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USE OF AN ARTIFICIAL NESTLING FOR DETERMINING THE DIET OF NESTLING TREE SWALLOWS

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Abstract.—Accurate determination of the diet composition of nestling swallows can be difficult because of the small size and large numbers of food items delivered per visit. We describe a method for determining the diets of nestling tree swallows (*Tachycineta bicolor*) using artificial nestling puppets constructed of the skins from salvaged nestlings mounted on crucible tongs. By obtaining multiple samples from individual nests while keeping prey size bias to a minimum, this method eliminates some of the sources of possible error associated with other means of determining diet composition.

UTILIZACIÓN DE POLLUELOS ARTIFICIALES PARA DETERMINAR LA DIETA DE PICHONES DE *TACHYCINETA BICOLOR*

Sinopsis.—El determinar con exactitud la composición de la dieta de polluelos de golondrinas puede ser muy difícil debido al tamaño tan pequeño de los artículos alimenticios y el número de éstos que son llevados por los adultos al nido. Describimos un método para determinar la dieta de polluelos de *Tachycineta bicolor* utilizando modelos artificiales construídos con la piel de polluelos que perecieron, montados sobre pinzas. Mediante la obtención de muestras múltiples de diferentes nidos, mientras mantenemos al mínimo el sesgo sobre el tamaño de los artículos alimenticios, eliminamos algunas de las posibles fuentes de error asociadas a otras formas de determinar la composición de la dieta en este grupo de aves.

Several methods have been used to obtain samples for the determination of diet composition in nestling birds. To conduct a detailed study of the foraging ecology of Tree Swallows (*Tachycineta bicolor*), we needed a method that would provide us with high quality samples without disrupting reproduction. Direct analysis of stomach contents (Beal 1918, Johnston 1967) can be rejected for most studies of behavioral ecology since it requires killing the individual to be sampled. The use of emetics to force regurgitation of stomach contents is highly stressful, and the fatality rate is too high for use in long-term behavior and ecology studies (Prys-Jones et al. 1974, Radke and Frydendall 1974). Analysis of fecal samples is difficult, since only small parts of food items are passed, making identification difficult and determination of quantity ingested impossible (Bryant 1973, Ralph et al. 1985). In addition, diets determined from fecal or stomach-content samples may be biased towards hard bodied prey (Blancher et al. 1987).

Methods that obtain samples before they are ingested by the nestlings provide more satisfactory results. High quality samples can be obtained by removing boli from the mouths of trapped adults (Quinney and Ankney 1985), and if a number of nests are sampled this method can provide a good measure of the diet of a population. Unfortunately, the number of samples that can be obtained from any one nest by this method without severely disrupting nesting is low. The ligature method (Bryant and

Turner 1982, Orians 1966, Willson 1966) is most commonly used, since it provides high quality samples, and multiple samples can be obtained from each nest. However, this method may not be appropriate for all studies. Johnson et al. (1980) and Orians and Horn (1969) both reported errors associated with the ligature method that affected the frequency of feedings and the size of food items obtained. Holroyd (1972) found the begging behavior of older nestlings to be inhibited by collars in several swallow species. The tendency of small food items to slip past the ligature (Orians and Horn 1969) is of particular concern in swallows since the diet consists primarily of small Diptera. Additionally, Blancher et al. (1987) noted a tendency for large prey items to be under-represented when comparing the ligature method to five other methods. The problem of nestlings disgorging feedings (Johnson et al. 1980) is especially troublesome in swallows, since many of the food items delivered are still alive and able to fly away if not immediately swallowed (McCarty and Winkler, unpubl. data).

In an attempt to overcome these problems, we modified a method developed by Betts (1954, 1956) for obtaining food samples from Pied Flycatchers (*Ficedula hypoleuca*) and Coal Tits (*Parus ater*). This method consists of using an artificial nestling puppet to obtain food samples directly from the parent. We know of no successful attempts to use this method since these papers were published, although Orians (1966) with Yellow-Headed Blackbirds (*Xanthocephalus xanthocephalus*) and Evans (1964) with sparrows both attempted to use Betts's method.

MATERIALS AND METHODS

In our initial trials with this method, we soon learned that its efficient use requires realistic puppets that closely match the size and maturity of the live nestlings. Thus, a series of different-sized nestlings was constructed. We found that the skins of actual Tree Swallow nestlings provided an effective basis for construction of puppets. All nestlings used had been found dead (of starvation) in nest boxes in previous years and had been kept frozen. Nestlings were skinned and the mouth, head and neck were dried. The dorsal and ventral halves of the head were separated by cutting from the corners of the mouth through the neck. Each half was then mounted with cyanoacrylate glue on the filed and pointed tips of straightened, 25-cm long crucible tongs. The ventral part of the nestling skin was attached so that one tip of the tongs formed the "tongue." The dorsal half of the skin was attached to the other tip to form the roof of the mouth. Blackened athletic tape was used to form the sides of the mouth and a partial body. This resulted in a "gullet" in the form of a pocket 30–40 mm deep. The inside of the mouth, the pocket, and the "tongue" were painted with bright yellow latex tool-handle coating to mimic the natural lining of the mouth (Fig. 1). Our attempts to use puppets constructed of rubber pipette bulbs as described by Betts (1954) were not successful. While realistic puppets constructed of different ma-

FIGURE 1. Front and side view of artificial nestling puppet. Dorsal and ventral portions of the puppet are constructed of skins and the sides covered with blackened, cotton athletic tape.

terials would probably be acceptable substitutes for the puppets we used, we found puppets constructed of natural skins to be both inexpensive and easy to construct.

The nestling puppets were manipulated from a blind set 0.5 m behind the nest box. A nest box with a plexiglass panel on one side, an entrance hole opposite the plexiglass panel, and a 3.5-cm diameter hole in the bottom was substituted for the regular nest box. The inside of this nest box could be viewed from the blind through a cloth sleeve between the plexiglass panel and an opening in the blind. A second sleeve ran from an opening in the blind below the first sleeve to the hole in the bottom of the nest box (Fig. 2). The lower sleeve concealed the puppeteer's arm while the artificial nestling was inserted into the nest through the hole in the bottom of the nest box. The hole in the bottom of the nest box was kept plugged when the puppet was not in place to prevent the nestlings from falling through.

This method was used to obtain samples from two nests in 1989. At the first nest, a blind was placed 0.5 m from the nest box after the clutch of six eggs was completed. Seven days later the two sleeves were attached to the nest box. The nest contents were transferred to the special nest box after two additional days, and an observer began sitting in the blind the following day to habituate the adults to our presence. The adult birds readily adjusted to all of the changes in the nest, resuming regular visits to the nest within 5–30 min of the changes, and the eggs hatched on 2 June (=day 1), 1 d after the blind was first occupied.

We installed the blind at the second nest after its clutch of four eggs was completed. One day later the sleeves were attached and the nest contents moved to the modified nest box. The adults adjusted to this accelerated change, but the time before resuming normal nest visits in-

FIGURE 2. Puppet blind and modified nest box. Note the sleeves running between the blind and the nest box for viewing the nest (top) and concealing the puppeteer's arm (bottom).

creased (up to 75 min). Two days later we began sitting in the blind, and the eggs hatched on 1 July (=day 1), two days after the blind was first occupied.

Nestlings remained in the nest box during puppeting sessions. By placing the hole in the bottom of the nest just to the rear of the nest cup we found that the puppet could be inserted into the nest box with a minimum of disturbance to nestlings (or even to brooding adult females). When the parents approached the nest box with a food bolus, the begging motions of the swallow nestlings were imitated. When the adult attempted to feed the nestling puppet, the food bolus was grabbed gently by squeezing the tongs, and the artificial nestling was quickly withdrawn from the nest box to avoid loss of food items. The food sample (usually the entire bolus, although the artificial nestling occasionally failed to grab the entire bolus) was then removed from the pocket in the artificial nestling using forceps. Samples were preserved with 70% EtOH and later identified and measured to the nearest 0.1 mm using a dissecting microscope.

RESULTS

Samples were collected from the first nest beginning on day 4. If a smaller artificial nestling had been used, samples could probably have been obtained earlier; however, we found it progressively easier to obtain samples as the nestlings grew and begged more vigorously. At this first nest, we obtained 16 samples between day 4 and day 11, with a maximum of five samples obtained in a single day. Multiple samples within a single trial (each trial lasting several hours) were separated by between 20–90 min. A minimum of 15 min between samples was allowed to minimize disturbance to the nest, and longer intervals between samples represent periods in which the parents fed live nestlings instead of the puppet. We did not attempt to obtain samples after day 11 at this nest.

At the second nest we delayed the start of attempting to obtain food samples until day 10 and were able to obtain samples on that day. We continued to obtain samples until day 15, after which we did not attempt to obtain samples. Ten samples were collected at this nest.

Food samples collected so far provide us with preliminary information on nestling diet composition. Samples contained insects from eight orders with a mean length of 4.5 mm (Table 1). The most common food items delivered to Tree Swallow nestlings were small Diptera (85% of food items obtained, mean length = 4.2 mm), followed by small Coleoptera (6% of food items obtained, mean length = 4.7 mm). Although odonates made up only 1% of the items delivered, their large size (mean length = 30.4 mm) makes them an important component of the nestling diets, beginning at least by nestling day 7.

DISCUSSION

We believe that this method overcomes many of the problems associated with other methods used to obtain samples of the diets of nestling birds. Samples are recovered in very good condition, with many items still alive.

TABLE 1. Diet composition of nestling tree swallows. Mean lengths of insects are calculated over all 26 samples (16 samples from nest 1, 10 from nest 2). Count equals the total number of individuals in the 26 samples analyzed. Percent of food items is the percent composition (by number) of the diet at each nest.

Taxa	Mean length	(Count)	Percent of food items	
			Nest 1	Nest 2
Diptera	4.2 mm	(362)	86%	84%
Coleoptera	4.7	(25)	7	5
Homoptera	2.8	(16)	2	5
Hymenoptera	4.0	(13)	—	5
Odonata	30.4	(5)	3	—
Hemiptera	3.3	(2)	1	—
Plecoptera	8.0	(2)	<1	<1
Lepidoptera	10.0	(1)	—	<1
Araneae	3.5	(1)	<1	—

The adults often feed the entire bolus to the artificial nestling, allowing the quantity of food delivered to be accurately determined. Although the adults displayed some hesitancy before feeding the artificial nestling, and usually tried to feed live nestlings in preference to the puppet, we were able to obtain repeated samples from the same nest without placing excessive stress on the adults. Nestlings showed no obvious signs of stress; chicks as old as 15 d showed no fear of the artificial nestling. Other studies of nestling Tree Swallow diets have also found large numbers of small Diptera. Holroyd (1983) used the ligature method to determine the diet of nestling swallows in Ontario and found Diptera made up 87% of the food items in the diet. Quinney and Ankney (1985) determined the diets of nestling swallows by removing boli from trapped adults at two sites in Ontario. At a dry-field-habitat site they sampled, Diptera made up 74% of the food items, followed by Homoptera (21%). At the dry-field site, 41% of the items were between 1–3 mm, 45% between 4–6 mm, and 14% between 7–10 mm. At a site near water 94% of the food items were Diptera, followed by Homoptera (5%). Items at this site were larger, with 19% between 1–3 mm, 61% between 4–6 mm and 20% between 7–10 mm. Blancher et al. (1987) compared several methods, including collecting boli and the ligature method, and found that Diptera made up over 46% of food items. In contrast to the other two studies, Blancher et al. (1987) also found significant numbers of odonates in the diet, as in this study.

Although we have only described the two initial trials from 1989 in this paper, we have since used this method successfully on 10 additional nests during the 1990 season and feel that it could be modified to be used with other species of insectivorous birds. The ability to detect a wide range of sizes and to obtain multiple samples at the same nest through a large portion of the nestling period makes this method a viable alternative to others more commonly used.

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