sides were studied in another collection of *M. affine* and in *M. cuspidatum*. In the latter, saponaretin was identified as a hydrolytic derivative of a spot occupying the position of saponarin (7-*O*-glucoside of saponaretin). Diverse flavonoids including flavonol-3-glycosides have also been found in *M. arizonicum* (*8*).

Preliminary results indicate a rich flavonoid chemistry in *Mnium* that will contribute significantly to understanding of its systematics.

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Energy Intake of the Mouring Dove Zenaidura macroura marginella

Abstract. *Wild mourning doves follow a discrete cycle of feeding activity. Analysis of their food habits has provided an estimate for their average daily caloric intake.*

Samples of food taken from the crops of wild mourning doves during early fall of 1963 and 1964 provided evidence that the birds feed according to a discrete diurnal cycle. The data have been used to estimate daily caloric intake.

Crop samples were obtained from adult doves collected in Grand Forks County, North Dakota, between 15 August and 5 September. Birds were shot at various times of day and in various habitats in order to obtain a complete picture of feeding behavior.

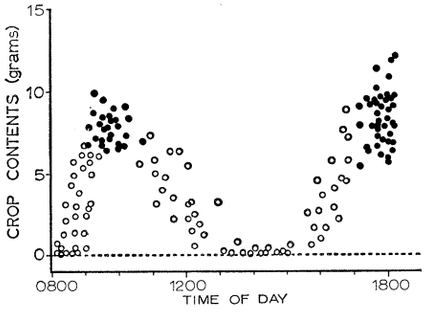

Fig. 1. Diurnal pattern of crop weight variation. The pattern of crop weights indicates two periods of feeding each day. The open circles (○) represent doves shot in fields or in roosting areas. The closed circles (●) represent doves with full crops, shot over water holes.

They were placed in plastic bags; labeled with the date, time of day, and habitat; and frozen for later analysis. After these specimens thawed, crop contents were removed, dried to constant weight at 100°C, and weighed. The contents of 120 crops were subsequently sorted according to seed species and reweighed. In addition, five samples of each of the nine major seed species were analyzed for caloric value by oxygen bomb calorimetry (Parr oxygen bomb calorimeter, Parr Instrument Co., Moline, Illinois).

Analysis of the food habits agreed with previous reports (*1*) which indicated that almost the entire diet of the mourning dove comes from plants. Nine seed species comprised 98.4 percent by weight of the 531.8 g of crop material examined (Table 1). An overall estimate of 4.41 kcal/g crop contents was obtained by weighting the caloric value of each seed species with the proportion of occurrence of each (by weight):

$$\sum_{i=1}^{9} (\text{kcal/g})_i \times (g_i/\text{total g}) = \text{kcal/g crop contents}$$

The daily variation in weight of crop contents indicated the pattern of feeding activity (Fig. 1). The birds fed twice each day, early in the morning and late in the afternoon. This observation is consistent with the suggestion of Davison and Sullivan (*2*). Examination of gizzards from birds with full crops, taken at water holes, indicated, since they lacked food materials, that digestion did not start until the crop contents were wetted. The daily pattern seemed to be: (i) early morning feeding to fill crops; (ii) drinking at water holes; (iii) roosting and digesting of food taken during the morning; (iv) late afternoon feeding to fill crops; and (v) evening drinking at water holes followed by flying to night roost areas.

Crops taken from the birds shot over water holes were used to estimate the total food intake of doves in a day. The average weight of seeds taken from crops after the morning feeding was $7.86 \pm .32$ ($SE_{\bar{x}}$) g, and after the evening feeding, $8.23 \pm .37$ g. The total weight of seed taken by a bird in a day was estimated to be the sum of that taken in the morning and in the evening periods, $16.09 \pm .49$ g/day. The daily caloric intake was obtained by multiplying the seed intake of 16.09 g/day by the caloric value of crop contents, 4.41 kcal/g, to yield an estimated average energy intake of 71 kcal/day per bird. A 95-percent confidence-interval estimate placed the daily energy intake per bird between 66.6 and 75.4 kcal.

Recognition of a discrete cycle of feeding activity in natural populations of the mourning dove provides an opportunity to analyze the energy budget

Table 1. Crop contents, with energy equivalents, of mourning doves in northeastern North Dakota.

Species of seed in crop	Occurrence (%)		Energy content (kcal/g)
	By bird*	By wt.†	
Green foxtail (*Setaria viridis*)	83.0	39.8	4.40
Yellow foxtail (*Setaria lutescens*)	68.9	21.4	4.70
Wheat (*Triticum aestivum*)	58.5	19.6	3.96
Black bindweed (*Polygonum convolvulus*)	25.5	5.1	4.21
Maize (*Zea mays*)	5.7	4.7	4.06
Proso millet (*Panicum miliaceum*)	3.8	3.0	4.29
Flax (*Linum usitatissimum*)	15.1	2.0	6.30
Field mustard (*Brassica arvensis*)	24.5	1.6	5.98
Lamb's quarters (*Chenopodium album*)	5.09	1.2	4.63

* Total number of crops = 120. † Total weight of crops is 531.8 g.

of a wild avian population. In this case, premigratory hyperphagia would be of particular interest. Previous studies of energy input in migratory species have been limited to captive populations (*3*). However, daily variations in environmental stimuli (for example, temperature or precipitation) as well as the more gross changes of season may elicit adaptive changes in energy input which could be missed in captive birds. In wild populations of birds like the mourning dove which may feed in a way amenable to quantitative evaluation, the influence of such environmental factors may be evaluated. If analyses of energy input could be combined with techniques for evaluation of the metabolism of migratory birds in their natural habitat (*4*), a complete picture could be obtained of the bioenergetics of migratory habit.

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Electrical Output of Lizard Ear: Relation to Hair-Cell Population

Abstract. *Cochlear potentials measured in several species of lizard show a close correlation between maximum electrical output and number of hair cells, whereas there is no uniform relation to sensitivity. These results are interpreted as indicating structural differentiation and frequency discrimination in spatial terms in the more advanced lizard ears.*

We have reported measurements of cochlear potentials on 11 species of lizards (*1–5*), and data are now available on two other species. The most represented families in our observations are the Iguanidae with five species and the Gekkonidae with three (Table 1).

Our object has been to investigate the character of hearing in this group of reptiles, and especially to explore the range of species variations in auditory function in relation to the structure of the ear. Such a study is related to the problem of the evolution of the vertebrate ear, and may provide clues concerning the origins of the more complex auditory mechanisms found in birds and mammals. This paper presents results on two basic aspects of ear performance, sensitivity and maximum output, in relation to the level of inner-ear development.

Sensitivity is measured as electrical output compared to sounds of known magnitude; more truly stated it is the sound pressure required to produce some constant amount of cochlear potential. Sensitivity, when measured in this way, is the inverse of the required sound pressure: the less sound required the greater the sensitivity. For the range of frequencies for which responses were obtainable, our measurements show the sound magnitude in decibels, relative to a pressure of 1 dyne/cm^2, that must be applied to produce a standard potential of 0.1 μv at the round window of the cochlea.

The maximum output for a given sound stimulus is taken as the first point on the intensity function beyond which an increase in stimulus intensity leads to a reduction in electrical potential. This is a maximum in a mathematical sense, and it is often possible to drive the ear to yield outputs greater than this maximum value, though always at the risk of permanent injury.

Our measure of the degree of inner ear development is the number of hair cells contained in the auditory papilla resting on the basilar membrane. This number varies greatly among lizard species, from less than 100 in most iguanids to about 1600 in the Tokay gecko (*Gekko gecko*).

For the study of electrical potentials the round window of the cochlea on the right side was approached through an incision in the throat region, and an active electrode was placed on the round-window membrane, with another electrode in indifferent tissue near by. A curve for sensitivity was obtained by presenting pure tones of various frequencies at the sound pressures necessary to produce a potential of 0.1 μv (root mean square). These potentials were read directly on a selective voltmeter. The changes in the magnitude of the electrical response were then observed over a range from the minimum detectable up to where the response showed overloading and passed through a maximum.

When intensity functions are determined for a number of tones throughout the range of a given animal, it is then possible to draw a curve of maximum responses for this ear. Such curves have been obtained for several of our animals, and observations on others are sufficient to show the general level of the maximums though they do not represent the complete function. The maximums produced in the different species varied significantly from 0.4 μv in the alligator lizard (*Gerrhonotus multicarinatus*) to over 50 μv in the Tokay gecko.

After the observations of cochlear potentials were completed a number of the animals—usually three or four of each species—were prepared for histological examination. While still under anesthesia the animals were perfused through the heart, first with Ringer's solution for a few moments to clear the blood vessels and then with a form of Maximow's solution for a period of 20 to 40 minutes to fix the tissues. The head, with only moderate trimming, was prepared by the celloidin process and sectioned serially in a plane transverse to the long dimension of the auditory papilla. Through the ear region every section was stained and mounted. For most of the specimens a staining procedure was used (hematoxylin, orange G, and azocarmine) that provided special differentiation of the hair cells.

The hair cells of the auditory papilla were counted in every section; they were observed with an oil immersion objective (×1400). Hair-cell counts were made on both ears, though electrical measurements had been made only in the right ear.

For each species electrical potentials were measured in some ears, but the ears were not prepared histologically. Alternatively, for many ears (all left ears plus both ears of a few other animals), the histological preparation was not preceded by electrical study. Consequently there are two ways of handling the data. In one way ("same ear" method) the electrical measurements may be compared with the hair-cell counts in the very same ears.