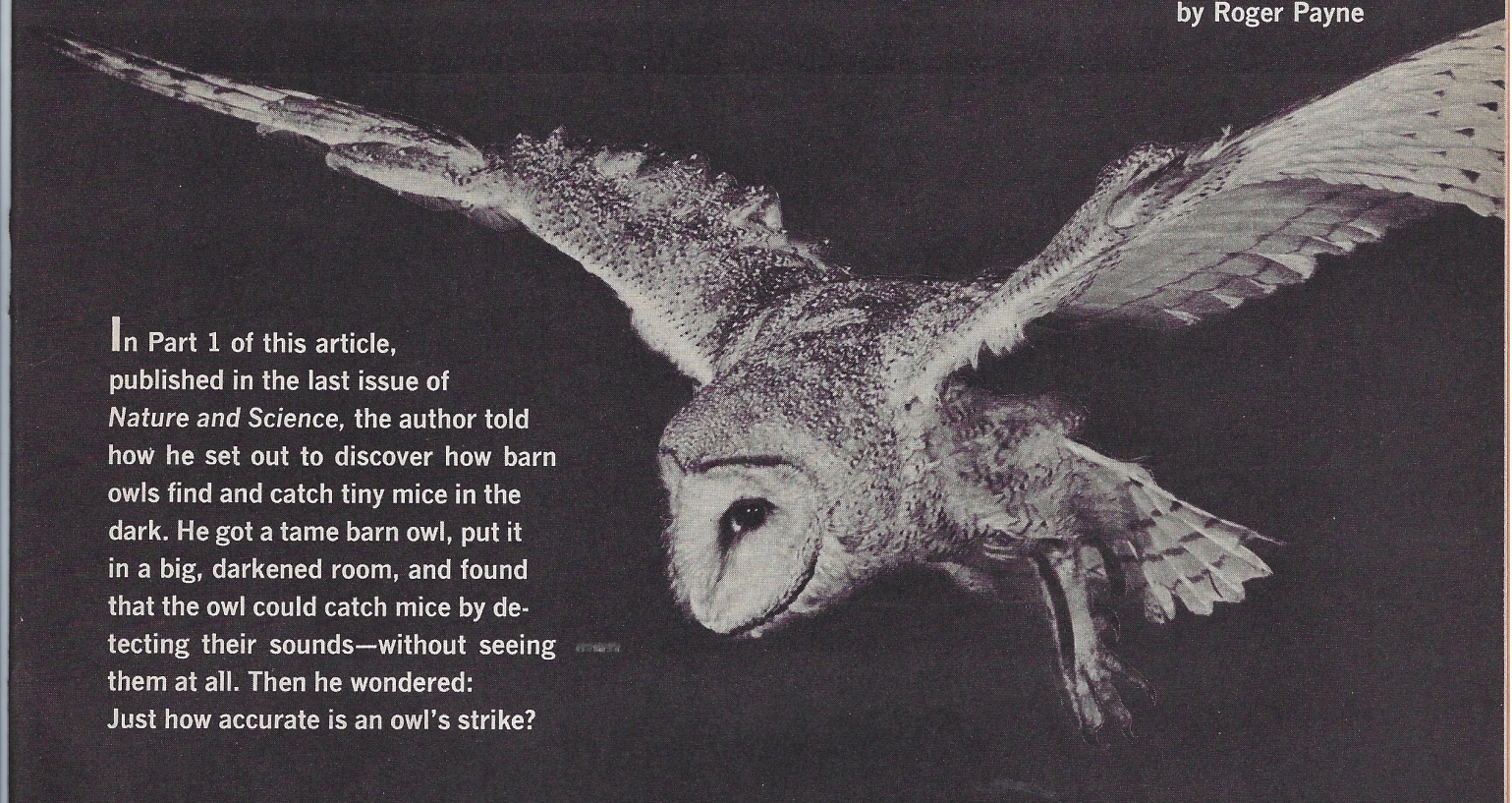
When an Owl Strikes

by Roger Payne



In Part 1 of this article, published in the last issue of *Nature and Science*, the author told how he set out to discover how barn owls find and catch tiny mice in the dark. He got a tame barn owl, put it in a big, darkened room, and found that the owl could catch mice by detecting their sounds—without seeing them at all. Then he wondered: Just how accurate is an owl's strike?

■ Whenever the barn owl attacked a mouse, I always turned on the lights as soon as I heard the sound of the owl striking. But I found that I was always looking in the wrong place when I switched on the light. The mouse was never where I thought it was, yet the owl seemed always to know where the mouse was. It missed rarely, and then only by inches. I was so impressed by the accuracy of the owl's hearing that I wanted to measure exactly how accurate it was.

Since I had no way of knowing just where a live mouse would be when the owl struck, I decided not to use live mice for targets in my accuracy measurements. Also, the dry leaves on the floor made it impossible for the owl to leave claw marks or any other sign showing *exactly* where it struck. I solved this problem by sweeping away all the leaves and covering the floor with sand.

Then I turned out the lights so the owl would not see what I was doing. I walked to about the middle of the room and put a dead mouse on the sand. The mouse had a leaf tied to its tail. It also had a long string tied to it. I took the end of the string and made my way through the dark to a small hideout I had built in one corner of the owl room. There I listened until I could tell that the owl was sitting calmly on its perch. Then I pulled gently on my end of the string, moving the mouse and the leaf. When the owl heard the sound of the leaf scraping on the sand, it left its perch and struck. I turned the lights on quickly.

I did this many times. If the owl missed, I would run to it before it had time to pounce on the dead mouse. Then I would make notes on both the position of the dead

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mouse and the place where the owl's feet had left marks on the sand.

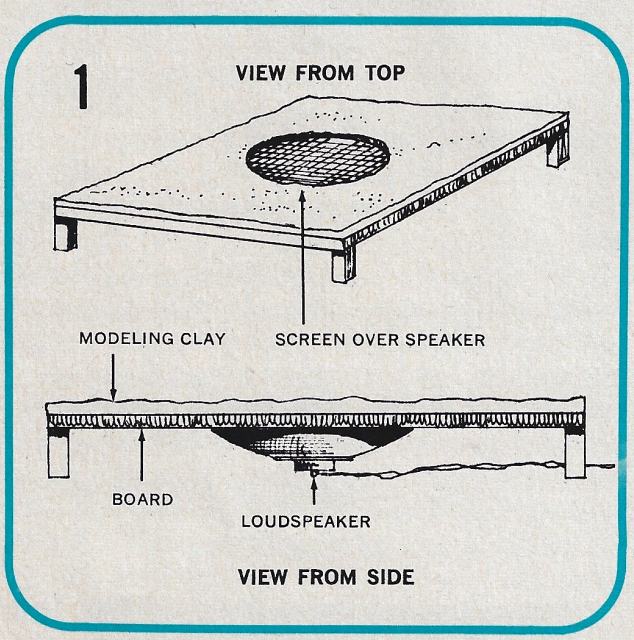
Search for a Foolproof Test

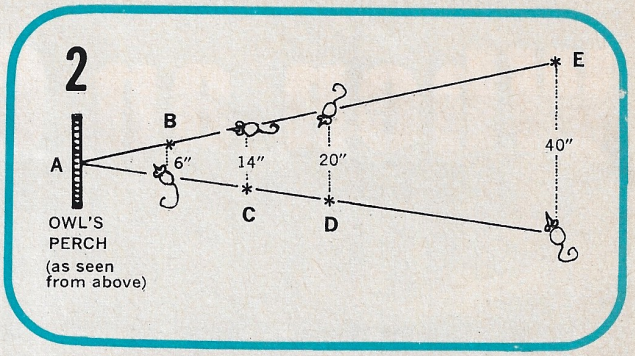
Before long, I discovered that there were things wrong with this experiment. It was not a foolproof test of the owl's hearing accuracy. For one thing, the owl's feet hit the sand hard and spread it around. This made it impossible for me to find the *exact* place where the claws struck the sand. My measurement might be wrong by as much as one and a half inches, a distance almost as great as the length of a mouse's body.

Second, I could not be sure that the leaf had not changed its position and rustled a little when the owl was in flight. If it did, the noise would give the owl an extra clue. I knew this because a few times I had tried rustling the leaf on purpose while the owl was in flight. Whenever I did, the owl didn't miss the target—even when it had to fly the whole 40-foot length of the room. This meant that the owl could correct its aim while flying.

Finally, I had no way of knowing what kind of error I was measuring. Was the owl missing the target because it could not hear perfectly? Or because it could not fly perfectly in the dark? Or both? It seemed to me that it must be difficult for an owl to fly well in pitch darkness, just as it is for a person to keep his balance and walk in a straight line when he is blindfolded.

In order to get rid of these three weaknesses in the experiment, I decided to use a tiny loudspeaker for the owl to strike at. When I wanted the owl to strike, I broadcast through the speaker a tape recording of a mouse





This drawing shows the distance an owl would be off target if it made an error of 20 degrees as it tried to catch mice farther and farther from its perch. Actually, the barn owl never made an error as big as one degree.

rustling leaves. On the perch, I put a switch which turned the recording off automatically when the owl left the perch. This meant that there was no chance of the owl getting extra sounds to guide it as it flew. On top of the speaker I put a dead mouse so that the owl would be rewarded each time it found the speaker correctly.

I mounted the speaker on a board covered with modeling clay except for one small hole above the speaker *(see Diagram 1)*. When the owl struck at the sound, it would dig its claws into the clay around the speaker hole. This would give me an accurate record of the landing place.

I left the light on during the experiment. The owl could then use its eyes, if it wanted to, for flying. Even with the light on, however, the owl couldn't see where the loudspeaker and the mouse were because the whole floor was evenly spread with leaves, and the mouse and the speaker were hidden under them. I also put up a screen between the owl and me so that the owl never saw me when I was hiding the loudspeaker.

How Might You Measure an Owl's Accuracy?

Every time the owl missed the speaker, I made notes on the exact position of the speaker and of the claw marks in the clay. My next problem was figuring out a way of describing the owl's accuracy. Suppose I said, "The owl never missed a mouse by more than one inch." Would this statement tell you whether the owl was a good shot or a bad shot?

If the owl was 100 feet away, a one-inch miss would show excellent aiming, but if the mouse was just a foot away, a one-inch miss would be very poor aiming. What I needed was a way for figuring out how much the owl would be likely to miss at *any* distance. So I decided to measure the owl's accuracy in *angles* rather than in inches.

Diagram 2 shows what I did. Suppose you are looking

down at the floor of the owl room from the ceiling. Point A is where the owl sat on its perch when it was deciding where the mouse was. Points B, C, D, and E are where the owl struck on different flights (as I could tell from its claw marks). The picture of the mouse shows where the mouse sound really was. By drawing a line from the perch to the mouse, and another line from the perch to the claw marks at Point B, for example, I could make an angle that showed the number of degrees the owl was off target. By doing this every time the owl struck, I got an average measurement of its error in degrees.

As it turned out, the owl never made an error as large as one degree. An owl can locate a mouse by sound correctly within less than one degree to the left or right. By any standard, that is good aiming when you are talking about "setting your sights" by hearing.

What About Up-and-Down Aim?

Aiming to the left or right is not all an owl has to do to catch a mouse. The owl could have a perfect left-right aim and still overshoot the mouse if it aimed high. Or it could land short of the mouse if it aimed low.

Diagram 3 shows how I measured the accuracy of the owl's up-and-down aim. It is drawn as if you are looking sideways across the owl room. Point A is where the owl's ears were when it decided where the mouse was. Point B is where the owl struck the mouse, and the drawing of the mouse shows where the mouse sound really came from. Notice that the owl's up-and-down aim covers more ground than an error of one degree from side to side.

Even if the owl had ears that could aim up and down as accurately as they can right to left, it would still be harder for it to tell how far from the base of its perch a sound was than it would be for it to tell how far to one side it was. For example, even if the owl could locate the sound in an area only six inches wide, that area might be 10 inches long. However, when I put together my measurements of the owl's strikes, I discovered that its up-and-down aim is almost *twice* as good as its side-to-side aim. It can correctly locate the spot that a sound comes from within about one-half of a degree up and down!

Exactly how does this sort of accuracy help a barn owl to catch a mouse? At a distance of 20 feet, for instance, the owl should be able to pinpoint a sound to an area roughly three inches wide and six inches long. This happens to be the area covered by the spread-out claws of the owl added to the length of an average mouse. Thus, no matter where the mouse is in such an area, the owl should hit it with at least one *talon*, or claw, when it strikes. Thus my accuracy measurements showed that an

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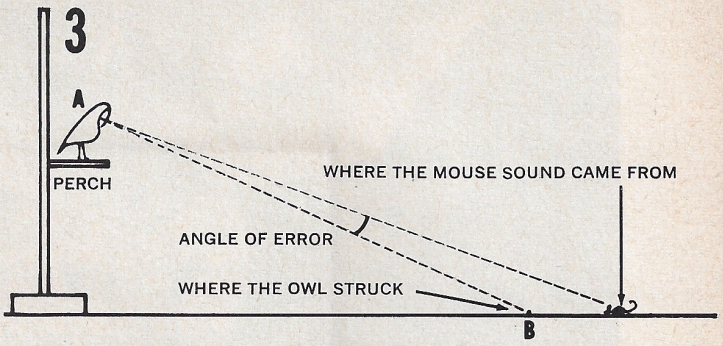
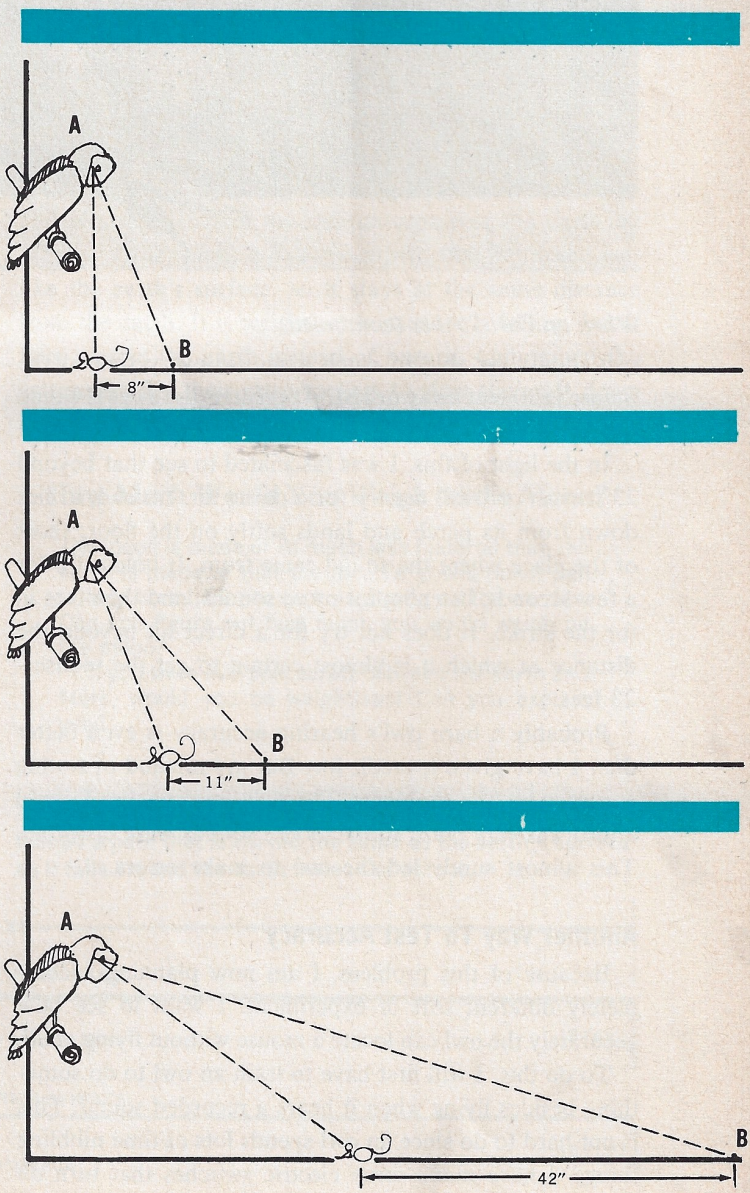
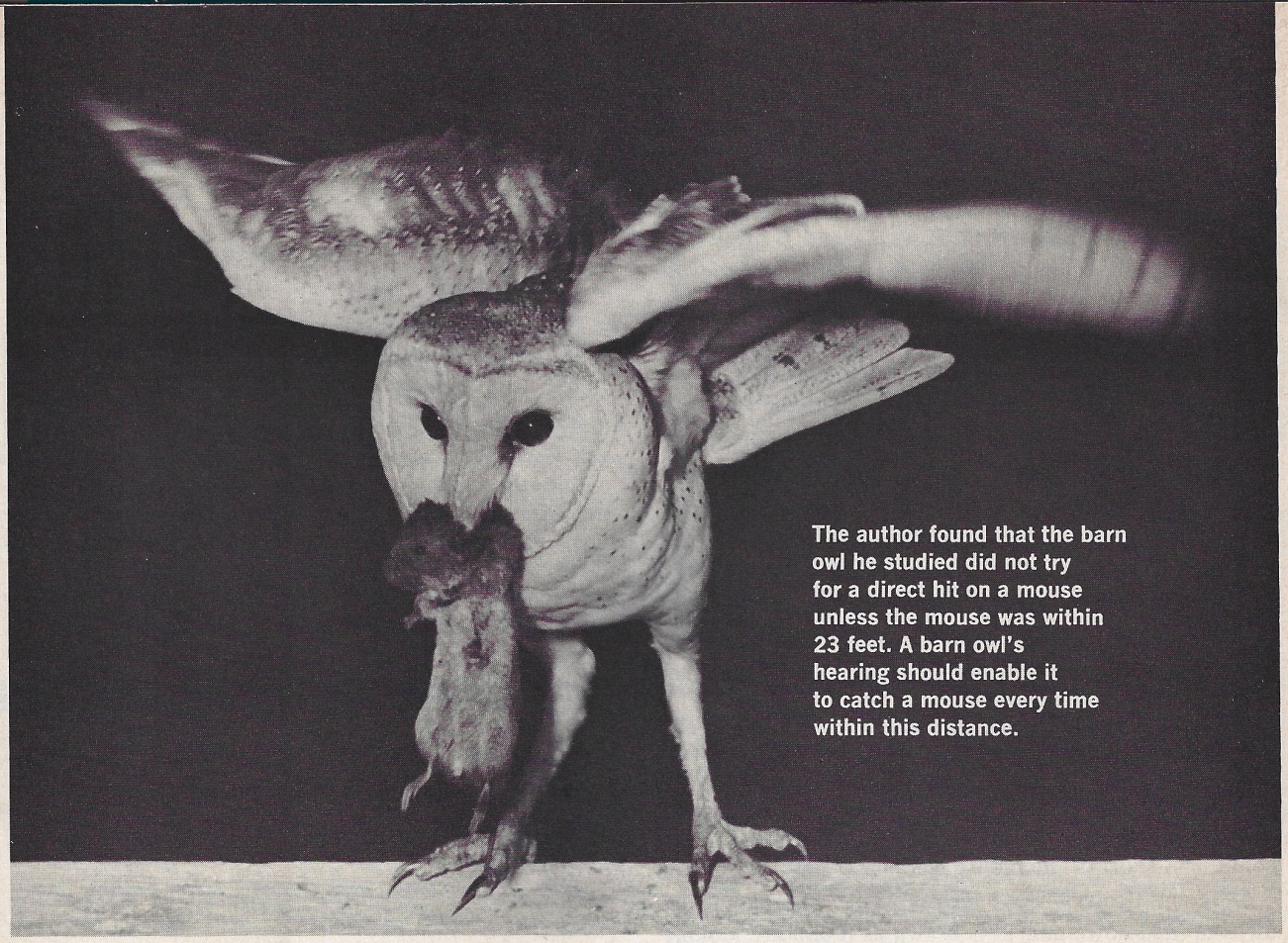


This side view of the "owl room" shows how the author measured a barn owl's up-and-down aim. The drawings below show how an owl's distance from a mouse affects its aim. The angle of error stays the same, but the size of the error increases with distance from the owl's perch.





The author found that the barn owl he studied did not try for a direct hit on a mouse unless the mouse was within 23 feet. A barn owl's hearing should enable it to catch a mouse every time within this distance.

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owl should be able to catch a mouse every time if the mouse is 20 feet away or less. At greater distances it would miss quite often.

In the light of this, I was fascinated to see that beyond 23 feet an owl will not try for a direct hit. Instead, it flies down from its perch and lands softly on the floor, short of the place where the sound came from. It holds still for a few seconds, listening for more sounds, and then flies in for the strike. It does not try for a direct hit beyond the distance at which it is almost certain to get the mouse—23 feet.

Probably a barn owl's hearing accuracy is even better than I have given it credit for. But my method of testing accuracy had its problems. The only loudspeaker I could afford was very poor, so the mouse sounds were distorted. This almost surely led the owl to make errors.

Another Way To Test Accuracy

Because of this problem, I am now planning a completely different sort of experiment. I want to see how accurately the owl can locate a mouse without flying *at all.*

To do this, I will first have to train an owl to do something besides flying when it hears a recorded sound. This is not hard to do since an owl spends lots of time nibbling things. I have made some electric switches that turn on when nibbled. So all I have to do is wait for the owl to nibble a switch and then reward the owl with food.

When the owl has learned to do this, I will train it to nibble the wood near its left foot when it hears the sound coming from its left side, and to nibble the wood near its right foot when it hears the sound coming from that side. Only when it nibbles near the correct foot will it get a food reward. As an owl gets used to earning its meal in this way, I will then begin to play the sounds closer and closer to a spot directly in line with the owl's line of sight. When the owl is unsure which piece of wood to nibble, it should make as many wrong nibbles as correct ones.

By gradually moving the sounds farther to either the left or the right (until the owl can again correctly locate the sound), I can draw an angle that shows at what point the owl stops "guessing" at the location of the sound. This angle will be the smallest angle within which an owl can locate a sound source accurately.

This experiment might be fun to try yourself. Have a friend blindfold you and then make clicking or tapping sounds to the left, right, and in front of you. Find out in what area you can no longer tell whether the sound is coming from the right or the left side ■

Just how does an owl grab a mouse when it strikes? In the next issue, the author tells how he tried to find out.