early behavior to adult sexual behavior, and that the mechanism underlying at least some parts of the complex behavior patterns associated with the courtship ritual are present at, or shortly after, hatching.

As well as sexual components, a considerable number of aggressive components are also present in the courtship display of the Sharp-tailed Grouse (Lumsden, loc. cit.). In one-day-old Red Grouse chicks, Watson and Jenkins (Brit. Birds, 57:137, 1964) describe attempts to "sing" on the ground in characteristic adult posture. The young Red Grouse also exhibited several other adult-like aggressive displays. Reactions towards an imprinting or other object may also contain aggressive components in young domestic chicks (Andrew, loc. cit.; Evans, Anim. Behav., 16:24, 1968). These results raise the possibility that tail-rattling in Sharp-tailed Grouse chicks may also contain elements of aggressive behavior. This hypothesis seems to agree with what has been observed, and perhaps offers a superior alternative to the explanation that these responses represent precocious sexual behavior. Possibly the ultimate interpretation of phenomena such as precocious tail-rattling in Sharp-tailed Grouse involves elements of both hypotheses reviewed here. In either case, it seems likely that the complex and highly competitive mating system of the Sharp-tailed Grouse may have favored the very early development of many of the motor components of the displays associated with reproduction.

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Energetics of a Spotted Sandpiper feeding on brine fly larvae (*Paracoenia*; Diptera; Ephydridae) in a thermal spring community.—The Spotted Sandpiper (*Actitis macularia*) a very adaptable shore bird, is found in both marine and fresh water habitats (Bent, U.S. Natl. Mus. Bull., 146:78–97, 1929). We have observed a Spotted Sandpiper feeding in a habitat which we believe has not been previously reported. Several meadows throughout Yellowstone National Park have flowing hot springs ranging in temperature from 35 to 70 C. Many of these hot spring effluents support blue-green algal mats with large populations of grazing flies. Herbivorous flies complete their entire life cycles in the mat matrix and both larval and adult stages feed upon the blue-green algae. Such thermal communities contain a rich animal food source which we found was exploited by Spotted Sandpipers.

The predominant substrate upon which hot spring algal mats develop is silica; however virtually identical blue-green algal mats grow on artificial substrates such as wooden platforms (Wiegert and Fraleigh, Limnol. Oceanogr., 17:215–228, 1972). The particular sandpiper which we studied fed upon insects found in mat systems throughout the meadow. Most of its feeding, however, occurred upon mats on elevated wooden platforms one meter wide and 24 meters long. Effluent from a hot spring (56 C, pH 6.0) was piped to each of two platforms at 30 liters per minute. The two large algal mats were similar to the several surrounding blue-green algal mats found in the meadow except that the formers' boundaries were clearly defined and effluent inputs and outputs from the boards could be accurately determined. Both algal mats supported a very large population of grazing flies, most of them *Paracoenia turbida* Cresson, Ephydridae. Each summer since 1969 one Spotted Sandpiper has been feeding almost daily from the platforms. This note

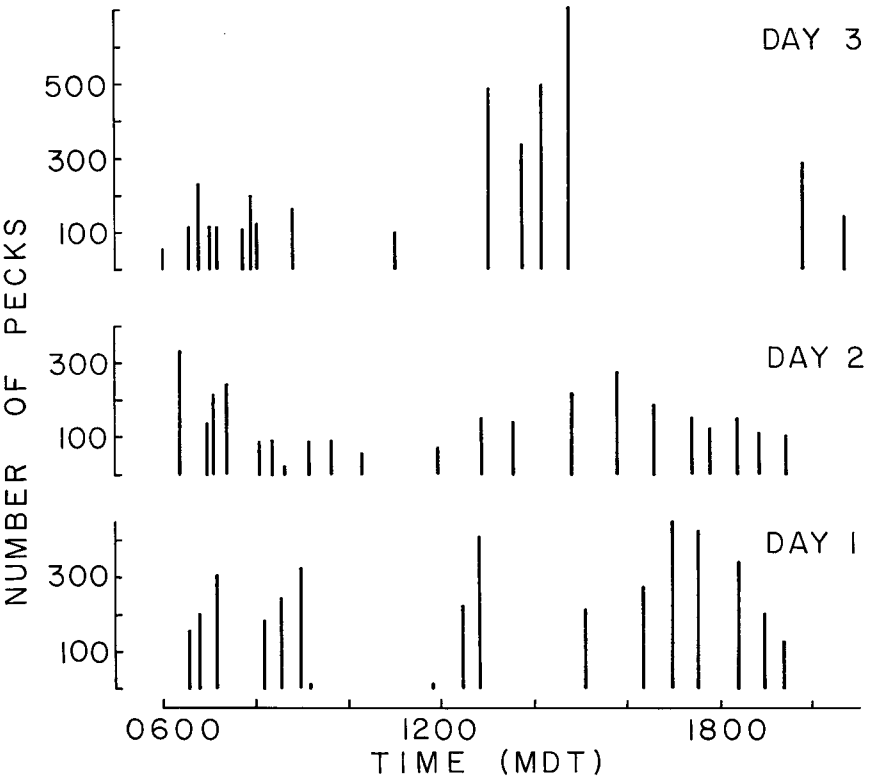

FIG. 1. Diurnal feeding behavior of Spotted Sandpiper. Vertical bars represent onset and number of pecks of each feeding bout.

reports observations (made between 8 July and 20 July 1971) of predation on brine flies by the sandpiper. No other adult sandpiper was seen in the study area.

A diurnal feeding pattern was established by recording the following data each time the bird flew to the algal mat to commence a feeding bout: time of day, number of pecks and duration of feeding bout. When off the algal mats, the bird was observed with a 20-power spotting scope. Feeding bouts were recorded for three days from dawn to dusk. On only two occasions was the bird observed to feed off of the wooden platforms. The bird averaged 18 feeding bouts per day; a greater proportion occurring near the beginning and end of each day (see Fig. 1). The mean number of pecks/bout was 203 ± 37 ($\bar{x} \pm 2$ SE; $n = 54$). The total number of pecks recorded for the three days were 4135, 3067, and 3771 giving a mean number of 3638 pecks/day.

We could not determine from field observation what the sandpiper was eating due to the rapid movements of head and bill. We did note two distinct types of feeding behavior. One, the common type, was a probing, rapid downward peck at the mat while the second (rare) was a very deliberate, slow approach (toward a potential prey?) followed by a quickened pace, forward thrust of the neck and horizontal movement of the bill. Both

types of feeding behavior were noted previously in two different species of sandpiper (Drury, Auk, 78:176–219, 1961). The rapid peck was characteristic of the White-rumped Sandpiper (*Calidris fuscicollis*) while the deliberate slower feeding occurred in Baird's Sandpiper (*Calidris bairdii*). Stomach content analyses of the former revealed mostly larvae while Baird's Sandpiper preyed upon adult and flying insects. The present observation of both types of feeding behavior in the same species suggests that the Spotted Sandpiper feeds on both larvae and adult flies.

Direct evidence of prey consumed by the Spotted Sandpiper was obtained from study of feces. A fresh fecal sample was partially dissolved in xylene and insect fragments were identified. The two rounded chitinous caps on the tracheal tubes of *Paracoenia* larvae passed through the bird's digestive tract intact. The number of caps found in the feces (divided by two) gave the number of larvae consumed. The feces contained remains of: 98 larvae, 1 pupa and 2 adults of *P. turbida* plus remains of 1 spider and 1 beetle.

We computed the daily respiratory energy loss of a Spotted Sandpiper using a live weight of 57 g (2 oz.—Palmer, Fieldbook of Natural History, McGraw Hill, X:664, 1949) and the formula relating non-passerine metabolic requirements to body weight: kcal $\times$ bird^{-1} $\times$ day^{-1} = 78.5 $\times$ body wt (kg)$^{.723}$ (Zar, Condor, 70:278, 1968). These calculations gave a conservative estimated maintenance energy cost of 9.9 kcal $\times$ bird^{-1} $\times$ day^{-1}. This is a minimum estimate because a free-ranging bird is not at the thermoneutral temperature and expends some energy in diel activity. However, the Spotted Sandpiper flew seldom, usually from the platforms to a perch some 50 meters distant. Its only sustained activities were walking on the platforms during the feeding bouts and an occasional flight about the study area. Therefore the actual respiratory energy loss could be close to the minimum.

An estimate of maximum ingestion was obtained by assuming every peck resulted in the capture of a prey item. Under this assumption 3529 larvae, 36 pupae and 73 adults of *P. turbida* would be consumed per bird per day (percentages based on proportions in the fecal sample). From the caloric equivalents of these stages (Wiegert, unpubl.) we computed total daily ingestion from the boards as 13 kcal, or corrected for the 10 percent of the daily food obtained off of the boards, 14.3 kcal $\times$ bird^{-1} $\times$ day^{-1}. This should be enough to sustain the sandpiper, because the assimilation efficiency for the *P.* larvae is probably rather high because of their lack of a heavily chitinized exoskeleton. Although the larvae are abundant and relatively immobile, the real efficiency of capture is undoubtedly less than 100%. Therefore the sandpiper's estimated total daily ingestion represents a maximum intake, but for reasons stated above the figure should be close to actual caloric consumption.

Total standing crop of the fly population on the platforms averages 11 kcal $\times$ m^{-2}. There are 58 m^2 in the two board ecosystems. Thus the sandpiper removes a maximum of 0.22 kcal $\times$ m^{-2} (13/58) or only 2 percent of the total standing crop per day. Under optimum conditions of temperature the brine fly (*P. turbida*) can produce as much as 25 percent of its standing crop per day (Wiegert, unpubl.), so this level of predation by the Spotted Sandpiper cannot by itself be a controlling factor on the fly population.

Spotted Sandpipers appear to remain in small areas when food is abundant (approximately 3 acres per sandpiper) and usually are sedentary when not feeding. They can tolerate the presence of man within 15 to 20 feet, facilitating direct observation of feeding and they eliminate fecal samples which can be analyzed with relative ease. Accurate, diurnal feeding behavior can be monitored employing minimal equipment: a spotting scope, a stopwatch and a counter. Although this study is preliminary it suggests that the Spotted Sandpiper is an ideal species for studying the energy budget of a wild avian population.

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Electrocution of birds by an electric fence.—In passing the farm of W. J. Whitehead a short distance west of Scotland Neck, North Carolina, on 20 January 1973, I saw a dead Screech Owl (*Otus asio*) hanging, head downward, from the top of a post of an electric fence (Fig. 1). The bird's left tarsus was between the wire and the post, thus grounding the fence wire on the steel post. The tarsus was burned so the foot fell free from it when I removed the dead bird from the fence. Mr. Whitehead advised me that he finds as many as 25 birds killed by his fence at one time when Brown-headed Cowbirds (*Molo-*

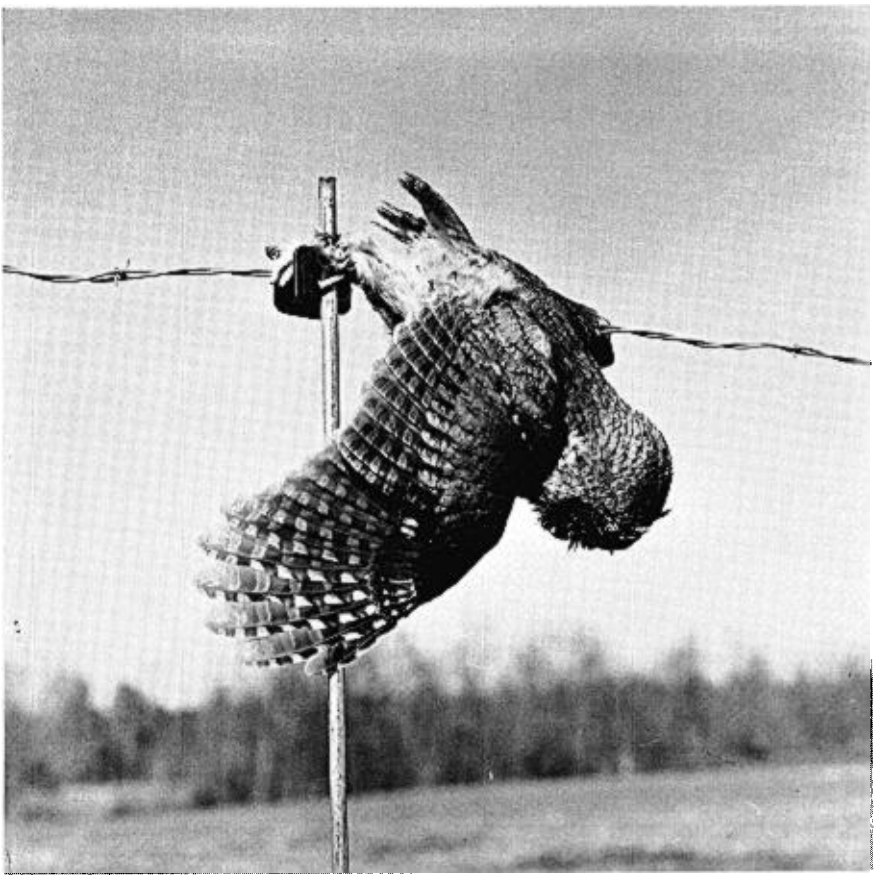

FIG. 1. Dead Screech Owl on electric fence.