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A MOTORIZED FOOD BOX FOR USE IN SUPPLEMENTAL FEEDING EXPERIMENTS

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Abstract.—Few supplemental feeding experiments have been conducted on carnivores because of the difficulty involved in providing food to these species. We conducted a supplemental feeding experiment on the Northern Goshawk (*Accipiter gentilis*), an avian predator, in north-central New Mexico. To avoid attracting potential nocturnal predators of Northern Goshawk nestlings, we provided dead quail in a food box with a motorized cover that closed at night and opened the following morning. The box, constructed of rough lumber and simple hardware, was a reliable way to deliver food during the nestling period. Of 14 boxes, nine worked for the entire nestling period (approximately 4 wk), or until nest failure, four boxes became inoperable after being knocked over by black bears, and one box developed loose wires and no longer functioned by the end of the third week. We recommend the following food box design improvements: increased connection stability of box to post, heavier metal for cover and hinge arms, improved operating link connection to hinge arms, and a completely covered circuit board to minimize wire disconnection.

UTILIZACIÓN DE UNA CAJA MOVIDA CON UN MOTOR PARA EXPERIMENTOS DE ALIMENTACIÓN SUPLEMENTARIA

Sinopsis.—Se han hecho pocos experimentos de alimentación suplementaria a carnívoros, por la dificultad para proveerle alimento a estos organismos. En este trabajo, llevamos a cabo un experimento de alimentación suplementaria en individuos de *Accipiter gentilis*, halcón de la parte norcentral de Nuevo México. Para evitar atraer depredadores potenciales nocturnos a los polluelos de halcón, el alimento se les proveyó (codornices muertas) en una caja con un motor que permitía que ésta fuera tapada de noche y abierta en la mañana. La caja, construida en madera, fue confiable para proveer de alimento a la aves durante el periodo de crianza. Nueve de las 14 cajas trabajaron adecuadamente durante el periodo experimental (cuatro semanas). Cuatro de las cajas se dañaron cuando fueron golpeadas por osos negros y a la restante se le soltaron los alambres de conección y dejó de funcionar para la tercera semana de trabajo. Se recomiendan mejoras en el diseño de las cajas para lograr mejores resultados en este tipo de estudio.

A multitude of supplemental feeding experiments have been conduct-

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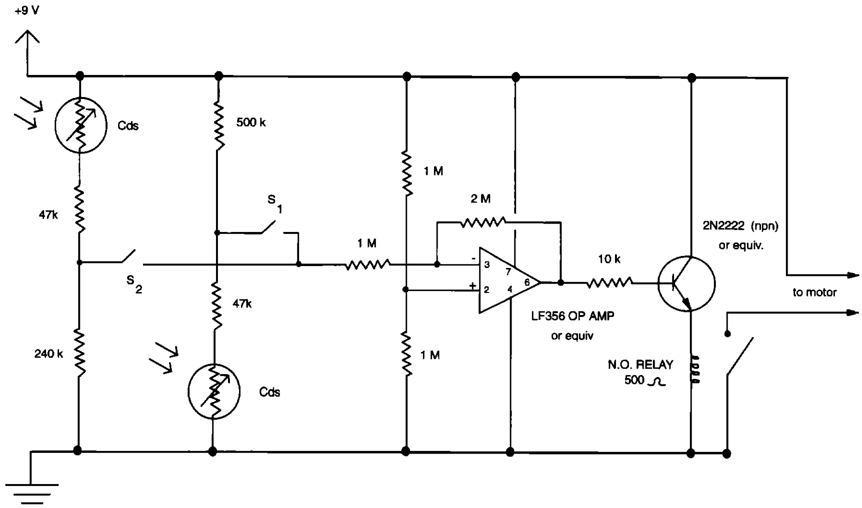

FIGURE 1. Schematic of circuit connections for food box. S_1: rear limit switch, closed when box closed; S_2: front limit switch, closed when box open. Cds photoresistors: 2M dark, 2K light.

ed on terrestrial vertebrates, including nesting birds (Boutin 1990). Because passerine diets can be easily supplemented (e.g., bird seed, dog food), most avian supplemental feeding experiments have been conducted on small herbivorous birds (only 3 of 58 avian experiments cited by Boutin [1990] were conducted on carnivores). One of many challenges of supplemental feeding of predators is providing food to the study species while deterring other potential predators.

We conducted a supplemental feeding experiment on an avian predator, the Northern Goshawk (*Accipiter gentilis*) in north-central New Mexico (Ward and Kennedy 1996). We wanted adult Northern Goshawks to be able to take supplemented food to their nest. However, it was not feasible to place food directly in nests because excessive disturbance may have led to nest failure (Fyfe and Olendorff 1976, Newton 1979). We provided dead Japanese Quail (*Coturnix coturnix*) that goshawks could remove from a food box placed on a post within 15 m of the nest. We were not concerned that this feeding method would attract potential diurnal predators to active nests because Northern Goshawks rigorously defend their territories. However, Great Homed Owl (*Bubo virginianus*) predation on Northern Goshawk nestlings occurred regularly in our study area (Ward and Kennedy 1996). To avoid attracting potential nocturnal

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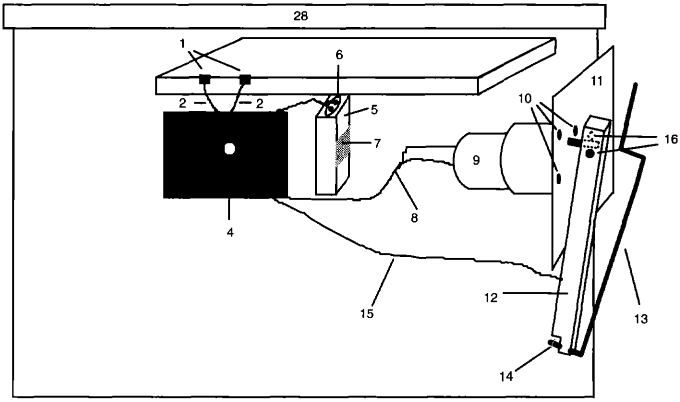
FIGURE 2. A. Front panel of food box. B. Right side panel of food box. C. Left side panel of food box. Numbered parts are listed in Table 1.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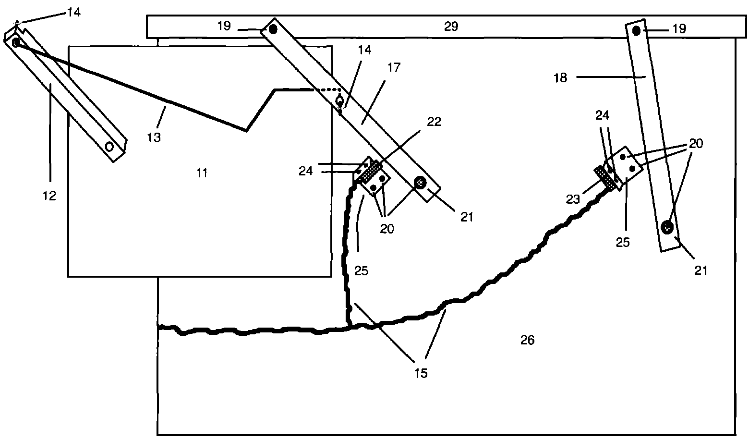
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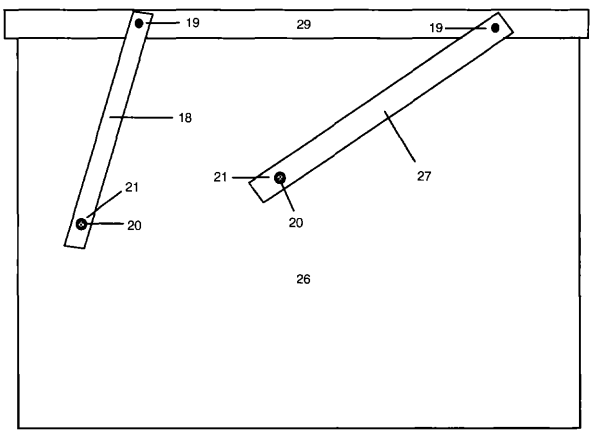
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predators, the cover of each food box was electro-mechanically closed at night and opened during the day. A food box was designed to operate through at least the nestling period (approximately 4 wk) when predation was highest (Ward and Kennedy 1996). Here we describe the construction and use of the food box.

METHODS

We constructed the food boxes (26 × 23 × 20 cm) from rough pine. The boxes were large enough so that provisioned food (approximately 6–10 quail) would easily fit inside, and adult and juvenile Northern Goshawks would have sufficient space to perch. Food boxes were attached to the top of a 2.5-m pine post. A solar-activated 9 VDC motor powered by a 9-volt battery (one 9-volt battery was required to run one box for approximately 6 d) opened and closed the aluminum cover (Fig. 1). The circuit board, battery, and motor were all located on the front panel of the food box and protected with a pine cover (24 × 8 × 2 cm; Fig. 2a). The circuit components (wiring, transistor, fuses, battery connection, photoresistors) can be purchased at most electronics stores. Each side panel had a front and a rear hinge arm connected to the sheet aluminum cover, which is attached to an aluminum angle frame (Fig. 2). The right panel has four moving parts: the front and rear hinge arms, the operating arm, and the operating link (Fig. 2b). Both hinge arms and the operating arm were aluminum and the operating link was steel. The operating link was connected to hinge arms by a press-on retaining clip attached to the end of the operating link after the link had passed through the hinge arms. The left panel of the food box has two moving parts, the front and rear hinge arms (Fig. 2c). The mechanical linkage is set up so that the motor runs in the same direction at all times. In 1992, it cost approximately US $80.00 to build one food box; the 9 VDC motor was the most expensive component, and cost about US $40.00.

During the last week of May 1992 and 1993, motorized food boxes were placed at six and eight treatment nests, respectively (food boxes without motorized covers were placed at six and eight control nests in 1992 and 1993) (see Ward and Kennedy [1994] for additional experimental design details). We visited nest stands every other day to place supplemental food in food boxes; at this same time we tested batteries and replaced dead batteries, inspected wire connections, and initiated box closure to evaluate motor, hinge arm, operating arm, operating link, and limit switch function.

RESULTS AND DISCUSSION

Over the two years of the experiment, five food boxes (36%) worked the entire nestling period, four boxes (29%) were still operational after nest failure that occurred at 1–3 wk, and four boxes (29%) were knocked over and damaged by black bears (*Ursus americanus*) and were inoperable because the cover, hinge arms, and operating link were bent. One food box developed loose wire connections and unreliable linkage between

TABLE 1. Material list corresponding to numbered parts shown in Figure 2.

Part no.	Part title	Description
1	Photoresistor	See schematic (Fig. 1)
2	Wires	80-mm length, 14-gauge wires from photresistor to circuit board
3	Circuit board	70 × 35 × 1 mm
4	Transistor	Switch, 2N2222; see schematic (Fig. 1)
5	Battery	9-volt
6	Battery connection	Connection of 9-volt battery to circuit board
7	Battery holder and screw	Aluminum; back (17 mm) sides (25 mm). Hole on back panel (3 mm); screw (11 × 6 mm)
8	Wire	15-cm length, 14-gauge wire from circuit board to motor
9	Motor	9 VDU motor 100 to 1 gear reduction; Globe Motor Company
10	Screw	10 × 4 mm
11	Plate	Aluminum, 120 × 1 × 120 mm; four 3-mm holes along edge for attachment to side panel; one 12-mm hole, and three 3-mm holes in triangular arrangement around 12-mm hole for motor attachment
12	Operating arm	Aluminum 10 × 1 × 1 cm; 5 × 5-mm square cut out of top to allow for rotation of operating link (one 3-mm hole at this end that operating link passes through); one 4-mm hole at opposite end that motor rod passes through
13	Operating link	Steel rod, total length ca. 220 × 3 mm, bent to fit
14	Retaining clip	Steel, for 1.5-mm diameter rod (operating link)
15	Wires	40-cm length, 14-gauge wire from circuit board to rear limit switch; 26-cm length, 14-gauge wire from circuit board to front limit switch
16	Screw	8 × 3 mm
17	Right side front hinge arm	190 × 1 × 10.5-mm aluminum arm with three 3-mm holes; one at each end, and one in the middle
18	Rear hinge arm	130 × 1 × 10.5-mm aluminum arm with two 3-mm holes at each end
19	Bolt, lock nut, and washer	6 × 11 mm bolt; 6 mm lock nut; 10 × 6 × 1 mm washer
20	Screw	6 × 20 mm
21	Stop and washer	PVC stop 10 × 7 × 6 mm; 11 × 4 × 1 mm washer
22	Front limit switch	Micro switch lever-type, SPDT 5 A at 250 VAC, Radio Shack part #275-016
23	Rear limit switch	Micro switch lever-type, SPDT 5 A at 250 VAC, Radio Shack part #275-016
24	Bolt and lock nut	14 × 4 mm bolt; 4-mm lock nut
25	Right angle	Aluminum, 30 × 20 × 1 mm
26	Side panel	Pine, 28 × 2 × 20 cm
27	Left side front hinge arm	Aluminum, 190 × 1 × 10.5 mm
28	Front/rear pieces of angle frame	Aluminum angle, 315 × 12 × 12 mm (1-mm thick)
29	Side pieces of angle frame	Aluminun angle, 267 × 12 × 12 mm (1-mm thick)
	Cover	Sheet aluminum, 315 × 0.5 × 267 mm, (not shown)
	Floor board	Pine, 26 × 2 × 28 cm, (not shown)
	Post	Pine, 10 × 10 × 240 cm, (not shown)

the operating link and hinge arms, and, after three weeks, no longer functioned.

Based on these results, we recommend increased connection stability of food box to post, heavier metal for cover and hinge arms, improved operating link connection to hinge arms, and a completely covered circuit board to minimize wire disconnection. Angle arms or shelving brackets attached to the food box bottom and the post side would stabilize attachment to the post and may decrease animal damage. A stronger metal cover and hinge arms may also minimize food box damage after being knocked over or hit by an animal. Because the press-on retaining clips used to hold the operating link in place were sometimes dislodged, the operating link should be bent at a 90° angle to hinge arms so that if retaining clips fall off the operating link will remain in place. Aluminum rather than steel operating links would minimize corrosion. To prevent circuitry damage, completely encase the circuit board and wires with either a wood or plastic box with a removable front that will allow access to the circuit board. We caution other researchers that our food box was designed to function for a short period of time (4 wk) and recommend that design modifications be implemented if boxes are to be used for longer investigations.

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