and author: "Glory to God in the heights of His divinity! Glory to God in the depths of His humanity! Glory to God in His all-sufficiency! Into His hands I commend my spirit."

***Augustus Toplady* (1778),** preacher and author of the hymn, *"Rock of* Ages": "The consolations of God to such an unworthy wretch are so abundant that He leaves me nothing to pray for but a continuance of them. I enjoy heaven already in my soul."

Sir Walter Raleigh, English admiral, before his beheading: "It matters little how the head lies if the heart be right. Why doest thou not strike?"

***Countess of Huntingdon* (1791):** "I have the hope which inspired the dying malefactor. And now my work is done; I have nothing to do but go to the grave and thence to my Father."

***Robert Burns,* the Scottish poet:** "I have but a moment to speak to you, my dear. Be a good man; be virtuous; be religious. Nothing else will give you any comfort when you come to be here."

***John Wesley* (1791):** "The best of all: God is with us!"

Lady Glenorchy: "If this is dying, it is the pleasantest thing imaginable."

***John Bacon* (1799),** eminent English sculptor, whose monument of Lord Chatham stands in Westminster Abbey: "What I was as an artist seemed to be of some importance while I lived; but what I really was as a believer in the Lord Jesus Christ is the only thing of importance to me now."

Francis Ridley Havergal, songwriter. After requesting a friend to read to her Isaiah 42, she uttered these nine words after verse 6-and died: ("I the Lord have called thee in righteousness, and will hold thine hand, and will keep thee."): called-held-kept! I can go home on that!"

***George Washington (1799*)**, an earnest Christian and the first president of the United States: "Doctor, I am dying, but I am not afraid to die."

John Huss, Bohemian reformer and martyr, asked at the last moment by the Duke of Bavaria to recant: "What I taught with my lips, I seal with my blood."

***Lady Powerscourt* (1800):** "One needs a great many Scriptures to live by, but the only Scripture that a person needs to die by is 1 John 1:7, and that verse never was sweeter to me than at this moment." ("But if we walk in the light, as He is in the light we have fellowship with one another, and the blood of Jesus Christ His Son cleanseth us from all sin.")

***Sir Walter Scott* (1832)**, the famous author was talking with his son-in-law: "What shall I read?" said Lockhart. "Can you ask?" The dying man replied, "there is only one Book."

John Pawson, minister: "I know I am dying, but my deathbed is a bed of roses. I have no thorns planted upon my dying pillow. In Christ, heaven is already begun!"

***William Wilberforce* (1833)**, member of Parliament who helped eliminate slavery in England: "My affections are so much in heaven that I can leave you all without a regret; yet I do not love you less, but God more."

Adoniram Judson: American missionary to Burma: "I go with the gladness of a boy bounding away from school. I feel so strong in Christ."

***Captain Hedley Vicars* (1855):** "The Lord has kept me in perfect peace and made me glad with the light of His countenance. In the Lord Jesus I find all I want of happiness and enjoyment."

***Sir Henry Havelock* (1857),** when felled by an attack of malignant cholera and told that he could not survive, calmly replied: "I have prepared for this for forty years," and then he added to those around him: "Prepare to meet thy God!"

***The Apostle Paul* (A.D. 66):** "I have fought a good fight, I have finished my course, I have kept the faith; henceforth there is laid up for me a crown of righteousness." (2 Timothy 4:7-8).

Longfellow., "For the Christian, the grave itself is but a covered bridge leading from light to light, through a brief darkness."

***Polycarp* (A.D. 155),** disciple of the Apostle John, at his own martyrdom: "Eighty and six years have I served Him, and He has done me nothing but good. How could I curse Him, My Lord and Saviour?"

David Brainard, pioneer missionary to the American Indians: "I do not go to heaven to be advanced, but to give honour to God. It is no matter where I shall be stationed in heaven, whether I have a high or low seat there, but to live and please and glorify God . . My heaven is to please God and glorify Him, and give all to Him and to be wholly devoted to His glory."

Susanna Wesley, mother of John and Charles Wesley: "Children, when I am gone, sing a song of praise to God."

George Whitefield, English evangelist: "Lord Jesus, I am weary in Thy work, but not of Thy work. If I have not yet finished my course, let me go and speak for Thee once more in the fields, seal the truth, and come home to die."

***Philip Melanchthon* (1560),** after several passages of Scripture were read to him by his son-in-law, he was asked if he would have anything else: "Nothing else but heaven!"

***Preston*:** "Blessed by God! Though I change my place, I shall not change my company."

***Samuel Rutherford* (1615)**: "Mine eyes shall see my Redeemer. He has pardoned, loved, and washed me, and given me joy unspeakable and full of glory. I feed on manna. Glory, glory, glory to my Creator and Redeemer forever!"

***Francis Bacon,* lord chancellor of England:** "The sweetest life in this world is piety, virtue, and honesty."

***John Bunyan* (1688),** author of Pilgrim's Progress: "Weep not for me, but for yourselves. The Father of our Lord Jesus Christ, who, through the mediation of His blessed Son, receives me, though a sinner. We shall meet to sing the new song, and remain everlastingly happy."

***Baxter,* the English martyr:** "I have pain; but I have peace, I have peace!"

***David Brainard* (1747)**, well-known missionary in the American Colonies: "I am going into eternity; and it is sweet to me to think of eternity; the endlessness of it makes it sweet. But oh! What shall I say of the future of the wicked! The thought is too dreadful!"

Ann Hasseltine Judson, missionary to Burma and wife of Adoniram Judson: "Oh, the happy day will soon come when we shall meet all our friends who are now scattered--meet to part no more in our heavenly Father's house."

Abbott: "Glory to God! After the grave heaven will open before me!"

John Knox. "Live in Christ, and the flesh need not fear death."

Everett. "Glory, glory, glory!" (This expression was repeated for 25 minutes and only ceased with life itself.)

John A. Lyth: "Can this be death? Why, it is better than living! Tell them I die happy in Jesus!"

Martin Luther: "Our God is the God from whom cometh salvation. God is the Lord by whom we escape death! Into Thy hands I commit my spirit; God of truth, Thou hast redeemed me!"

Margaret Prior: "Eternity rolls before me like a sea of glory!"

Goodwin: "Ah! is this dying? How have I dreaded as an enemy this smiling friend!"

***Martha McCrackin**:* "How bright the room! How full of angels!"

Mary Frances: "Oh, that I could tell you what joy I possess! The Lord doth shine with such power upon my soul!"

Sir David Brewster, scientist and inventor of the kaleidoscope: "I will see Jesus; I shall see Him as He is! I have had the light for many years. Oh how bright it is! I feel so safe and satisfied!"

***Michael Faraday* (1867)**, chemist, electrical engineer, and leading British scientist, as he neared death, replied to a scientist who asked him what he would do in heaven: " 'Eye hath not seen, nor ear heard, neither have entered into the heart of man, the things that God hath prepared for them that love Him.' I shall be with Christ, and that is enough." When a journalist interjected and questioned him as to his speculations about a life after death, he said, "Speculations! I know nothing about speculations. I'm resting on certainties. **`I know that my Redeemer liveth,' and because He lives, I shall live also."**

Daniel Webster (1852), the well-known orator and legislator, had William Cowper's hymn read to him:

"There is a fountain filled with blood,

"Drawn from Immanuel's veins."

Then he read the last stanza:

"Then in a nobler, sweeter song,

"I'll sing Thy power to save.

"When this poor lisping, stammering tongue

"Lies silent in the grave."

At this, Webster, one of the most powerful speakers in American history, replied, "Amen! Amen! Amen!"

Owen, the Puritan, lay on his deathbed, and his secretary was writing a letter, in his name, to a friend: "I am still in the land of the living," he wrote and read what he had written to Owen.

"No, please do not write that," Owen said. "I am yet in the land of the dying, but later I will be in the land of the living!"

On November 20, 1847, in Nice, France, ***Henry Frances Lyte,*** a retired pastor of the Church of England died. He had spent his life working in the slums of London helping people. After his death, his family found a paper he had written during those last days. It is now a hymn sung around the world:

"Abide with me: fast falls the eventide.

"The darkness deepens; Lord, with me abide!

"When other helpers fail, and comforts flee,

"Help of the helpless, 0 abide with me."

The epitaph on the grave in Canterbury, England, of Henry Alford, the hymn writer is this: *"The inn of a pilgrim journeying to Jerusalem."*

A 22-year-old Dutch patriot wrote the following letter to his parents before he was executed by a Nazi firing squad for the crime of trying to escape with his three companions to England:

"In a little while at five o'clock it is going to happen, and that is not so terrible . . On the contrary, it is beautiful to be in God's strength. God has told us that He will not forsake us if only we pray to Him for support. I feel so strongly my nearness to God, I am fully prepared to die . . I have confessed all my sins to Him and have become very quiet. Therefore do not mourn but trust in God and pray for strength . . Give me a firm handshake. God's will be done.. we are courageous. Be the same. They can only take our bodies. Our souls are in God's hands . . May God bless you all. Have no hate. I die without hatred. God rules everything."

Pilgrim's Progress is generally considered one of the greatest books every written by a follower of Christ. In it, the two pilgrims, Christian and Hopeful, finally received their summons and came down to the river. But, when they saw how deep, wide, swift, and dark were its waters, they were stunned.

Then they were told, "You must go through, or you cannot come at the gate." Then they asked if the waters were all of a depth, and the answer was given: "You shall find it deeper or shallower as you believe in the King of the place."

Then they went into the water, and Christian began to sink, and said: "I sink in deep waters; the billows go over my head; all His waves go over me."

But Hopeful answered, "Be of good cheer, my brother: I feel the bottom, and it is good."

And with that Christian broke out with a loud voice, "Oh, I see him again; and he tells me, "When thou passest through the waters, I will be with thee; and through the rivers, they shall not overflow thee."

Then they both took courage, and the enemy was after that as still as a stone until they were gone over.

They had passed through the grave to the glorious resurrection day beyond.

Little Kenneth was very sick. He felt that he was not going to get well. Turning toward his mother, who sat by his bedside, he asked, "Mother, what is it like to die?"

Mother was filled with grief, and she knew not how to answer him. She replied, "Kenneth, I must go to the kitchen. I'll be right back." Hurrying there, she prayed, "Lord, show me how to answer Kenneth's question." Immediately, she knew how to express it.

Returning to Kenneth, Mother said, "Kenneth, you know how you have often played hard and gotten very tired in the evening? Then you have come into my room and climbed upon my bed and gone to sleep. Later your father carried you in his arms and put you in your own bed. In the morning you have awakened and found yourself in your own room, without knowing how you got there."

Kenneth said, "Yes, Mother, I know that."

"Well, Kenneth," Mother continued, "death is something like that for God's children. Jesus spoke of death as sleep. God's children go to sleep with they die. Later, at the resurrection, they will arise and be with Christ forever. Heaven is a wonderful place, Kenneth!"

Then the boy smiled and said, "Mother, I won't be afraid to die now. I'll just go to sleep and, later, wake up and be with Jesus forever. I know God will take care of me."

Henry Van Dyke wrote this very accurate statement: "Remember that what you possess in this world will be found at the day of your death and belong to someone else; what you are will be yours forever."

All that you own will someday be given to another, but your character--what you are--will determine your future destiny.

[And I, who am proofing this book to put on the website, wish to add my testimony. I sat by my father as he lay dying in the hospital. I repeated to him the Shepherd's psalm, especially the part about walking through the valley of the shadow of death, and fearing no evil. His face was shining with hope and joy. Again and again he said, "Praise the Lord! Praise the Lord!" I cannot weep for him. I can only pray that I will be ready to join him some day.]

But now the entire picture changes. We leave the deathbeds of the Christians and visit the deathbeds of the atheists.

We have observed how men and women who have given themselves to God--who earnestly love and obey Him--have died. They confidently declared at the portals of death, "Yea, though I walk through the valley of the shadow of death, I will fear no evil: for Thou art with me." (Psalm 23:4).

The Apostle Paul said, "To die is gain" (Philippians 1:21), and "O death, where is thy sting?" (1 Corinthians 15:55). But to so many others death is a fearsome, dreadful thing.

***Aristotle* wrote:** "Death is a dreadful thing, for it is the end!"

John Donne, the English author, wrote: "Death is a bloody conflict and no victory at last; a tempestuous sea, and no harbor at last; a slippery height and no footing; a desperate fall and no bottom!"

Rousseau cried, "No man dares to face death without fear."

The infidel, ***Robert Ingersoll,*** when standing at the grave of his brother, said, "Life is a narrow vale between the cold and barren peaks of two eternities. We strive in vain to look beyond the height. We cry aloud, and the only answer is the echo of our wailing cry. From the voiceless lips of the unreplying dead there comes no word."

After the death of Alexander the Great one of his generals, ***Ptolemy Philadelphus,*** inherited Egypt and lived a selfish life amid wealth and luxury. As he grew old, he was haunted by the fear of death, and even sought in the lore of Egyptian priests the secret of eternal life. One day, seeing a beggar lying content in the sun, Ptolemy said, "Alas, that I was not born one of these!"

We shall discover that the last words of the atheists are far different than those who love and honor their Creator. For example, when ***Phineas T. Barnum,*** the famous circus showman of yesteryear, died in his 82nd year, his last words were a question about the big show's gate receipts at their latest Madison Square Garden performance. Then he was gone!

But, for most atheists, their concerns are far more dramatic. Here are the dying words of atheists:

Voltaire, the most influential atheist of Europe in his day, cried out with his dying breath: "I am abandoned by God and man; I shall go to hell! I will give you half of what I am worth, if you will give me six months life."

Honore Mirabeau, a leading political organizer of the French Revolution: "My sufferings are intolerable: I have in me a hundred years of life, but not a moment's courage. Give me more laudanum, that I may not think of eternity! O Christ, O Jesus Christ!"

Mazarin, French cardinal and advisor to kings: "O my poor soul! what will become of thee? Wither wilt thou go?"

Severus, Roman emperor who caused the death of thousands of Christians: "I have been everything; and everything is nothing!"

Thomas Hobbes, the political philosopher and sceptic who corrupted some of England's great men: "If I had the whole world, I would give anything to live one day. I shall be glad to find a hole to creep out of the world at. I am about to take a fearful leap in the dark!"

Caesar Borgia**:** "I have provided, in the course of my life, for everything except death; and now, alas! I am to die, although entirely unprepared!"

Sir Thomas Scott, chancellor of England: "Until this moment, I thought there was neither God nor hell; now I know and feel that there are both, and I am doomed to perdition by the just judgment of the Almighty!"

Edward Gibbon, author of "Decline and Fall of the Roman Empire": "All is dark and doubtful!"

Sir Francis Newport, the head of an English infidel club to those gathered around his deathbed: "You need not tell me there is no God for I know there is one, and that I am in His presence! You need not tell me there is no hell. I feel myself already slipping. Wretches, cease your idle talk about there being hope for me! I know I am lost forever! Oh, that fire! Oh, the insufferable pangs of hell!"

M.F. Rich: "Terrible horrors hang over my soul! I have given my immortality for gold; and its weight sinks me into a hopeless, helpless Hell!"

Thomas Paine, the leading atheistic writer in American colonies: "I would give worlds if I had them, that *The Age of Reason* had never been published. O Lord, help me! Christ, help me! . . No, don't leave; stay with me! Send even a child to stay with me; for I am on the edge of Hell here alone. If ever the Devil had an agent, I have been that one."

Napoleon Bonaparte, the French emperor who brought death to millions to satisfy his selfish plans: "I die before my time, and my body will be given back to the earth. Such is the fate of him who has been called the great Napoleon. What an abyss between my deep misery and the eternal kingdom of Christ!"

Aldamont, the infidel: "My principles have poisoned my friend; my extravagance has beggared my boy; my unkindness has murdered my wife. And is there another hell yet ahead?"

John Wilkes Booth, who assassinated Abraham Lincoln: "Useless! Useless! The terrors before me!"

Thomas Carlyle**:** "I am as good as without hope; a sad old man gazing into the final chasm."

David Strauss, leading representative of German rationalism, after spending a lifetime erasing belief in God from the minds of others: "My philosophy leaves me utterly forlorn! I feel like one caught in the merciless jaws of an automatic machine, not knowing at what time one of its great hammers may crush me!"

Tallyrand was one of the most cunning French political leaders of the Napoleonic era. On a paper found at his death were these words: "Behold eighty-three passed away! What cares! What agitation! What anxieties! What ill-will! What sad complications! And all without other results except great fatigue of mind and body, a profound sentiment of discouragement with regard to the future, and disgust with regard to the past!"

Some 15 years before his death, ***Mohandas K. Gandhi*** wrote: "I must tell you in all humility that Hinduism, as I know it, entirely satisfies my soul, fills my whole being, and I find a solace in the Bhagavad and Upanishads."

Just before his death, Gandhi wrote: "My days are numbered. I am not likely to live very long-perhaps a year or a little more. For the first time in fifty years I find myself in the slough of despond. All about me is darkness; I am praying for light."

"What did you do to our daughter?" asked a Moslem woman, whose child had died at 16 years of age. "We did nothing," answered the missionary. "Oh, yes, you did," persisted the mother. "She died smiling. Our people do not die like that." The girl had found Christ and believed on Him a few months before. Fear of death had gone. Hope and joy had taken its place.

In a *Newsweek* interview with **Svetlana Stalin, the daughter of Josef Stalin,** she told of her father's death: "My father died a difficult and terrible death . . God grants an easy death only to the just. . At what seemed the very last moment he suddenly opened his eyes and cast a glance over everyone in the room. It was a terrible glance, insane or perhaps angry. . His left hand was raised, as though he were pointing to something above and bringing down a curse on us all. The gesture was full of menace. . The next moment he was dead."

Charles IX was the French king who, urged on by his mother, gave the order for the massacre of the Huguenots, in which 15,000 souls were slaughtered in Paris alone and 100,000 in other sections of France, for no other reason than that they loved Christ. The guilty king suffered miserably for years after that event. He finally died, bathed in blood bursting from his veins. To his physicians he said in his last hours:

"Asleep or awake, I see the mangled forms of the Huguenots passing before me. They drop with blood. They point at their open wounds. Oh! that I had spared at least the little infants at the breast! What blood! I know not where I am. How will all this end? What shall I do? I am lost forever! I know it. Oh, I have done wrong."

William E. Henley, an atheist, wrote a famous poem, the last two lines of which have often been quoted:

"Out of the night that covers me,

"Black as the pit from pole to pole,

"I thank whatever gods may be.

"Beyond this place of wrath and tears

"Looms but the horror of the shade;

"And yet the menace of the years

"Finds, and shall find, me unafraid.

"It matters not how strait the gate,

"How charged with punishment the scroll,

"I am the master of my fate;

"I am the captain of my soul."

Men who have been bold in their defiance of God have lauded Henley's poem, but most of them were not aware that **William Henley later committed suicide.**

Few men in Europe have tried to eradicate the Bible and the knowledge of God from the minds of the people as did the French infidel, Voltaire. **The Christian physician who attended Voltaire during his last illness later wrote about the experience:**

> "When I compare the death of a righteous man, which is like the close of a beautiful day, with that of Voltaire, I see the difference between bright, serene weather and a black thunderstorm. It was my lot that this man should die under my hands. Often did I tell him the truth. 'Yes, my friend,' he would often say to me, 'you are the only one who has given me good advice. Had I but followed it, I should not be in the horrible condition in which I now am. I have swallowed nothing but smoke. I have intoxicated myself with the incense that turned my head. You can do nothing for me. Send me an insane doctor! Have compassion on me-! am mad!'
>
> "I cannot think of it without shuddering. As soon as he saw that all the means he had employed to increase his strength had just the opposite effect death was constantly before his eyes. From this moment, madness took possession of his soul. He expired under the torments of the furies."

Well, we have looked at the hour of death. But the rest of our life is just as revealing.

An American tourist in France went to the hotel keeper to pay his bill. The French hotel keeper said, "Don't you want a receipt? you could be charged twice." "Oh, no," replied the American, "if God Wills I will be back in a week. You can give me a receipt then."

"If God wills," smiled the hotel keeper, "do you still believe in God?" Why, yes," said the American, "don't you?" "No, said the hotel keeper, "we have given that up long ago."

"Oh," replied the American, "well, on second thought, I believe I'll take the receipt after all!"

It was over a century ago, and a man and his nephew were traveling west through the Colorado mountains. But they had lost their way, and finally came upon a cabin among the trees. The country was still wild, and they were nervous when they knocked on the door. Could they sleep for the night? they inquired.

As they prepared for bed, they heard low mumbling words in the adjoining room where the family (a husband, wife, and grown son) were. Almost in terror by now, the two men feared for their lives. They were carrying considerable money. What should they do? they only had one revolver.

After a time, they heard the chairs move, a shuffling, and more low mumbling. This must be it! A plot was afoot to kill them. With beads of sweat on his cold brow and hands, the nephew crept softly to the door and peered through the keyhole.

Coming back to the bed, his entire demeanor was changed. *"Everything is all right,"* he whispered, and explained what he saw. Immediately both fell soundly asleep and did not wake until morning.

Through the keyhole the young man had seen the family kneeling. They had read from the Bible, pushed back their chairs, and were praying.

The two men knew they had nothing to fear; they were in the home of genuine Christians.

"Have you studied Voltaire, Tom Paine, Robert Ingersol, or any of those fellows?" asked a passenger as he stood by the captain at the wheel of a steamship.

"No," replied the captain.

"Well, you should. You can't fairly turn down their argument until you have thoroughly investigated for yourself," the passenger replied.

"I've been captain of this ship a long time," said the captain. "The charts that I work with tell me the location of the deep water, so I can safely guide the ship into port. When I first became a sea captain, I decided that I would not investigate the rocks. The experience I've known other chaps to have with the rocks has been sufficient warning for me.

"Over the years I've watched the lives of men who have read the Bible everyday and loved God. Those were the men who had solid families, stayed away from drink, and helped other people in the community.

"And I've also seen the others: the drunkards, drug addicts, criminals, and all the rest. Those are the ones who have nothing to do with God and the Bible, and who never attend church.

"No, I've made my decision; *I stay away from the rocks.* My mother taught me the Bible when I was little, and I worship and serve the God of heaven who made all things. I'm not a bit interested in anything that Ingersoll, Voltaire, and Paine have to offer."

The preacher was on the street corner telling the passing crowds about Jesus Christ. A crowd had gathered and was listening intently. Then a hoarse voice spoke up from the back.

"Preacher, you've got it all wrong. Atheism is the answer to humanity's problems. People get into trouble and go crazy when they hear about Christianity. Religion is bad for minds and ruins lives. Come on now-prove to me that Christianity is real, and I'll be quiet."

Everyone was interested to see what would happen next.

The preacher held up his hand for quiet, and then said this:

"Never did I hear anyone state, 'I was undone and an outcast, but I read Thomas Paine's *Age of Reason* and now I have been saved from the power of sin.' Never did I hear of one who declared, 'I was in darkness and despair and knew not where to turn, until I read Ingersoll's *Lectures,* and then found peace of heart and solutions to my problems.'

"Never did I hear an atheist telling that his atheism had been the means by which he had been set free from the bondage of liquor. Never did I learn of anyone who conquered hard drugs by renouncing faith in God.

"But I have heard many testify that, when as hopeless and helpless sinners, they had turned in their great need to the Son of God and cast themselves upon Him for forgiveness and enabling power to overcome sin-they were given peace of heart and victory over enslaving sin!"

Then, turning to the atheist, he said:

"Who starts the orphanages, the city missions, and the work among the poor? It is the Christians. Who owns and operates the taverns, and manufactures the liquor sold in them? It is the atheists. Who risk their lives to help poor people in mission fields all over the world? It is the Christians. Who runs the abortion mills and the houses of prostitution? It is the atheists. Who are the most solid, kindly, industrious people in the nation? It is the Christians. Who operates the gambling halls and the crime syndicates? It is the atheists.

"Who are the swindlers, bank robbers, and embezzlers? It is the atheists. Who helps men put away their sins, live to bless others, and prepares men for death and eternity? It is the Christians.

"Yes, professed Christians sometimes do bad things. But it is infrequent enough to be newsworthy. If an atheist does a criminal act, it is to be expected. But if a church leader does it--it will make the headlines, because it is such a rare event.

"What leads men to throw away the bottle and stop beating their wives? It is Christianity, not atheism. What saves the wayward girls, the teenage boys, and the rest of us out of lives of sin? It is Christianity, not atheism.

"Christianity offers eternal happiness that begins now. Atheism can only offer doubt, skepticism, a miserable end, and eternal death."

Then the crowd turned to the atheist to give an answer, but he was gone. He had crept away without answering a word.

Wonders of Nature: Vol. 1 and Wonders of Nature: Vol, 2. Index

In order to simplify the task of locating nature nugget information in these two books, a single Index covers them both. But a single index would cause confusion in identifying which book each page number referred to. So the paging of Volume 2 of the set begins at page 101. This means that any listing over page 100 will be found in Volume 2. The two books, together, contain a rich mine of valuable Information about natural history.

There are two primary ways to refute the foolish errors of evolutionary theory: The first is by a discussion of scientific facts. This is done in Books 1-20 of this series. The second is by describing a few of the multitudes of design factors in nature. In the structure and function of plants, animals, and the rest is to be found profound evidence that God is their Maker. This Design Index lists but a few of these many "nature nuggets." Even the smallest bug is amazing In planning, construction, and movement!

This Index is entirely to Volumes 21 and 22 in this series (Wonders of Nature: Vols. 1 and 2). In the index, below, certain codes are given after the description and before the page reference. Here is what they mean:

A crosshatch indicates that the Item listed is the name of an item, which includes several topics. - A dash indicates that this nugget will be one of several mentioned in a topic on that page, so it will not be labeled in full caps in the item title. No code after an entry indicates it is a major heading.

Biographies of creation scientists

Vance Ferrell

Evolutionists tell the public that creation scientists are not smart enough to do worthwhile research or make useful contributions to science. Yet the foundations of modern science were primarily laid by the research discoveries of brilliant creation scientists. These pages are filled with a few of the many biographies of creation scientists.

In reading these and other histories of scientific research, a common pattern emerges: An Individual with unusual Intelligence and determination spends years studying nature, and finds a few of its extremely technical secrets.

How could the random confusion of "natural selection" or damaging, lethal effects of mutations produce such sophisticated laws, high-level functions, and complicated organs? Only a Person with far higher Intelligence and craftsmanship could have produced what we find in nature.

AGASSIZ-(Ag'uh-see) Jean Louis Rodolphe Agassiz (May 28, 1807 - December 12, 1873). Swiss-American naturalist and glaciologist.

Agassiz was the son of a pastor, and a descendant of a French Huguenot family that fled France during religious persecutions under Louis XIV.

After obtaining a Ph.D. at Munich, he completed a medical degree in 1830. Arriving in Paris in 1832, he worked with Cuvier and then became professor of natural history at Neuchatel in Switzerland.

While there he completed a massive study on fossil fish, which was published in 5 volumes between 1833 and 1844. Europe's leading scientist, Humbolt, paid to have it published. He later received the Wollaston Prize for this achievement. Then Agassiz began studying glaciers, and became the father of glaciology. Immense boulders had been carried into the valleys of Switzerland, and Agassiz decided that glaciers were responsible. If true, this meant that glaciers at some earlier time were much larger than today, and that they moved.

In the summer of 1836 and 1837 he explored glaciers and found evidence of that movement. The sides and ends of glaciers contained piles of rock. In addition, rocks had been scoured by glacial movement. He also found similar grooved rocks where no one remembered ever having seen glaciers. Then, two years later in 1839, Agassiz found a cabin that had moved nearly a mile since being erected in 1827. Next, he drove heavy stakes into the ground in a straight line across a glacier. Two years later, in 1841, he found that the stakes had formed a U shape. This meant that the center of the glacier was moving faster than the edges.

"Charles Lyell, who led out in encouraging "Charles Darwin to write his book Origin of the Species, was not happy with Agassiz' discoveries, for they disproved his concept of uniformitarianism, which theorized that no unusual changes had ever occurred in past time.

Acclaimed as one of Europe's leading scientists, Agassiz spent the last 27 years of his life in the United States, most of it at Harvard University as a professor. He spent his spare time studying glaciation and ancient lakes in North America.

When Charles Darwin published his book, Agassiz resolutely refused to accept it. In fact, he became the most prominent biologist in America to oppose it, just as Sir Richard Owen in England was the leading biologist in Europe to resist Darwin's theory of evolution by natural selection. Evolutionists today declare that creationists never make good scientists. But men such as Louis Agassiz prove them wrong.

BABBAGE-Charles Babbage (December 26, 1792 - October 18, 1871). English mathematician.

Charles Babbage was an earnest Christian who, as a youth, taught himself mathematics. Then he applied for and received permission to study at Cambridge University. While there, he founded the Analytic Society and gathered together young mathematicians who wanted to research more deeply into mathematics than had been done since the time of Newton.

Before long, Babbage became so prominent that he was elected to the Royal Society in 1816. Vigorously, he sought to encourage British scientists to do more advance work in mathematics. Practical as well as mathematical, Babbage devised new methods of mass production in post offices and public work places, using methods strikingly similar to those Henry Ford would later employ in America.

Babbage developed the first reliable actuarial (lifespan) tables, now in use by governments and insurance companies around the world. In 1847 he invented the first ophthalmoscope, for examining the retina of the eye.

A major achievement was his development of a calculating machine. Very much aware of the mathematical errors in astronomical data and logarithm tables, he devised a machine which could automatically calculate numbers. Obtaining the backing of the British government, he worked on the, machine for several years, and then hit on something totally new: a computer.

This entirely new concept, which forms the basis of the latter 20th century computer revolution, was keyed to punched cards directing the calculating machine in its operations, and enabling the calculator to do many functions beyond that of mathematical operations. He thought out many of the basic principles which guide modern computers. However, he only had machines with which to do it, not our present electronic gadgetry.

BOYLE-Robert Boyle (January 25, 1627 - December 31, 1691). English physicist and chemist.

Born into a wealthy home, Boyle early showed great brilliance. At the age of eight he was enrolled at Eton College, and then traveled through Europe with a private tutor. While in Geneva, during a terrible thunderstorm he determined to dedicate his life to God. For the remainder of his life he was an earnest Christian.

In 1654, supported by a liberal inheritance, he made his home at Oxford, began research with other scientists, and helped found the Royal Society. Boyle was ahead of his age in that he not only had a brilliant mind, but he also believed in experimentation and not just theory.

In 1657 he devised an air pump, and the vacuum produced by it was for a time called a Boylean vacuum. He was one of the first to make use of evacuated, hermetically sealed thermometers. Galileo had earlier said that in a vacuum all objects fall at the same velocity. Using an evacuated cylinder, Boyle was the first to verify Galileo's principle. He also demonstrated that sound could not be heard across a vacuum, while an electrical attraction could still be maintained.

Then he began research on gases. He was the first chemist to collect a gas. He discovered the inverse relationship of air pressure (called Boyle's law). He concluded from this that, since air was compressible, it must be composed of discrete particles separated by a void. Compression merely squeezed the particles closer together.

Boyle was the first scientist to carefully and thoroughly write down the process and results of each experiment, so it could be repeated by others. This was a major step forward in science.

By the publication of a book, which explained that basic elements could not be changed into one another, but could be combined into compounds, Boyle changed alchemy into the science of chemistry. He appealed to scientists to determine elements experimentally, not theoretically. He is today considered to be the father of modern chemistry.

Boyle was the first to distinguish between acids, bases, and neutral substances, and he pioneered the use of acid-base indicators. He was the first to discover that water expanded as (and just before) it froze.

Before Boyle's time, discoveries were often kept secret, but Boyle insisted that they be made public as soon as possible to aid scientific research.

Robert Boyle was deeply religious, and later in life learned Hebrew and Aramaic to aid him in his Biblical studies. He wrote essays on religion and financed missionary work in the Orient. In his will, he founded the Boyle Lectures to defend Christianity against atheism.

BRAUN- Warnher Magnus Maxmillian von Braun (March 23, 1912 - June 16, 1977). German-American rocket engineer.

Von Braun was educated in Zurich, and completed his doctorate at the University of Berlin in 1934. Fascinated with rocketry, he began research into them. One went a mile high. The German government took over the project, and a rocket research center was built in Peenemunde on the Baltic, and by 1940 Von Braun was in charge of it. But Hitler did not like his views and he was briefly imprisoned in 1944, till Hitler was persuaded that the rocket program could not continue without Von Braun's brilliance.

When the war ended, Von Braun and many of his colleagues fled westward to surrender to the Americans. Now he was free to express openly his Christian beliefs. The United States government, recognizing that he was the leading rocket scientist in the world, appointed him to head up the Huntsville Research Center that placed America's first satellite (Explorer I) into orbit on January 31, 1958. In 1962, his team began construction of the Saturn 5 rocket that eventually carried men to the moon.

BREWSTER-Sir David Brewster (December 11, 1781 - February 10, 1868). Scottish physicist.

Son of a schoolteacher, Brewster was educated for the ministry but, although a fervent Christian, went into scientific research instead.

In 1815 he found that a beam of light could be split into a reflected portion and a refracted portion, at right angles to each other, and that both would then be completely polarized. Still known as Brewster's law, it earned him the

Rumford medal in 1819.

In 1816, Brewster invented the kaleidoscope. Later still, he produced the stereoscope, which produces three-dimensional pictures. He helped found the British Association for the Advancement of Science in 1831, and was knighted in 1832.

EULER-(Ol'ler) Leonhard Euler (April 15, 1707 - September 18, 1783). Swiss mathematician.

Euler was deeply religious from his youth, and considered entering the ministry as his father had done, but his mathematical brilliance led him into science instead.

Euler has been considered the most prolific mathematician of all time. He wrote extensively on every branch of the subject and was always careful to explain what he had done, and every false path he had entered in the course of his investigations. In 1766, he became blind, but this hardly slowed his work. In addition to all he had previously learned, he could remember several pages of newly-researched formulas. During his lifetime he published 800 scientific papers, many quite lengthy. At his death, he left behind so many additional papers that it took 35 years for mathematicians to process and print them.

He applied mathematics to astronomy, replaced the geometric proof methods used by GaliIeo and Newton with algebraic proofs, did advance research into lunar motions, was the first to announce that light was a wave form and that color depended on wavelength. We could fill all three of these books, plus many more with all the discoveries of this earnest creation scientist.

FARADAY-Michael Faraday (September 22, 1791 - August 25, 1867). English physicist and chemist.

Faraday was an earnest creation scientist, as well as one of the greatest scientists of all time. Without his research and discoveries, the 20th century would be far different.

He came from a poor family, and was apprenticed to a book binder. But his keen mind soon took him into scientific research.

This brilliant, self-taught scientist first devised methods for liquefying gases such as carbon dioxide, hydrogen sulfide, hydrogen bromide, and chlorine under pressure. He was the first to produce lab temperatures below O°F. In 1825 he discovered benzene, improved Davy's initial studies on electrolysis, and developed what are now called Faraday's laws of electrolysis which established the connection between chemistry and electricity, putting electrochemistry on a solid basis.

In 1821, Faraday showed that a current of electrified wire around a magnet could convert electrical and magnetic forces into continual mechanical movement. This provided the basis of modern electric motors. Later research that he did, produced open and closed circuits, electric induction, and the first transformer. Faraday was the first to discover magnetic lines of force and the magnetic field.

Interestingly enough, Faraday was the greatest scientist in history who knew no mathematics- He was entirely self-taught. Maxwell, another creation scientist, was later to devise the mathematics of electromagnetism-and in doing so arrived at the same conclusions that Faraday had. In 1831 Faraday produced the first electric generator. It is considered to be the greatest single electrical discovery in history. Later expansion of this discovery made it possible to produce large amounts of inexpensive electricity, whether it be coal-fired, hydroelectric, or nuclear-generated. Because of it we now have electrified cities, offices, factories, and homes.

FLEMING-Sir John Ambrose Fleming (November 29, 1849 - April 18, 1945). English electrical engineer.

Fleming was the brilliant son of a Congregational minister. After completing university work at Cambridge, he worked with Edison Electric for a time, and then with Marconi. After this, he set out on his own to advance the research of both scientists.

He found that the Edison effect (the passage of electricity from a hot filament to a cold plate within an evacuated bulb) to be caused by electrons boiling off the hot filament. This helped clarify certain important facts about alternating current. In 1904 he developed the rectifier. (De Forest, in America, added a grid to it, and this made electronic instruments practical.)

Fleming was knighted in 1929, and lived to be nearly 100.

GESNER-(Guess'ner) Konrad von Gesner (March 26, 1516 - December 13, 1565). Swiss naturalist and natural historian.

Gesner was the son of a furrier killed in the religious wars, and the protégé of the Protestant reformer, Ulrich Zwingli. In 1541, Gesner obtained a medical degree at the University of Basel and became a physician.

In his time, he was known as a master of erudition, for he spent his time researching and collecting a wide variety of natural materials: plants, animals, rocks, fossils, etc. He wrote extensively, and discovered over 500 species hitherto unknown.

GUTENBERG-(Goo'ten-berg) Johannes Gutenberg (c. 1398 - c 1468). German Inventor. Gutenberg ranks as one of the most influential men of all history. His invention of the basics of the printing press laid the basis for all modern research, transmission of knowledge, invention, and modern life.

Gutenberg is often called the inventor of printing. What he actually did was to develop the first method of utilizing moveable type and the printing press in such a way that a large variety of written material could be printed with speed and accuracy.

For thousands of years men had used seals and signet rings, which work on the same principle of block printing. Block printing could print a book, but required a completely new set of carved blocks for each new book. Gutenberg made movable type-each letter of the alphabet was a separate block. But he also did far more. Modern printing required movable type, along with some procedure for setting it and fixing it in position. The printing press itself was needed. Special inks were required. And, last, paper was needed.

Gutenberg already had the paper available to him, and some work had earlier been done on the other aspects. But he made brilliant improvements on each of the first three-and succeeded where others before him had failed.

Gutenberg developed a metal alloy suitable for type. He made a mold for casting blocks of type precisely and accurately. He made an oil-based printing ink. He made a press suitable for printing. But Gutenberg did far more: he combined them all into a complete manufacturing process. Mass-production of books, pamphlets, and tracts was needed, and Gutenberg supplied it.

When Gutenberg lived, China and Europe were about equally advanced. But within 50 years after Gutenberg introduced high-speed printing to the West, Europe shot ahead. Gutenberg's invention was not the only reason for this, but it was a major one.

HENRY- Joseph Henry (December 17,1797 - May 13, 1878). American physicist.

Like Faraday, Henry came from a poor family, had little schooling, and had to go to work while young. Also, like Faraday, he became interested in electrical experiments. Trying to wrap additional wires about a magnet to induce a greater magnetic field, he found he could not do so because the wires touched and short-circuited. So he began producing home-made insulated wires. He was now able to make powerful electromagnets. In 1831 he developed one that could lift 750 pounds (Sturgeon had earlier lifted 9 pounds). At Yale, later that year, using an ordinary battery he lifted more than 2,000 pounds of iron. In 1832, he was accepted as a professor at Princeton.

By 1831, he was sending signals over a mile by small, insulated wires. One problem was that, according to Ohm's law, the longer the wire, the greater its resistance and the smaller the current flowing through it. So Henry invented the electrical relay in 1835. This enabled the signal to be sent much greater distances than otherwise possible.

In effect, Henry had invented the telegraph. But he did not patent any of his devices, and it was Morse, another creation scientist, who worked out the details to put the first telegraph to practical use (in 1844). Henry freely helped Morse develop it.

In England, Wheatstone, after a long conference with Henry, produced a second telegraph. In 1830, he discovered the principle of induction (an electric current in a coil can induce a current not only in another coil, but in itself). In 1831, he published a paper describing an electric motor. An electric motor is the opposite of an electric generator: In a generator, mechanical force turns a wheel and produces electricity; in a motor, electricity turns a wheel and produces mechanical energy. One creation scientist (Faraday) had invented the generator to produce the electricity; another one (Henry) described the motor to use that electricity. The two inventions together have changed all modern civilization.

By means of an ingenious experiment in 1846, Henry demonstrated that sunspots were cooler than the rest of the sun.

In 1846, he was elected first secretary of the newly-formed Smithsonian Institution, and quickly made it a clearing house for scientific information. He also helped found the National Academy of Sciences, and was one of its first presidents.

Later still, he set up a system of obtaining weather reports from all over the nation. When the U.S. Weather Bureau began, it used his system. At the funeral of this creation scientist, high government officials were in attendance, including President Hayes.

HERSCHEL-Sir William Herschel (November 15, 1738 - August 25, 1822). German-English astronomer.

In 1757, at the beginning of the Seven Years' War, Herschel's parents managed to send him to England, where he remained the rest of his life. He began his career by becoming a well-known organist and music teacher. Then he taught himself Latin and Italian. The theory of musical sounds led him to a study of optics, and a desire to see the heavens through a telescope. Not able to afford a telescope, he learned how to grind lenses, and then he made his own.

He refused to be satisfied with his first lens, until he had made 200 of them! Then he was ready to produce them perfectly. In 1772, he brought his sister Caroline over from Germany, and she proved an earnest fellow worker in lens grinding and telescope making. Eventually, the pair were producing the finest telescopes available anywhere. By 1774 they were producing the best refracting and reflecting telescopes in the world.

But that was not good enough. Herschel decided to systematically scan the heavens through his marvellous telescopes. Soon he began turning out the first of hundreds of scientific papers and articles on his findings on the mountains of the moon, variable stars, the possibility that sunspot activity could affect agriculture on earth, and more besides.

In 1781, Herschel discovered a new planet which he named Uranus. He was to become the most important and successful astronomer of his time, yet he was entirely self-taught in that occupation. He was the first to discover binary stars, and found 800 of them. He was the first to systematically report on the periods of variable stars, and the first to discover that our solar system was moving in a certain direction (toward the constellation Hercules). He catalogued 2500 cloudy objects, which he called *galactic clusters.* In 1787 he discovered two of Uranus' moons, and, after constructing a 48-inch reflector, on the first night of viewing found two new moons of Saturn. He was the first to time the rotation of Saturn and ascertain that its rings rotated also.

In 1800, he tested various portions of the sun's spectrum for heat, and found that the hottest was just off the red end; he had discovered infrared radiation. In 1816, this creation scientist was knighted.

JOULE-(Jowl or Jool) James Prescott Joule (December 24, 1818 - October 11, 1889). English physicist.

Born into wealth, Joule was frail in health and weakened by a spinal injury in childhood. His father encouraged him to rest and spend his time in study and research, which he so much enjoyed. Supplied with a home laboratory, he was largely self-educated. Above all, Joule loved to measure things. Soon he was publishing papers on heat production by electric motors, the formula for the development of heat by an electric current. Although he later had to manage his father's business, Joule still found time to continue his research. He spent ten years measuring the heat of every process he could think of. In it all, he carefully calculated the amount of work that had entered the system, and the amount of heat that came out. Consistently, a certain amount of work always produced a certain amount of heat, and the formula was called the *mechanical equivalent of heat.*

For years, Joule's discoveries and reports were snubbed by the scientific community because of his lack of formal education. Fortunately, his work eventually came to the attention of William Thomson (later known as Lord Kelvin), who helped him become accepted. The later formulation of the First Law of Thermodynamics (on the conservation of energy) was partly based on Joule's determination of the mechanical equivalent of heat. Consistently thereafter, through the work of such men as Einstein and Pauli, the First Law has been re-established more and more firmly.

Joule collaborated with Thomson in 1852 in analyzing the temperature of gas when it expands, and discovered that freely-expanding gas always falls in temperature. Knowledge of this formula, the *Joule-Thomson effect,* enabled later researchers to obtain extremely low temperatures.

Although living at a time when Darwin's theories were gaining in popularity, Joule, Kelvin, and many other scientists remained conscientious creation scientists. In 1850 Joule was elected to the Royal Society; in 1866 he received its Copely medal; in 1872 and 1887 he was made president of the British Association for the Advancement of Science; and in 1878, he received a lifetime pension from Queen Victoria.

HARVEY-William Harvey (April 1,1578-June 3, 1657). English physician.

Harvey studied medicine at two of the leading European medical schools: Cambridge and Padua. Harvey was in Italy during the time that Galileo went through his heliocentric crisis with the authorities.

Returning to England in 1602, he became a well-known physician (Francis Bacon was one of his patients), and was eventually appointed court physician to James I and Charles I.

Yet, in spite of this success, Harvey was more interested in medical research than regular practice. In the first 14 years of his medical practice (1602-1616), he had, on the side, dissected over eighty species of animals. A special interest of his was the heart and blood vessels. Other researchers had tried to figure out the purpose of the heart and blood vessels, but it was Harvey that solved the problem. His great asset was persistence and research, instead of speculation and glances at anatomy.

After years of careful examination, Harvey correctly decided that the heart was a muscle; actually a blood pump. He was astounded at the high degree of planning and intelligence that must have gone into making it in the beginning.

Through actual dissection, he found that the valves which separated the two upper chambers (auricles) of the heart from the two lower chambers (the ventricles) were one-way valves. Blood could go from auricle to ventricle, but not back again.

Then he carefully examined the veins and found that the valves in them, which Fabricius had earlier discovered, were also one-way! This meant that blood in the veins could only travel toward the heart, not away from it. (In later years, Harvey told young Boyle, another creation scientist that it was the valves in the veins which convinced him he was on the right track in his research.)

HOOKE-Robert (July 18, 1635- March 3, 1703). English physicist.

Even in childhood Hooke was recognized as brilliant. Scarred by smallpox, he attended Oxford. In his early 20s, he teamed up with fellow creation scientist, Robert Boyle, in developing the air pump. In 1663 he became a member of the Royal Society, and later became an influential officer. He was an ingenious and capable experimenter in almost every field of science. He did theoretical research into the wave theory of light, gravitational theory, steam engines, and the atomic composition of matter. He was the second to discover a double star. He studied the action of springs and formulated what is today known as Hooke's law. His analysis of the expansion and contraction of spiral springs made possible wristwatches and ship's chronometers with "hairsprings;" no longer were bulky clocks and their pendulums required.

Hooke did outstanding work in the field of microscopy and insects. His data and illustrations were unrivaled in his time. During his discovery of the porous structure of cork, he gave the microscopic holes a new name: cells, which has became a basic word in biology.

It needs to be understood that in Harvey's day, scientists assumed that the blood just sloshed back and forth through the arteries and veins. But Harvey calculated that in one hour the human heart pumped a quantity of blood that was equal to three times the total weight of a man! Since blood could not possibly be formed that rapidly, it had to be the same blood which was being pumped out of the heart through the arteries and then flowing back in through the veins. Blood did not slosh, it circulated.

Harvey also tied off an artery and noted that only the side toward the heart bulged. When he tied off a vein, the side away from the heart bulged.

As early as 1616, he began lecturing on these principles, but it was his 72-page book, Exercitatio De Motu Cordis et Sanguinis (On the Motions of the Hearth and Blood) published in 1628, which settled the matter. Among professionals, this book was to became famous.

But not at first. Harvey received ridicule, patients stopped coming, and learned physicians wrote articles and books against him. Men of science denounced him as a quack. Interestingly enough, their scientific evidence consisted of the theories of Galen, a Greek physician who lived 1400 years earlier! This reminds us of the current controversy over evolutionary theories, which are also based on assumptions and not facts.

By the time Harvey was old, his discoveries were accepted nearly everywhere.

Interestingly enough, there was one loophole in his position: nothing was known about how the blood got from the arteries to the veins. The arteries became smaller and smaller until they could no longer be seen, and then extremely tiny veins appeared out of nowhere. Four years after Harvey's death, Malpighi, another creation scientist, applied the microscope to the wing of a bat-and discovered capillaries-the extremely tiny tubes that connect the arteries with the veins. We now know that those capillaries are so small that the blood cells pass single file through them. Harvey was also one of the first researchers to study the development of the chick within the egg. Harvey was elected president of the College of Physicians in 1654, but declined because of his age.

KELVIN-Lord Kelvin (William Thomson; June 26, 1824 - December 17, 1907). Scottish mathematician and physicist.

The son of an eminent mathematician, Kelvin was an infant prodigy who, by the age of eight, was carefully listening to his father's mathematics lectures. At eleven he entered the University of Glasgow, and finished second in his class in mathematics. After that he studied in Cambridge and then in Paris.

Kelvin collaborated with Joule, another creationist, in discovering the *Joule-Thomson effect.* After researching further into the temperature drop of gas, Kelvin announced in 1848 that the lowest possible temperature that could be achieved was -273°C. It was later discovered that this temperature *(absolute zero,* or 0°K) applied to all matter, not merely to certain gases. Scientists working with low temperatures regularly use the *Kelvin scale,* which uses the same graduation marks as the centigrade scale. The motion *(kinetic energy;* a term introduced by Kelvin), of molecules becomes virtually zero at absolute zero.

The First Law of Thermodynamics specified that energy is never actually lost. Kelvin helped in formulating that law. In 1951 Kelvin deduced from Carnot's work that all energy, even though not lost, gradually becomes unusable. This is the *Second Law of Thermodynamics.* Everything in the universe is gradually running down, or, to say it another way, is gaining *entropy.*

Kelvin invented improvements in cables and galvanometers, in order to make possible the laying of the Atlantic cable. He introduced Bell's telephone into England, and in 1866 was knighted. He improved the mariner's compass, devised new types of sounding gauges, tide predictors, and many other things. He was buried in Westminster Abbey next to Newton.

KEPLER- Johann Kepler (December 27, 1571 - November 15, 1630). German astronomer.

As a child Kepler had smallpox which damaged his body and weakened his eyes. Attending the University of Tubingen to study for the ministry, his brilliance in mathematics was soon recognized. By 1594 he was teaching science at the University of Graz in Austria.

In 1598, he went to Prague and began working with the aged Tycho Brahe. On Tycho's death, all his research papers passed to young Kepler. This represented a lifetime of careful measurements of the apparent motions of the planet Mars. Repeatedly, Kepler tried to figure out how this data could be properly interpreted by mathematics and geometry. He found that the planet moved in an ellipse, or somewhat flattened circle, about the sun. He then applied this concept to data for other planets and their moons.

Kepler also described improvements in telescope manufacture, including double convex lenses, and a compound microscope. In addition, he showed that a parabolic mirror focused parallel rays of light, thus laying the basis for optics and Newton's work.

Using the newly-developed logarithms, he completed revised **tables of planetary motions, and** produced a star map. He **also calculated the** transits of the inner planets in front of the sun. After his death, his calculations were shown to be correct.

LISTER-Baron Joseph Lister (April 5, 1827 -February 10, 1912). English surgeon.

The son of the inventor of the achromatic microscope, Lister studied medicine and became a surgeon. He was thankful he could use the newly-developed technique of anesthesia during operations and amputations. But he was concerned that so many patients died afterward from infections.

Learning of the research work of another creation scientist, Pasteur, he decided to try to kill any germs present at the time of the incision. For this purpose he used carbolic acid (phenol) in 1867, and deaths by infection stopped.

He had thus founded the science of antiseptic surgery, and later research by other scientists improved on the means of doing it.

He was the first physician to sit in the House of Lords, and in 1885 succeeded Kelvin as president of the Royal Society.

MARCELLO MALPIGHI (Mahl-pee'gee) Marcello Malplghl (March 10, 1628 - November 30, 1694). Italian physiologist.

Malpighi is known as the father of microscopy because of his pioneer research with the newly-invented microscope. A physician by training, he lectured at various Italian universities and carried on basic microscope research.

In 1660 he showed that, in the frog, the blood flowed through a complex network of vessels over the lungs. This discovery explained how, through breathing, the blood could carry oxygen throughout the body.

Malpighi's observations of a bat's wing membranes revealed the finest blood vessels, which were eventually named capillaries. These connected the smallest arteries with the smallest veins. This discovery explained the missing link in Harvey's theory of the circulation of the blood.

He studied chick embryos and the respiratory vessels in insects, and found the stomata-small openings-on the underside of leaves.

MAURY-MATTHEW FONTAINE- Maury (January 14, 1806 - February 1, 1873). American ocea-nographer.

In 1830, at the age of 18, Maury entered the U.S. Navy, and we never would have heard more about him if he had not been lamed in a stagecoach accident in 1839. He was retired from active duty and given an office job as superintendent of the Navy Depot of Charts and Instruments.

Frankly, nothing was expected of him, but Maury surprised everyone and did a prodigious amount of work. He studied ocean winds and currents, and distributed specially-prepared logbooks to captains of ships so he could collect further data. He studied the Gulf Stream, and called it "a river in the ocean." His research received international recognition because ocean voyages were shortened as captains were now able to work with the currents instead of fighting them.

In 1850 he developed a set of ocean depth charts of the Atlantic to aid in the laying of the transatlantic cable. Recognizing that international cooperation was needed to properly study the ocean, he convened an international conference, which was held in Brussels in 1853.

The work of Maury laid the foundation of the United States Naval Observatory, and he is considered the father of oceanography. To the consternation of many scientists, however, he refused to accept evolutionary teachings.

In later years, he invented an electric torpedo and taught physics at the Virginia Military Institute. He is honored today by Maury Hall at the Naval Academy at Annapolis. In 1930 he was elected to the Hall of Fame for Great Americans.

MAXWELL-James Clerk Maxwell (November 13, 1831 • November 5, 1879). Scottish mathematician and physicist.

Early recognized as having unusual mathematical ability, he contributed a paper on oval curves to the Royal Society of Edinburgh. It was so well done that they refused to believe that a 15-year old had produced it.

In 1857, Maxwell showed that the rings of Saturn consisted of particles, instead of being solid or liquid.

Analyzing movement of gas particles in 1860, he co-developed the *Maxwell-Boltzmann kinetic* theory of gases in relation to temperature. This showed that temperature and heat were velocity of molecules and nothing else.

Maxwell conceived a theory of color perception which was to form the basis for the later development of color photography.

Between 1864 and 1873, he placed into mathematical form the lines of force found in a magnetic field. His work verified that electricity and magnetism always exist together, so his work is usually referred to as the electromagnetic theory.

Maxwell showed that the speed of electromagnetic radiations was constant, that it was equivalent to the speed of light, and that that speed was 300,000 kilometers per second [186,000 miles per second]. (It has since been refined to 299,792.5 kps [186,282 mps].) Because the speed of light was identical to other radiations, he decided that light itself was produced by an oscillating electric charge. Later researchers found that to be correct. Maxwell also predicted that many other radiations would be found-far beyond the infrared and ultraviolet, which were yet unknown that has proven true also.

MERCATOR-(Mer-kay'ter) Gerardus Mercator (March 5, 1512 - December 2, 1594). Flemish geographer.

The great voyages of discovery had begun by the time Mercator graduated from the University of Louvain in 1532. Good maps were necessary, and so the young man founded a geographical institute at Louvain University two years later.

He began the preparation of a lengthy series of maps, using instruments that he himself designed, plus a lot of mathematical calculations. Religious persecution nearly cost him his life, so he fled to Protestant Germany in 1552 and there continued his work as cartographer to the Duke of Cleves.

In 1568, he made his great improvement in mapmaking. Drawing flat maps of spherical surfaces is difficult, but Marcator devised a way to partially do it. He made a cylindrical *projection,* today known as a Mercator *projection. This* is the shape of the world most often seen on a world map.

To understand it, take a globe of the world and place a light at the center of it. Then place a cylinder of paper around it which only touches the sphere at the equator. The light shining through the globe traces an image onto the rolled-up paper. THAT is the Mercator projection. All the meridians of longitude (north-south lines) are equidistant and parallel, and the parallels of latitude run horizontal and parallel. The result is a round world portrayed on a flat map. As one goes farther north or south the east-west distances become wider than they really are, and the latitudinal (east-west) lines gradually lengthen the closer they are to the poles. The result is that such places as Antarctica, Canada, Greenland, and the northern Soviet Union are portrayed much larger than they actually are.

But there was a decided advantage for navigators, in that, following a constant compass direction, a route appeared straight on a Mercator projection, but curved on any other.

NEWTON- Sir Isaac Newton (December 25, 1642. March 20, 1727). English scientist and mathematician.

In childhood, this frail child occupied himself constructing devices such as sundials, kites, and water clocks. In school he seemed somewhat slow. Then he was taken out of school to help on the farm, but his uncle, a college teacher thought he might have ability and urged the family to send him to Cambridge. While there he was an average student, who worked on little projects in his room.

Sent home to escape the plague, which had arrived in London, he had already in his spare time worked out the very important binomial theorem in mathematics,-a formula of great importance which no one before his time had ever thought of. On his grandmother's farm he one day watched an apple fall from a tree, and began to think through gravity. (Newton was strictly honest, and he himself said the apple story was true.)

This young man decided that "the rate of fall was proportional to the strength of the gravitational force and that this force lessened according to the square of the distance from the center of the earth." That was his famous Inverse square law. Yet Newton questioned whether he could be right, so he set that idea aside for 15 years, until he had developed an entirely new mathematical system for reanalyzing such problems.

At this same time, the 23-year-old Newton conducted experiments on the farm, which were scientific breakthroughs in the field of optics. Among other things, he discovered that white light contained all the colors, and the prism merely separated them. When his experiments became known, Newton became famous. Returning to Cambridge, he remained there for 30 years. At the age of 27, he became a professor of mathematics at the school. He was only required to give about eight lectures a year; the rest of the time he could spend in research. Elected to the Royal Society in 1672, he went on to invent calculus.

Then he developed the particle theory of light, and turned his attention to telescopes. Refractors were getting about as large as they could without producing aberrations, so he invented the reflecting telescope, which used mirrors instead of lenses.

In 1684, Christopher Wren, the well-known architect, offered a reward to anyone who could solve the problem of the laws governing the motion of heavenly bodies. Halley (the one who predicted the return of the comet bearing his name) asked Newton if he could solve it. He replied, yes, he already had-20 years before, while back on his grandmother's farm after that apple fell!

Halley then asked him how did the planets move, and Newton replied, "In ellipses." "How do you know?" "Why, I calculated it" was the reply. Urged by Halley to work out the calculations again, and this time write them down, Newton wrote a book. Eighteen months later Principia Mathematlca was published. It is generally considered the greatest scientific work ever written. Later in life, Newton wrote a large book of commentary on the Bible, which he had a deep respect for. He said that the Bible contained solid, worthwhile principles which helped people, and which had greatly helped him think more clearly and live a better life.

In 1696, a Swiss mathematician challenged Europe's scholars to solve two problems. The day after Newton saw it, he anonymously mailed him the correct answers. Upon reading them, the challenger said, "I recognized the claw of the lion." In 1716, when Newton was 75, Leibniz stated an extremely difficult mathematical problem specifically to stump Newton. Newton solved it in an afternoon.

In 1696, this highly-honored creation scientist was appointed master of the British mint-and reorganized that branch of the government. In 1703, he was elected president of the Royal Society. In 1704 he wrote Optlcks, to summarize his research in that field. In 1705 he was knighted by the queen. At his death he was buried in Westminster Abbey. The atheist, Voltaire, who was visiting London at the time, said, “England honors a mathematician as other nations honor a king."

Two famous statements by Newton are worth repeating: "If I have seen further than other men, it is because I stood on the shoulders of giants."

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

MORSE-Samuel Finley Breese Morse (April 27, 1791 - April 2, 1872). American artist and Inventor.

He started out as a successful artist who made little money. But then, in the 1830s, he started carrying out electrical experiments. Morse decided to build an electrical telegraph, but quickly realized he lacked the electrical knowledge to do so. By accident he met the creation scientist, Joseph Henry, who patiently over a period of time answered every question he put to him.

Morse then decided to obtain financial backing for his project, and had the bulldog determination needed to carry it through to completion. After patenting the device in 1840, he lobbied Congress into appropriating $30,000 to construct a 40-mile telegraph from Baltimore to Washington. Completed in 1844, it worked. The first message, sent by Morse in a dot-and-dash code he had devised, was “What hath God wrought?"

NAPIER-(Nay'pee-ur) John Napier (1550 -April 4, 1617). Scottish mathematician.

Napier, who grew up amid religious warfare in Scotland, was an earnest Christian. In 1594 he devised the exponential method of expressing numbers (22 5 4; 23 5 8; etc.), and spent 20 years working out complicated formulas for obtaining exponential expressions for various numbers, including trigonometric functions needed so much in astronomical calculations.

He called these new numbers logarithms, or "proportionate numbers." In 1614, he published his tables of logarithms, which were not improved on for over a century. Scientists everywhere eagerly grasped them. Now it was possible to do complex multiplication and division, simply by adding or subtracting numbers.

Napier became famous for his logarithms, so much so that few today remember that it was Napier who also invented the decimal point-and thus gave us decimal fractions.

PASCAL-(Pas-kal') Blaise Pascal (June 19, 1623-August 19,1662). French mathematician and physicist.

Pascal was a sickly child that nearly died in infancy. But he was later seen to be a mental prodigy. By the age of 9, he was reinventing Euclid's first 32 theorems; at 16, he published a book on conic sections that was more complete than that of anyone before his time. When he was 19, he had invented a calculating machine operated by cogged wheels which could add and subtract. Pre-electronic cash registers in the 20th century were based on it.

Shortly after that, he laid the basis of the modern theory of probability. Turning to physics, Pascal studied fluids and came up with Pascal's principle, which is the basis of the hydraulic press, which Pascal then described in theory.

Turning to the atmosphere, Pascal correctly theorized the relation of atmospheric weight to altitude, and predicted that a barometer could identify altitude by sensing atmospheric weight. This was shortly afterward proven.

In 1654, Pascal decided to devote the remainder of his life to religious studies, and, after a lifetime of being chronically ill, he died at the age of 39.

PICARD-(Pee-kahr') Jean Picard (July 21,1620 - July 12, 1682). French astronomer.

Picard was a creation scientist who first became an astronomer, and later in life became a priest. In 1655 he became professor of astronomy at the College de France and was one of the charter members of the French Academy of Sciences. He helped found the Paris Observatory, and searched through Europe for capable men to work in it.

Picard was the first astronomer to use the telescope-not merely for observation-but for the accurate measurement of small angles. He also obtained the best clock mechanisms available to record time and time intervals in astronomic observations.

Picard was the first person since the Greeks to measure the earth with any accuracy. Using a star instead of the sun, Picard arrived at almost the exact measurement.

PRIESTLY-Joseph Priestly (March 13, 1733 -February 6, 1804). English chemist.

Priestly was frail, but early revealed a brilliance of mind. In his youth he studied a variety of languages, ancient and modern, but never studied science formally. Yet it was in that field that he did his outstanding work.

In 1766 he met Benjamin Franklin who was in London in a vain effort to solve the taxation problem and avert the Revolutionary War. As a result, Priestly decided to enter a career in science.

Priestley researched into electricity and was the first to discover that carbon is an electrical conductor. He then wrote an important history of electrical research in 1769, followed by another on the history of optics. He predicted that electricity would eventually become important in chemical research.

Fermenting a grain produces a certain gas. Priestly noted that this gas snuffed out flames, was heavier than air, and part of it dissolved in water. Priestly had found carbon dioxide. Priestly studied more gases and found nitrous oxide, ammonia, sulfur dioxide, and hydrogen chloride. He also isolated oxygen.

Later he investigated and named rubber from a South American tree recently brought to Europe.

PASTEUR-(Pas-teur') Louis Pasteur (December 27, 1822 - September 28, 1895). French chemist.

Pasteur was an average student in school, although showing talent in mathematics. He was interested in art and wanted to become a professor of fine arts. But then he attended a series of chemistry lectures by Jean Dumas, and was determined to succeed as a chemist. Immediately his grades in science classes improved.

Upon graduation, this creation scientist began a lifetime of top-flight research work. He received the Rumford medal from the Royal Society for his first research work (separating tartaric acid crystals into both clockwise and counterclockwise planes under polarized light). Ten years later he showed that living creatures only have left-handed amino acids. The implications of both discoveries were important, because of what they revealed about the shape of molecules.

These and similar chemical discoveries gave him a succession of professorial appointments and made him a member of the Legion of Honor. But his research discoveries in biology and medicine were to far overshadow in importance what he had accomplished in chemistry.

In 1856, a Lille industrialist asked the young chemist to solve the problem of why certain liquids (such as wine, beer, and milk) fermented, and what could be done to prevent it. Under the microscope, Pasteur found that such liquids normally contained different types of yeast cells, that fermentation did not require oxygen, and that it was lactic acid yeast which was causing the souring. The solution he offered was to gently heat the liquid to 120°F. He said that this would kill any yeast in the solution, and, if immediately stoppered, the liquid would not sour. That process is today called pasteurization.

Then Pasteur chose to step into a full-blown controversy over the origin of life. The aged Biot warned him to stay out of it, but Pasteur ignored the warning. Because this point is a subject of concern in this present three-volume set of books (especially chapter 9), we will view it here in some detail:

A century earlier, Lazzaro Spallanzani had run experiments showing that when a vessel is heated, no life afterward forms within it. But in Pasteur's day, the spontaneous generation advocates-especially Ernst Haeckel-maintained that Spallanzini had, by his experiments, destroyed vital principles in the air-and this prevented lifeless chemicals from changing into living creatures.

Pasteur was a fervent creation scientist, and he was determined to enter this controversy. He was certain that there was no evidence that life sprung spontaneously from chemicals. So he devised an experiment in which the air in the vessel was not heated.

Pasteur showed that dust in the air included spores of living organisms and that by introducing dust into nutrient broths he could cause the broth to swarm with organisms. The next step, then, was to show that if the dust was kept out, no organisms could form in the broth. In 1860, the year after Darwin's book was published, Pasteur boiled meat extract and left it exposed to air, but only by way of a long, narrow neck bent down, then up. Although unheated air could circulate throughout the tube, the dust particles would settle in the entry-way bottom curve. As a result, the meat extract did not spoil; no decay took place; no organisms developed. Haeckel could not say that "vital principles" in the air had been destroyed by heating the air.

Pasteur announced the results at a meeting of the Sorbonne on April 9, 1864. A committee of scientists, under the direction of Dumas, studied the experiments and found them conclusive. There was no doubt that Pasteur was right and that the theory of "spontaneous generation" had been disproved.

This experiment, incidentally, greatly helped scientists develop better techniques for sterilizing nutrient cultures, and thus aided the science of bacteriology.

By this time, Pasteur was considered the greatest chemist in all of France. In 1862, a disease in southern France threatened to wipe out the silkworm industry. Traveling south, Pasteur examined the silkworms with his microscope, and found a tiny parasite was infesting both the worms and the mulberry leaves that were fed to them. Pasteur ordered all infested plants and worms immediately destroyed. This was done and the silkworm industry in France was saved.

Pasteur's attention was now fully turned toward communicable disease, and he developed the germ theory of disease, which said that germs could cause disease and they could be passed from one person to another.

During the Franco-Prussian War, he urged physicians to boil their military hospital instruments and steam their bandages in order to prevent death by infection. To whatever extent this was done, outstanding success followed. So in 1873, Louis Pasteur, who had no medical degree, was made a member of the French Academy of Medicine. .

Next he studied anthrax, a fatal domestic animal disease. He determined that infected animals must be killed and buried deep, and any animal surviving it would thereafter be immune. Pasteur then developed a vaccine to inoculate the herds. Similar methods were established against chicken cholera and rabies (hydrophobia). As a result of his work, the Pasteur Institute was established in 1888.

RAMSAY-(Ram'zee) Sir William Ramsay (October 2, 1852 . July 23, 1916). Scottish chemist.

Ramsay was the son of a civil engineer, and had a strong body, and good mechanical and thinking ability. After studying chemistry, he took positions at various British colleges and universities.

Researchers had found that a mystery was connected with nitrogen, and Ramsay suspected that another gas was mixed with it. In 1894 he experimented and found spectroscope lines of what clearly was' a new gas. He named it argon.

The next year he found helium. It had earlier been named when found in spectra of sunlight. In 1898 he found the rare gases neon, krypton, and xenon. In 1903 he helped another researcher who found the last of these Inert gases, radon. Knighted in 1092, he received the Nobel Prize in 1904.

RAYLEIGH-Lord Rayleigh (John WIlliam Strutt; November 12, 1842 - June 30, 1919). English physicist. Born into wealth, he showed remarkable mathematical ability at Cambridge. Elected to the Royal Society in 1879, he succeeded Maxwell, another creation scientist, as director of the Cavendish Laboratory at Cambridge the same year. Research into wave motion became his specialty. He worked out an equation of the variation between light-scattering and wavelength of electromagnetic waves. This confirmed that it was light-scattering in the atmosphere which caused the sky to appear blue. He next developed equations for black-body, long-wave radiation wavelength distribution.

Rayleigh studied sound waves, water waves, and earthquake waves. His work, along with that of Rowland in America, established accurate determinations of absolute units in electricity and magnetism.

Turning next to chemistry, he found that the atomic weights of oxygen and hydrogen was not 16:1, but 15.882:1. This led him to the discovery that nitrogen sometimes had the wrong weight. Ramsay, another creation scientist, checked into that and found that a new gas, argon (which constitutes about 1 percent of the atmosphere), had been included in the weight of atmospheric nitrogen.

Rayleigh received the Nobel Prize in 1904, and the next year was elected president of the Royal Society. In 1908, he became the chancellor of Cambridge University.

REDI-(Ray'dee) Francesco Redi (February 18, 1626. March 1. 1697). Italian physician.

Redi received a medical degree at the University of Pisa in 1647. In the year 1668, he performed a very important scientific experiment.

For thousands of years, people thought that small creatures, such as worms, frogs, and flies, automatically came to life when manure, mud, pond water and similar non-living substances changed into these living organisms!

This theory was called spontaneous generation. Common folk and deep thinkers (including Aristotle) believed in spontaneous generation. One of the best examples, in their thinking, of this was decaying meat, which produced maggots which hatched into flies.

At about the time that Redi was born, the English physician, William Harvey, wrote a book establishing the circulation of the blood. In it, Harvey noted that it was entirely possible that spontaneous generation might not be true, and that small eggs laid by living creatures had merely hatched. Redi decided to test this idea of Harvey's.

In 1668, he put a variety of meats into eight flasks, then sealed four of them, and left the other four open to the air. Flies could enter the four that were open, and those were the only ones that bred maggots. Next, desiring air to circulate through all eight flasks, he performed the experiment again; but this time with gauze over the openings of four of them. Once again, only the four open flasks bred maggots.

Redi concluded that maggots came from fly eggs, and not from spontaneous generation. Incidentally, this was the first scientific experiment on record when controls were used.

The spontaneous generation theory did not die because of Redi's experiment, for soon Leeuwenhoek discovered microbes, and because they seemed to appear out of nothing, it was thought that they originated by spontaneous generation. The theory of spontaneous generation was believed by many scientists until the middle of the 19th century, at which time another creation scientist, Louis Pasteur, performed a special experiment which totally collapsed the possibility that the theory could be true.

Yet, ironically, that did not eliminate belief in the theory of spontaneous generation. For Charles Darwin's 1859 theory, which came to be known as evolution, required spontaneous generation. Evolution in all its forms (Darwinism, neoDarwinism, Saltation theory, etc.) absolutely requires spontaneous-generation. Yet scientific research has repeatedly disproved the possibility that spontaneous generation can occur. Redi in 1668 was the first scientist to disprove it, Spallanzani in 1768 was the second, and Pasteur in 1860 was the third. But evolutionary theory survives because its advocates consistently ignore the mountain of scientific evidence opposed to it.

RIEMANN-(Ree'mahn) Georg Friedrich Riemann (September 17, 1826 - July 20, 1866). German mathematician.

The son of a Lutheran pastor, Riemann planned to become a minister, but was so talented in mathematics that he majored in that field at the University of Gottingen and graduated in 1851.

Although he died of tuberculosis at the young age of 39, he still accomplished much in mathematical research. His best-known contribution to science was a non-Euclidean geometry, published in 1854, that was different than any devised earlier. (His was keyed to geometry on a curved surface.) A half-century later, Einstein based his work on Riemann's non-Euclidian geometry.

SPALLANZANI- (Spahl-/ahn-tsah'nee) Lazzaro Spallanzani (Janaury 12, 1729 - February 11, 1799). Italian biologist.

Spallanzani graduated from the University of Bologna in 1754, and then became a priest to help support himself. He taught at several Italian universities, collected natural history specimens in Turkey in 1785, and visited Naples in 1788 while Vesuvius was erupting.

His primary contribution to science was an experiment done in 1768. Earlier, in 1668, Redi had established that creatures visible to the eye did not originate by spontaneous generation from non-living materials. But many scientists still believed that microscopic creatures came to life by spontaneous generation.

What Spalianzani did was simple enough: He boiled solutions for 45 minutes and then sealed the flasks. No microorganisms appeared In the solutions regardless of how long they stood. Spallanzani found that some of these organisms survived brief boiling, but that none escaped lengthy boiling.

Spallanzani concluded that microorganisms appeared In such solutions only because they were already there; either in the solution, in the air around it, or on the inside of the flask. Clearly, no spontaneous generation occurred, no matter how long the matter remained inside the flasks. In later years, Spallanzllni carried out two other pioneering experiments. In 1779, he showed that sperm cells had to make actual contact with egg cells in order for fertilization to occur.

In the 1790s, he tried to figure out how bats flew in the dark. He covered their eyes and found they navigated and avoided obstacles just fine. But when he covered their ears, they became helpless. Spallanzani was astounded. How could bats see with their ears? If he had taped shut their mouths, he might have come closer to the answer. Bats emit cries with their mouths which they hear with their ears. It was not until the 20th century that scientists discovered those ultrasonic sound vibrations and the principle of radar which bats use.

SWAMMERDAM- (Svahm'-er-dahm) Jan Swammerdam (February 12, 1637 - February 17, 1680). Dutch naturalist.

Swammerdam studied medicine at Leiden University, but afterward spent his time studying things under the microscope. He collected 3,000 species of insects, placed them under the microscope and drew excellent pictures of their anatomy. The drawings were as good as anything produced later, and he is considered the father of modern entomology-the study of insects.

He was the first to show that muscles change shape but not volume. He also found the reproductive organ of insects, which aided in disproving the spontaneous generation theory.

In 1658 he announced a special discovery: he had found the red blood corpuscle (which we now know to be that unit of the blood which carries oxygen to the cells, and carries off carbon dioxide, lactic acid, and other wastes).

STENO-(Stay'noh) Nicolaus Steno (January 11, 1638 - December 5, 1686). Danish anatomist and geologist.

Steno was raised a Lutheran and later converted to Catholicism. Obtaining his medical degree from Leiden in 1664, he eventually became court physician to the Grand Duke Ferdinand II of Tuscany.

Steno carried out many research projects in animal and human anatomy. He found the parotid gland duct (the salivary gland near the front of the back of the jaw), and the fibril nature of muscles. He discovered the pineal gland in animals. Steno was one of the first to decide that fossils were the remains of ancient animals which had died and been petrified.

He also set forth the first law of crystallography.

STOKES-Sir George Gabriel Stokes (August 13, 1819 - February 1, 1903). British mathematician and physicist.

Stokes, a pastor's son, graduated from Cambridge in 1841 with highest honors in mathematics. Within a few years, he became a Cambridge mathematics professor; secretary, and then president of the Royal Society.

He developed Stokes' law, which explains cloud motion, wave subsidence, resistance of water to ship movements, and a variety of other things.

Stokes introduced the word, fluorescence, and did research into it, along with sound and light. He was the first to show that ultraviolet light passed through quartz, but not through ordinary glass.

In 1896 he suggested that the newly-discovered X-rays were electromagnetic radiations, akin to light rays. He received the Rumford medal of the Royal Society in 1852 and its Copely medal in 1893.

DURER-(Dyoo'-rer) Albrecht Durer (May 21, 1471 - April 6, 1528). German art geometrician.

Durer was not only a highly-talented artist, but also a skilled craftsman. An earnest Christian, he lived at the time of the 16th century reformation, and was a personal friend of Martin Luther. One of the greatest artists of history, he was also the inventor of the art of etching. He worked in oils, engraving, woodcuts, as well as etching.

Like Leonardo da Vinci, Durer's interest in art drove him into scientific research. In 1525 he published a book on geometrical constructions, using the straightedge and compass. His discoveries made possible more exact three-dimensional pictures on two-dimensional surfaces. It is considered the first surviving text on applied mathematics. Not only did he explain how to do it, he also provided careful mathematical proofs for his formulas, which included complex curves. He also devised and published mathematical formulas for body proportions.

VIRCHOW-(fihr'-khoh) Rudolph Carl Virchow (October 13, 1821 - September 5, 1902). German pathologist.

Obtaining his medical degree at the University of Berlin in 1843, he became a well-known surgeon, and later university professor. In 1845, he was the first to describe leukemia, and went on to specialize in cellular pathology (the study of how cells become diseased).

In 1860, Virchow stated what became a famous axiom: "All cells arise from cells." This statement, accepted by all scientists today, actually has more meaning than most scientists recognize.

Yes, all living cells today only come from other living cells. But so it has always been! This fact renders the self-origin of life (spontaneous generation) totally impossible. Life must come from life. It can never come from non-life.

Virchow refused to accept Pasteur's germ theory of disease. Virchow considered disease to arise from problems within the body, not from germ invasion from without. In actuality, both concepts are at times correct.

In later years, Virchow went into politics and rapidly rose to high positions in the German government. A thorough despiser of Darwin's theory, he voted in the Reichstag (the German national congress) for a law that banned the teaching of Darwin's theory in the public schools.

WATT -James Watt (January 19, 1736 - August 19, 1819). Scottish engineer.

A frail child with chronic migraines, Watt was taught at home by his mother. As a young man, he went to London and completed an apprentice as a tool and instrument maker, then joined the faculty of the University of Glasgow.

Conversations with a chemist, Joseph Black, about latent heat turned his mind toward the possibility of designing an efficient steam engine. Those in operation (Newcomen steam engines) were produced too little power for the amount of fuel they required.

After repairing a Newcomen in 1764, he set himself to the task of improving on it. He added a second chamber to hold the heated steam, so the first chamber would not have to be reheated each time. Within five years (1769), he had made a far more efficient steam engine, that did its work much more quickly.

In addition, he introduced steam from both sides. In this way the piston could be driven by air pressure in both directions. In 1774 he began manufacturing and selling them. In 1781 he devised mechanical attachments that converted back-and-forth piston movement into rotary movement of a wheel. .

Watts' steam engine rapidly replaced the Newcomen, and by 1800 five hundred of his engines were working in England. His invention quickened modern history, for it began the industrial revolution, lessened home piece-meal work and farm work, and increased cities and slums.

Watt also invented a centrifugal governor that kept the energy output of the steam engine steady, and never too large or too small.

In 1783 he tested a strong horse to see how much it could lift and the distance it could lift it in one second. He defined this amount as 550 foot-pounds per second, or, as he called it, "one horsepower. " When the metric system was later devised, the standard was called "one watt, " with one horsepower equaling 746 watts.

In 1800 Watt retired and received an honorary doctorate from Glasgow University, and election to the Royal Society.

WOODWARD-Robert Burns Woodward (April 10, 1917 - July 8, 1979). American chemist.

Even as a boy, Woodward tinkered with chemistry. Entering the Massachusetts Institute of Technology at 16, he displayed such extraordinary ability in chemistry-and such poor aptitude in some other fields-that, instead of flunking him, the faculty assigned him to a special program. Four years later at the age of 20 Woodward had, not a B.A., but a Ph.D.

He immediately accepted a position on the staff of Harvard. In 1944 Woodward, with Doering, succeeded in synthesizing quinine. This was a total synthesis from chemicals, and not from any animal or plant product. By 1951 he was synthesizing such steroids as cholesterol and cortisone. In 1954 he synthesized strychnine and lysergic acid. In 1956 he synthesized reserpine, and in 1960 chlorophyll. Many more syntheses were to follow. Woodward received a National Medal of Science Award in 1964 and the Nobel Prize for chemistry in 1965.