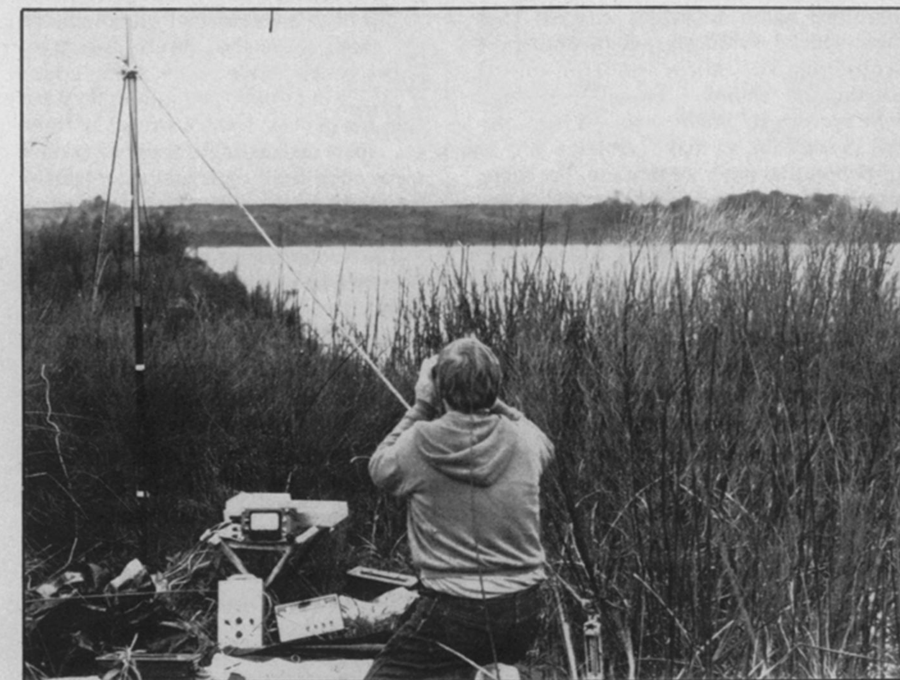
MONITORING THE PHYSIOLOGY

Radio transmitters attached to, or implanted in, animals are producing some unexpected insights into their physiology under natural conditions

BY JOAN AREHART-TREICHEL

An eight-foot alligator sticks its snout out of a lake near Sinton, Tex., and, finding the midmorning sun to its liking, crawls onto a nearby bank to bask. The reptile is unaware that a Northeastern Oklahoma State University biologist named E. Norbert Smith is observing it from a boat. It is also unaware that, during its recent confinement in Smith's lab, it was outfitted with a radio transmitter that is now informing Smith not only of the animal's whereabouts, but of its heart rate and body temperature.

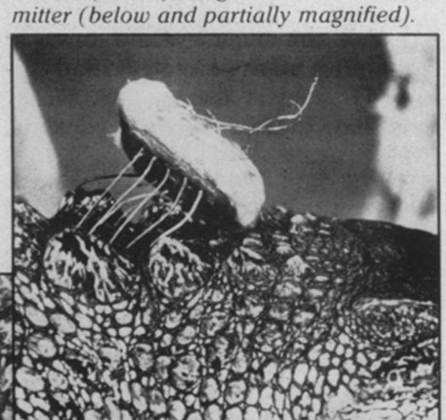
Radio telemetry has emerged during the 1970s as a powerful tool for studying the physiology of animals under natural conditions, just as it has already been used for three decades to locate and track animals in the wild. Smith, one of the leaders in this provocative new field, designs much of his own research instrumentation and his work already has yielded unexpected insights into animals' physiology under natural conditions. He was the keynote speaker at the recent world conference on biotelemetry in biology and medicine at England's Oxford University.



Photos. Smith et al.

Smith receives signal from telemetered animal (above); alligator with neck transmitter (below and partially magnified).

"Telemetry," Smith explains, means "measurement at a distance," and "radio" implies that "wires are not used." First an animal of interest is captured, and a radio transmitter is attached to, or surgically implanted in, it. The frequencies of the transmitted radio signals reflect body temperature, heart rate, brain waves, blood pressure, breathing rate and other physiological activities of the animals.



OF ANIMALS IN THE WILD

The researcher picks up the radio signals in the field on an inexpensive receiver, and at the same time records the received signals on a cassette tape recorder. Once back in the lab, the researchers can convert (demodulate) the signals into physiological measurements.

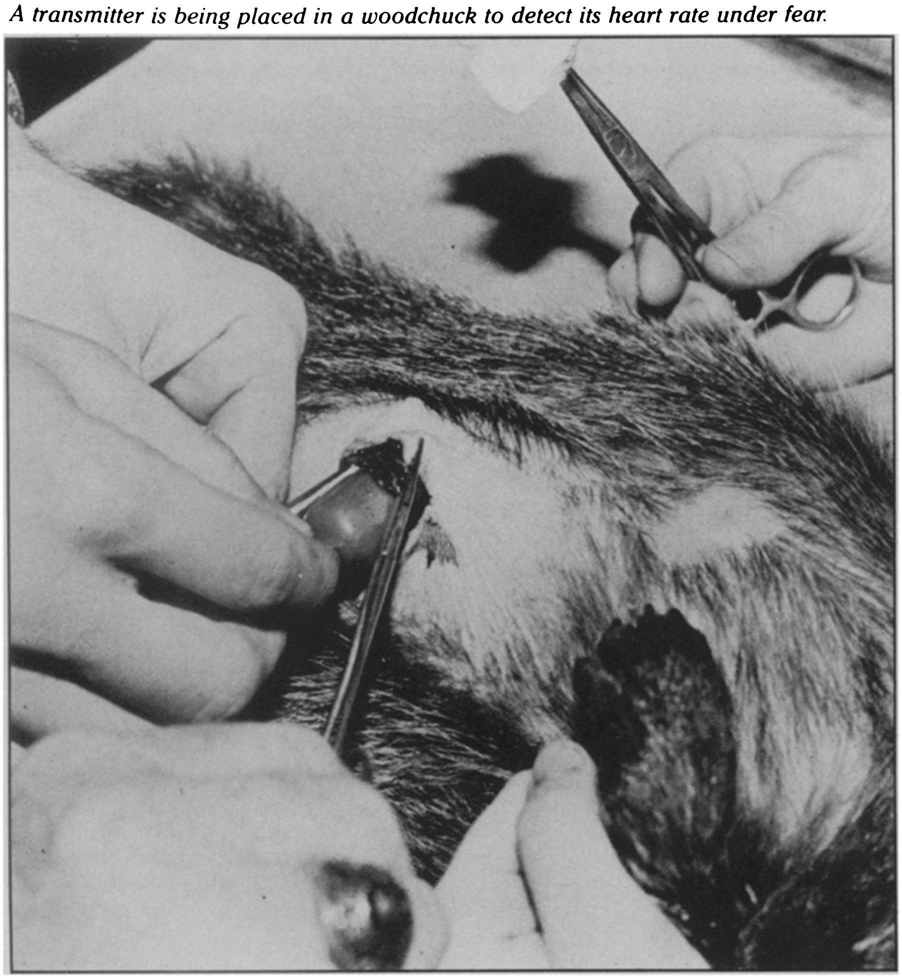
Thanks to radio telemetry, Smith and his colleagues have learned something quite unexpected about animals' heart rates in the wild — that they don't always speed up when frightened (which has previously been believed on the basis of studies conducted under artificial conditions), but that they may slow down instead. For instance, if a rabbit crouches or hides from a predator, its heart rate drops off by 25 percent, whereas if it runs away in fear, its heart rate increases. When an alligator is scared and dives underwater, its heart rate slows down to two beats a minute. "This is a phenomenal drop," Smith says, and is one of the most interesting discoveries he has made.

Although Smith and his team have not expressly studied *why* animals' heart rates drop under certain fear conditions in the wild, they believe it probably helps the animals adapt physiologically so that they can escape danger. In other words, animals' heart rates speed up to prepare them for fight or flight, but their heart rates slow down to help them hide until danger is past.

Radio telemetry has also given Smith and his co-workers unprecedented insights into the interaction of heart rates and breathing rates of animals under real-life conditions. For instance, most of the time groundhogs' heart rates are not synchronized with their breathing rates, but when the animals are inactive, the two are remarkably related. Although the adaptive significance of this heart-respiratory synchrony — the first to be reported in a free-ranging, burrowing animal — is not clear, Smith believes that it might help groundhogs make more economical use of the limited oxygen in their burrows.

The body temperature of alligators in the wild is yet another area that Smith and his team have measured with radio telemetry. Once an alligator starts basking in the sun, the temperature of its back increases sharply, and the temperature of the core of its body increases more slowly, which is what one might expect. However, if the animal moves around while basking, its core warms up faster than if it doesn't move. Why is this? Apparently because muscles force warm blood from the back into general circulation.

A transmitter is being placed in a woodchuck to detect its heart rate under fear.



And when an alligator is in the water, telemetry reveals, its body temperature is higher than surrounding water temperatures. This excess body temperature has to be attributed to some kind of endogenous heat production—say the metabolism of food into ATP energy molecules with heat given off in the process. But isn't endogenous heat production only limited to warm-blooded animals? Not necessarily, Smith replies. Recent research by other investigators suggests that big reptiles, such as dinosaurs, used internal heat production (SN: 4/8/78, p. 218). In other words, it appears that the alligator is cold-blooded like small lizards in that it largely depends on the sun to warm itself, but it is like warm-blooded animals in that it can derive some of its heat needs from endogenous heat production. Why don't small lizards also get heat from food metabolism? "They have such a small size and therefore such a large surface area to volume ratio that the heat is dissipated to the environment," Smith conjectures. "But because alligators are large animals, they have a relatively smaller surface area for their mass and thus retain more heat."

But perhaps the most intriguing tidbit that Smith and his team have obtained with telemetry concerns a particular female alligator whose body temperature was higher and whose heart rate was faster than those of other alligators they telemetered. Because certain water snakes have been found to have elevated body temperatures when gravid (carrying eggs), and because the alligator of interest was caught in the spring when female alligators are gravid, Smith suspects that her carrying eggs may have explained her unusually high temperature and exceptionally fast heart rate. And if gravid alligators indeed have higher temperatures and faster heart rates than normal, it would be physiological support for a superstition prevalent among old-time alligator hunters — that female alligators "have a fever" during the springtime and thus are more dangerous then and should be left alone.

What will radio telemetry eventually reveal about animal physiology in the wild? "Lots more," Smith hopes. This depends, however, he says, on "how much life scientists and engineers cooperate in making telemetry equipment increasingly practical and economical for physiological work in the field. Presently, telemetry technology has outpaced biological applications because of a communications gap between engineers and biologists." □