BIONICS

# Bats, Porpoises Teach Electronics

**Bats, dolphins, snakes and a variety of other animals are aiding engineers by acting as models for complex electrical systems, creating bionics, William E. Small reports.**

## See Front Cover

➤ A GUIDED MISSILE designed like a bat, computers based on the dolphin brain—such relationships of animals and engineering are common in the strange marriage of biology and electronics; bionics.

Organisms have built-in mechanisms for the coordination of perception, analysis, defense and decision-making, all neatly packaged for their special use. Location and direction finding, for example, is easily observable in birds and spiders, porpoises and fish, all containing natural "radar-sonar" or homing systems.

The study of bionics relates these natural "devices" of animals to the development of machines which can "see" and "hear," or in some way sense a situation, and then interpret these results and act quickly, much like the organisms themselves.

## No Bionics Specialists

Although there are no bionics specialists, researchers from biology, physiology, physics, electronics, mathematics, communications, psychology, aeronautical and marine engineering and many other disciplines have combined forces, many of them under direction of the Office of Naval Research, to study the various facets of biological adaptation to engineering. Recently, there have been several symposia and meetings devoted primarily to the growing field.

Automatic homing devices for planes, missiles and ships, systems which can identify hostile environments and act accordingly, sensory and detection equipment, and many yet unknown devices are expected from studies of biological organisms.

The porpoise or bottlenose dolphin is perhaps one of the best known species under investigation at present. Dr. John C. Lilly, director of the Communication Research Institute at Miami, Fla., has been working with the dolphin for several years to learn how they communicate with each other and how their "radar-sonar" works.

Dr. Lilly has already taught some of the dolphins at the Miami laboratories to mimic human sounds. Man has also discovered how the sonar works. But much more information could come from further investigations.

Another of the projects directed by the Office of Naval Research is concerned with the flight habits of a tropical bat, *Noctilio leporinus*. This small mammal, seen on this week's front cover, skims the surface of the water at night, spearing fish located by echo emission.

These bats are being studied with an ultrasonic detector and a small tape recorder by Dr. D. R. Griffin of Harvard University. He has been able to take photographs with an electronic flash, showing the exact second when the bat snatched the resting fish from the surface.

Insect-eating bats are also under study, along with the insects which are able to outmaneuver them. The large hearing centers of the brain of the bats have been monitored in order to find not only how they can sense and catch the tiny bugs, but how they can prevent "jamming" of their echo location device.

The insects, on the other hand, have had tiny electronic devices surgically planted in their nerve centers. Several species show the ability to dodge and dart from the path of the speeding bat, probably using some hearing mechanism.

These and similar studies are leading to more improved and refined devices which can be attached to ships or space vehicles, to locate and detect foreign bodies and outmaneuver them. Radar and sonar are forerunners of these devices, also coming from biological investigations.

To discover the shapes best suited for high speeds in water, Dr. Vladimir Walters, zoologist at the University of California, Los Angeles, has photographed various fish as they move through a chemical dissolved in water. Under polarized light, optically active bentonite produces bright lines which indicate the flow of liquid around the fish.

Hydrophonics, the sounds of the sea, is becoming an important subject of research. Recently, the Navy and oceanographic agencies and institutions recorded the sounds produced by species of animals, in order to compensate for unaccountable noises picked up by sonar hydrophones. Communication between many species of marine animals is well grounded, researchers find. Grunts and groans, cracks and clicks, all have meaning to the individual species.

Land animals are also being studied for communication patterns. In the New York zoo, for example, monkey chatter was recorded when a rain was approaching. On a bright day, when the recording was played back to a cage, all the monkeys rushed for cover.

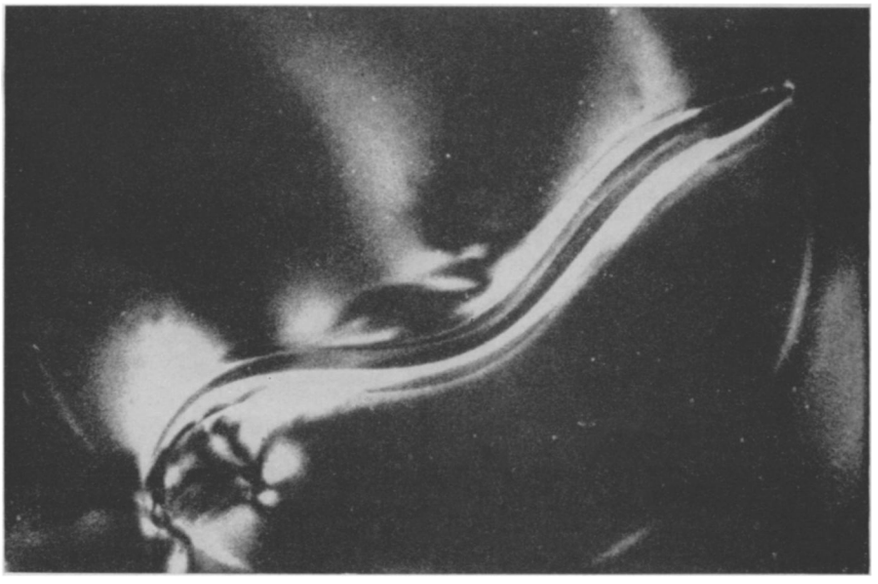
## Animal Communication Studied

Just how animal communications might be applied is uncertain. It is known that some tribes of primitive peoples, with no written language, pass their histories from generation to generation. If man can learn to talk to other species, he may learn the workings of animal organs, as well as the development of the species.

Homing pigeons and other birds are being tracked throughout their flights to determine how they fly to familiar grounds over unfamiliar terrain. Navigation studies are of particular interest to the Navy for fog-bound ships or those in waters where there are no navigational guides.

A tiny transmitter has been designed to fit the backs of these birds, sending signals to ground and air receivers to mark the exact position of the bird in flight. A 40-inch antenna trails from the transmitter, clearing the tail feathers while in flight.

One of the objectives of the study is to understand what factors might influence birds to live farther away from airfields



*BIONICS RESEARCH—An eel is seen swimming through a bentonite-liquid mixture during studies of hydrodynamic design.*

where they cause flight problems.

Along with this study is one by the Federal Aviation Agency on the many recent accidents of the Electra. Scientists have now discovered sounds in the plane's spectrum which are similar to the chirp of field crickets. Starlings, they found, are attracted by the noise and rise in the air before take-off. When the planes turn and zoom through the flock, several of the creatures are sucked in, causing engine failure and accidents.

### Effect of Electricity

The effect of electricity on organisms has been noted by almost every observer. Animals recoil, are stimulated or in some way react to a shock or dose of electricity, ever so slight.

Recently, scientists even found that the number of patients admitted to hospitals for psychiatric disturbances was related to an increase in electrical storms.

Since electricity influences biological behavior in so many ways, it seems only natural that biological responses and actions be applied to engineering through bionics.

Researchers are interested in the many facets of biological senses, whether human or otherwise. Among the sensory receptors of animals are eyes, ears, smell sensing organs, taste buds and the sense of touch.

The subconscious drives and moods which determine animal behavior, including humans, appear to be mainly electrochemical, arising in the stem of the brain or nerve center. A great deal of neural and psychiatric work in bionics goes toward determining how these drives are formulated so that the information may be applied to calculating or "thinking" devices which could combine all of the animal senses to solve acute problems rapidly.

The memory systems of animals appear to be the least understood. How an organism can record a situation and store the information, only to be called forth when another situation warrants it, is far beyond the application of computers with their limited storage space.

One reason for the great advances man has made in electronics in the past 10 years is the swift advance in circuitry: miniature tubes and wires, transistors and other solid-state circuit devices. Some of the devices now range down through the size of the proverbial "gnat's eyebrow."

These tiny instruments have been developed through the study of biological organisms, pushed by the necessity of smaller pay loads in space and better, safer navigation equipment.

Scientists envision the day when electronic machines will be as smart as humans, relieving the labors of physical and mental work of the population, giving man a chance to concentrate on refinement and conscientious knowledge-seeking, through the strange marriage called bionics.

• Science News Letter, 81:408 June 30, 1962

## Do You Know?

Inhalation of *acetone* vapor can cause liver cirrhosis.

Requirements for *bearings* and seals operating in space have spurred a whole new area of lubrication research.

Subsurface *rock* "talks" or gives off audible cracks and pops when it is in the process of failure.

A machine has been developed that will make *Dry Ice* pellets as needed for seeding supercooled clouds, directly from liquid carbon dioxide stored in the aircraft.

*Lignin* comprises between 20% and 30% of the weight of wood.

Early in the 20th century ocean *depths* were measured by dropping a sinker to the bottom on piano wires.

• Science News Letter, 81:409 June 30, 1962

## Questions

BIOCHEMISTRY—In what part of a cell is histone believed to be produced? p. 403.

BIONICS—Which systems of animals appear to be the least understood? p. 409.

ENTOMOLOGY—What happens to most screw flies in the winter? p. 411.

PARASITOLOGY—What are the symptoms of hookworm infection? p. 406.

PHYSIOLOGY—With what is increased heart rate associated in sleep? p. 410.

SPACE—What are the objectives of Tiros V? p. 405.

*Photographs:* Cover, U. S. Navy; p. 403, University of Michigan; p. 408, Dr. Vladimir Walters, University of California, Los Angeles; p. 412 (top), Kusan, Inc.; p. 412 (bottom), U. S. Fish and Wildlife Service.