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The effect of digestion on the osteological composition of owl pellets

Wpływ trawienia na skład osteologiczny zrzutek sów

Влияние пищеварения на состав остеологических элементов в погадках сов

[with 2 tables and 1 graph in the text]

Abstract. Determinations were made, by analysing owl pellets, of the elements missing from skeletons of birds and mammals fed to three species of owls. It was found that the pelvic girdle is most often missing (up to 80%), and less often skulls (up to 35%) and mandibulae (maximum 25%), due to damage and digestion of bones in the birds' stomachs. In general the largest number of missing elements of the skeleton occurred in the tawny owl (51%) and long-eared owl (46%), and a smaller number in the barn owl (34%). Losses in the number of individuals identified in owl pellets were correspondingly: 16%, 20% and 8%. The amount of missing elements of the skeleton is in reverse proportion to the age of the owls and their prey.

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INTRODUCTION

Analysis of the pellets of predatory birds, including owls, is a very commonly employed research method, and there is today a very extensive literature on the use of owl pellets for determining the species eaten and the relative

proportions in which these are taken by owls. The comprehensive study by UTTENDÖRFER (1939), using uniform methods throughout, initiated a long series of similar studies on different species of owls. At the same time pellets, particularly those of owls, have become an object of interest to biologists generally, studying the distribution of small mammals. Recently increasing use has been made of owl pellet analysis for evaluating the regulating effect of predatory birds (*Falconiformes*) and owls (*Strigiformes*) on populations of small mammals (e.g. HAGEN, 1965; HAMAR, SCHNAPP, 1971), and also in bioenergetic studies to define the food requirements of these birds (e.g. GRABER, 1962).

Studies of owl pellet material to determine the feeding habits of owls and daily food requirements from the proportions of the different components of their food are based on quantitative analysis of remains obtained from collections of owl pellets. Often, however, insufficient attention has been given to the possibility that the number of animals in an owl pellet on the basis of skeletal elements may be smaller than the actual number of individuals eaten.

No mention has been found in the literature, concerned with the digestive physiology of birds, of the possibilities of owls' digesting bony elements (GROEBELS, 1934-1937; MARSHALL, 1960). Only SHORT and DREW (1962), in experimental work on owls' food, mention the fact that when comparing the food supplied and remains expelled they found the pelvic girdle was absent in one case. They explain these facts by the mechanical destruction of bones during the owl's consumption of its food. It is understandable that analysis of owl pellet material from field conditions does not afford the possibility of interpreting the losses found, apart from the fact that the whole of given individual was not consumed.

Missing elements of voles' and mice skulls in the pellets of the tawny owl were found by V.P.W. LOWE, in his experiments on feeding these birds in captivity. Detailed data have not been published, but some figures are given in a paper by SOUTHERN (1970).

When carrying out preliminary experiments under laboratory conditions on feeding a young tawny owl, *Strix aluco* L. (autumn 1965) considerable variations observed in the number of individuals (birds and mammals) found in the owl pellets, in relation to the number supplied as food. This phenomenon, one of importance in studies based on analysis of owl pellets, was extended to include observations on other species of owl, where available in order to ascertain the extent to which it occurs in other species and the way in which it is conditioned.

MATERIAL AND METHODS

Feeding experiments were made with three species of owl of different ages. The birds were caught under field conditions (the long-eared owls and tawny owls being obtained at Białowieża and barn owls from a church tower in the small town of Hajnówka not far from Białowieża and were ringed with marked rings

of the Ornithological Station of the Institute of Zoology, Polish Academy of Sciences — Table 1). The owls were fed on natural food, consisting of captive and free-living animals, primarily mammals (94%) — *Mus musculus* L., *Clethrionomys glareolus* (SCHREBER), *Pitymys subterraneus* (de SÉLYS-LONGCHAMPS), *Microtus oeconomus* (PALLAS), *Microtus agrestis* (L.), *Microtus arvalis* (PALLAS) and sporadically *Soricidae*. Birds were supplied less frequently — mainly sparrows, *Passer domesticus* (L.) — (immaturus and adultus) and amphibians of the genus *Rana* (jointly about 6%). The mammals were divided into two age groups for feeding purposes — juv — up to 2 months old and — adults — over three months old. The owls were supplied with dead prey which they ate readily, except for the tawny owl (*pullum* C-24694) and young long-eared owls, *Asio otus* (L.) in the early phase of the experiment, during which food was supplied into the beak.

Table 1. Numbers of experimental birds

Species of owl no. of ring (1)	Age (2)	Duration of experiment (3)	Number of pellets (4)
<i>Asio otus</i> (L.)			
C-24691	pull.	15 V 1967 — 22 V 1967	8
C-24692	pull.	11 V 1967 — 22 V 1967	13
C-24693	pull.	8 V 1967 — 15 V 1967	7
Total			28
<i>Strix aluco</i> L.			
C-20068	pull.	28 VII 1965 — 13 VIII 1965	18
C-22765	ad	15 V 1968 — 6 VIII 1968	67
C-24694	pull.	14 V 1967 — 17 VII 1967	56
C-26631*	ad	15 III 1968 — 25 III 1968	9
Total			150
<i>Tyto alba</i> (SCOP.)			
C-22762	pull.	24 VII 1967 — 9 VIII 1967	20
C-22763	pull.	24 VII 1967 — 9 VIII 1967	25
C-22764	pull.	24 VII 1967 — 9 VIII 1967	24
C-24698	pull.	10 VII 1967 — 24 VII 1967	15
C-24699	pull.	10 VII 1967 — 24 VII 1967	15
Total			99

* — This tawny owl (♀ ad) reached us 16 Feb. 1970, exhausted with hunger during the hard winter, and died as a result.

An attempt was made to simulate the natural feeding rhythm, by supplying food in the evening; if not eaten at once the food was left to be eaten

sometime during the night. The amount supplied varied with the bird's age and species. Individuals, which could feed themselves, were in principle fed ad libitum. When the effects of „fasting” were to be determined the owls were kept without food for a 24-hour period.

A record was kept of the weights of all the experimental birds. Since regular increases in weight were observed in the young owls. None of the owls kept in cages exhibited any perceptible digestive disturbances during its captivity; all retained healthy appetites and regularly regurgitated pellets. All the birds were in good condition at the end of the experiments and were either set free or returned to their nests.

The owl pellets were particularly carefully prepared. All the bony elements, even single ribs and *vertebrae* were removed from them. Each portion of food was balanced individually and related to the remains contained in the pellet produced the following day. The fact was borne in mind in this connection that some traces of the food may be encountered in several successive pellets regurgitated in the same or on the following day.

The methods used to identify and quantify individuals in the pellets were those normally used, and were not modified. Thus even a single bone, identifying a species, such as half an upper skull (fragment of *maxilla* with teeth), half a mandible or M_1 tooth of a vole, was treated as an individual of a given species.

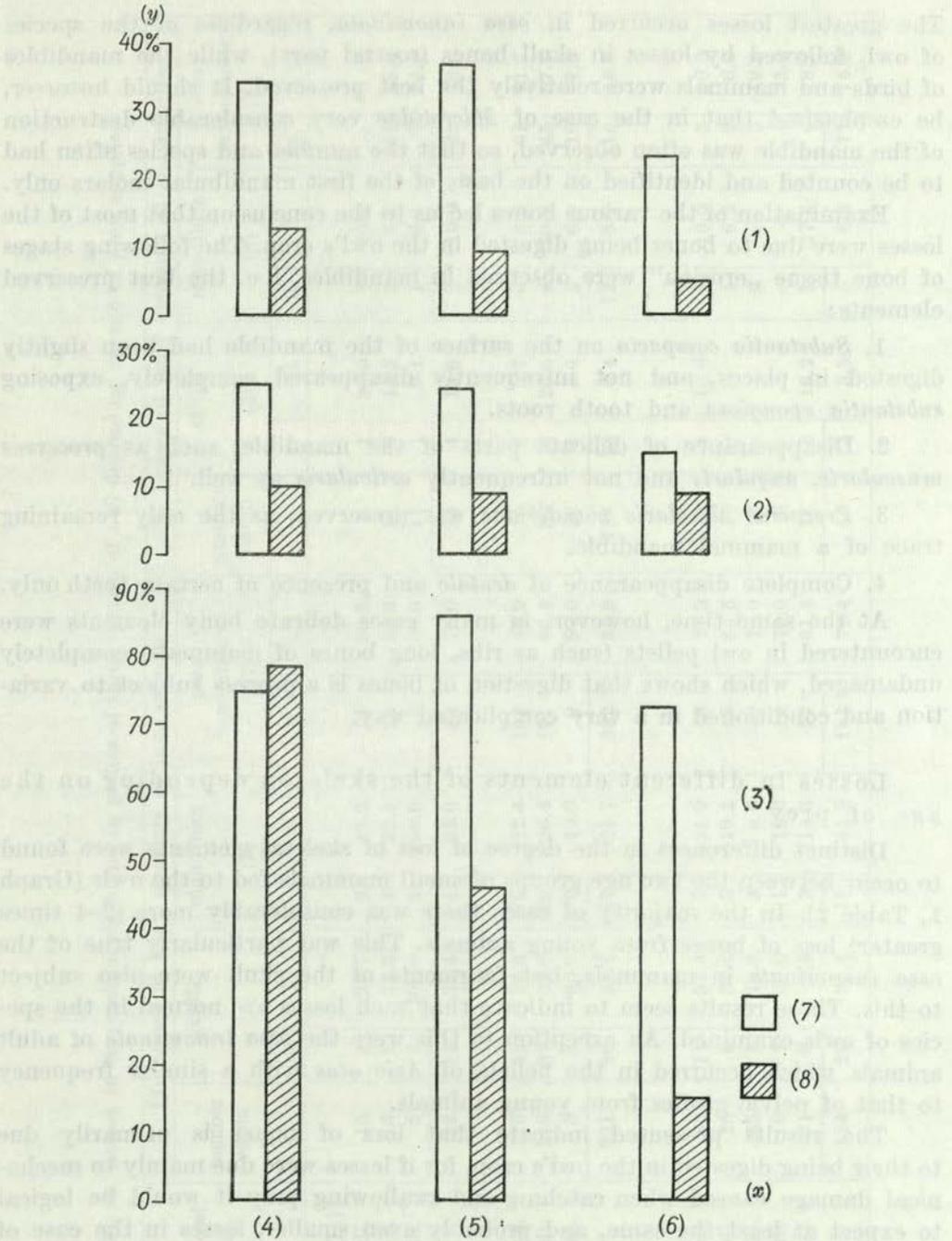
Independently a record was kept of missing parts of the following elements: skulls (whole and halves of the rostral part), mandibles and pelvic girdles. The number of the other parts of the skeleton contained in the pellets were evaluated according to a 3-degree scale (losses — small, medium and large).

A standard system for calculating losses was devised in order to be able to compare the degree to which bony elements were digested by different species of owls. The various elements of the skeleton taken into consideration in calculations were given a point value, for instance, the complete skeleton of a mammal was allocated 9 points (both half of *maxilla* — 2 points, mandible — 2, *ossa innominata* — 2, other elements of the postcranial skeleton — 3). The maximum number of points for a bird skeleton was 7. Losses from the skeleton expressed in points thus formed a relative comparative scale.

RESULTS

Losses in different elements of the skeleton

Losses of different parts of the skeletons of prey in owl pellets varied in degree with the species of owls examined. Differing degrees of losses were observed between the three most important groups of bones being counted (Graph 1).



Graph 1. Differential loss of bones from owl pellets according to the age of the prey. (y) — lost in per cent; (x) — species of owl; (1) — skulls; (2) — mandibles; (3) — *ossa innominata*; (4) — *Asio otus* (L.); (5) — *Strix aluco* L.; (6) — *Tyto alba* (SCOP.); (7) — food composed of young animals (juv); (8) — food composed of adult animals (ad).

The greatest losses occurred in *ossa innominata*, regardless of the species of owl, followed by losses in skull bones (rostral part), while the mandibles of birds and mammals were relatively the best preserved. It should however, be emphasised that in the case of *Microtidae* very considerable destruction of the mandible was often observed, so that the number and species often had to be counted and identified on the basis of the first mandibular molars only.

Examination of the various bones led us to the conclusion that most of the losses were due to bones being digested in the owl's crop. The following stages of bone tissue „erosion” were observed in mandibles, i. e. the best preserved elements:

1. *Substantia compacta* on the surface of the mandible had been slightly digested in places, and not infrequently disappeared completely, exposing *substantia spongiosa* and tooth roots.

2. Disappearance of delicate parts of the mandible, such as *processus muscularis*, *angularis* and not infrequently *articularis* as well.

3. *Processus alveolaris mandibulae* was preserved, as the only remaining trace of a mammal mandible.

4. Complete disappearance of *dentale* and presence of certain teeth only.

At the same time, however, in many cases delicate bony elements were encountered in owl pellets (such as ribs, long bones of mammals) completely undamaged, which shows that digestion of bones is a process subject to variation and conditioned in a very complicated way.

Losses in different elements of the skeleton depending on the age of prey

Distinct differences in the degree of loss of skeletal elements were found to occur between the two age groups of small mammals fed to the owls (Graph 1, Table 2). In the majority of cases there was considerably more (2–4 times greater) loss of bones from young animals. This was particularly true of the *ossa innominata* in mammals, but fragments of the skull were also subject to this. These results seem to indicate that such losses are normal in the species of owls examined. An exception to this were the *ossa innominata* of adult animals which occurred in the pellets of *Asio otus* with a similar frequency to that of pelvic girdles from young animals.

The results presented indicate that loss of bones is primarily due to their being digested in the owl's crop, for if losses were due mainly to mechanical damage caused when catching and swallowing prey it would be logical to expect at least the same, and probably even smaller, losses in the case of food composed of young animals, smaller in size and consequently easier to swallow. This is not the case; for bones are lost even in the pellets from barn owls, *Tyto alba* (SCOP.), which are capable of swallowing such large animals as *Arvicola* sp. without damaging them.

Table 2. Losses in bony elements found in pellets of three species of owl depending on age of prey supplied

Species of owl, no. of ring, age (1)	(2) Losses of bony elements of juv. animals							(3) Losses of bony elements of ad. animals						
	number eaten (4)	skulls (5)		mandibles (6)		ossa innominata (7)		number eaten (4)	skulls (5)		mandibles (6)		ossa innominata (7)	
		n	%	n	%	n	%		n	%	n	%	n	%
<i>Asio otus</i> (L.)														
C-24691 pull.	15	4	26.7	2	13.3	16	53.3	5	1	20.0	1	20.0	—	—
C-24692 pull.	15	5	33.3	4	26.7	28	93.3	14	2	14.3	1	7.1	15	53.6
C-24693 pull.	2	2	100.0	2	100.0	4	100.0	11	1	9.1	1	9.1	7	35.0
(8) Total	32	11	34.4	8	25.0	48	75.0	30	4	13.3	3	10.0	22	78.6
<i>Strix aluco</i> L.														
C-22765 ad.	116	46	39.6	26	22.4	192	84.9	70	4	5.7	6	8.6	61	51.7
C-24694 pull.	110	37	33.6	29	26.4	191	86.8	39	8	20.5	4	10.3	45	57.7
C-26631 ad.	5	3	60.0	2	40.0	9	90.0	29	1	3.4	2	6.9	10	17.2
(8) Total	231	86	37.2	57	24.7	392	85.9	138	13	9.4	12	8.7	116	45.7
<i>Tyto alba</i> (Scop.)														
C-22762 pull.	32	11	34.4	7	21.9	46	71.9	10	1	10.0	1	10.0	2	20.0
C-22763 pull.	26	9	34.6	5	19.2	45	86.5	16	—	—	1	6.2	2	6.2
C-22764 pull.	35	5	14.3	3	8.6	49	70.0	13	—	—	—	—	5	19.2
C-24698 pull.	10	2	20.0	1	10.0	14	70.0	6	—	—	—	—	4	33.3
C-24699 pull.	21	2	9.5	3	14.3	27	61.4	11	2	18.2	3	27.3	4	18.2
(8) Total	124	29	23.4	19	15.3	181	72.4	56	3	5.3	5	8.9	17	15.2

Losses in number of individuals

The quantitative differences between the number of individuals given as food, and those found later in the remains from pellets, can be shown to be a serious discrepancy likely to affect the results of any study of owls' food under natural conditions. A trial was therefore made in which known numbers of individuals were fed and subsequently recovered from owl pellets, using the presence of one of three elements to identify the given species (skull, mandible and quantify the recoveries). The greatest degree of losses in the number of individuals in owl pellets was found in the case of *A. otus* — 20.9% ($n = 67$), a smaller number in the case of *S. aluco* — 16.2% ($n = 439$) and smallest in *T. alba* — 8.2% ($n = 255$).

Degree of digestion of bones in different species of owl

In order to trace the degree to which bony elements of prey were destroyed, characteristic of each species of owl, it was necessary to standardize the method. This was achieved by introducing a system of ranking (cf. Material and methods), in which losses in all elements of the skeleton were taken into account. Comparison was then made of the maximum number of points (food supplied to the birds) with points calculated from the remains found in owl pellets. The difference expressing the degree to which the skeleton was digested was calculated in percentages for each species of owl.

The greatest losses, up to 50.8%, were found in young tawny owls, fewer in long-eared owls — 45.9% and losses were least in the pellets of barn owls — 34.2%. These trials were made using young birds only. In addition to the differences between the owl species already described differences were observed between individuals in the degree to which bones were digested (Table 2).

The age of owls and degree of digestion of bones

It was possible to compare the extent to which bones were lost both young and adult birds, only in the case of the tawny owl. In this species it was found that the young birds exhibited a greater degree of digestion (50.8%) than adult birds (37.3%). The difference found (of about 13%) suggests that younger birds may make greater use of food, in particular of its mineral components (calcium and phosphorus salts) due to intensive development while still in the nest. Supporting evidence is provided by the data given by GRIMM and WHITEHOUSE (1963), who found higher acidity (pH) of stomach juices in young individuals of *Bubo virginianus* (GMELIN), which ensures them increased intensity of enzyme action.

Likelihood of finding birds' rings in owl pellets

Some species of birds, particularly sparrows (*Passer* sp.), periodically form an important component of owls' food and therefore, in order to define the possible usefulness of owl pellet analysis for assessing the influence of owls on spar-

row populations an additional trial was carried out. An adult tawny owl (C-22765) kept in an aviary was fed with ringed birds. Of the 15 birds with rings fed 13 rings were recovered from pellets. The other two rings, still attached to the birds' legs were never eaten.

DISCUSSION AND CONCLUSIONS

All the evidence presented in this study suggests that owls' digest some of the bones of their prey: yet no one else seems to mention this phenomenon in respect of owls (GROEBELS, 1934-1937; MARSHALL, 1960). Only CHITTY (1938) refers to digestion of bones by predatory birds of the genus *Falco* and *Aquila*; at the same time he emphasised that there was little loss of calcium from the bones from pellets of the short-eared owl, *Asio flammeus* (PONTOPPIDAN). The authors, who were able to carry out observations of captive owls (OLEŚ, 1961; SHORT and DREW, 1962; HAGEN, 1965; WOLK, 1965 and others), also fail to refer to losses in the bony elements in owl pellets, although they draw attention to the different degree of damage to the prey during feeding (e.g. the little owl, *Athene noctua* (SCOP.) tearing its food to pieces.

Our observations, however, show that we should allow for intensive digestion of bones of the birds' prey, every time if the owls used were not exceptional, and also that this process is probably strictly physiological in character. The variants of the experiment made (Graph 1, Table 2) show that losses depend on both the species of owl and its age, and also on the age of its prey. Other evidence, demonstrating the greater acidity of stomach juices in young birds (GRIMM and WHITEHOUSE, 1963), and the greater losses we found in bony elements in the pellets of young owls form, in addition to the partially digested parts of bones actually observed, seem to indicate that the losses found can be explained only by processes of digestion. Such processes must take place in the owl's stomach, since the passage of bony elements to the distal parts of the alimentary tract is prevented by the small diameter of the pylorus (GRIMM and WHITEHOUSE, 1963). This is also confirmed by the negative results of the excreta analysis which we made.

The differences revealed in the degree of digestion of bony elements between three species of owl would appear to be connected with the birds' biology. A significant factor here is, on the one hand, the duration of development in the nest, and on the other — differences in behaviour in the way food is consumed and the prey are killed. The high degree of digestion of bony elements observed in young tawny owls and long-eared owls can be explained by the relatively short period of time they remain in the nest. Unlike them, the barn owl, in which the young remain in the nest for 7-8 weeks (SOKOŁOWSKI, 1958) digested bones to a lesser extent. In relation to ethological differences KULCZYCKI (1964)

found a minimum amount of damage to the skulls of prey in barn owl pellets, much more in the case of the tawny owl and little owl.

The authors' own observations, supported by GRIMM and WHITEHOUSE (1963), enable them to conclude that the extent of the loss of bones probably depends on the following:

1. The amount of damage caused during consumption of food (ethology of killing and swallowing prey connected with species differences).
2. Amount of indigestible elements in the portion of food (fur, feathers, dependence of luxuriance of hair covering on mammals' age and the season).
3. Fortuitous movements of bones in the food mass contained in the *ventriculus*, and the possibility of direct contact of bony elements with the secretions of *proventriculus*, small intestine and *pancreas*.

The combined action of all these factors results in some loss of bones; those elements most resistant from both the chemical and mechanical aspect, such as teeth and mandible, have the best chances of remaining undamaged (Graph 1).

Data obtained from owl pellets have also been used in a wide variety of ecological studies. For instance calculations of numbers and density have been made of species forming the chief component of owls' food (CABOŃ-RACZYŃSKA and RUPRECHT, 1970), the relative proportions of the different species in these birds' food (UTTENDÖRFER, 1939; and numerous studies on analysis of the composition of owls' food), sex proportions in populations of some mammal species, on the basis of *ossa innominata* (cf. GUILDAY, 1951; DUNMIRE, 1955). Recently owl pellets, collected under field conditions, have been frequently used for bioenergetic evaluations in order to define food requirements (SCHMIDT, 1966) and to determine the energy budget of owls (GRABER, 1962). A circumstance, in addition to bone losses, rendering elaborations of this kind difficult, is the fact that the collection of owl pellets is probably incomplete, as part of them are usually lost outside the place in which the owl rests during the day (SCHMIDT, 1966). Attempts have also been made to define the effect of owls' predation on numbers for various common species of *Micromammalia* (HAMAR and SCHNAPP, 1971). The results of our studies thus require a critical evaluation of the use hitherto made of owl pellets, both for ornithological and theriological purposes.

Losses in the various elements of the skeleton occur, as has been shown, very often, *ossa innominata* most frequently disappearing, despite the fact that the prey is swallowed whole. Under natural conditions, however, it is also necessary to take into account the possibility that the owls might eat only the heads of rodents, particularly during a period when the latter are very abundant. Considerations such as these suggest that to base an estimate of the mass of food consumed on bone remains alone may entail a considerable degree of error, since as we have shown, it is also necessary to take into consideration the frequently considerable losses of the larger bones of the skull (Graph 1), these, of

course, contribute to an under-estimation of the actual number of animals eaten. In order to minimize the error, a group of bone elements identifying an individual — the skull, set of mandibles and *ossa innominata* — are taken into account in the pellet.

In any list of prey species taken by a given species of owl the phenomenon of digestion of bones also introduces a further difficulty. Moreover the size of the error made in such cases cannot be defined precisely in the form of a constant correction since, as shown by our observations, digestion as such appears to be variable. Apart from being dependent on the age of prey and owl, no correlation was observed between bone digestion and the hunger of the bird. It must, however, be emphasised that the trials were made under laboratory conditions and only during the summer season, which does not, therefore, rule out the possibility of seasonal differences. In any case it is necessary to take into account greater disturbances in the age structure of the prey than its species composition. From the point of view of Micromammalia faunistics owl pellet material is of undeniable value.

The effect of bone loss on the estimates of the number of individuals eaten by an owl, proved to be far smaller than might have been expected from the amount of digestion of skull and mandible fragments found. It is essential to use the proper method of calculation in order to get near to the actual number of individuals eaten (mammals and birds). In single pellets there are often discrepancies in the number of elements identifying an individual, making interpretation of material difficult (cf. SHORT and DREW, 1962). If the number of individuals is established on the basis of predominance of one of the countable elements, then the chances of omitting an individual are consequently far smaller, since one of the four elements has a greater chance of being preserved than the whole skull. A condition essential to obtaining more accurate quantitative data is, however, the use of single pellets only as a basis, and treating each of them as a unit containing the remains of the complete portion of food eaten. The bones of one individual being mixed in two successive pellets is a rarity, and should not be taken into consideration under field conditions. On the other hand establishment of the number of individuals eaten, by adding identifying elements from the whole collection, leads to considerable under-estimation.

The results obtained showed that the barn owl is one of the most suitable species for a study of the effect of owls on populations of their prey, because it digests its prey to a lesser extent than do the other species.

Note in proof added.

Digestion of bony elements of mice has been also observed by H. ROTH in experiments with young little owl (J. Orn., 97, 1: 90–91, 1956).

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REFERENCES

- CABOŃ-RACZYŃSKA K., RUPRECHT A. L., 1970. Distribution and relative density of *Microtus arvalis* (PALLAS, 1779) in Poland as based on an analysis of owl pellets. EPPO Public. Ser. A., **58**: 81-85.
- CHITTY D., 1938. A laboratory study of pellet formation in the Short-eared Owl (*Asio flammeus*). Proc. Zool. Soc. London, **108** A: 267-287.
- DUNMIRE W. W., 1955. Sex dimorphism in the pelvis of rodents. J. Mammal., **36**: 356-361.
- GRABER R. R., 1962. Food and oxygen consumption in three species of owls (*Strigidae*). Condor, **64**, 6: 473-487.
- GRIMM R. J., WHITEHOUSE W. M., 1963. Pellet formation in a Great horned Owl: a roentgenographic study. Auk, **80**, 3: 301-306.
- GROEBBELS F., 1934-1937. Der Vogel, Bau, Funktion, Lebenserscheinung, Einpassung. 1-2. Berlin.
- GUILDAY J. E., 1951. Sexual dimorphism in the pelvic girdle of *Microtus pennsylvanicus*. J. Mammal., **32**: 216-217.
- HAGEN Y., 1965. The food, population fluctuations and ecology of the Long-eared Owl (*Asio otus* (L.)) in Norway. Meddelelser fra Statens viltundersøkelse, ser. 2, **23**: 1-43.
- HAMAR M., SCHNAPP B., 1971. Impact of *Asio otus* L. on the small mammal population in Romania. Ann. Zool. Fennici, **8**: 157-159.
- KULCZYCKI A., 1964. Badania nad składem pokarmu sów z Beskidu Niskiego. Acta Zool. Cracov., **9**, 9: 529-559.
- MARSHALL A. J., 1960. Biology and comparative physiology of birds. 1. New York-London.
- OLEŚ T., 1961. Obserwacje nad obyczajami pokarmowymi pójdzki. Przegl. Zool., **5**, 4: 377-378.
- SCHMIDT E., 1966. Daten zur täglichen Beutemenge der Schleiereule in Natur- und Kulturgebieten. Vertebrata Hungarica Mus. Hist. -Nat. Hung., **8**, 1-2: 123-133.
- SHORT H. L., DREW L. C. 1962. Observations concerning behaviour, feeding, and pellets of Short-eared Owls. Am. Midl. Nat., **67**, 2: 424-433.
- SOKOŁOWSKI J. 1958. Ptaki ziem polskich. 2. Warszawa.
- SOUTHERN H.N. 1970. The natural control of a population of Tawny owls (*Strix aluco*). J. Zool. Lond., **162**, 2: 197-285.
- UTTENDÖRFER O. 1939. Die Ernährung der deutschen Raubvögel und Eulen und ihre Bedeutung in der heimischen Natur. Neudamm.
- WOŁK K. 1965. Z badań nad odżywianiem się płomykówki, *Tyto alba* (Scop.). Przegl. Zool., **9**, 4: 404-407.

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STRESZCZENIE

Na podstawie kontrolowanego karmienia w laboratorium trzech gatunków sów (tab. 1), stwierdzono fakt występowania w wyplawkach niedoborów elementów szkieletu ptaków i ssaków, podawanych jako pokarm. Zjawisko to autorzy tłumaczą trawieniem kości w żołądku ptaka, bardziej intensywnym u młodych sów i wyrażającym się różnym stopniem nasilenia w stosunku do poszczególnych elementów szkieletu (rys. 1, tab. 2). Największe ubytki kości w zrzutkach stwierdzono u puszczyka, *Strix aluco* L. (50.8%), mniejsze u sowy uszatej, *Asio otus* (L.) — (45.9%), a najniższe u płomykówki, *Tyto alba* (SCOP.) — (34.2%), co tłumaczy się różnicami w biologii tych gatunków.

Trawienie kości zaniża w zmiennym stopniu liczbę osobników kręgowców identyfikowanych w wyplawkach. Ogranicza to zastosowanie analizy zrzutek w badaniach bioenergetycznych i pracach nad zapotrzebowaniem pokarmowym sów. Autorzy postulują uściślenie obliczania osobników w wyplawkach metodą opierania się na przewodzie jednego z elementów identyfikujących osobnika (fragment czaszki lub żuchwy) w poszczególnych wyplawkach jako jednostkach obliczeniowych.

Objaśnienia do tabel i ryciny:

Tabela 1. Liczebność ptaków doświadczalnych. (1) — gatunek sowy, numer obrączki; (2) — wiek; (3) — czas trwania eksperymentu; (4) — liczba zrzutek. *Puszczyk ten (♀ ad) trafił do nas 16 II 1970 wycieńczony głodem w okresie ciężkiej zimy, wskutek czego padł.

Tabela 2. Niedobory w elementach szkieletu stwierdzone w wyplawkach trzech gatunków sów w zależności od wieku podawanej zdobyczy. (1) — gatunek sowy, numer obrączki, wiek; (2) — niedobory elementów kostnych zwierząt (juv); (3) — niedobory elementów kostnych zwierząt (ad); (4) — ilość zjedzonych; (5) — czaszki; (6) — żuchwy; (7) — *ossa innominata*; (8) — razem osobników i przeciętny procent.

Rycina 1. Wpływ wieku zdobyczy na niedobory elementów kostnych w zrzutkach sów. (y) — niedobory w %; (x) — gatunek sowy; (1) — czaszki; (2) — żuchwy; (3) — *ossa innominata*; (4) — *Asio otus* (L.); (5) — *Strix aluco* L.; (6) — *Tyto alba* (SCOP.); (7) — pokarm złożony ze zwierząt młodych (juv); (8) — pokarm złożony ze zwierząt starych (ad).

РЕЗЮМЕ

На основании контролируемого кормления трех видов сов (табл. 1) в лабораторных условиях констатируется, что в погадках наблюдается недостача элементов скелета птиц и млекопитающих, использованных в качестве корма. Авторы объясняют это явление перевариванием костей в желудке птиц, которое происходит более интенсивно у молодых сов и различно по отношению к отдельным элементам скелета (рис. 1, табл. 2). Самая высокая недостача костей в погадках наблюдалась у обыкновенной неясыти, *Strix aluco* L. — (50.8%), затем у ушастой совы, *Asio otus* (L.) — (45.9%) и самая низкая у сипухи, *Tyto alba* (SCOP.) — (34.2%), что объясняется различиями в биологии этих видов.

Вследствие переваривания костей снижается численность особей позвоночных, которые могут быть определены в погадках. Этот факт ограничивает возможность применения погадок в исследованиях по биоэнергетике и по пищевой потребности сов. Авторы предлагают метод более точного подсчета особей в погадках, основанный на доминировании одного из элементов скелета определяемых экземпляров (фрагмент черепа или нижняя челюсть) в отдельных погадках как единицах вычисления.

Объяснения к таблицам и рисунку:

Таблица 1. Численность экспериментальных птиц. (1) — вид совы и номер кольца; (2) — возраст; (3) — длительность эксперимента; (4) — число погадок. *Эта особь неясны (♀ ad) попала к нам 16 II 1970 в состоянии истощения от голода в период тяжелой зимы и вследствие этого пала.

Таблица 2. Недостачи в элементах скелета констатированные в погадках трех видов сов в зависимости от возраста поедаемых животных. (1) — вид совы, номер кольца, возраст; (2) — недостачи костных элементов животных (juv); (3) — недостачи костных элементов животных (ad); (4) — численность съеденных; (5) — черепа; (6) — нижние челюсти; (7) — *ossa innominata*; (8) — всего особей и процент в среднем.

Рисунок 1. Влияние возраста поедаемых животных на недостачи костных элементов в погадках сов. (y) — недостачи в %; (x) — вид совы; (1) — черепа; (2) — нижние челюсти; (3) — *ossa innominata*; (4) — *Asio otus* (L.); (5) — *Strix aluco* L.; (6) — *Tyto alba* (SCOP.); (7) — корм состоящий из молодых животных (juv); (8) — корм состоящий из старых взрослых (ad).

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