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GOD'S DESIGN VEILED IN THE RIDDLE OF MIGRATORY BIRDS

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I. Introduction

Ever since man has watched the flight of birds, he has think about their disappearance in the Fall and their reappearance in the Spring. Long ago it was noted in the Bible as to the regularity of these seasonal comings and goings:

> *"Even the stork in the sky knows her appointed seasons, and the dove, the swift and the thrust observe the time of their migration"* (Jeremiah 8:7, NIV).

Many different answers were offered to solve this most interesting problem. Through the centuries those who attempted to explain the seasonal migration of birds reached new ideas and thought. Not all birds migrate, but migration is now accepted in many kinds of birds.[1]

Annually, millions of birds leave their wintering grounds in search of food and a place to raise their families. They are guided by the stars, the change in sunlight, landmarks, and the earth's magnetic field - following their ancient instincts. The biological urge that triggers migration causes birds to store up fat for the energy to make their trip. They battle with exhaustion, predators, and storms to reach the breeding grounds. Once the young are fledged, the remarkable trip is reversed.[2]

> *"Experimental works on migratory birds are these: (i) why do birds migrate at all; (ii) how did bird migration originate; (iii) how do birds know when it is time to leave; (iv) how do they know what direction to take; (v) how do birds know when and where to end the journey; (vi) when and how they should prepare themselves for the trip; and finally, (vii) what determines which individuals in a population of partial migrants will go away for the winter and which will stay?"*[3]

Even though some of the questions have been resolved easily, modern scientists are unable to give a clear explanation for the origin of birds' migration. We do not know all of them and can not know all the answers; it may remains an incomprehensible subject in certain areas.

The general ecological facts concerning birds can be taken mainly from the book, "Life Nature Library - Birds". Here, this writer's purpose in sharing this information is to show that the best explanation is God's design and plan for birds to adapt themselves to new circumstances.

II. Dispersion of Migratory Birds and Mystery of Migration

In a broad sense, migration means any traveling to go from one place to another place. Motility is almost universal among animals; they are not rooted to their environment, as are the plants. When applied to birds, migration usually means a two-way journey, a yearly round trip. The paths that migratory birds take often follow geographic features such as mountain ranges and river valleys. These paths may vary from year to year and also by species. Many migrants travel with a series of short flights and frequent stopovers. Others make longer flights.

To collect the basic information about destinations of migration, banding or ringing have been applied to many millions of birds extensively on all continents. Today some institutes use modern special equipment to detect signals from small transmitters attached upon birds, sometimes dyeing has been used to check the movements of birds.

A great number of North American species and a similar proportion of European birds take part in the great pageant of migration. Actually, migration is most pronounced in the long

migratory birds, much-larger lands of Northern Hemisphere are covered seasonally with winter's ice and snow. A considerable number of Eurasian and North American birds cross the equator to spend the winter season in Africa or South America, but a few land birds of the latter two continents do not cross the equator. They may journey northward toward the equator, and quite a number do, but the few do across the equator for a great distance.

By the recordings, an arctic tern picked up 90 days later on the coast of southeast Africa, 9,000 miles away. Another tern flew more than 10,000 miles from Greenland to reach southeast Africa. Still another, ringed on the Arctic coast of Russia, was retaken off Australia, a distance of at least 14,000 miles. The arctic tern will be certainly long-distance migrants.

Though there are vast places in the Arctic tundra during summer time, for golden plovers and other shore birds, no birds could survive there for eight or nine months of the year. However, by travelling from the arctic tundra to pampas of Argentina, 8,000 miles distant, they enjoy two summers each and do not know winter's bleaker climate.

The white-rumped sandpiper also makes the same autumnal sea hop from maritime Canada to the tip of the Antarctic, they does not stop in the latitude of the pampas, continues for more than 1,000 miles, to the end of the South America. And Baird's sandpiper makes an equally long journey from the Arctic via the high plains and the high Andes. Although their paths may be more than 2,000 miles apart- one over sea, the other through the interior -, these two sandpipers often finish their journey on the same Patagonian beaches of South America's end point.

Among land birds, the bobolinks navigate 7,000 miles or more between the clover fields of Canada and the grasslands of Argentina. Some barn swallows, however, may travel up to as much as 9,000 miles, for the species breeds north to Alaska and some reach southern Patagonia.

The most famous migrants in Europe is the widely beloved white stork. Sometimes they ride the thermals to a great height before gliding the 10 miles over water to Africa. Storks in Germany take a southeasterly course and enter into Egypt, following the Nile and then spend their wintering grounds in Rift Valley. For a Danish stork this is a journey of 8,000 miles.

What does the migration experience say about God? There are many phrases concerning birds and God's care of them in Scripture. For examples:

> *"Yet not one of them[birds] is forgotten by God"* (Luke 12:6, NIV).
>
> *"Look at the birds of the air; they do not sow or reap or store away in barns, and yet your heavenly Father feeds them"* (Matt 6:26, NIV).
>
> *"Even the stork in the sky knows her appointed seasons, and the dove, the swift and the thrust observe the time of their migration"* (Jeremiah 8:7, NIV).

The white-rumped sandpiper, which migrates from Argentina to the Arctic, belongs to the group of birds that are among the fastest flyers. Some sandpipers have been clocked at more than 100 miles per hour. Many birds have been seen from airplanes. Some birds migrating long distances over water may fly as high as 14,000 feet. The highest altitude recorded thus far for migrating birds is 29,500 feet for geese near the northwest India.

III. How Birds Navigate During the Migration

Migration is the greatest adventure in the bird's life. They have to endure the greatest risks. They seem to have not any built-in weather-forecasting system, as some people assist, but flight seems to be stimulated by the barometric pressure and other meteorological or unknown conditions prevailing at the start of their journey. They do not foresee the weather, storms, strong winds or fogs they may encounter along the way, conditions that may carry them

so far to sea at night. They might be unable to return to the land when they lost their flight position, sometime they died from collision with barriers in land.

Nevertheless, there are four theories that are accepted the most by biologists, and birds will use one of methods, or a combination of these theories. Some theories about birds' navigation methods are as geophysical, astronomical, sun's co-ordinates, etc. Experts feel that bird's navigation methods are based on these theories or combinations of these theories. The methods used for migration are as follows:[4]

A. Use of visual landmarks: The idea of birds using landmarks to navigate has long been a popular theory. Many birds have been known to follow visual clues such as rivers, coastlines, and mountain ranges in order to arrive at the correct destination. However, this idea does not explain how birds find their way during their very first migration without getting lost.

B. Use of the sun: Birds, like humans, possess an internal circadian clock that allows them to track the daily light-dark cycle. Along with this internal clock, birds use the sun's shadows to gain a sense of location. Through the use of these two devices, birds are able to use the sun as a compass. This theory is supported by an experiment that was conducted with homing pigeons. The pigeons were kept in an artificial cycle of light and darkness that was out of step with the natural 24-hour cycle. As a result, the birds misinterpreted the position of the sun. Upon being released in an unfamiliar location, instead of orientating themselves toward their home range, they orientated in an incorrect direction. One of the main problems with using the sun as a compass is that birds cannot compensate for the rapid changes in time zones that occur when they make a long transfer in an easterly or westerly direction in a relatively short period of time. This problem would increase as the birds approach the poles, where longitude lines become closer together.

The late Gustav Kramer of Germany brilliantly showed that birds which travel by daytime would orient themselves by the position of the sun. On the other hand, on cloudy days when the birds could not see the sun at all, they were unable to align themselves properly.

The creatures have an internal time clock by which they are ruled. This can be explained as the result of God's creation: the same as the 24 hours comprising one day and night during creation week.

C. Use of the stars: Because many birds migrate at night, the sun is not available as a guide. These nocturnal migrants have learned to use the stars for navigation. In the Northern hemisphere, the constellations appear to rotate around the North Star. Birds can orient themselves in relation to the North Star, and unlike the sun-compass, this "star-compass" is not time dependant. Young birds learn this pattern of rotation and use this to distinguish north from south. This theory is supported by an experiment that was conducted with indigo buntings. Two groups of young buntings were kept in a planetarium. One of the groups experienced the planetarium's "sky" rotating around the North Star. The other group experienced the constellations rotating around Betelgeuse, a star in the constellation Orion. Normally indigo buntings migrate south in the autumn, and when it came time to migrate, the birds that had seen the constellations rotate correctly orientated themselves to the south, away form the North Star. In contrast, the other birds orientated themselves away from Betelgeuse. Some birds are able to use patterns of stars, small clusters of stars, or the moon to determine what direction they need to fly.[5] A disadvantage of using the stars to navigate is that the North Star cannot be seen in the southern hemisphere. Another problem arises on cloudy nights, when the stars cannot be seen.

Although there is increasing evidence that birds use celestial navigation in establishing the main direction of their travel, it still remains a mystery how they pinpoint their goals. In

addition to radar, there have been numerous setups employed to obtain more precise information about navigation.

D. Use of the earth's magnetic field: Biologists have two different theories on how birds can use the earth's magnetic field to navigate. One theory is that birds have certain pigments in their eyes that become weakly magnetic when they absorb light and thus alter certain nerve signals which the eyes send to the brain.[6] A second, and more popular theory, comes from the fact that scientists have detected tiny crystals of magnetite along the olfactory tract in the brains of some birds.

A problem arises with magnetic navigation, because the magnetic poles and the magnetic equator do not coincide with the geographic poles and the geographic equator. Some biologists think that the magnetic compass is not based on polarity, but the inclination of the magnetic field. Others say that the magnetic compass is recalibrated against the sun and star compasses during rest stops along the migration route, and that if the birds do not have enough time to rest, they may get lost.[7]

Biologists still do not know how the birds can sense the position of the magnetite crystals in their heads, and there is little experimental data on the subject. Interestingly enough, some researchers say that humans have the ability to sense the magnetic field as well. This came about after researchers at the California Institute of Technology identified crystals of magnetite in human brains. They did not know if these crystals were sufficient to give humans an unconscious magnetic sense, but a later experiment showed that might be true. Robin Baker and his colleagues at the University of Manchester blindfolded volunteers and drove them to unfamiliar locations. Still wearing the blindfolds, some of the volunteers could state their direction relative to "home". But those wearing bar magnets on their heads lost the ability.[8]

"Careful tests with homing pigeons and other birds displaying the ability to judge direction show that the birds are affected by changing magnetic fields. Small coils placed near the birds' heads to create unnatural magnetic fields there do disturb the ability of pigeons to find home. Magnetic storms do the same. If birds are released at places where the earth's magnetic field is anomalously strong, their homing ability is entirely disrupted.

A possible reason why birds can sense the earth's magnetic field and perhaps use it for navigation is given by Charles Walcott and co-authors in the 7 September 1979 issue of Science magazine. Dissecting a number of pigeons, these scientists found the equivalent of a compass needle in each pigeon's head.

Next to, or essentially in, each pigeon skull, they located a tiny piece of tissue 1 mm by 2 mm (about 1/16 in by 1/8 in) that was somewhat magnetic. Searches inside this tissue with an electron microscope revealed the presence of more than ten million tiny crystals each four times as long as wide. Other tests demonstrated that these crystals were magnetite, the iron-oxygen compound of which compass needles are made."[9]

"How birds find their way from a northern Wisconsin pine tree, south to the Amazon and back again is still not completely understood by science. But a half-century of research is shedding some light on this amazing feat.

Birds can track the sun, the moon and the stars, using their apparent movement as a compass. Birds also use other senses. They can detect weak magnetic fields with tiny magnetite crystals in their heads. They follow faint odors as does a salmon returning to its birth river from the ocean. They can see polarized light and use barometric pressure. Along with memory and genetic urges to head in a certain direction, birds use a combination of these senses to cross continents and oceans."[10]

Moreover, recently it was discovered that monarch butterflies have an internal magnetic compass that enables them to make their winter journey without the guidance of sunlight. According to the researchers' findings, the monarch butterflies subjected to normal magnetic conditions flew in a southwest direction. When those conditions were reversed, the same butterflies flew northwest. And when the butterflies were released in a room encased with a nickel-iron alloy that screened the magnetic field, they showed no consistent direction.[11]

As mentioned in above paragraphs concerning the birds' navigation, it was proved that some fishes and butterflies also use their magnet-detecting senses.

"One of the mysteries of nature is how salmon manage to navigate in the oceans and return to spawn in the very same streams from which they came. It is known that the odor or taste of the particular stream plays a role. Salmon can home-in on the smell of "their" stream if they are sufficiently close to its mouth so that the water has not been diluted to the point where it is unidentifiable.

But how can odor play a part when the fish migrate over thousands of miles in the open ocean and cross ocean currents which destroy any possible "trail" that may lead them back? At any rate, it is known that salmon do not follow meandering paths back "home" to answer the spawning instinct, but travel directly to their spawning grounds by the most direct route when sexual maturity occurs.

For example, sockeye salmon leave their freshwater origins in the streams entering Bristol Bay and make their way to the Alaska Gyre in the North Pacific and western Bering Sea. They then complete one or several circumnavigations of the Gyre before starting their spawning migrations back through the Aleutians. The important point is that regardless of surface currents or other oceanographic features, the migration pattern is abruptly interrupted at any point in the circuit where the fish may find themselves when they attain the sexual maturity which induces spawning. In other words, there are no road signs pointing out the way back to their stream from the open ocean, so the fish must have some internal "map sense" by which to navigate.

What is it that points them in the right direction? Probably there is more than one homing mechanism that fish use to find their way. An olfactory "imprint" is made on smolts as they leave their home stream. This enables them to identify it by smell as they approach it later from the ocean. But to approach the stream mouth from the open sea, at least one other imprint must first be made in order for them to arrive in the general area. It has been shown that some fish are remarkably perceptive of the sun's azimuth and altitude, and that they are sensitive to the time of day. Under ideal conditions, this would permit a method of determining geographic north. But in a region where overcast conditions predominate (as they do in the North Pacific and Bering Sea), and because the fish move at night and in deeper water during the day, celestial clues are not consistently available. Therefore another means of correcting navigation is probably used. It is strongly suspected that the ability to sense the earth's magnetic field may provide this additional method.

It has already been demonstrated that such diverse creatures as homing pigeons, salamanders and bees can detect a magnetic field. So can salmon fry; that will change their orientation when subjected to an artificially applied magnetic field.

Extrapolating these findings to the migration process, the conjecture is that, after the salmon fry have grown to smolts and entered salt water, chemical and hormonal changes occur which imprint upon the fishes' nervous system a "memory" of its magnetic latitude and longitude at the time that it enters the ocean.

There appear to be two possible ways by which the magnetic field can influence a fish's nervous system. The first is that the ferromagnetic mineral magnetite in the creature's brain may function as a biological compass which is "set" at the time of entry into the ocean (magnetite occurs across the biologic spectrum from bacteria to dolphins). The information retained is the vertical and horizontal components of the earth's magnetic field at that point, and the declination of the horizontal component, which is the difference between magnetic and true north, presumably determined by the sun. These factors taken together provide a combination that is unique for any geographic location." [12]

E. Other bird navigation theories: There are several other, less-accepted theories dealing with bird migration as well. One of these deals with birds using polarized light from the sun as a compass. Normal sunlight oscillates in random orientations, but sunlight coming from distant parts of the sky is usually polarized. This results from particles in the atmosphere scattering some orientations of light more than others. Some biologists say that it is likely that birds use polarized light as a source of compass directions, because it would work even if the sun was obscured by clouds.

Another theory is that some birds use smell to navigate. Researchers found that they can disorientate pigeons by exposing the birds to air collected at one site and then temporarily destroying their sense of smell with a local anaesthetic before releasing the birds at a different site.[13]

Despite all the theories and experiments dealing with navigation, there is much that is still not understood about how birds determine their position in relation to a fixed goal. For example, a Manx Shearwater bird was transported from its burrow in Wales to Boston, several

thousand miles away. Yet within 12 days, the same bird was back in its burrow in Wales.[14] This is just one example of birds' amazing navigational and orientational ability that still mystifies biologists. Automatic devices have been used in a wide range of experiments concerned with migratory restlessness and orientation as displayed by caged migrants.

IV. What causes birds to migrate?

What causes birds to migrate? When did the practice of migration begin? Some scientists suggested that the ice sheets during the Ice Age might have been originally responsible. Most creation scientists have been thought the Ice Age existed for hundreds of years according to local area after Noah's Flood because of change in weather. Birds were forced to migrate southward fleeing from advancing glaciers, and followed them back when glacier receded. In evolution theory, each winter is now like a brief reoccurrence of the ice age, with the birds retreating to their ancestral haven and returning when the snow and ice have gone. This idea sounds plausible, but it does not explain migration in many parts of the world that have never been touched by glaciations. Consequently most ornithologists now reject this theory as a basic cause of migration.

There is no question that the birds that originated in warm climates spread outward in their search for food. After Noah's flood, many found food in abundance in higher latitudes but were forced to withdraw when winter came.

What stimulates birds to begin their migration at approximately the same time each year - what internal clock or what external stimuli? From physiological point of view, we know that the endocrine glands, the controls that make male birds sing and females lay eggs, undergo

great changes before the nesting season. There are other changes after the nesting season is over. Most birds migrate during this periods. We know, too, that one of the forces that seem to start these changes is light - the increase of light in the spring and the decrease of light in the fall. When the right day comes, the bird, without any thinking how or why, leaves for its distant goal, their new grounds.

We attributed all these magnetic mysteries to God's design, the same as we do with many other kinds of animal migration.

The factors that initiate migration are so complex as to be the despair of analysts. The annual stimulus may be reflected in the states of the gonads in some species, but not in others. Some birds build up a fat reserve, but others do not. Light and meteorological conditions seem to trigger migration in some birds but not in others.

Birds have extraordinary stamina to travel long distances, these long-distance migrants have the ability to store a vast fuel supply in the form of fat, sometimes doubling their weight. Moreover, the greatest wonder of migration is the manner in which birds find the way - their navigation. Just how do they go long way themselves just directly over unknown country?

A large number of all migratory birds' travel at night even they cannot easily make use of landmarks. However, some waterfowl or geese are thought to be benefited by existing members of flock who know the traditional path they already experienced by visual memory of stopping places which might not be in a straight line. How else can we explain such journeys as European white stork, or of the Ross's goose which, migrating southward through the North American plains, makes an abrupt westward turn in the vicinity of Great Falls, Montana, to cross the Rockies?

Besides these mysteries, scientists pursued their works about how birds can take "home-coming" abilities over unknown territory, by releasing the birds that has been snapped; some achieved notable records. A European swift transported 155 miles for its homing in four hours. A Laysan albatross, released 3,200 miles apart from it's home, returned within 10 days. A male shearwater that had been moved to Boston Airport flew 3,050 miles back, across the Atlantic ocean to arrive at its burrow on Skokholm Island 12.5 days later.

Some scientists have suggested that perhaps birds are able to record and memorize in some way all the twists and turns made by the vehicle that transported them and that, when returning, they simply retrace these twists and turns. To test this fact, one cage was trained 90 miles away, this cage was put on a phonograph turntable that revolved 5,000 times during the railroad journeys. Yet when this bird was released, it returned home as quickly as that in the other cage. More results that are conclusive were obtained when pigeons were transported in dark drums that rotated erratically.

Students of migration have also advanced the idea that birds are sensitive to the earth's magnetic field and may be able to measure it. It has further been suggested that their inner ear react to the Coriolis effect, the mechanical effect produced by the rotation of the earth. In recent years, scientists have been accumulating data at an increasing pace, but even these data are often so contradictory that they give no clear answers.

V. Conclusion

Navigation is the part of migration that has puzzled biologists the most. For some species, biologists still do not know how the birds navigate thousands of miles to the exactly same place every year.

How birds can find their way with apparent ease over vast distances remains the unsolved riddle of migration. So precisely can they follow their invisible paths that scientists have from time to time suspected that birds possess a special sense unknown to man. At one time they were thought to have a kinesthetic sense, by which they could form patterns of their route through pressures on the inner ear. Another idea was that birds navigate through responses to the earth's magnetic field, perhaps even to its rotational effects. None of these hypotheses has, however, stood the test of experiment.

More convincing is the evidence that the bird's vision plays the primary role in its sense of direction and position. If the bird locates itself by means of visual landmarks like river valleys or mountains, it is only a step further to the idea advanced by Gustav Kramer and others that a bird might be able to use the sun as a compass and even have a time sense which enables it to adjust its course to compensate for the sun's movement across the sky.

Ellen G. White said early as to migratory birds as follow:

> *"The swallow and the crane observe the changes of the seasons. They migrate from one country to another to find a climate suitable to their convenience and happiness, as the Lord designed they should."* [15]

> *"The animals themselves are to be his teachers. . . . And the birds are teachers of the sweet lesson of trust. Our heavenly Father provides for them; but they must gather the food, they must build their nests and rear their young. Every moment they are exposed to enemies that seek to destroy them. Yet how cheerily they go about their work! how full of joy are their little songs!"* [16]

"The birds which were caroling forth their songs without a care, the flowers of the valley glowing in their beauty, the lily that reposed in its purity upon the bosom of the lake, the lofty trees, the cultivated land, the waving grain, the barren soil, the tree that bore no fruit, the everlasting hills, the bubbling stream, the setting sun, tinting and gilding the heavens— all these He employed to impress His hearers with divine truth. He connected the works of God's finger in the heavens and upon the earth with the words of life He wished to impress upon their minds, that, as they should look upon the wonderful works of God in nature, His lessons might be fresh in their memories." [17]

In Bible we may think about following phrases:

"Ask the animals, and they will teach you, or the birds of the air, and they will tell you: . . . Look at he birds of the air, . . . your heavenly Father feeds them." (Job 12:7, 8; Matthew 6:26, NIV)

Here, let's examine three views of point. First, do all the birds migrate? No. Not all birds do migrate. Therefore, the migration is not the law of all flying birds. Secondly, do the migratory birds select their routes according to their conditions or status? Do they select this flyway and others at another times by chance? No! Though their route differs somewhat annually, they mostly take same flyway with same season! Their special chances do not control their habitude, or even the migration! Third, before sin, there would be no migration. In Eden, there was no effort to breeding their flock. But after Flood, they faced a ruined earth and the worst circumstances. Therefore, they had to move somewhere to avoid the winter cold, realizing the need to migrate.

Now we can consider the earth's magnetic field and gravity. The magnetic field changes according to latitude of the earth and height, and the strength of gravity changes according to latitudes too, though we usually say, "gravity is constant". God created the earth,

filled it with all kinds of creatures, and designed each of them to be adapted to their circumstances. Also, sun radiates the light and electromagnetic energies to the all creatures. All creatures might feel quantum energy (or affected although they cannot feel it). God designed the birds to make good use of their tiny variation in energy and also gave them abilities to detect even the smallest amount of gravity and magnetic field in ways that are unknown to man, and to orient themselves toward this direction. It is God's intelligent design and providence!

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