Taste, smell and ecology

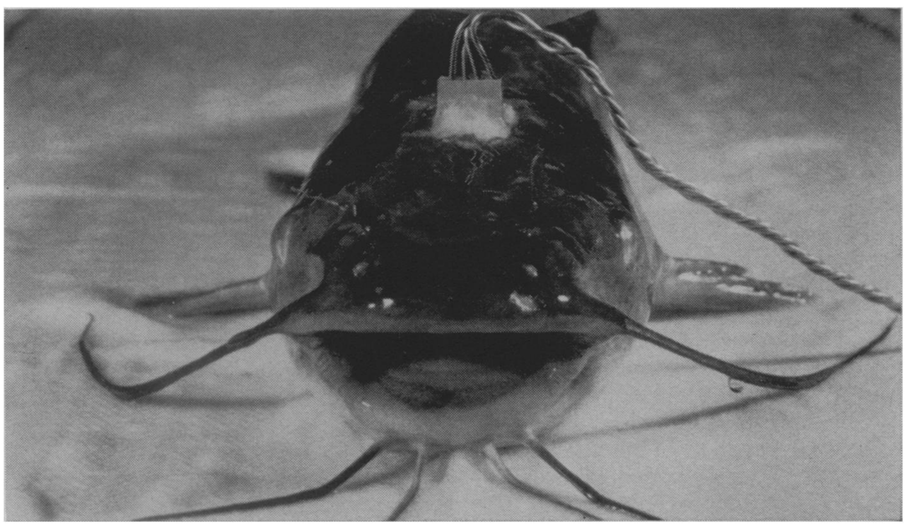
Common catfish may teach scientists more about how chemicals influence behavior and ecology of animals

by Richard H. Gilluly

Some ecological processes depend on various chemicals in amounts as small as one part per million—for example, those that attract predators to prey. It is possible, says Dr. Max Blumer of Woods Hole Oceanographic Institution that extremely small amounts of certain hydrocarbons from oil spills can interfere with these processes.

"There is still a great mystery about the role [these hydrocarbons] play in marine life processes," says Dr. Blumer. "But even if they are nontoxic, they can interfere" (SN: 3/14/70, p. 264).

The chances are strong that the behavioral cues provided by the chemicals act through the chemosensory systems of the animals involved (that is, olfactory and gustatory systems, which are the same in fish). But the extremely important ecological and behavioral roles of chemosensing are just beginning to be appreciated and understood by science.



Trinity Univ.

A psychologist at Trinity University in San Antonio, Texas, Dr. Vernon A. Benignus, is working with common fresh-water catfish in an effort to differentiate the various neurological responses of the fish to odors.

"We're using the catfish," he says, "because it has a very neat olfactory system in its brain." Dr. Benignus' technique is to insert electrodes into the olfactory bulbs to record electroencephalographic information. "The operation is very easy with the catfish," he says. "All we have to do is strip away a few millimeters of bone, which is done easily under local anesthetic."

There is no doubt, says Dr. Benignus, that electrical activity in catfish brains changes markedly when the sense of smell is stimulated. "The voltage in his brain rises from a continuous alternating voltage of 50 to 100 microvolts to around 500 microvolts, and there are also significant changes in the electrical patterns and frequencies generated by the brain."

Using a computer, Dr. Benignus is now attempting to find meaningful statistical patterns in the voltage fluctuations, frequencies and other characteristics of the electroencephalograms. Then he will work in two directions: To identify what effects these patterns have on the rest of the nervous system of the fish and to learn if specific odorous chemicals create specific patterns.

There is no doubt, he says, that a variety of neurological patterns are manifested in the catfish in response to various odors. But finding correlatives for these is still in the beginning stages and "to demonstrate them conclusively is difficult," he says.

"Maybe the voltage changes we get don't code specific odors at all," he explains. "Maybe instead they code the amount or the intensity of odor. Or maybe the amount of odor is coded in one part of the nervous system and the kind of odor in another part."

But there is no doubt, he says, that catfish, in order to survive, must possess fairly sophisticated odor discrimination. "This is an extremely important ecological ability, not only in the face of pollutants, but in a natural state. For example, catfish somehow know decaying leaves are not food."

There is evidence from earlier work that some mammals can "adapt out—or ignore" certain strong odors in order to distinguish those that are important to them, he says. He plans to use a Y-maze to teach the catfish to use odor cues to avoid strong electric shocks. Then he will add some odor-producing contaminants. "Then," he says, "we can quantify the ratios of the two odors to determine how much of one it takes to mask another." Such work could be important in gauging the effects of pollutants on fresh-water ecology.

Just as important, however, is relating the neurological patterns in olfactory bulbs to other neurological functions, and consequent behavior. "When the olfactory bulbs of cats or rats are removed," he says, "researchers get dramatically different behavior—or lack of some behavior customarily found in these animals." For example, they exhibit passivity, can't recognize food, have learning difficulties and change their mating habits.

In humans, removal of the amygdaloid nuclei in the outer cortex of the brain—an operation once performed in an effort to cure epilepsy—causes similar effects on behavior. An important input to these nuclei in some animals is olfactory, Dr. Benignus said. On the other hand, the dolphin has very large amygdaloid nuclei—but no sense of smell. The olfactory work could be important in clarifying such seemingly anomalous differences in neurological function, he says.

He has tried numerous odor-producing materials with his catfish, including morphylene—which smells like dirty socks—and ethyl mercaptan, which smells like rotten eggs. He has also tried organisms such as saltwater shrimp. In fact, this is where the first major practical application of his work originated.

"The saltwater shrimp really turned the catfish on," he says. "So I decided to try some of them as bait when I went fishing. They worked beautifully."

But they also raised another question. Why should catfish show such a strong attraction to organisms not found in their natural environment? Dr. Benignus is hoping to find out. □