FEATURE: Nature's Novel Navigator, the Bat

VOICE (THROUGH ECHO): Echo. Reverberation. Waves that bounce and reflect back to their source.

PROF.: Those are the principles that make ***radar and sonar*** work. But if you thought those inventions originated in the twentieth century, you're in for a surprise.

FORMAT: THEME AND ANNOUNCEMENT

PROF.: Researchers are carrying laptop computers into tropical jungles – to learn from unusual teachers: bats. These unusual flying mammals have a sonar system that scientists are still studying.

VOICE: If I recall correctly, sonar works like radar, but it uses sound waves instead of radio waves.

PROF: Yes. "Radar" gets its name from abbreviating the English words, "<u>RA</u>dio <u>D</u>etecting <u>A</u>nd <u>R</u>anging."

VOICE: In other words, radar uses radio waves to ***detect*** objects, and to determine their ***distance and speed.*** A radio transmitter sends out short pulses of radio waves. If the waves strike an object, some of them are reflected back to a radio receiver.

PROF.: Yes. By detecting the ***direction*** from which the waves return, radar equipment can tell where an object is. By measuring the ***length of time*** from when a wave is sent until is arrives back, the radar computes ***how far away*** the object is.

There are many variations and refinements of this technique, but this is the basic principle of them all.

VOICE: Why did engineers apply the radar principle to sound waves, and develop sonar?

PROF.: Because radio waves don't travel reliably in some conditions, such as in detecting submarines under water.

Sonar is short for SOund Navigation And Ranging. Engineers thought they had invented it during World War II – until they discovered ***bats had been using it for many centuries!***

VOICE: I was reading that an Italian scientist had suspected that bats were using some kind of technology, back in the 1770's. Lazzaro Spallanzani [lah-ZAR-roh spal-lan-ZAH-nee] observed that bats navigated in the dark as accurately as people do in daylight.

PROF.: He thought bats might have eyes sensitive enough to see in light too dim for humans, he experimented by blindfolding several bats. The bats avoided flying into obstacles as well ***with*** blindfolds as ***without*** them.

Spallanzani made the experiment more difficult by adding obstacles, including thin silk threads. The blindfolded bats somehow sensed even these, and continued flying with no collisions.

VOICE: About the same time a Swiss researcher found that if he blocked bats' ***ears,*** they flew into objects. Neither scientist had the sophisticated equipment that we have today, so neither of them figured out the complete answer of how bats navigate. They simply noted the curious facts.

PROF.: Shortly before World War II, two scientists at Harvard University pursued the problem. They discovered bats were sending and receiving sounds at frequencies too high for humans to hear – at about 35,000 Hertz.

Researching further, they found that a bat emits sounds in short pulses – about 1/100 second long. When it is flying through a clear area, it transmits about ***five*** short, staccato pulses per second. As it approaches an obstacle, it speeds up to about ***sixty*** pulses each second, to make sure it detects every danger and avoids it.

VOICE: Don't bats often fly ***in groups?***

PROF.: Yes.

VOICE: If the whole group navigates by sending out sonar signals, how do they avoid confusing each other? How does every bat separate its signals from the rest of the crowd?

PROF.: Each bat transmits on a slightly different frequency, as if a frequency-control bureau has given them assignments. And each bat's ears are so selective that either he's deaf to sounds from other bats, or at least he can ignore them and concentrate on his own sounds.

VOICE: Amazing!

PROF.: They also discovered that the bats' mouths and ears are ***directional.*** The mouths send the sound in just one direction, and the ears listen in the same direction. Reducing interference still further, these high frequencies fade out and disappear in a shorter distance than the waves we humans can hear.

So we wonder how these miniature mammals know what frequencies to use!

VOICE: How can the bat make 5 to 60 sounds per second, and ***still breathe?*** How can it eat the insects that it catches while flying, when its success in flight depends on having its mouth open, emitting sound pulses?

PROF.: Research on bats is continuing. An article in the *New York Times* says, "As the sun goes down, two conservation biologists, Bruce and Carolyn Miller, trudge into the tropical forest of Belize carrying a portable table and laptop computer swaddled in plastic to keep the bugs from gumming up the keys."

The article continues, "Within 15 minutes, high-speed blips are racing across the computer screen... The blips record the sonar signals sent out by bats as they flit unseen through the night, navigating around obstacles and locating prey. The researchers' Australian-made system, which detects signals too high to be audible to the human ear, has made it possible to study these often misunderstood mammals by ***capturing the voice, not*** [capturing] ***the bat***."

VOICE: That's a major improvement. Before that, researchers trying to count bats have had to capture them with nets or traps. This technique enables researchers to do far more than count the total bat population.

PROF.: The article continues, "So far the Millers have catalogued the distinct calls of 17 of the 37 insect-eating bat species known in Belize. Once all have been identified, it will be possible for a scientist to set up the gear at night and tell relatively quickly which bats are present." End quote.

For example, experts used to think the shaggy-haired bat was extremely rare. But new data shows it is quite common in Belize. Before, people thought that leaf-nosed bats were the dominant species because they were the ones getting caught in the nets. Now they know insectivore bats are also abundant.

VOICE: Will that kind of information enable leaders to plan logging and agricultural development in ways that won't drive rare species to become extinct?

PROF.: Yes. The disadvantage of the new acoustic method is that a researcher must not only hear a voice but also see the face of each species of bat at least once – or he can't know which sound represents which species. That's not easy. One trap in a 120,000-acre study area is like a postage stamp on the forest.

The researchers tracked one mysterious bat voice through the forest for months. When they caught it, they let the bat fly around their kitchen, which also serves as a laboratory. As the bat flew around the ceiling fans, scientists turned on the bat detector and immediately recognized the sound pattern they had previously heard.

VOICE: So they could know which species had made the sound pattern that they had been hearing before.

PROF.: Right. After nights of listening and analyzing the sounds, the team has gotten to know the bat species songs by heart. "We sit there with the computer, naming them off," Mrs. Miller said. Her husband can identify some when he hears just two notes.

VOICE: We can summarize by saying, some of the world's most capable scientists are still amazed at the bat's sonar navigation system. Yet the little bat has been carrying and using this sophisticated apparatus for thousands of years.

PROF.: And we can ask: Who designed and made it for him? And who taught him how to use it?

Maybe this flying creature who can out-navigate humans, can help us find ***our*** way.

VOICE: What do you mean?

PROF.: Maybe the bat's sonar system is leading us to discover that there's a Being far smarter than either bat or man.

Maybe the famous scientist Lord Kelvin was right when he said, "If you think strongly enough, you will be forced by science to believe in God."

VOICE: "Maybe this flying creature…can help us find ***our*** way."

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