'BIRDS AS SOLAR MACHINES'—THE SUN'S PLACE IN BIOLOGY

By AUSTIN L. RAND
CURATOR OF BIRDS

The energy with which birds hop and fly, sing, and build their nests, comes from the sun. The materials that compose the bird's body, the materials of which each new coat of feathers is composed, and the substance that goes into the eggs, all come from the earth ("Dust thou art and unto dust shalt thou return").

But not directly. Plants are the only living things that can use directly the sun's energy and combine it with raw materials from the earth. Through the green stuff, chlorophyll, in their leaves, plants use the sun's energy to photosynthesize carbon dioxide and water into carbohydrates, and these may then be combined with mineral matter into other compounds, the compounds that form roots, stems, leaves, flowers, and fruit.

We would have no birds at all if it were not for the mantle of green vegetation that covers the earth. The dependence of birds on plants is more than a habitat preference and more than a need for shelter or nesting sites. Plants are the necessary converters that make energy and material available in a form birds can use. Without plants, all birds, with all animal life, would starve.

Birds eating these plant substances (fruit, seeds, leaves) are one stage removed from the source of raw materials. A great many birds live largely on other animals; the diet may vary from plant lice to dead mammals. But if you follow the chain back, sooner or later it will come to a plant eater. A vulture may feed on a cat that ate a shrike that ate a grasshopper mouse that ate grasshoppers that ate plants. The dependence on plants is inescapable. Though the plants are a necessary link in the chain, the final dependence on the sun for energy is also inescapable.

The use of the term "solar machines" in reference to birds is based on this dependence on the sun for energy as well as on the earth for material, and the bird as an organism takes in the material, its food or fuel. This is changed in the bird so that energy stored in the plant material is released and used in activity and heat production, and the material is changed into bird tissue or waste.

This simple but basic principle, true for most other animals as well as birds, is set forth in a new exhibit in Hall 21, devoted to the systematic exhibits of birds. The sun appears at the upper left, yellow in color, with the words "Energy from the Sun" across it. The earth at the lower left, in blue and green, is labeled "Minerals, Water, Carbon Dioxide from the Earth." Between them stands a tree symbolizing vegetation, which alone can utilize the two directly.

In the first column are some plant products utilized by animals: seeds, fruit, grass, leaves, and algae. Opposite each is one kind of animal that eats them—the sparrow eating seeds, the cedar waxwing eating fruit, the mouse eating grass, the caterpillar eating leaves, and the tadpole eating algae. These depend on plants and are one stage away from the raw material.

In the next column are birds two or more stages removed from the raw material, birds that feed on plant-eating animals—the hawk eating a sparrow, the owl a mouse, the oriole a caterpillar, and the heron a frog (frogs in adult life eat insects, but when young, as tadpoles, eat such plants as algae).

At the extreme right is the digestive system of a grouse, part of the bird's apparatus for using the bird's food (or fuel). The bill is used in seizing the food, as birds have no hands. The food goes down the gullet into the crop, where it can be stored until needed. Then it goes into the glandular stomach where gastric juices are secreted. In birds that eat grain or other hard food, the stomach may have thick muscular walls and be a gizzard, whose muscular activity helps to break down the food by mechanical

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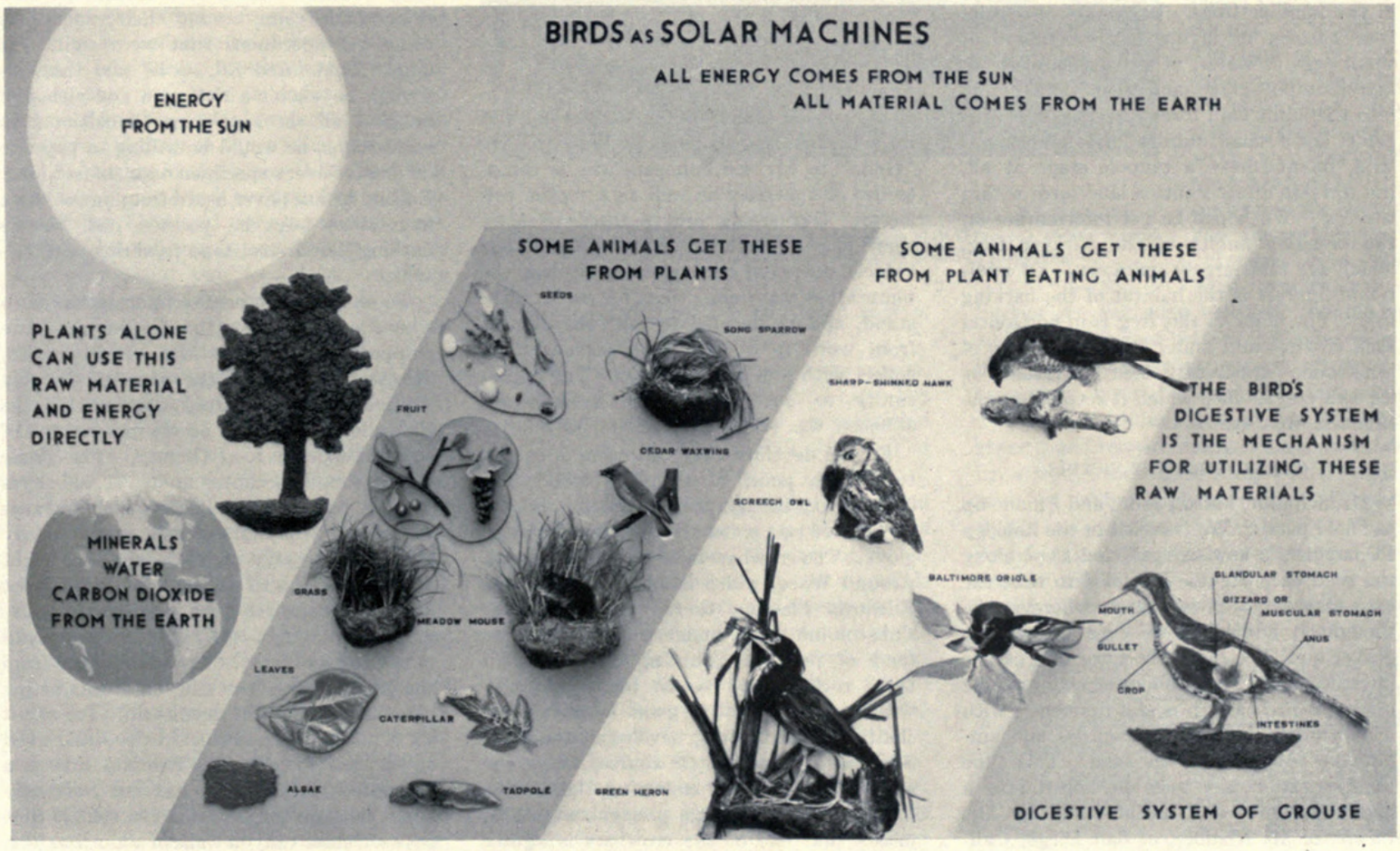


THE SUNLIGHT-EARTH-FOOD STORY OF BIRDS APPLIES EQUALLY TO ALL OTHER FORMS OF LIFE

The chain could be similarly charted for insects, reptiles, fishes, mammals, and other members of the Animal Kingdom—including, of course, Man.

TRAIL OF THE TEXAS BARKING FROG

By ROBERT F. INGER
ASSISTANT, DIVISION OF REPTILES

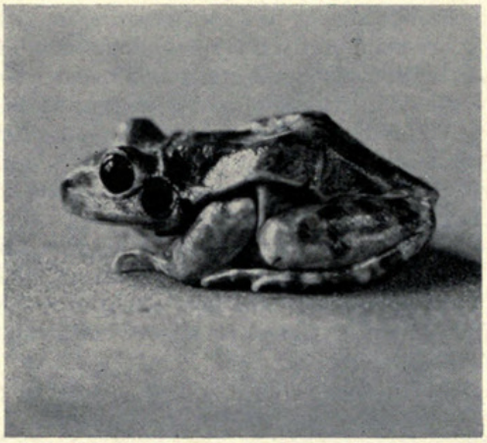
FOR a number of years Mr. Karl P. Schmidt, Chief Curator of Zoology, has been spending several weeks each spring in Texas. This spring I was privileged to make the trip with him. In planning our destination, we decided it would be a good idea to get specimens from the southwestern escarpment of the Edwards Plateau, a limestone formation that occupies west-central Texas. The collections of the Division of Reptiles contain specimens from only the northern parts of the escarpment, particularly from the region around Waco, where Mr. J. E. Johnson, Jr., a frequent contributor of specimens, has been an active collector for a number of years. The selection of the southern part of the Edwards Plateau, a part of Texas not previously explored herpetologically by Mr. Schmidt, fitted in with his study of the fauna of the state.

That region is also the home of the "barking frog," *Eleutherodactylus latrans*. This frog has a remarkable call that somewhat resembles the barking of a dog. This frog is interesting for a number of reasons. First of all, it represents the northernmost member of a tropical American genus. As far as is known, species of this genus, *Eleutherodactylus*, have breeding habits that are quite different from those of the familiar frogs. Instead of the usual frog pattern of laying large numbers of small eggs in water, of passing through an active tadpole stage, and then transforming into the adult land form, the species of this genus lay a small number of large eggs on land, do not have a tadpole stage at all, but develop directly into a land form within the egg. We hoped to get information on the breeding habits of the barking frog, which are still largely unknown. Of additional interest is the habitat of the barking frog. The home of this frog is in horizontal rock crevices and under large flat blocks of limestone. Apparently each individual has its own crevice into which it retreats at the slightest disturbance.

COLLECT HIGHWAY VICTIMS

Mr. Schmidt, his son John, and I made up the field party. We traveled in the Zoology Department's new carryall and slept along the road each night. We tried to take the least-traveled highways and, wherever we thought it advisable, we even drove over gravel and dirt roads, because one of the interesting and profitable observations to be made on such a trip is the frequency with which different species of reptiles and amphibians are seen on the road. This type of observation has been developed into a highly accurate and useful study by Dr. Lawrence M. Klauber, of San Diego, California. Dr. Klauber has kept detailed notes on hundreds of auto trips that he has made in southern California in the course of the last twenty years, recording each specimen seen along the road. Using such data, he has been able to make valuable estimates of the reptile and amphibian populations of southern California and draw exact maps of their distributions. Usually such specimens are found dead on the road, and it is now customary to refer to such specimens as "dead on road." Final contraction of this term has led to the use of DOR. By traveling on the least-frequented roads our opportunities for spotting DORs were increased and we found the scenery, minus billboards, much more beautiful.

Our route carried us along the north bank of the Illinois River, through the Ozarks region of Missouri and Arkansas, through



BARKING FROG
His call sounds like a dog's bark

the Ouachita Mountains of Oklahoma, and into Texas. We stopped in Waco to say "Hello" to Mr. Ed Johnson, who is comptroller of that city as well as a reptile collector. Our seeing him resulted in more than just a "hello." When he saw our vehicle and us in our collecting clothes, the temptation was more than he could withstand, and he decided to take the day off from work if we could be persuaded to collect with him around Waco. The opportunity to collect with the veteran Ed Johnson was far too interesting to miss.

Ed has developed the collecting of snakes to a high point of technical skill. His equipment, though simple, is unique. It consists of two crowbars and an old leather glove. The crowbars need further comment. Around Waco, which is on the edge of the Edwards Plateau, there are many large slabs of limestone under which snakes are fond of retiring. Turning over some of these rocks would be an impossible task without the aid of a good lever. Drive shafts from old Fords, beveled at the ends, serve this purpose. Of course, when one spends the entire day collecting, these crowbars are apt to become pretty heavy. Ed insists that one of the crowbars is lighter than the other and that he always gives the lighter one to the visitor. However, it seemed to the one of us who carried the bar that the one we had must be the heavier. We tried swapping crowbars with Ed from time to time but that didn't seem to make much difference.

'BIGGEST ONES GET AWAY'

The day's collecting was not profitable so far as the number of specimens collected was concerned; however, a day in the field with Ed Johnson is not without its rewards. Some of the stories of his own experiences with which he regaled us are worthy of note. As I said before, Ed has been collecting around Waco for many years. In Texas the western diamondback rattler is a much discussed and prominent feature of the fauna. Ed has collected his share of this snake. As is usual with most human beings where snakes are concerned, Texans are quite apt to exaggerate both as to the size and the number of rattlesnakes in their own bailiwicks. Ed has had to put up with this minor irritation for a long time. He says that if you get three Texans together and show them a big rattler at least one of them will tell you, "Why, that's just a small one!" Ed was particularly annoyed one time when he got a rattler that measured five feet eight inches, a remarkable length, by the way. Ed showed this snake to some of the men who saw him on his way in and was met with the usual, "That's just a small one." Some of the men even claimed that if he would come around their ranches he could get specimens that were eight feet long. That irked Ed, so he said that, although he wasn't a rich man and although he gave all the specimens he collected to institutions, he would be willing to pay five dollars for every specimen over six feet long. Ed said he has never heard from one of those men since. As he pointed out, there's nothing like a steel tape to shrink a rattlesnake.

To obtain some precise information as to where we might get the barking frog, we stopped to talk to Mrs. Roy Quillin, directress of the Witte Museum in San Antonio. She suggested that we try the Prade Ranch, located on the headwaters of the Rio Frio in Real County. The Prade Guest Ranch occupies about 10,000 acres on the southern limits of the Edwards Plateau. Mr. Earl Prade very kindly allowed us to stay on the ranch that night and directed us to an old cabin at a point about eight miles from the ranch house where he thought we might be successful in getting the frogs. The eight miles from the ranch house were the most interesting miles traveled on the entire trip. For about six of these the road runs in the stream bed of the Rio Frio itself. The Rio Frio is a spring-fed stream that has cut vertically down through the limestone so that it runs between sheer canyon walls of about 100 feet. Since the stream has now begun to cut sideways, the lower 25 feet of the canyon

walls are undercut. This undercut portion is plastered with the globular mud nests of cliff swallows.

The actual business of collecting barking frogs didn't start until after dark when they first began to call. Although none of us had any previous experience with this species, there was not the slightest doubt in our minds as to what animal was the author of that call. The first one we heard was across the main canyon, but we decided to try a small branch first. After about ten minutes of walking up the bed of the branch, we were rewarded by hearing two barking frogs calling within 50 feet of each other. The method of stalking the barking frog is the same as that used for stalking any frog except for the details of the actual capture. What we did was to concentrate on one voice and approach it until the frog stopped barking. At that time we stopped, turned out our flashlights, and waited quietly. After a few moments, and sometimes after a more considerable wait, the frog began to call again. We advanced a little farther. The frog stopped; we did too. This process was repeated about six or seven times until finally Mr. Schmidt caught sight of the frog in the beam of his flashlight. It was sitting at the opening of a crevice about ten feet from the branch canyon rim. As soon as the light hit it, the frog backed into its crevice.

We had learned that afternoon how deep some of the crevices in the canyon walls could be by trying to catch lizards that had ducked into them. Consequently we were afraid that we were in for a hard and possibly fruitless task of prying and digging. We scrambled up to the crevice and looked in. Squatting in the beam of the flashlight was our clay-colored barking frog with its broad flat head and very prominent eyes.

We were relieved to see that the crevice was only about two feet deep. A little maneuvering and we had him! In about half an hour, by repeating this process, we were able to get the other frog.

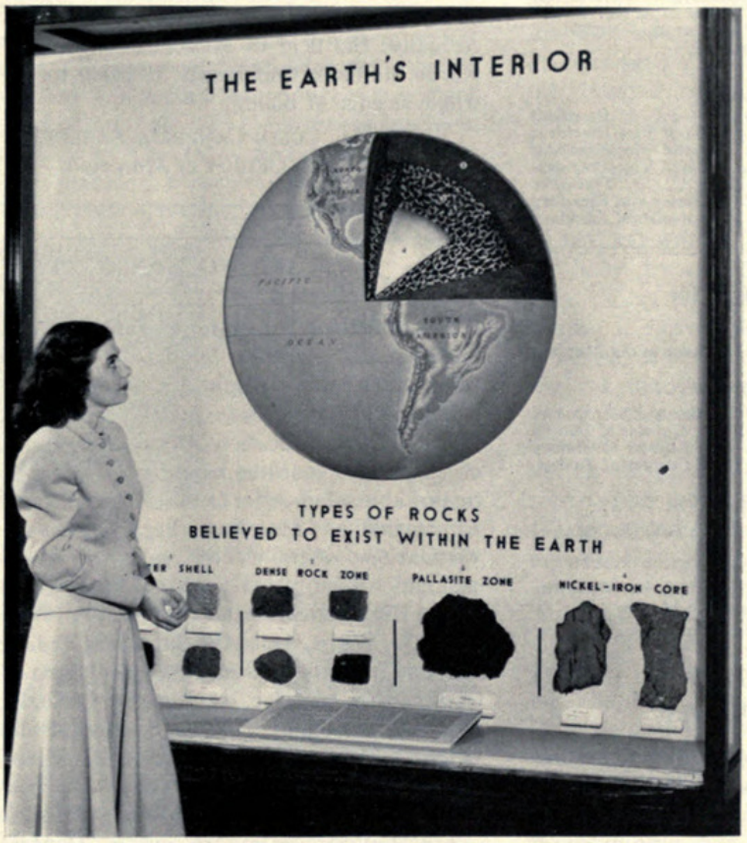
Although securing the barking frog was really the highlight of our stay at the Prade Ranch, Mr. Prade aided us in obtaining quite a few species of other amphibians and reptiles. Of these the most noteworthy was a species of neotenic salamander. Neotenic salamanders are those that retain certain larval characteristics, such as external gills, and are consequently obliged to spend their entire life-cycle in water. This locality represents an extension of the known range of these salamanders 100 miles westward.

The barking frogs we obtained represented the first of that species in the collections of the Division of Reptiles. Although we were unable to make any observations of their breeding habits, we hope to be successful in future trips. The distribution of the neotenic salamanders represents another problem for further study in the region of the Edwards Plateau.

A QUICK PEEK INTO THE INTERIOR OF THE EARTH

By SHARAT K. ROY
CHIEF CURATOR, DEPARTMENT OF GEOLOGY

The earth has a radius of nearly 4,000 miles. Of this, no more than five or ten miles has been seen by direct observation. What lies beyond? What are the materials and conditions that exist at great depths? Does the density and composition of rocks change with depths? Is any large part of the interior in a liquid state?



220 MILES TO THE INCH

That's the scale of model illustrating the principal features of the interior of the earth, on exhibition in Clarence Buckingham Hall (Hall 35). Miss Joanne Neher of the Department of Geology staff is shown inspecting it.

To illustrate what is known of the answer, a new model of the interior of the earth has been constructed and placed on exhibition in Clarence Buckingham Hall (Hall 35) of the Department of Geology.

Our chief sources of knowledge concerning the interior of the earth are the average density of the earth and the varying velocities with which earthquake shocks are transmitted through the earth at different depths. The average density of the earth as a whole is 5.5. No surface rock with which we are familiar has a density much above 3, and the average density of surface rocks, using rocks of all kinds, is only 2.7. As this is less than half the density of the whole earth, the interior must consist of much heavier material than the outer part. The density change from the surface to the center is due either to the presence of intrinsically heavier material toward the center or a diminution in volume of surface-type rock caused by the tremendous pressure existing at great depths.

Doubtless, this pressure has an effect in compressing the deeper material, but from the behavior of earthquake waves it is unlikely that the surface-type rocks can be compressed sufficiently to give the high average density of the earth. If the entire earth were composed of such rock, the speed of transmission of earthquake waves should increase with depth at a nearly uniform rate, so long as the material remains rigid.

This is not the case, however. There are irregularities in the rate at which the speed of earthquake waves increases downward, indicating that at and around the center there is a considerable amount of heavier material, presumably some metal such as meteorites, the majority of which are composed of iron and nickel with an average density of about 8. The sum of evidence supports the view that the earth has a "density stratification," with the heaviest material near the center and the lightest near the surface.

Instead of a thin crust over a molten interior as was once believed, the model, which is made on a scale of 220 miles to one inch, shows an earth composed of several concentric layers of rocks of increasing density. The outer layer consists of lighter, granitic and related rocks. This is underlaid by a dense rock zone composed of rocks, such as gabbro and peridotite. Beneath this is the pallasite zone, a mixture of compounds of metallic and stony materials. The core or the innermost layer, as has been stated, is composed of an alloy of iron and nickel.

The problem of the earth's interior has not yet been conclusively solved. The model shown here presents only the information known to us. Further advances in the field of geophysics may provide a more satisfactory and accurate conception.

The model was made by Mr. Joseph B. Krstolich, Museum artist, and Mr. John Janacek, former staff illustrator.