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A Subterranean Camera Trigger for Identifying Predators Excavating Turtle Nests

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Predation is the predominant source of nest mortality for most North American turtle species, including populations that are in decline (Brooks et al. 1992; Congdon et al. 2000). The identification of nest predators—crucial to understanding predator-prey relationships—has been previously accomplished largely by use of techniques that rely on the availability of physical evidence, such as animal sign (predominantly tracks) and nest/egg remains at depredated nests (e.g., Standing et al. 2000). Such techniques, however, are subjective and might preclude the identification of those species actually responsible for nest predation for numerous reasons, including: nesting substrates seldom retain identifiable tracks (Burger 1977; MacIvor et al. 1990), more than one species of predator might visit nests (Burger 1977; Larivière 1999; Leimgruber et al. 1994), and numerous predator species might leave similar nest remains (Hernandez et al. 1997a; Larivière 1999; Pietz and Granfors 2000). Further, the behavioral and temporal patterns of predators are rarely discernible via animal sign or nest remains. Therefore, comprehensive quantitative evaluations of turtle nest predation and predators have been infrequent (Burger 1977), although such detailed studies are clearly required (Tinkle et al. 1981).

The use of remote photography has allowed detailed evaluation of predation at artificial and natural avian nests (Maier and DeGraaf 2000; Pietz and Granfors 2000), yet there have been few applications of this technology in herpetofaunal studies (Cutler and Swann 1999). Preliminary efforts have indicated that remotely-triggered cameras might be used to study turtle nest predators (Doody and Georges 2000; Tuberville and Burke 1994); however, triggering devices (e.g., infrared beam) might be misaligned by animals, require frequent monitoring, and are often conspicuous (Hernandez et al. 1997b; Sadighi et al. 1995; see Fig. 2 in Doody and Georges 2000). Furthermore, such triggers often might be unduly activated by wind-blown vegetation, heavy precipitation, and by animals other than predators (Buler and Hamilton 2000; Rice et al. 1995; TJM, pers. observ.). To circumvent such limitations, we developed a small, simple, subterranean camera trigger that is relatively

FIG. 1. Raccoon (*Procyon lotor*) tripping subterranean camera trigger while excavating artificial turtle nest on 26 June 2000 at 0202 h in central Massachusetts.

easy to install, requires no maintenance, and is designed to activate only when the nest is excavated or otherwise greatly disturbed (Fig. 1).

Methods.—This trigger consists of a non-mercury tilt switch (manufactured by Assemtech Europe, part no. CW1300-1; distributed by Farnell Components [U.K.], part no. 540614; available from Newark Electronics® [USA]), 4.7 mm in diameter and 22.2 mm in total length, that contains two hermetically-sealed, non-toxic contact spheres (Fig. 2a). Each switch was soldered to the exposed doubled-leads at one end of a 4 m length of 24-gauge, solid telephone wire (Fig. 2b); with a modular plug crimped on the other end of the wire (Fig. 3). To re-insulate and waterproof the switch's soldered-connection, we dipped switch-ends of trigger wires in black Plastidip® (manufactured by PDI, Inc.; Circle Pines, Minnesota, USA), shaking off excess fluid and hanging them to dry. Plastidip® (previously used in field studies; e.g., Haskell 1999) provides a tough, flexible coating that has no apparent scent after being aired a few days. The modular plug of each trigger wire was connected to a modified 35-mm camera ("point-and-shoot" with 35-mm lens [f/3.5], ISO 200 color negative film [24 exp.], and a time-date function). The camera was enclosed in a camouflage-painted, weatherproofed wooden box with screened anti-condensation ports and glass windows (adapted from Danielson et al. 1996).

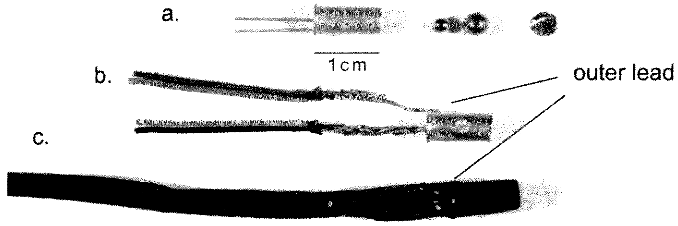

FIG 2. a) Non-mercury tilt switch showing contents, b) example of soldered switch, c) subterranean-end of trigger wire coated with black Plastidip®.

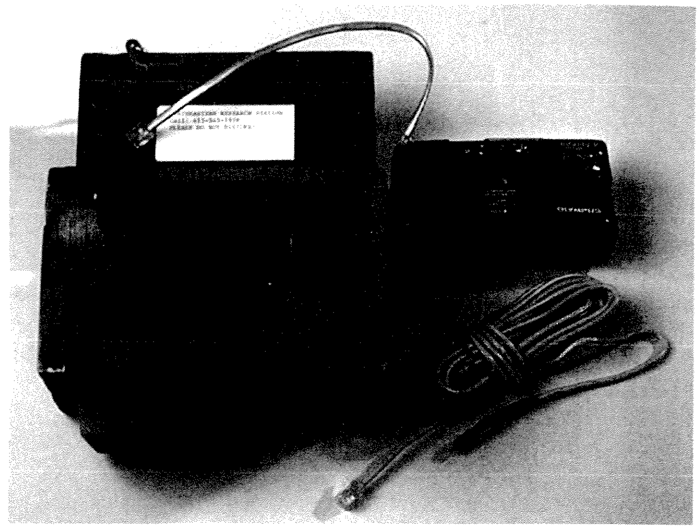

FIG. 3. Camera box assembly with trigger wire.

Switches cost $2 each (all costs approximate U.S. dollars), a 4 m length of telephone wire costs $1, a 429-ml can of Plastidip® costs $8, the camera box with modifications costs $15 to construct, a wood stake to support cameras set up in open areas costs $1, and cameras with modifications cost $105 (cost based on Danielson et al. 1996); totaling $125 per assembly.

We tested triggers by monitoring a total of 111 artificial turtle nests with remotely-triggered cameras at known turtle-nesting habitats in southern New Hampshire and central Massachusetts during May–July 2000. Each nest contained several eggs of either snapping turtle (*Chelydra serpentina*) or northern bobwhite (*Colinus virginianus*). Camera triggers were positioned horizontally (similar to that illustrated in Fig. 2c) and buried 5–10 cm below the soil surface (within nest chambers) with moist soil repacked over the nest. Preliminary trials indicated that shallower trigger placement often resulted in their activation during heavy rain or when non-target animals, such as wild turkey (*Meleagris gallopavo*), stepped on nests. Trigger wires were buried in a thin slit between nest and camera at similar depth to triggers using a trenching shovel. Camera triggers were most sensitive to disturbance when the switches' outer lead (i.e., lead originating off switch casing [see Fig. 2b], easily seen under the Plastidip® coating [see Fig. 2c]) was placed downward. Cameras were mounted 1–1.5 m above ground on wooden stakes or trees at a distance of 1.5–2.5 m from nests (Fig. 4). While installing artificial nests and camera equipment, we wore clean gloves, clean rubber boots, and placed our equipment on clean plastic drop-sheets to minimize human scent and disturbance at the sites (Whelan et al. 1994).

Results and Discussion.—Our use of subterranean camera triggers enabled us to photograph several species of "turtle nest" predators without experiencing many of the problems associated with other triggering devices. Raccoons (*Procyon lotor*) were the most frequently photographed predators both in New Hampshire and Massachusetts. We also identified striped skunks (*Mephitis mephitis*) in Massachusetts, gray fox (*Urocyon cinereoargenteus*) in New Hampshire, and fishers (*Martes pennanti*) in New Hampshire as nest predators. To our knowledge, fishers have not previously been reported to depredate turtle nests. Red squirrels (*Tamiasciurus hudsonicus*) sporadically disturbed nests in New

Hampshire sufficiently to trigger cameras but did not destroy nests, suggesting either that they may be sensitive to our cameras' activity or that they are not turtle nest predators. Cameras also were occasionally triggered by moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*) that stepped directly on turtle nests. Other apparent false-triggers (i.e., nothing visible in photograph) may have been caused by unidentified burrowing animals as posited by Congdon et al. (2000).

We also photographed multiple predators at the same nest in a number of cases, occasionally simultaneously. For example, a gray fox was photographed 4 June at 0150 h, just prior to a raccoon at 0201 h. At a second nest, a raccoon was photographed 9 July at 0442 h and 0609 h, followed by a fisher at 1806 h the same day. Additionally, we photographed multiple raccoons simultaneously at the same nests. Photographing subsequent visiting predators was possible after nests and camera triggers were either partially or completely excavated because our camera units remained active as long as unexposed film was available. Camera triggers proved extremely sensitive when uncovered, often repeatedly firing the camera at any slight disturbance such as raindrops or another predator. As used in our tests (i.e., without time-delays on cameras), trigger sensitivity also resulted in multiple exposures of individual predators engaged in prolonged digging activity, bouts often lasting at least 5 min. Such series of photographs occasionally provided useful behavioral insights; this, however, at the expense of photographs of any subsequent visitors when all film was exposed. Thus, even more nests may have had subsequent visitors than we were able to detect.

Further use of subterranean camera triggers, along with the time-date function of the cameras, may allow researchers to quantify patterns of turtle nest predation. For example, an association between precipitation events and predation on older nests has been reported (Congdon et al. 2000; Wilhoft et al. 1979); however, heavy precipitation has been reported to depress predation rates by inhibiting predators (Burger 1977; Hammer 1969; Legler 1954). Unfortunately, all reports have been incidental observations and the potential association has never been investigated systematically (Brooks et al. 1992). Confirmation of turtle nest predators and nest predation times, along with on-site precipitation-humidity data (and perhaps soil moisture gradients), would allow the quantitative evaluation necessary to establish not only the association between predation and precipitation but potentially underlying mechanisms as well.

Fig. 4. Field installation of camera and buried trigger at artificial turtle nest.

The presence of remote photography equipment (e.g., triggering mechanisms) may affect animal behavior (Cutler and Swann 1999; Maier et al., unpubl. data). As such, our inconspicuous subterranean triggers provide a more objective and effective means by which researchers may quantitatively examine turtle-nest predators and patterns of predation. Field trials yielded numerous detailed photographs of various potential predator species, their behavior, and time of activity while depredating artificial turtle nests. Additionally, multiple predator species were detected at the same nests, highlighting the shortcomings of subjective identification methods that rely on physical evidence such as animal sign or remains at depredated nests. These observations and others afforded by use of this inexpensive remote-recording device may prove useful in understanding many factors affecting the reproductive success of turtles.

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