the wonders of nature

Volumes 1

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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THE EVOLUTION DISPROVED SERIES - BOOK 21-22

A SWEEPING COVERAGE OF THE FIELD - IN LOW-COST BOOKLETS

EDS 21

WONDERS OF NATURE; VOL 1 by Vance Ferrell

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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 ultra-violet 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 mater-ial?

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!