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AN INEXPENSIVE COMPACT AUTOMATIC CAMERA SYSTEM FOR WILDLIFE RESEARCH

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Abstract.—This paper describes the design, conversion, and deployment of a reliable, compact, automatic multiple-exposure photographic system that was used to photograph nest predation events. This system may be the most versatile yet described in the literature because of its simplicity, portability, and dependability. The system was very reliable because it was designed around a high quality, all-electronic camera. It was an inexpensive alternative (about US $110) to the few other commercially available photographic systems that offered similar features, and was the first system to provide these features in a compact, highly portable, and easily concealed field unit. Under all field conditions, in all seasons, day and night, the system consistently produced clear photographs of animals visiting artificial nests and scent-stations. This system was simple to operate because there was only one moving part, making malfunctions rare and easy to identify and fix.

UN SISTEMA DE CÁMARAS DE BAJO COSTO PARA ESTUDIAR LA VIDA SILVESTRE

Sinopsis.—En este trabajo se describe el diseño, conversión y utilización de un sistema fotográfico automático y de exposición múltiple, que fue utilizado efectivamente para fotografiar depredación en nidos. Este sistema podría ser el más versátil de los descritos previamente, debido a su simplicidad, portabilidad y confiabilidad. El sistema es muy confiable ya que en su diseño se utiliza una cámara electrónica de alta calidad. Su bajo costo (approximadamente US $110) representa una excelente alternativa. Este sistema es el primero de proveer aditamentos esenciales (ej. enfoque automático) en forma portátil, compacta y fácil de pasar desapercibido en el campo. Este equipo produjo buenas fotografías de aves depredando en nidos a través del año, durante el día o la noche y bajo diferentes condiciones climatológicas. El sistema es muy útil para estudios de campo y es fácil de operar porque tan sólo tiene una parte movible, lo que a su vez permite identificar problemas facilmente y corregirlos.

Accurate identification of nest predators is one of the most formidable and frustrating aspects of nest-predation studies. Although predation has been shown to be the major cause of nest failure in open-cup nesting birds, the identity of predators usually remains unknown or is inferred (Sealy 1994). Many methods to identify nest predators have been developed (Baker 1980, O'Reilly and Hannon 1989, Santos and Telleria 1992, Willebrand and Marcstrom 1988) but they most often implicate the predator rather than providing positive identification. Clear photographs of nest predators offer indisputable evidence (Dunn 1977, Major 1991). Shiras (1935) was the first to describe photographic methods and how they could be applied to wildlife research. Ever since, many wildlife researchers have experimented with cameras (e.g., Abbott 1964, Custer 1973, Dane et al. 1959, DeGraaf 1995, Goetz 1981, Jones and Raphael 1993, Joslin 1986, Mace et al. 1994, Major 1991), and while many inexpensive automatic camera systems have been described (e.g., Bull et al. 1992, Carthew and Slater 1991, Dodge and Snyder 1960, Picman 1988), these systems are often designed around inexpensive, low-technology cameras which required elaborate firing mechanisms and/or bulky power supplies (e.g., Browder et al. 1995). Recently, however, cameras that no longer require as many auxiliary components have been developed. The cameras themselves have become much more complex, but are easier to use. Major and Gowing (1994) developed a photographic system using a high-technology camera, and we have taken the technique one step further, creating a system that uses a small switch, a strand of wire, and an electronic camera. We selected the Olympus AF-10 camera (not an endorsement of this product) based on the following features: (1) small size, (2) electronic flash, (3) auto focus, (4) automatic film advance, (5) built in time-date function, and (6) all-electronic operation.

CONVERSION OF THE OLYMPUS AF-10 CAMERA

When the camera is opened, the leads of the flash capacitor will be exposed. These leads are located on the circuitboard directly above the flash next to a small chip labeled "DK FU". If you make the connection between these leads with your finger you will receive a painful shock. Capacitors are designed to store an electric charge and release it all at once, so you can receive a shock even if you remove the battery. To convert a camera into an automatic photographic system for field research follow these steps. (1) At the back of the camera, remove the screw located in the upper left corner of the back plate. (2) Open the back of the camera and remove the 3 remaining screws, one of which is next to the hinge at the bottom of the door. (3) Pull the backplate off the camera while holding the door-release latch (used to open the back for film insertion) in the up position, being careful to prevent the spring on the release latch from coming loose. This spring is located under the back plate above the arrow on the release latch. (4) Pull the frontplate off the camera and release the door latch while being careful not to lose the spring. This leaves you with the camera body itself. (5) Take a section of telephone wire and strip off about 5 cm of the outer insulation. (6) Then strip about 3 mm of the insulation from the black, red, and green wires (the yellow wire is not used so cut it to the level of the outer insulation). (7) Lay the camera on its back and solder the green wire to the left-most gold-plated spot (Fig. 1). (8) Repeat using the red wire and the right spot, being careful to avoid a connection between the spots. (9) Set the camera upright and solder the black wire to the flat part of the angled, gold-plated shutter button spring located on the top of the camera body

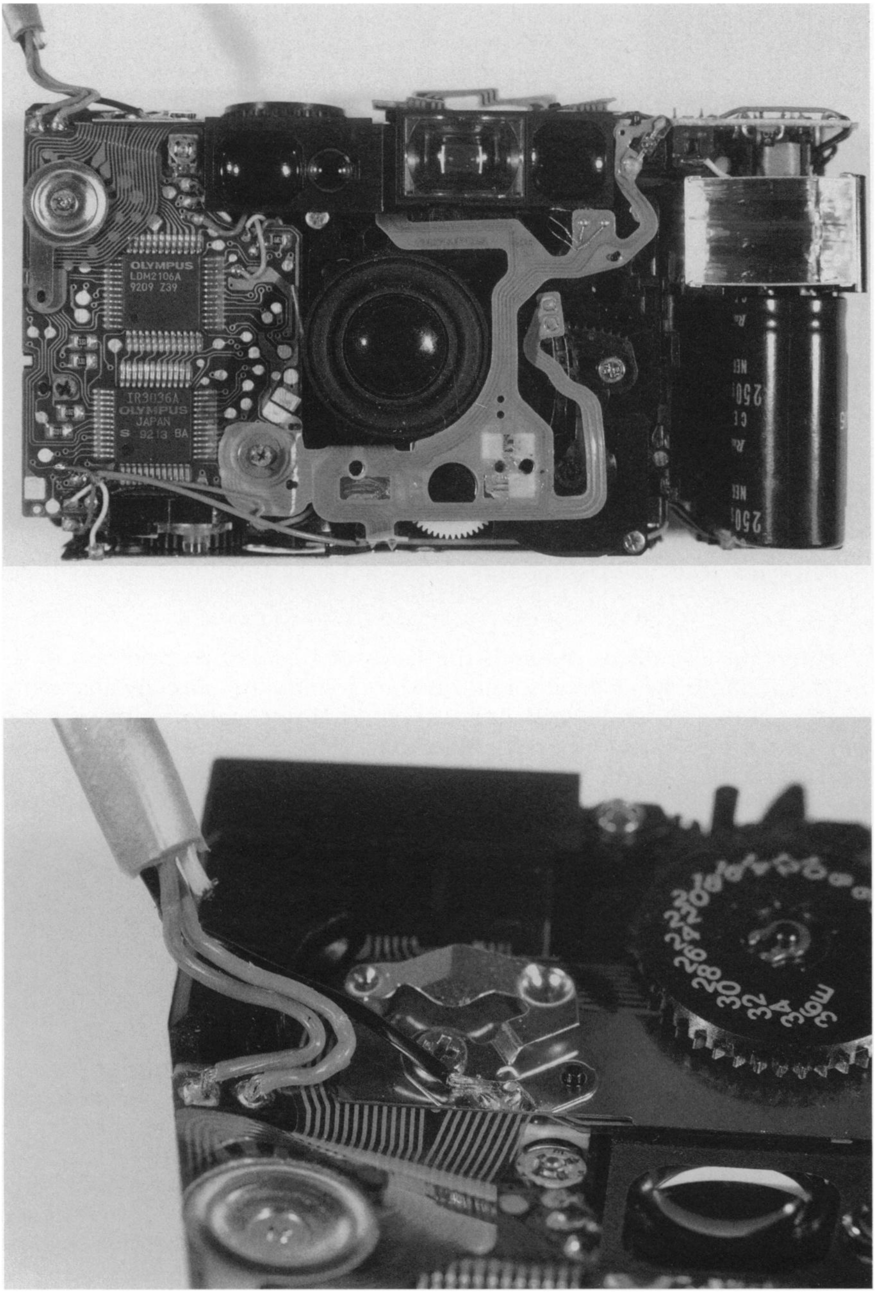

FIGURE 1. An Olympus AF-10® with front- and back-plate removed. Top—General location of soldering points critical to the conversion of the camera into an automatic photographic system. Bottom—Detail (moving left to right) of locations for green, red and black wires (steps 7–9).

(Fig. 1). Be careful not to interfere with the section of this item that has some "spring" to it or you may not be able to use the shutter button in the future. No further soldering is required. (10) Take the front cover (printed letters should be facing away from you), and drill a hole in the upper right corner (from the inside out). This should be on the same side as the shutter button. (11) Thread the free end of the telephone wire through the hole in the frontplate and press the frontplate into place (make sure the rubber dust cover is still around the lens). (12) To test the connections, strip about 2.5 cm of insulation off of the red, green and black wires and twist the red and green wires together. (13) Open the lens cover, let the flash charge, and then touch the black wire to the red and green wires. If the procedure was performed correctly, the camera will be activated. (14) Carefully hold the door-release latch spring in place while putting the backplate into place. (15) Replace the 4 screws to reassemble the camera. (16) Now take the microswitch and connect the black wire (black is always the ground wire) to the switch's ground connection. The ground connection is the one on the bottom of the Cherry E22-50hx microswitch we used. (17) You should have two connectors left on the microswitch. One will activate the camera when the switch is depressed (similar in effect as the foot treadle in a live trap), and the other will set off the camera when pressure is taken off the switch (used for bait stations or eggs).

To create a modular switch system you will need the following additional parts: 4-lead telephone junction box, modular telephone plug (4-strand), and a modular telephone crimping tool. To install the modular switch: (1) Replace the 3-m section of phone wire with a 30-cm section. (2) Drill a 6-mm hole on the left side of the floor of the wood camera box (as it is facing you) for the wire. (3) Thread the wire through the hole and attach the red, green, and black wires to the corresponding connectors in the telephone junction box. (4) Then screw the junction box to the bottom of the camera box. (5) Take a 3 m strand of telephone wire, use the stripper on the modular crimping tool to remove the correct amount of insulation, and attach a modular phone plug to the end of the wire. It is important to remember that the wires in the modular plug have to align with the correct junction box wires. If the camera does not activate you will have to put the wires into the plug in reverse. The other end of the wire will have the female disconnects attached to the microswitch. This configuration allows broken wires to be quickly changed in the field, and protects the camera from damage that may result when a large animal pulls on the switch wire with force.

RESULTS AND DISCUSSION

Versatility and flexibility made this an extremely useful photographic system. The camera's most important feature was its advanced internal-triggering circuitry, which eliminated the need to design an elaborate external triggering device. As a result, each camera could be fired by any kind of simple switch (e.g., limit switches, mercury switches, reed switches, pressure plates, and light sensitive switches based on either visible or infrared light). Our design used 3 m of 4-strand indoor telephone wire, 2 female disconnects (wire-terminal connectors), a Cherry E22-50HX snap-action microswitch (28 mm × 16 mm × 10 mm), and the following tools: wire stripper/cutter, small Philip's head screw driver, electric drill, 0.25-in drill bit, soldering iron, and resin (flux) core solder.

The camera, wire, switch, and connectors cost about US $105. In our study, the system was armed when an egg was placed on the microswitch, and the camera shutter was triggered when the egg was moved. Other applications could involve the same switch firing the camera when pressure was applied to the lever, as when an animal walks over a treadle (Goetz 1981). In one test of the system, 10 microswitches were wired in parallel so the camera would fire when any one of them was stepped on. Different triggers could allow this system to be used for still other kinds of research (e.g., a camera equipped with a light-sensitive switch could be set up to monitor the entrance to a nest cavity).

The camera's all-electronic design and quality components provided several other important features, perhaps the most important of which was the power supply. The camera was engineered around a single 3-volt lithium battery, which provided power for all camera functions, and eliminated the need for an external battery pack. In one case, 12 nighttime photographs were exposed in less than 60 s, and the flash system recharged for each photo. This kind of reliability was important because 53.5% of our photographs were taken during nighttime hours. We used 80 of these camera units, with flash systems continuously active, for a total of 4 wk each (a total of 3520 camera-days) and had no failures due to low battery power. This was important from both economic and logistic standpoints, because the system could be left in the field for extended periods of time without the need to change the batteries or schedule inspection visits. In addition, the camera's auto focus ensured that pictures produced by this system generally came out clearly, day or night, and the time-date feature allowed either the day-month-year or day-time to be recorded on the film for each exposure (Fig. 2). This provided valuable information and eliminated the need to design a separate time-recording device (Carthew and Slater 1991, Osterberg 1962, Picman 1988).

To protect the camera, we made boxes out of 1.9-cm exterior-grade plywood with plexiglass windows for the view finder, lens, auto focus sensor, and flash. A router could be used to recess the windows if desired. The dimensions of the box components are as follows: sides = 5.3 cm × 10 cm; front and back = 15.8 cm × 10 cm; bottom = 5.3 cm × 12.2 cm; lid = 10 cm × 16 cm. The lid of the box (10 mm × 16 mm) was hinged to the box and was locked with an ordinary hook-and-eye latch. The interior of the box was painted black to minimize flash rebound. To minimize water leakage, the edges of the box that meet the lid were lined with foam weather stripping tape. The boxes were held together with 3-cm drywall screws and all seams were sealed with silicon caulk. The protective

FIGURE 2. Photographs of a Blue Jay removing an egg from an artificial nest. Top—Blue Jay seizes an egg in its beak on 14 June at 0719 h. Bottom—Seconds later, the same individual flies off with the egg. The time date function allowed us to determine that the same bird appeared in both photographs, and the auto focus feature provided a clear picture of a flying predator.

housing costs about US $5–10 to construct, and each complete camera unit weighed about 1.35 kg, and measured 12 cm × 15.8 cm × 9 cm, making it easy for a single researcher to carry many units over long distances.

We painted the camera boxes with exterior latex paint to seal the wood and used camouflage patterns to make them visually inconspicuous. The nest/camera units were almost invisible when observed from a distance of about 5 m. The boxes also dampened the noises of the cameras enough so that they could not be heard from 2.5 m away. To reduce odors on the camera boxes and nests we placed them outside for 2 wk to "weather" prior to their use, and during this time they were subjected to several rain storms. As a result, the units operated almost silently and were inconspicuous both visually and chemically. Photographs taken under field conditions suggest that most animals photographed were unaware of the camera until the flash fired.

The boxes were attached to trees (as small as 10-cm dhb) using 3.8 cm × 15.25 cm camouflaged plywood brackets and 10-cm drywall screws. It took about 3 min to get a box set in position, and once aimed the box did not need to be readjusted unless something moved it. The camera could be lifted out of the box to change the film, and then replaced for reuse without affecting the positioning of the box. The plywood boxes protected the cameras from the elements and most animals. The only cameras lost were to bears (*Ursus americanus*) and porcupines (*Erethizon dorsatum*). Only one camera was actually destroyed by a bear, while 5 others were ruined by rain after the boxes had been ripped down or chewed open. Steel boxes are recommended in areas where bears are present.

Although some of the Infinity Jr. models of this Olympus camera developed minor problems (35 of 85), there were no problems with the 35 newer AF-10's. Since the Infinity Jr. model is no longer available, we do not expect anyone using this camera system to encounter such problems. This is an all-weather, highly portable, and highly dependable system that can be of great use in many types of research.

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