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Zdzisław Bogucki

A Study on the Diet of Starling Nestlings

[Pp. 357—390 and 8 text-figs.]

Badania nad składem pokarmu piskląt szpaka

Исследования состава корма птенцов скворца обыкновенного

Abstract. A total of 260 one-hour samples of the food of Starling nestlings were gathered by the collar method. The material was derived from 16 nests during the first brood in two successive breeding seasons. The food was analysed both quantitatively and qualitatively. Changes in the food composition connected with the environmental situation, the time of year, the size of nestlings fed, the time of day, and differences between various pairs of the same colony were demonstrated. Food given to the nestlings is properly prepared and the degree of preparation depends upon the age of nestlings. Starvation of short duration is not dangerous to nestlings as long as they remain in the nest, surrounded by other young birds, which provide them with indispensable warmth. The loss in body weight caused by starvation is soon compensated.

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I. INTRODUCTION

Much has already been written about food of the Starling *Sturnus vulgaris* Linnaeus, 1758. These are, however, mostly short notes reporting occasional observations, chiefly those concerning particular species taken by the Starling but giving no quantitative data. The application of the collar method for the study of food composition in birds, used for the first time by Kluijver (1933), caused a dramatic turn towards quantitative analysis. Kluijver's (1933) paper itself belongs to the most important studies on the quantitative aspect of the Starling's food in the breeding season, including, in addition to many other observations on the biology of this period, a comprehensive section on the composition of food of nestling Starlings in Holland, in a typical region of meadows and pastures. Szijj (1957a and b) discusses the changes in the composition of the Starling's food in the annual cycle. Gromadzki's (1969) paper very much resembles the previous study in its general aspect. Dunnet (1955) deals with the problem of the dependence of the food composition in Starlings on the supplies of feeding grounds, but his division of the food items into three groups only (earthworms, larvae of crane-flies, and the remaining food components) does not allow the full utilization of this work. Besides the studies mentioned, there is a number of publications which, treating of the food of other avian species, comprise also some data about the Starling (e.g. Pfeifer and Keil, 1958, 1959; Görnandt, 1959 a and b; Mansfeld, 1956).

The present paper, apart from its part given to the qualitative and quantitative analyses of the food of nestling Starlings, aims at the demonstration of differences in its composition according to the age of nestlings, the time of day, the breeding season and the parents' individual preferences, etc.

I wish to express my heartfelt thanks for the disinterested determination of the Starling's prey to Mrs. H. Kędra *(Gastropoda)*, Dr B. Dominiak *(Isopoda)*, Dr A. Dziabaszewski and Dr K. Stępczak *(Araneae)*, Mrs. J. Jaskowska *(Trichoptera)*, Dr J. Kaczmarek *(Chilopoda)*, Dr S. Mielewczyk *(Odonata)*, Assist. Prof. J. Pawłowski *(Carabidae)*, Dr. Z. Witkowski *(Curculionidae)*, and to all those who helped me to complete this study by giving valuable advice and in other ways.

II. MATERIAL AND METHOD

The field work connected with this investigation on the composition of food of nestling Starlings was carried out from 10 to 21 May 1962 and from 12 to 23 May 1963. In the first year of study I took samples of food from 9 nests containing altogether 42 nestlings and a year later from 7 nests with 29 nestlings. The study material was therefore derived from 16 nests with the young of the first brood in two consecutive breeding seasons.

I collected samples of food in a small colony of Starlings at Puszczykowo in the territory of the Wielkopolski National Park. This locality is situated in the valley of the River Warta about 13 km south of Poznań. On the east and west sides it is bordered by coniferous and deciduous forests, on the south side neighbours upon a residential quarter called Puszczykówko, and upon meadows, which were the main feeding grounds of the Starlings observed, on the north side.

The edge of the meadows lies about 300 m from the colony. They are for the most part damp meadows, often flooded in spring, cut by several, seasonally dried-up drainage ditches. Most of them are hay-growing meadows, only small plots being used as pastures. The higher situated places, roadsides and forest edges are much drier and have less exuberant vegetation. A small area is occupied by a local refuse dump.

Another, less frequently visited, feeding ground includes the neighbouring gardens, courtyards, streets and trees. The area of the gardens is relatively small, since the park-like type of wooded areas predominates here. Small areas are put under vegetables. Most of the streets and courtyards are unpaved and the roadsides are overgrown by herbage.

It may be stated that the Starlings examined nested in typical conditions of a suburbian residential quarter situated in the vicinity of meadows and characterized by park-like wooded areas. In addition to natural feeding grounds (meadows, trees), the Starlings foraged in the close neighbourhood of the houses (courtyards, refuse-bins).

In 1963 the breeding period was much warmer (by 3°C), sunnier (by 55·4 sunny hours) and drier (33·9 mm of rainfall less and 7 rainless days more) than the same period in 1962.

The collar method was used to obtain the food brought for nestlings by their parents. I gave a detailed description of this method in one of my previous papers (Bogucki, 1964). As collars I used rings made of copper wire in plastic insulation. The calibre of the rings was adjusted to the size of the nestlings. The rings were put on in all the nestlings in the nest at the same time. It often happened that a nestling, unable to swallow the food, spat it out into the nest. Not to lose any of the bits spat out I placed the nestlings on a special shelf of cloth spread on a wire frame. Rings were put in position once for an one-hour period and I removed the food from the nestlings' gullets and from the nest twice: after 30 and 60 minutes. The food obtained during the one-hour period was put in a small vessel filled with 70% alcohol. Such a one-hour ration of food brought to the nest will be referred to as a sample.

Frequent inspections of the nest upset the birds, which may cause them to behave differently than usual, and that would certainly have an effect on the routine course of the feeding of chicks. I tried to avoid that, at least partly, by making the birds accustomed to my presence in the vicinity of the nest systematically. As early as the incubation period I used to visit the nests everyday and, as a result, later the parents showed no unease during my manipulations at the nest with the nestlings in it. I always wore the same clothes when visiting the nests.

In 1962 I collected 78 samples, in 1963 — 182. Thus my material consisted of 260 one-hour samples representing the food of nestling Starlings from the 2nd to the 14th day of life and the food that they receive at different times of day. Since in the case of 25 samples the age of nestlings and the time of day were not determined exactly, they were omitted and I used only the remaining 235 samples for my study of changes in the food composition.

The quantitative relations of food were analysed in two aspects: I both established the number of specimens belonging to particular systematic units and measured their volume. This method is more advantageous than weighing, because it can be used also for the material kept in alcohol. Saturation with alcohol causes far smaller differences in volume than it does in weight.

I measured the volume of material in the following manner: a specimen removed from alcohol was superficially dried on filter paper and placed in a suitably small burette filled with alcohol. The difference between the levels of alcohol before and after placing the specimen in it was found. This method of measuring does not ensure the perfect accuracy of readings, but the results obtained provide sufficient information about the volume relations between individual food items.

The method that I applied to group the food components according to their quantity or the frequency in the samples demands a somewhat more detailed consideration. Analogous divisions used hitherto (e.g. Czarnecki et al., 1955) are based on classes artificially established and ungrounded. Besides, the nomenclature of these groups does not discriminate between the frequency and the quantity of a given sort of food.

The particular groups of food have been named according to the aspect which is taken into account in them (number, volume, or frequency):

a. with respect to quantity (number and volume) dominant food — the sum of the highest values of the percentage share is about 68 (range of the single standard deviation); supplementary food — the sum of the values of the percentage share following the previous ones in order is about 27 (68% + 27% = 95% or the range of the double standard deviation); vestigial food — the remaining sorts of food, altogether about five-percent share;

b. with respect to the frequency in samples I use the same criteria as for quantity and have distinguished; constant food, frequent food, and sporadic food.

All the three aspects of the quantitative relations of the food presented in Table I (frequency, number and volume) are treated synthetically in Table II. The column headed "Primary Food" contains the components that never occur in the groups of sporadic and vestigial food and are at least once numbered in the constant or dominant food. The "Secondary Food" consists, in the first place, of the components which are included in the groups of frequent and supplementary food, and the "Incidental Food" is composed of the items that at least once occur in these last groups. As a result of such classification the groups of primary and secondary food comprise the components whose total quantity (as regards both the number of specimens and their volume) is about 95% of all the food examined. Although the incidental food shows the greatest diversity, its quantity does not exceed 5% of the nestlings' food.

III. SURVEY OF THE STARLING'S FOOD ITEMS

A total of 4142 specimens, belonging for the most part to different arthropodal groups, have been obtained from 260 one-hour food samples collected in the course of two-year investigation. The quantitative relations, i.e. the frequency in samples, number and volume are given in Table I. The material has been divided into 37 groups corresponding with systematic units of various ranks, chiefly with families and — in the case of not numerous groups — orders. The only species that has been treated separately is the cockchafer *Melolontha melolontha* L., which needs such treatment on account of its conspicuous predomination in the food of the nestlings examined. It is hard to regard the remaining four sorts of food (Larvae indet., Pupae indet., Indeterminatae and Garbage) as systematic units. The first three of them contain members of different orders, which we failed to identify accurately.

In discussing particular sorts of food, I keep to the systematic order of all systematic units, whereas all the lists of families and species in tables are arranged according to the number of specimens.

The *Lumbricidae* were constant components of the nestlings' food. They formed 2·2% of the number of specimens and 2·4% of the volume of all the food. Their number in the food brought to the nests seems to have been particularly small, if we consider the Starling's way of foraging and the occurrence of earthworms. The earthworms given to the nestlings were mostly alive, but very often with their cephalic portion torn off. They were not cleared of sand and earth.

There were 18 specimens of the *Isopoda* (0·4%), their total volume being slight, hardly 0·48 cu. cm. In this group *Porcellio scaber* LATR. (8 specimens) was the most numerous species and *Trachelipus rathkei* BRDT. and *Asellus aquaticus* RACOV. numbered 5 specimens each.

The *Chilipoda* were represented by only 5 specimens, namely, *Lithobius microps* MEINERT (2 specimens) and *Lithobius mutabilis* L. KOCH., *Geophilus l. longicornis* LEACH and *G. carpophagus* LEACH one each.

The *Diplopoda* were an interesting component of the Starlings' food. They are never abundant in the food of this species in Europe, but in the U.S.A. make one of its main element (KALMBACH, 1928). The 22 specimens of this order (0·5% in quantity and 6·4% in frequency) included 18 members of the family *Julidae*.

In the material examined the *Odonata* occurred exclusively as imagines. Out of the 12 specimens identifield, 5 were *Agrion puella* L., 4 *A. pulchellum* V. d. LIND. and 2 *Cordulia aenea* (L.) joined in copulation.

Although not numerous in the food of the nestlings, the *Orthoptera* (20 specimens) constituted a relative large volume (7·93 cu. cm) mainly thanks to the presence of 6 specimens of *Gryllotalpa gryllotalpa* L. and 3 of *Gryllus campestris* L. The other orthopters found were young forms. This order plays a minor role in the food of nestlings of the first brood, because, excepting the above-mentioned species, its members occur chiefly as small larval forms at that time.

The *Homoptera* were 30 in number, but their volume was slight (0·17 cu. cm). I found 27 specimens of *Pseudococcus* sp. and 3 winged aphides.

The *Heteroptera* were represented by 9 specimens, of which 2 were identified as *Dolycoris baccarum* L., 1 as *Podops inuncta* FABR. and 1 as *Sechirus bicolor* L.

The *Coleoptera* were both the most numerous and, owing to the presence of the cockchafer *Melolontha melolontha* L., decidedly dominant group in the total volume of food. Altogether 1612 larvae and imagines of beetles were found in all food samples, which makes 39% of food. This number should be augmented by some of the unidentified larvae and pupae gathered in the groups Larvae indet. and Pupae indet. The share of beetles in the total volume of food is over 79%.

Both imagines (im.) and larvae (l.) of *Melolontha melolontha* L. were fed to the Starling nestlings. Although the imaginal cockchafers formed only 13% of the total number of preys, as regards volume, they prevailed unquestionably, forming 66% of the total volume of food and 90% of the volume of beetles. The number of cockchafers per sample was very various. There were most often 2—3 specimens, but samples with 7 cockchafers were also met with and 18 samples contained specimens of this species only. The presence of larval cockchafers in the Starling's food need not indicate that soil cultivation work was being done in this region, because, as has been described by PFABE and SZYPUŁA-GĄDOR (1964), starlings can search out larvae of cockchafers feeding underground effectively by listening for sounds made by them in the soil. Cockchafers constitute attractive food for Starlings, if not for other reasons, because their mass appearance generally coincides with the feeding period of the young of the first brood. Arable fields and forest plantations infested with cockchafer larvae supply Starlings with food which is comparatively easy to get at and at that occurring in abundance.

The *Scarabaeidae* (without cockchafers) were not numerous in the food of the nestling Starlings. Among the 15 specimens belonging in this family 5 were *Aphodius fimetarius* L., 4 *Geotrupes silvaticus* L., 2 *Cetonia aurata* L., 1 *Geotrupes mutator* MRSH. and 3 members of the genus *Aphodius*.

The *Cantharidae* were one of the more numerously represented families making up the food of the Starling chicks. However, in view of the abundant occurrence of these beetles their presence in the food of the starlings must be regarded as relatively unfrequent (they were found in 46% of samples), though, if present, they usually occurred in fairly large numbers. Twenty-three specimens of *Cantharis rustica* FALL. were numbered in one sample. Out of the 342 specimens belonging to this family, 171 were *Cantharis obscura* L., 116 *C. rustica* FALL., A comparison of the frequency, numbers, and volume of main food items of nestlings from the first brood of Starlings, on the basis of material collected in 16 nests in 1962 and 1963. The thick line surrounds the constant (frequency) and dominant (numbers and volume) food, the thin line the frequent and suplementary food. Out of frames — sporadic and vestigial food. Developmental stages of insects: l. — larva, p. — pupa, im. — imago

Frequency	%
Melolontha im.	69·4
Araneae	37·4
Tipulidae	34·0
Diptera im.	33·6
Carabidae	26·8
Larvae indet.	25·5
Gastropoda	24·2
Bibionidae	22·6
Lumbricidae	22·2
Elateridae im.	21·7
Curculionidae	21·7
Pupae indet.	20·9
Cantharidae	19·6
Diptera l.	19·6
Lepidoptera l.	18·7
Hymenoptera	17·5
Tipulidae im.	17·0
Elateridae l.	14·8
Hymenoptera l.	14·8
Melolontha l.	12·3
Chrysomelidae	10·6
Dytiscidae l.	7·2
Staphylinidae	7·2
Garbage	6·4
Diplopoda	6·4
Coleoptera indet.	6·4
Orthoptera	6·0
Trichoptera	5·5
Silphidae	5·1
Scarabaeidae *	5·1
Isopoda	4·7
Heteroptera	3·8
Coccinellidae	3·4
Indeterminatae	3·4
Odonata	3·0
Homoptera	2·5
Lepidoptera im.	2·5
Dystiscidae im.	2·1
Chilopoda	2·1
Salientia	0·9
Neuroptera	0·9

Number of specimens	No	%
Melolontha im.	525	12,7
Bibionidae	497	12·0
Cantharidae	342	8·3
Diptera im.	307	7·4
Araneae	256	6·2
Trichoptera	253	6·1
Larvae indet.	186	4·5
Tipulidae l.	185	4·5
Carabidae	161	3·9
Curculionidae	147	3·6
Tipulidae im.	122	3·0
Diptera l.	104	2·5
Pupae indet.	97	2·4
Gastropoda	96	2·3
Elateridae im.	92	2·2
Lumbricidae	91	2·2
Melolontha l.	91	2·2
Hymenoptera	88	2·1
Elateridae l.	82	2·0
Lepidoptera l.	61	1·5
Hymenoptera l.	53	1·3
Chrysomelidae	52	1·3
Homoptera	30	0·7
Dysticidae l.	25	0·6
Staphylinidae	22	0·5
Diplopoda	22	0·5
Orthoptera	20	0·5
Coleoptera indet.	20	0·5
Isopoda	18	0·4
Silphidae	18	0·4
Scarabaeidae *	15	0·4
Odonata	12	0·3
Coccinellidae	11	0·3
Heteroptera	9	0·2
Indeterminatae	8	0·2
Lepidoptera im.	8	0·2
Dystiscidae im.	7	0·2
Chilopoda	5	0·1
Salientia	2	0·05
Neuroptera	2	0·05
Garbage	—	—
	4142	

Volume	cu. cm	%
Melolontha im.	620·20	65·9
Tipulidae l.	51·40	5·4
Melolontha l.	38·38	4·7
Lumbricidae	22·85	2·4
Lepidoptera l.	18·01	1·9
Cantharidae	17·49	1·9
Araneae	16·14	1·7
Pupae indet.	13·70	1·5
Dytiscidae l.	13·48	1·4
Diptera l.	13·46	1·4
Garbage	12·90	1·4
Carabidae	11·01	1·2
Orthoptera	7·93	0·8
Chrysomelidae	7·88	0·8
Bibionidae	7·31	0·8
Diptera im.	7·29	0·8
Tipulidae im.	7·14	0·8
Trichoptera	6·20	0·7
Larvae indet.	6·03	0·6
Elateridae im.	5·98	0·6
Scarabaeidae *	5·24	0·6
Elateridae l.	4·55	0·5
Gastropoda	3·46	0·4
Curculionidae	3·33	0·3
Hymenoptera l.	3·09	0·3
Hymenoptera im.	2·61	0·3
Silphidae	2·51	0·3
Salientia	2·30	0·2
Diplopoda	2·15	0·2
Staphylinidae	1·43	0·1
Odonata	1·19	0·1
Coleoptera indet.	0·93	0·1
Dytiscidae im.	0·75	0·1
Lepidoptera im.	0·72	0·1
Isopoda	0·48	0·05
Coccinellidae	0·41	0·04
Indeterminatae	0·25	0·03
Heteroptera	0·23	0·03
Homoptera	0·17	0·03
Chilopoda	0·09	0·01
Neuroptera	0·07	0·01
	942·61	

* without *Melolontha*.

39 *C. fusca* L. and 16 *C. livida v. rufipes* HBST. The *Cantharidae* formed 8·3% of the total number of preys brought by the Starlings to their nests and among the beetles their number exceeded 21%. The abundance of these beetles in the samples with their relatively low frequency indicates that their appearance in the food was connected with the mass emergence of imagines.

Compared with the other beetles the *Carabidae* were second only to the *Scarabaeidae* and *Cantharidae* in respect of their number in the nestlings' food. The fairly high frequency of the members of this family (63%) accompanied by their moderate abundance allowed their classification as a constant component of the Starlings' food. The 161 specimens of the *Carabidae* were reckoned in as many as 32 species, which are as follows:

Harpalus pubescens MÜLL.	45	specimens
Amara aenea DEG.	18	,,
Amara familiaris DUFT.	11	,,
Harpalus affinis SCHRANK	10	,,
Harpalus tardus PANZ.	9	,,
Harpalus anxius DUFT.	8	,,
Agonum moestum DUFT.	8	,,
Pterostichus lepidus LESKE	8	,,
Carabus nemoralis MÜLL.	4	,,
Amara similata GYLL.	4	,,
Amara apricaria PAYK	3	,,
Harpalus griseus PANZ.	3	,,
Harpalus autumnalis DUFT.	3	,,
Pterostichus coerulescens L.	3	,,
Blethisa multipunctata L.	2	,,
Broscus cephalotes L.	2	,,
Oodes helopioides F.	2	,,
Harpalus serripes QUENS.	2	,,
Amara curta DEJ.	2	,,
Pterostichus nigrita F.	2	,,
Carabus granulatus L.	1	specimen
Calosoma inquisitor L.	1	,,
Dyschirius globosus HERBST.	1	,,
Harpalus latus L.	1	,,
Harpalus anxius DUFT.	1	,,
Amara plebeja GYLL.	1	,,
?*Amara schimperi* WENCK.	1	,,
Amara majuscula CHAUD.	1	,,
Pterostichus cupreus L.	1	,,
Agonum assimile PAYK	1	,,
Agonum gracilipes DUFT.	1	,,
Agonum sexpunctatum L.	1	,,

All the specimens except one exceeded 6 mm in length. It often happened that these beetles found in the gullet of a nestling were still alive and agile enough to run away briskly when being removed from the gullet by means of a pincette. In one case I found a beetle that had bitten strongly into the tongue of the nestling. Most often, however, the carabids, especially those of larger species, were deprived of their heads. Similar observations were made by KLUIJVER (1933) and HASSEL (1961).

Although the *Curculionidae* are marked by a relatively high frequency in the food (51%) and their share in it is fairly numerous, their total volume is not very large, since small specimens prevail among them. *Philopedon plagiatus* SCHALLER, which occurs locally in north-western Poland, appeared to be most numerously represented among the 147 specimens of this family. The following are the curculionid species found in the samples:

Philopedon plagiatus SCHALLER	66	specimens
Phyllobius piri L.	34	,,
Phyllobius urticae DEGEER	9	,,
Otiorrhynchus raucus FABR.	6	,,
Tanymecus palliatus FABR.	6	,,
Phyllobius maculicornis GERM.	6	,,
Phyllobius virideaeris LEICH.	5	,,
Cleonus piger SCIP.	2	,,
Trachyphlocus scabriusculus L.	2	,,
Trachyphlocus bifoveolatus BECK	1	specimen
Balanobius crux FABR.	1	,,
Barypithes mollicomus AHRENS	1	,,
Barypithes pellucidus BOHEM	1	,,
Hylobius abietis L.	1	,,
Limnobaris pilistriata STEPH.	1	,,
Otiorrhynchus ovatus L.	1	,,
Phyllobius calcaratus FABR.	1	,,
Phyllobius viridicollis FABR.	1	,,
Sitona griseus FABR.	1	,,
Strophosomus faber (HRBST.)	1	,,

Both larval (l.) and imaginal (im.) forms of the *Eleateridae* occurred in the food of the nestling starlings, but neither of them very often (the frequency was 35% for larvae and 51% for imagines) or in large numbers (about 0·2%). This seems interesting insomuch that many of the eleaterid species are more or less closely associated with the soil surface and the foraging Starlings should find it easy to catch them.

The *Chrysomelidae* were represented in the food of the nestling Starlings by 52 specimens, of which 40 were imagines of the Colorado beetle *Leptinotarsa decemlineata* SAY. Colorado beetles did not appear in the food of the Starling chicks at Puszczykowo until these last were seven days old. Out of the 40 beetles collected, 27 were found in the food of the chicks more than 9 days of age. From among the other specimens, 4 were identified as *Gynandrophthalma cyanea* FBR., 1 as *Donacia crassipes* F. and 3 as members of the genus *Cassida*.

The *Staphylinidae*, which are characterized by the epigeal mode of life, should become easy prey to Starlings, but their number in the food of this species was relatively small. As regards size, small forms, not exceeding 5 mm in body length, prevailed.

There were three species of the *Silphidae*: *Silpha quadripunctata* L. — 11 specimens, *S. obscura* L. — 5 specimens, and *Nicrophorus vespillo* (L.) — 2 specimens.

The *Coccinellidae* are considered to be very unwillingly taken by birds or simply not eaten by them at all. In the material collected there were 11 specimens including 6 *Anatis ocellata* (L.), 2 *Subcoccinella 24-punctata* (L.) and 1 *Coccinella 7-punctata* L.

The *Ditiscidae* occurred in the Starling's food above all as larvae (l.). The size of the ditiscid larvae was very various, from quite small ones, about 1 cm long, to those, very large, exceeding 4·5 cm in length. The larvae of these beetles were probably found in drying up water reservoirs or at the time of their coming out on to the bank to pupate. The imagines must also have been caught while leaving the water reservoirs. The imaginal *Ditiscidae* included 3 specimens of *Colymbetes fuscus* L. and 2 specimens of *Rhantus exoletus* FORST.

The remaining 20 beetles (*Coleoptera* varia et indet.) could not be determined closely because they were very badly damaged. In this group I also placed two specimens, identified as *Opilio mollis* L. *(Cleridae)* and *Hydrophilus caraboides* L. *(Hydrophyllidae)*, which, being the only members of these families, were not distinquished as separate units.

The *Neuroptera* s.l. were represented by only two specimens, one of *Sialis flavilatera* (L.) and a member of the genus *Chrysops*.

The *Hymenoptera* were not very abundant in the Starlings' food. Both larvae and imagines were met with. The 141 specimens of this order included 88 imagines and 53 larval *Symphyta*. Seven specimens of the *Terenbrantia*, 11 of the *Symphyta* and the most numerous, for as many as 70, of the *Aculeata* were found among them. Ants *(Formicidae)* were chiefly responsible for so large a number of these last insects. Small forms predominated here, there being 43 *Lasius niger* F., 6 *Myrmica scarabinodia* NYL. and 1 *Lasius flavus* DEG. The larger species were represented by 2 *Polyergus rufescens* LATR. and 6 members of the genus *Formica*. The small species of the genera *Lasius*, and *Myrmica* occurred exclusively as workers and the large species (*Formica* sp. and *Polyergus rufescens* LATR.) mostly (81%) as winged forms. As regards volume, two members of the genus *Cimbex* predominated among the *Hymenoptera*.

The *Trichoptera* well exemplify the utilization of the mass emergence of insects by Starlings. Out of the 253 trichopterans which were found in the samples of food, as many as 249 were colected in the first year of investigation. The mass emergence of the *Trichoptera* must have occurred from 18 to 20 May

1962, which is indicated by the numbers of these insects brought to the nests: 17 May — none, 18 May — 50 specimens, 19 May — 139, 20 May — 48 and 21 May — 10. *Limnophilus auricula* CURT. (127 specimens) and *Limnophilus griseus* L. (114) were the most numerous species. *Holocentropus stagnalis* was represented by only one specimen. The other specimens were unidentifiable. An interesting fact was the presence of 3 trichopteran pupae of the genus *Limnophilus*, conspicuous by the strong structure of their cases, which besides were missing from the samples. The *Trichoptera* are probably an attractive and relatively easily get-at-able food for Starlings and the fluctuations observed in its quantity are caused by the irregularity of emergence and the very variable number of emerging insects.

The *Lepidoptera* formed less than 2 % (69 specimens) of the total of specimens in the food. The number of adult forms (8) was considerably smaller than that of larvae (61), among which the *Noctuidae* and *Geometridae* prevailed. Strikingly little damage was done to the body of larvae. Most of them showed no signs of crushing, in which they besides resembled the larvae of the *Hymenoptera*.

In respect of number the *Diptera* were second only to the *Coleoptera*, there being 1155 specimens, including 926 imagines and 229 larvae. Only two most numerous families were separated among the imaginal forms, i.e. the *Bibionidae*, 497 in number (54 % of the total of adult dipterans) and the *Tipulidae*, which numbered 122 specimens (13 %). Females filled with eggs made about three quarters of all the *Tipulidae*. Out of the 229 dipteran larvae, 82 % (185 specimens) were *Tipulidae* (l.), and the *Stratiomyidae* and *Tabanidae* predominated among the remaining larvae. There were also larvae of *Eristalis* sp. In the samples of the Starling's food collected at Puszczykowo the *Diptera* formed nearly 28 % of the total number of preys, but only 7·6 % of their volume.

The *Araneae* constituted one of the basic components of the food of the nestlings. As regards both the number of specimens and their frequency, they held one of the top positions: 256 specimens formed 6·3 % of all the food, whereas 37·4 % of samples contained members of this arthropodal group. Qualitatively, the epigeal species prevailed, which was due to the Starlings' mode of foraging. Here, the *Lycosidae*, which made 61 % of the total of spiders, were the most numerous family. The *Tetragnathidae* and *Thomisidae* were far less abundant.

Lycosidae		153 specimens
Trochosa spinipalpis (F. O. CAMBR.)	43	
Pardosa sp.	26	
Alopecosa pulverulenta (CLERCK)	14	
Trochosa ruricola (DE GEER)	11	
Pardosa palustris (L.)	7	
Pardosa pullata (CLERCK)	5	
Pardosa amentata (CLERCK)	4	
Pardosa agrestis (WESTR.)	3	
Pardosa arenicola (O. F. CAMBR.)	3	

Pardosa prativaga (L. K.)	3	
Pardosa monticola (Clerck)	1	
Trochosa terricola Thor.	1	
Alopecosa trabalis (Clerck)	1	
Alopecosa sp.	1	
Xerolycosa sp.	1	
Cocoons of *Lycosidae* indet.	29	
Tetragnathidae		51 specimens
Pachygnata degeeria Sund.	29	
Pachygnata clerckii Sund.	13	
Pachygnata listeri Sund.	9	
Thomisidae		38 specimens
Xysticus cristatus (Clerck)	21	
Xysticus kochii (Thor.)	7	
Philodromus sp.	5	
Xysticus audax (Schrank)	1	
Xysticus sp.	1	
Tibellus oblongus (Walck.)	1	
Oxyptila simplex (O. P. Cambr.)	1	
Oxyptila sp.	1	
Varia et indet.		14 specimens
Linyphia hortensis Sund.	4	
Araneus sturmi (Hahn)	2	
Clubiona sp.	1	
Araneus sericatus Clerck	1	
Dictyna arundinacea (L.)	1	
Araneae indet.	4	

Among the *Lycosidae* the large species of the genera *Trochosa* and *Alopecosa* were the most numerous in the nestlings' food. There were also many females and cocoons.

The *Gastropoda* were given to the Starling chicks together with their shells. The occurrence of snails in the food samples was not regular (their frequency was 24 %) and the number of specimens was 96 (2·3 %). The following list shows their specific differentiation and quantitative relations:

Succinea sp.	25
Zonitoides nitidus (O. F. Müll.)	23
Galba turricula Held.	18
Cochlicopa lubrica (O. F. Müll.)	12
Perforatella rubiginosa (A. Schmidt)	6
Planorbis planorbis (L.)	2
Galba truncatula (O. F. Müll.)	2
Aegopinella nitidula (Drap.)	1
Helicella obvia (Hartm.)	1

Nesovitrea hammonis (STROM.)	2
?*Oxychilus cellarius* (O. F. MÜLL.)	1
Arion circumscriptus JOHNST.	1

The *Gastropoda* brought to the nests included only one slug, although in the Starlings' feeding grounds they were not scarce.

The *Salentia* were the only vertebrates found in the samples of the Starlings' food, namely, two young specimens of *Rana arvalis* NILSSON taken by the birds on the 10th and 13th day of the feeding period.

All sorts of offal of man's food are included in the group Garbage. Cartilages, remains of sausage and bread were found in the food of the nestling Starlings. The Starlings did not give this sort of food to their chicks before they were at least 10 days old.

Table II

List of food components of Starling nestlings relative to their importance to birds (highest frequency, number of specimens and volume)

Primary Food	Secondary Food	Incidental Food
Melolontha im.	*Melolontha* l.	*Scarabaeidae*
Tipulidae l.	*Lepidoptera* l.	*Silphidae*
Cantharidae	*Dytiscidae* l.	*Diplopoda*
Araneae	*Chrysomelidae*	*Staphylinidae*
Carabidae	*Tipulidae* im.	*Coleoptera* indet.
Bibionidae	*Elateridae*	*Homoptera*
Diptera im.	*Gastropoda*	*Salientia*
Lumbricidae	Garbage	*Odonata*
Pupae indet.	*Orthoptera*	*Dytiscidae* im.
Diptera l.	*Elateridae* l.	*Lepidoptera* im.
Trichoptera	*Hymenoptera* im.	*Isopoda*
Larvae indet.	*Hymenoptera* l.	*Coccinellidae*
Curculionidae		Indeterminatae
		Heteroptera
		Chilopoda
		Neuroptera

The vegetable matter included only grasses, leaves and stalks of mosses and other plants. Fresh, green plants were very few, dead grass blades of the previous year being prevalent. The most vegetable parts occurred in the samples in which there were many small and common insects. Cherries were not found once in the food of the nestlings of the first brood. In the litter of the nests of retarded or second broods there were up to 111 stones from cherries.

Mineral components, like vegetable parts, cannot be treated as food, but as an addition providing nestlings with lime or as gastroliths. The Starlings brought the nestlings various pebbles (up to 5 mm in diameter), clods of lime, peat, weathered mussels, and even pieces of glass and china. Before the 5th day of life small nestlings did not receive any such objects and only from the 10th day onwards pebbles, not exceeding 2 mm in diameter, occurred in almost every sample.

Concluding this survey of the food items of the Starling nestlings it should be added that among the specimens identified there were several interesting species from the faunistic point of view. And thus in the family *Carabidae* there was a specimen identified as *Amara schimperi* WENCK, which species is regarded as a piedmont one, and in the order *Trichoptera Limnophilus auricula* CURT., never recorded from Wielkopolska before, although this region is thought to be well examined, appeared the most numerous species. Among the *Araneae* *Oxyptila simplex* (O. P. CAMBR.) and *Araneus sericatus* CLERCK are new to the Wielkopolski National Park, although they belong to the families already studied in this area.

IV. FOOD COMPOSITION IN DIFFERENT BREEDING SEASONS

A close analysis of the lists of food items brought to the nestlings provides many evidences for the fact that both the qualitative composition of the food and the quantities of its individual components may differ from year to year.

The qualitative changes observed in the composition of the food of the Starlings nesting in the same colony in two successive breeding seasons were restricted almost exclusively to systematic units numbered in the secondary and incidental categories of food. The systematic units distinguished as components of the primary food occurred in it in both seasons. Units of a higher rank and dominant species were also present in the food of either year.

The quantitative relations show much more essential differences between particular food items in these two breeding seasons. The range of these changes is presented in Table III. From the units listed in it we can separate those which underwent no essential changes in respect of frequency and number and the ones whose number changed from year to year. The first of them include, in the first place, cockchafers *Melolontha melolontha* im., *Tipulidae* l., *Araneae* and *Diptera* im. The quantitative relations of the other components of food present themselves quite differently in the two breeding seasons. In general, some of them were more abundant in the first year of investigation (e.g. *Cantharidae*, *Bibionidae* and, above all, *Trichoptera*), the others in the second year. (e.g. *Carabidae* and *Lumbricidae*). These quantitative changes are not limited to the primary food but they also occur in the two other groups of food.

The greatest differences were observed in the numbers of *Trichoptera* brought to the nests. The number of specimens collected in 1962 formed 98·5% of their total of 253, and it should be kept in mind that in 1963 the number of samples taken was twice as large as that in 1962.

As regards the *Cantharidae*, in addition to their above-mentioned reduced share in the second year of investigation, there was also a change in the percentage shares of particular species in the total for the given year. This is illustrated in Table IV. *Cantharis obscura* L., which was clearly dominant (78%) in the food of 1962, in the next year yielded precedence to *Cantharis rustica* FALL

Table III

Quantitative changes in the composition of primary food observed in two consecutive breeding seasons

Food item	Frequency in %		Number of Specimens per Sample		Volume, in cu. cm per Sample	
	1962	1963	1962	1963	1962	1963
Melolontha im.	76·9	65·5	2,1	2·6	2·66	2·41
Tipulidae l.	26·9	37·6	0·5	0·7	0·11	0·18
Cantharidae	29·1	17·8	2·6	0·6	0·11	0·04
Araneae	39·7	36·3	0·9	1·1	0·11	0·04
Carabidae	10·3	35·1	0·1	0·7	0·01	0·06
Bibionidae	42·3	12·7	5·5	0·1	0·07	0·01
Diptera im.	38·4	31·2	1·8	1·2	0·03	0·03
Lumbricidae	14·2	26·3	0·2	0·4	0·04	0·11
Pupae indet.	16·7	9·1	0·3	0·5	0·03	0·10
Diptera l.	16·7	8·3	0·3	0·5	0·04	0·06
Trichoptera	14·1	0·5	3·2	0·03	0·08	0·001
Larvae indet.	19·2	28·7	0·3	0·9	0·01	0·04
Curculionidae	12·8	26·1	0·3	0·8	0·001	0·02
Other foods	—	—	2·7	4·4	0·40	0·71

Table IV

Changes in the numbers of species of the genus *Cantharis* in the food of Starling nestlings in two consecutive breeding seasons

Species	Specimens, in %	
	1962	1963
C. rustica FALL.	14	64
C. fusca L.	5	20
C. livida rufipes HBST.	3	7
C. obscura L.	78	8
Total number of specimens	206	136

Quantitative differences are observed not only in the proportions between particular components of the food but also in the total number of specimens brought to the nest. In 1962 one sample contained an average of 20·8 specimens of various sorts of food and in the next year only 14·5, and thus the difference exceeds 30%. In respect of volume, however, the quantity of food delivered to the nests was more or less uniform in the two breeding seasons (respectively, 3·70 and 3·81 cu. cm per sample) and the difference was less than 3% in favour of the second year of investigation. This indicates that the average size of specimens in 1963 was nearly 1·5 times as large as it was in the previous year. Therefore, in spite of the 30-percent difference in the number of specimens, the volume of food given to the nestlings was more or less the same. It will also be seen from the foregoing that in studies on food the consideration of the number of specimens alone, without taking into account other parameters, e.g. mass, volume, calorific value, etc., may lead in some cases to false statements.

The changes in the abundance of some groups of food in different breeding seasons may sometimes be considerably larger than those observed at Puszczykowo. KLUIJVER'S (1933) three-year observation shows that e.g. the *Lepidoptera* formed 22·6% of food in 1929, 33·7% in 1930, and only 9·4% in 1931. Big differences were also found in the number of the larval *Tipulidae*, which ranged within limits of 4·9 and 26·8%. PFEIFER and KEIL (1959) give numerical data separately for each breeding season from 1952 to 1956. The numbers of the *Lepidoptera*, for instance, fluctuated from 61·8% to 89·5% and that of the *Diptera* from 0·9% to 25·2%.

The differences in the food composition observed in different breeding seasons seem to result, above all, from the fluctuations in the number of victim-species, but the lack of data on the abundance of the populations of these species in the Starlings' feeding grounds does not allow us to determine in what measure these suppositions are true. That such relationships exist, is evidenced by quite a number of observations. E.g., PFEIFER and KEIL (1958) proved that the maximum consumption of larval *Tortrix xiridana* L. occurred in the year in which the larval stage coincided with the hatching of starling chicks. The example with the *Trichoptera* given above leads to similar conclusions.

V. FOOD COMPOSITION AND THE AGE OF NESTLINGS

The intensity of feeding is not the same on all days of nestlings' life (BOGUCKI, 1972). In the first days of feeding the number of arrivals in the nests is the smallest; it is the largest about the 10th day and next decreases slightly again. Is the food brought to the nest, consequently, proportional to the intensity of feeding? This question is answered by the graph in Fig. 1. All the items of information illustrated in this graph as well as in the next ones, are comparable because the deviations from the mean values (= 100%) shown in the graphs are expressed in percentages.

A comparison of the graph presenting the number of specimens falling to one sample with the mean volume of the samples shows that, as the nestlings grow, the number of preys brought to the nests in particular stages of feeding remains nearly the same, whereas the changes in the volume of this food are incommensurably large (Table V). Moreover, after the 10th day of feeding the number of preys decreases — probably in connection with the decrease in the feeding intensity — but their volume still increases. This is due to the fact that large nestlings can swallow much bigger bits of food than small chicks can. Up to the 5th day of life there are on the average 7·2 preys in 1 cu. cm of food, from

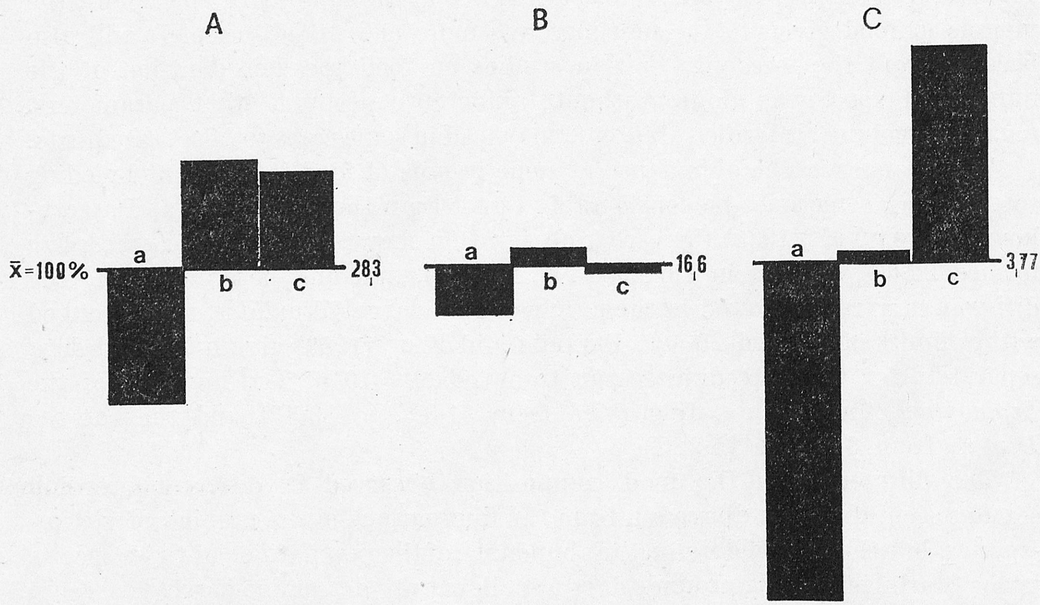

Fig. 1. Changes in the intensity of feeding (A — entries per day) and quantity of food brought to nests (B — specimens per sample, C — cu. cm. per sample) in three stages of development of nestlings (a: 2nd — 5th, b: 6th — 9th and c: 10th — 14th day of life)

Table V

Number of specimens and volume of food given to Starling nestlings in three stages of their development

Day of Feeding	Samples	Specimens	Specimens per Sample	Volume, in cu. cm	Volume per Sample
2— 5	63	985	15·6	136·67	2·17
6— 9	77	1332	17·3	292·18	3·79
10—14	95	1579	16·6	457·69	4·82
2—14	235	3896	16·6	886·54	3·77

the 6th to the 9th day of life 4·6 preys and from the 10th to the 13th day only 3·4. Thus, the sizes of preys in these periods are, respectively as 1·0:1·6:2·1.

Kluijver (1933) writes that the average weight of food given to a chick at one feed increases from 114 mg on the first day of life to 853 mg on the 10th day and later it keeps up at more or less the same level. The weight of a whole day's food eaten by a chick during the first days of life equals six-seventh of its body weight, and from the 12th day onwards a half of it. The number of specimens given to a chick at one feed is 2·0—2·4 on the first four days and 4·3 from the 5th to the 18th day of life. Similarly, TINBERGEN (1949) reports that Great Tits *Parus major* gather small larvae (less than 10 mm in length) only while feeding their newly hatched chicks.

Table VI

Changes in frequency and number of specimens of particular components of primary food brought to nests in three main stages of feeding (in consecutive days)

Food Item	Frequency, in %			Specimens per Sample		
	2—5	6—9	10—14	2—5	6—9	10—14
Melolontha im.	49·2	71·5	81·0	1·0	2·1	2·8
Tipulidae l.	30·2	32·5	38·0	0·9	0·9	0·7
Cantharidae	9·5	19·5	26·4	0·2	2·2	1·2
Araneae	57·1	35·1	26·4	2·1	0·7	0·4
Carabidae	23·8	28·6	27·4	0·5	0·7	0·6
Bibionidae	27·0	23·4	19·0	2·3	2·3	1·7
Diptera im.	34·9	39·0	28·4	1·8	1·6	0·6
Lumbricidae	9·5	26·0	27·4	0·2	0·3	0·5
Pupae indet.	34·9	19·5	12·6	0·8	0·4	0·2
Diptera l.	33·3	16·9	12·6	0·5	0·3	0·4
Trichoptera	1·6	1·3	11·6	0·03	0·04	2·6
Larvae indet.	34·9	24·7	20·0	0·8	0·9	0·6
Curculionidae	15·8	24·7	23·2	0·4	0·6	0·5
Other foods	—	—	—	4·1	4·3	3·8

As the chicks grow, both the total quantity of the food brought to the nest and its specific composition change. These changes, especially within the primary food, concern the quantitative relations mainly, and in a smaller measure the qualitative ones. As can be seen from Table VI, some food items are more abundant in the case of younger chicks (e.g. *Araneae* and *Diptera* im.) and others occur in larger numbers in the diet of older chicks (e.g. *Melolontha melolontha* im.). The graph in Fig. 2 illustrates these changes. The groups of foods represented in the graph differ from each other in body toughness. On account of the nature of their emergence (see above) the *Trichoptera* occurred nearly exclusively in the last of the breeding stages considered.

Among different sorts of food, spiders hold a special position, not only as a food very valuable to birds (thin chitine cuticle and comparatively high calorific value), but also because of the specificity of their occurrence in the samples taken. During the first days of life of Starling chicks spiders constitute a dominant element of their food, whose share decreases conspicuously as the chicks grow. KALMBACH (1928) and KLUIJVER (1933) obtained similar results, which are summarized in Table VII. During the first days of life of the nestlings,

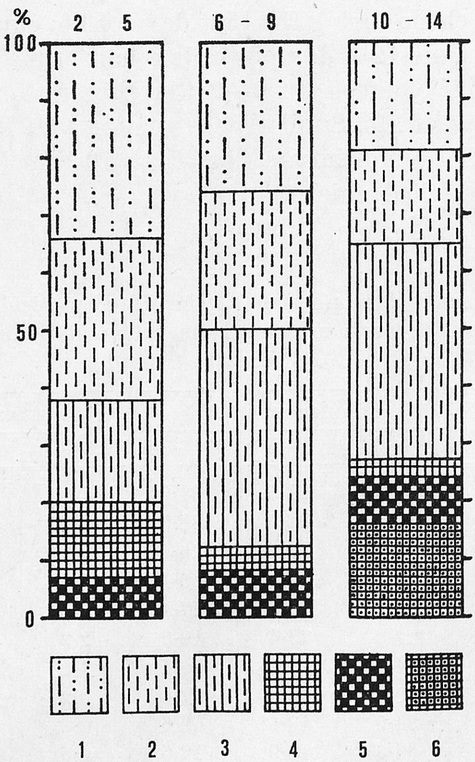

Fig. 2. Changes in the shares of particular food components in three stages of development of nestlings (2nd — 5th, 6th — 9th and 10th — 14th day of life). Food components: 1 — *Diptera* im. and *Hymenoptera* im., 2 — Larvae and Pupae, 3 — *Coleoptera* im., 4 — *Araneae*, 5 — Varia, including *Trichoptera* (6)

Table VII

Percentage share of Spiders *(Araneae)* in the food of Starling nestlings

	Day of Life of Nestlings		
	2—5	6—9	10—14
Own results	13·2	4·3	2·6
KLUIJVER (1933)	34·0	6·2	2·7
KALMBACH (1928)	23·4	3·6	3·3

and therefore in the period of the intensest increase of their body mass, this very sort of food was brought to the nest oftenest and in the largest numbers. However, it is not known whether the decrease in the share of spiders in the food of older nestlings is due to the fact that the adult birds stop taking this sort of food or whether they themselves more and more frequently eat the spiders that they hunt out.

Some "atypical" sorts of food do not appear but in the diet of older nestlings. E.g., the Colorado beetle *Leptinotarsa decemlineata* SAY., was not found in the food of nestlings less than seven days of age. Sixty-eight percent of all the Colorado beetles were found in the food of nestlings more than 9 days of age, although the emergence of these beetles had been observed a few days before. Similarly, garbage, which had never been missing in the neighbouring refuse bins or dumps, was brought as food to the nestlings which were at least ten days old.

VI. FOOD COMPOSITION AND THE TIME OF DAY

The differences observed in the composition of the food of nestling Starlings in the three main parts of day-time are quantitative ones. They are chiefly caused by the ununiform 24-hour cycle of activity of animals which make up the Starling's food. Table VIII shows that some animals taken as food by Starlings occur more frequently and more numerously in the morning (from dawn to 10 a.m.) than in the middle of the day (from 10 a.m. to 2 p.m.) or even in the afternoon (after 2 p.m.). An example of such food components may be the cockchafer *Melolontha melolontha* im., which in the morning was taken nearly twice as frequently as in the afternoon, and whose average number of specimens in a morning sample was three times as large as that in the samples taken after 2 p.m. Such big differences in the share of this beetle in the food of nestlings

Table VIII

Changes in frequency and number of specimens of primary food components brought to nests in three periods of day: till 10 a. m. from 10 a. m. till 2 p. m. — after 2 p. m.

Food Item	Frequency (in % of total of Samples)			Specimens per Sample		
	till 10a.m.	10a.m.- 2p.m.	after 2p.m.	till 10a.m.	10a.m.- 2p.m.	after 2p.m.
Melolontha im.	82·1	77·0	49·0	3·3	1·8	1·1
Tipulidae l.	16·3	55·0	35·0	0·3	1·3	0·8
Cantharidae	16·1	29·0	15·0	2·2	1·2	0·4
Araneae	25·5	42·0	46·5	0·8	1·0	1·1
Carabidae	19·8	36·2	26·4	0·5	0·8	0·6
Bibionidae	20·1	36·2	12·5	2·6	3·0	0·7
Diptera im.	44·1	37·6	18·8	2·2	1·1	0·4
Lumbricidae	23·3	21·7	21·2	0·4	0·4	0·3
Pupae indet.	14·0	23·2	26·4	0·3	0·4	0·4
Diptera l.	11·8	17·4	30·0	0·2	0·3	0·7
Trichoptera	5·8	8·7	2·5	1·8	1·2	0·2
Larvae indet.	24·5	26·1	26·4	0·6	1·3	0·5
Curculionidae	17·4	26·1	22·5	0·5	0·5	0·6
Other foods	—	—	—	3·8	4·4	3·6

may be due to two causes: either Starlings find cockchafers lying dead or exhausted by the night mating flight on the ground, or the morning dew discourages them from foraging in the wet grass and then they rummage the crowns of trees, finding cockchafers which have taken shelter there.

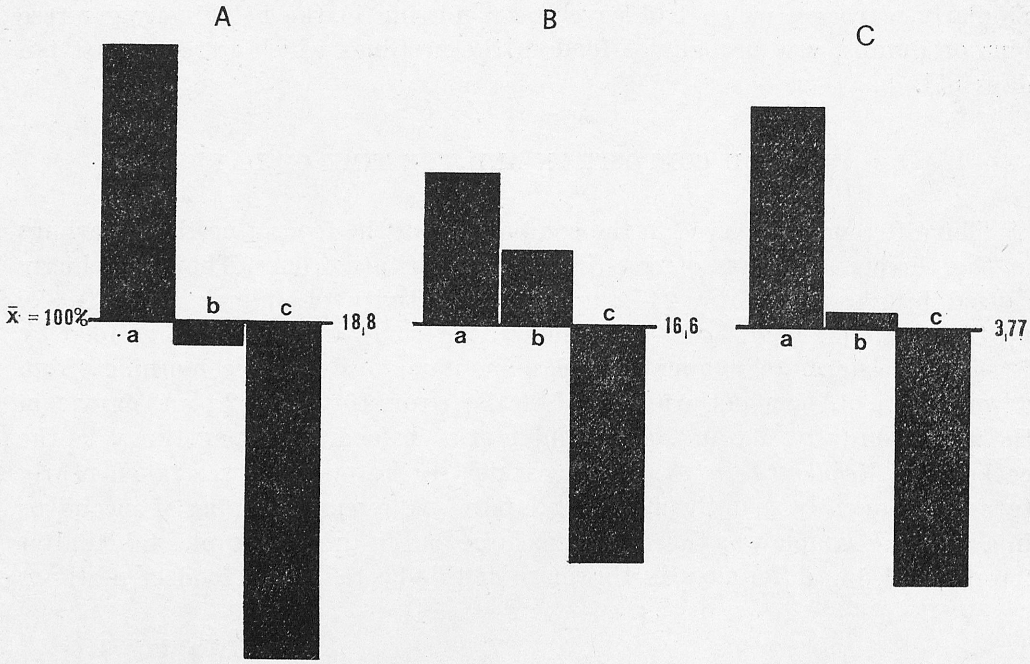

Fig. 3. Changes in the frequency of feeds (A — entries per hour) and quantity of food brought to nests (B — specimens per sample, C — cu. cm. per sample) in different times of day: a — in the morning (till 10 a. m.), b — at noon (from 10 a. m. till 2 p. m.) and c — in the afternoon (after 2 p. m.)

Table IX

Number of specimens and volume of food given to nestlings in different periods of day

Time of Day (hours)	Samples	Specimens	Specimens per Sample	Volume, in cu. cm	Volume per Sample (in cu. cm)
before 10a.m	86	1678	19·5	416·52	4·84
10a.m-2p.m	69	1291	18·7	267·76	3·88
after 2p.m	80	927	11·4	204·96	2·56
average			16·6		3·77

As regards earthworms *(Lumbricidae)*, no distinct differences were observed in their share in the food gathered at various times of the day in this study, whereas Dunnet (1955) found them to be dominant in the morning, when they formed about 35% of the total number of preys. On the other hand, Kluijver

(1933) writes that the number of earthworms in the Starling's food increases noticeably after the rain.

The quantity of food brought to the nest at different times of the day is proportional to the number of feeds (Fig. 3). In contradistinction to the graph in Fig. 1, Fig. 3 does not show great differences between the number of specimens and their volume: 1 cu. cm of food contained on the average 4·0 specimens in the morning, 4·8 at noon, and 4·5 after 2 p.m., the size ratio of the specimens being respectively as 1·0:1·2:1·1. The size of prey brought to the nest all day round is therefore more or less the same, although the rations given to the nestlings in the morning are nearly twice as large as those in the afternoon (Table IX).

VII. COMPOSITION OF FOOD GATHERED BY DIFFERENT PAIRS OF BIRDS

Out of the 7 nests observed in 1963, 4 were chosen at random to carry out a comparison of the composition of food gathered at the same time by different pairs nesting in the same area. Samples, 22—25 in number, representing the food of nestlings from the 2nd to the 14th day of life, were taken from each nest. All the samples were taken in the period of 12—23 May.

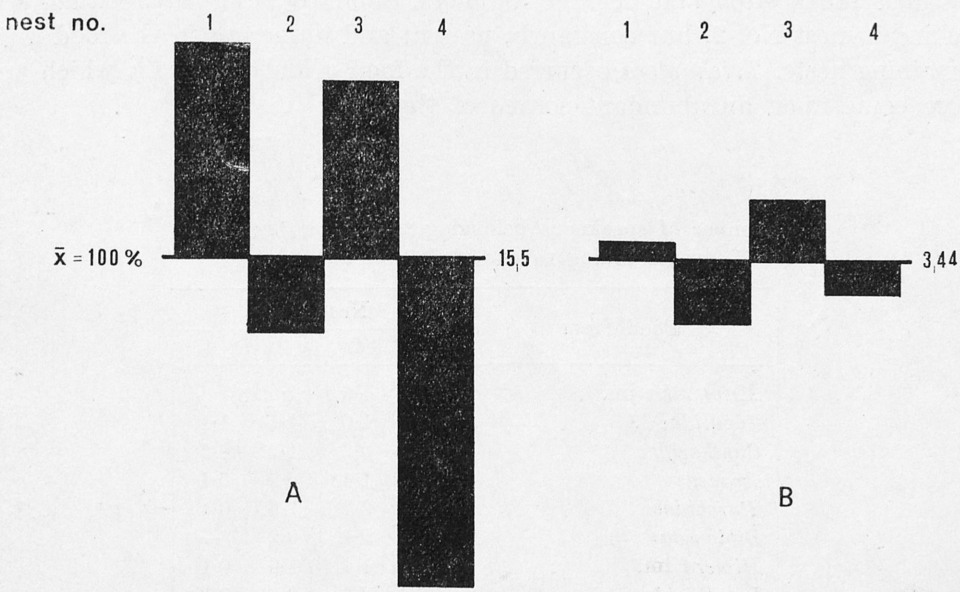

Fig. 4. A comparison of the number of specimens per sample (A) and volume of food in cu. cm per sample (B) brought to nests by 4 pairs of Starlings nesting in the same colony and the same time

Fig. 4 shows the quantitative relations characterizing the food brought to the nests by the four chosen pairs of birds. The variability of the number of specimens was much greater than that of the volume of samples, or in other words each pair brought more or less the same amounts of food made up of various numbers of specimens. The differences in food volume seem to be unrelated to the size of clutch. Nests Nos. 1 and 2 contained 5 chicks each, nest No. 3—4 chicks, and nest No 4—3. Table X demonstrates the mean quantities of food brought to the nests with 3, 4 and 5 chicks (altogether 16 nests). It is interesting that the largest number of specimens was in the samples from the nests with 4 chicks, in which the average volume of one sample was the smallest.

Table X

Number of specimens in food brought to nests with 3, 4 and 5 nestlings (on the basis of 16 nests)

	3 pull.	4 pull.	5 pull.	Mean
Specimens per Sample	11·5	21·1	18·5	16·6
cu. cm per Sample	3·70	3·44	3·99	3·77

The differences in the composition of food derived from different nests are mainly quantitative ones (Table XI). An interesting fact was however the lack of the *Bibionidae* in nest No. 4, although in the other nests they were given to the nestlings fairly often and in large numbers. Similarly, the *Curculionidae* were lacking in nest No. 2, but constantly present and numerous in the food in the remaining nests. *Trichoptera* occurred in the food of only one pair, which must have come upon an abundant source of them.

Table XI

Number of specimens belonging to different groups of preys falling to one sample in four nests

Food Item	Nest No.			
	1	2	3	4
Melolontha im.	2·1	1·6	1·6	1·8
Tipulidae l.	1·1	1·0	1·1	1·1
Cantharidae	1·0	0·2	1·2	0·9
Araneae	2·0	1·4	0·9	0·4
Carabidae	1·5	0·7	1·6	0·4
Bibionidae	1·2	0·1	0·9	—
Diptera im.	2·0	1·4	1·0	0·1
Lumbricidae	1·0	0·3	0·6	0·3
Pupae indet.	0·1	0·6	0·5	0·3
Diptera l.	0·2	0·4	1·4	0·3
Trichoptera	—	0·1	—	—
Larvae indet.	0·8	1·6	0·7	0·3
Curculionidae	1·3	—	1·4	0·4
Other foods	5·5	4·5	6·3	2·7
Specimens per Sample	19·8	13·9	19·2	9·0
cu. cm per Sample	3·57	3·17	3·72	3·29

The juxtaposition of the three most frequent sorts of food is also instructive:

Nest No. 1	Nest No. 2	Nest No. 3	Nest No. 4
Melolontha im.	*Melolontha* im.	*Tipulidae* l.	*Melolontha* im.
Carabidae	*Diptera* im.	*Araneae*	*Tipulidae* l.
Lumbricidae	*Cantharidae*	*Melolontha* im.	*Araneae*

Thus, the food gathered by different pairs of Starlings in the same breeding environments shows comparatively great differences, which are probably caused by their preference for some parts of the feeding grounds (as reported e.g. by DUNNET, 1955), marked by a different specific composition of their potential victims, rather than by different "tastes" of the birds. Individual variation in the diet has been found in many species of birds, e.g. in Herring Gulls *Larus argentatus* L. nesting in the same colony (GOETHE, 1939) or in different pairs of the Great Tit *Parus major* L., nesting in the same wood (TINBERGEN, 1949).

VIII. PREPARATION OF FOOD BEFORE ITS BEING GIVEN TO NESTLINGS

Birds can admittedly change the form of food before giving it to their young, but the range of such actions is very narrow, usually confined to the crushing of hard beetles or at most the tearing-away of the head. KLUIJVER (1933), for instance, writes that the only type of preparation of food for nestlings was the decapitation in the large species of the genus *Carabus* and in *Colymbetes fuscus* L. and *Dytiscus punctatus* F. There are still several other reports, according to which the birds tear the legs, wings, wing-cases and heads away from the bodies of insects brought to the nests (CREUTZ, 1967; HASSEL, 1961; WEINZIERL, 1961). No attempt has however been made to relate this phenomenon with the development of the young. On the other hand, some authors mention that the food for nestlings is almost undamaged. E.g. POKROVSKAYA (1956) states that the butterfly caterpillars removed from the gullets of young Starlings could be bred for many days.

Beetles brought to the nests with damaged bodies were frequently observed in the material collected and the various degree of damage suggested a certain connection of this fact with the development of the nestling for which they were designed. Most of the damaged beetles belonged to the species *Melolontha melolontha*. A total of 496 specimens of this species were examined for damage and some results are presented in Table XII. They show clearly that the degree and nature of damage was closely related to the age of nestlings. Beetles given to small chicks were damaged in a greater measure than those for the older nestlings. It might be supposed that soft abdomens are given to nestlings far more frequently than heavily chitinized thoraces. This was not the case, however. About 5% of beetles were devoid of the thorax and about 10% lacked the abdomen. As regards the other body parts, the beetles were, above all, deprived of wing-cases (93 % of cases lacking). Wing-cases did not occur in the food of the nestlings until these were nine days old. Still on the 13th day of feeding more than 60 % of wing-cases were thrown away by the birds. Having counted the cockchafer wing-cases torn away and left lying on the ground WEINZIERL (1961) estimated the quantity of cockchafers consumed by Starlings at 1—1·5 tons in a 40-hectare wood. My observations show that up to the 14th day of life of nestlings 93 % of cockchafers were without their wing-cases and, consequently, the quantity calculated by the above-mentioned author should be increased by about 10 %.

Table XII

Degree of damage to bodies of cockchafers *Melolontha melolontha* L. brought to nests

Day of Life of Nestlings	No. of Cock-chafers	Percentage of Cockchafers with Following Body Parts left						
		Thorax	Head	Wing--cases	Wings	Legs	Abdo-men	Pygidium
1— 5	61	88·5	5·6	—	10·2	2·2	86·8	32·0
6— 9	164	96·3	7·6	3·9	32·6	6·1	95·8	61·8
10—14	271	96·6	33·7	11·8	55·7	15·0	87·8	91·1
2—14	496	95·6	23·6	7·4	43·6	10·6	90·3	73·9

The data presented below and illustrating to which day of nestlings' life all cockchafers were deprived of particular body parts are a supplement to Table XII:

up to 2nd day of life	without	pygidium
up to 3rd ,, ,,	,,	wings
up to 4th ,, ,,	,,	head and legs, and
up to 8th ,, ,,	,,	wing-cases

As far as the legs are concerned, legs III were removed most frequently and legs II most rarely. In the total of 301 legs left legs I formed 33 %, legs II 40 %, and legs III 27 %.

It is also interesting how the food made up of a large number of small insects, e.g. *Cantharis* or *Bibionidae*, is prepared for nestlings. If such tiny specimens are numerous, they are given to them in the form of compact "noodles". The size of such rations is sometimes farily large, e.g. 31 × 14 mm or 22 × 14 mm, and they may contain as many as 50 specimens. They are firmly glued together by the bird with saliva and the whole is intertwined with and wound round in grass blades and moss stems. Such rations are so compact that it is hard to disintegrate them by means of a pincette without damaging some of the specimens.

IX. EFFECT OF SHORT-LIVED STARVATION ON THE PHYSICAL DEVELOPMENT OF NESTLINGS

Each night, when the adult Starlings do not bring food to the nest, the nestlings endure a short-lived starvation (lasting about 9 hours). This period is however long enough to affect the physical development of nestlings (Fig. 5). This is best seen from the rate of increase in the body weight of nestlings. After the night starvation nestlings lose on weight up to 10% of their weight in the preceding evening, but the loss is quickly compensated by normal feeding on the next day. Thus, the body weight of nestlings increases by leaps: intense increases occur in daytime (they may even reach 50%, the percentage being

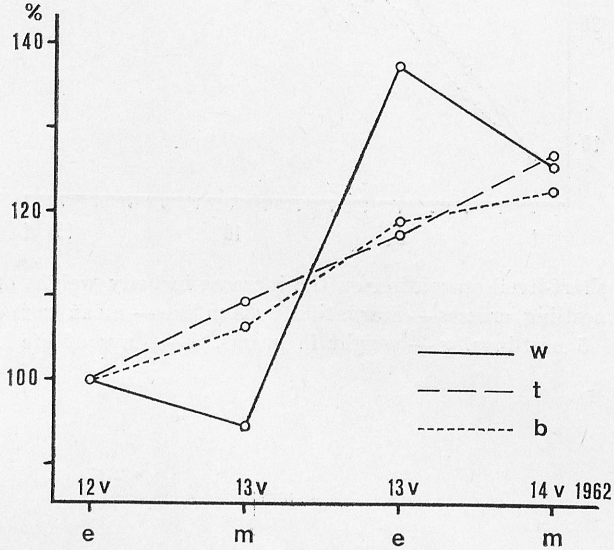

Fig. 5. 24-hour fluctuations in the increase rate of body weight (w), tarsometatarsus length (t) and bill length (b) in 42 Starling nestlings. m — measurements taken in the morning, e — measurements taken in the evening

dependent upon the age of the nestling) and partial resorptions in the night. The increase in the length of bill undergoes similar though much smaller daily fluctuations. Out of the three parameters of the development of nestlings measured by me, only the increase in the length of tarsometatarsus did not show any fluctuations connected with the deficiency of food in the night.

I succeeded in observing the effect of a somewhat longer starvation on the development of a Starling chick, when through an oversight I had left the collar placed round the neck of a five-day nestling in a brood of six. It had the collar on from 6·40 a.m. on the fifth day of life to 7·00 p.m. on the sixth day, i.e. for 36 hours. Thus the period of hunger lasted for nearly two whole days and a night and in spite of that did not end in the nestling's death.

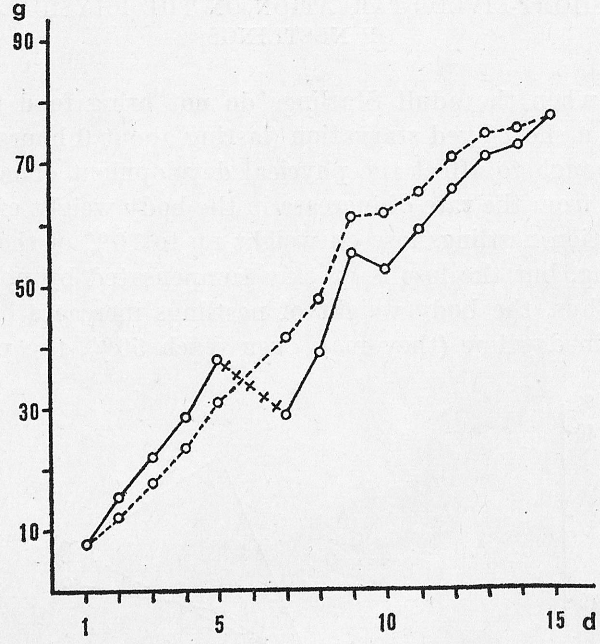

Fig. 6. Influence of short-lived starvation on the increase in body weight of Starling nestling Solid line — starved nestling, crosses — starvation, broken line — mean from data for remaining 5 nestlings. g — weight in grams, d — days of life

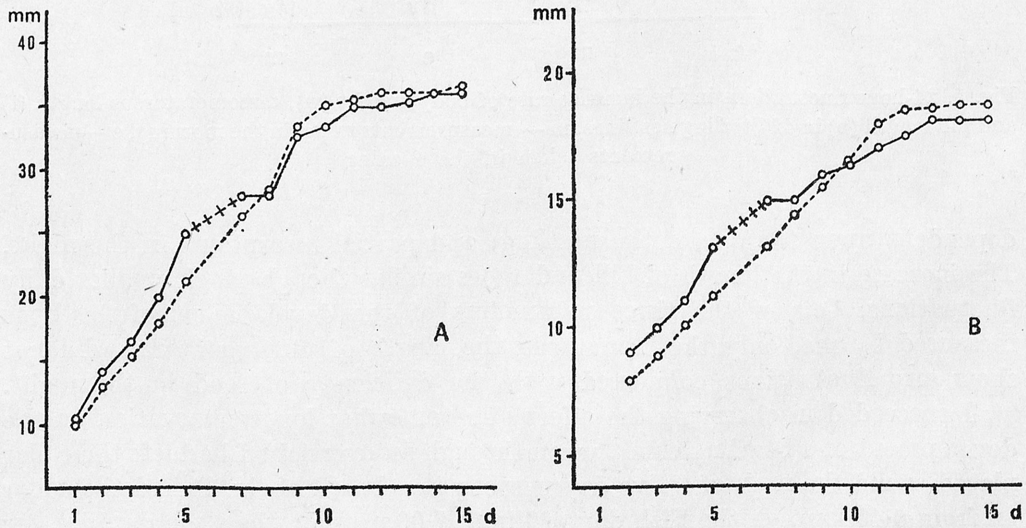

Fig. 7. Effect of starvation on the increase in length of tarsometatarsus (A) and bill (B). For explanation see Fig. 6

As the nestlings were individually marked, it was possible to observe further increments in the weight of body, the length of bill and that of tarsometatarsus of the starved nestling and to compare them with these parameters in the other five nestlings from the same nest. The results obtained are shown in graphs (Figs. 6 and 7).

This observation of the physical development of the starved nestling shows that the rate of increase of the body weight responses to starvation in quite a different manner than does the rate of length increase of the bill and tarsometatarsus. The greatest difference was found in the body weight, which during the 36-hour period of starvation decreased by nearly 24%, from 38·0 g to 29·0 g. The means for the other 5 nestlings in the same period were respectively, 30·8 and 41·2 g. Therefore their body weight increased by nearly 34%, whereas the backward nestling at the end of its starvation was lighter on the average by about 30% than the other nestlings. A slight fall in the weight of the starved nestling on the 10th day of life was also interesting. On that day the other nestlings of the brood put on the average only 0·2 g (0·3%) on weight and the backward nestling lost 3·5 g or about 7% of its body weight. The inhibition of increase and the fall in body weight were probably due to a smaller intensity of feeding caused by heavy rain. This indicates how great an influence is exerted by disturbances in the normal course of feeding, caused by e.g. unfavourable weather conditions, upon the development of the smallest nestlings of a brood. In extreme cases they may lead to the unusual mortality of broods (e.g. MIERZWIŃSKI, 1955), especially that of the smallest chicks in the nest.

The effect of starvation on the increase in length of the bill and tarsometatarsus was quite different. Both the bill and legs grew almost normally during the period of starvation. The complete inhibition of the growth of these parts of body did not occur before the second day after the ending of starvation. It lasted a day and night. At that time, with the size of the skeleton remaining unchanged, the soft body parts, previously resorbed, were being regenerated. Two days after the end of starvation the nestling attained normal body proportions and differed from the other chicks in the nest only in its smaller size.

It can be seen from the foregoing observations that the skeleton grew almost normally in spite of unfavourable nourishing conditions, probably at the cost of the fat supplies and perhaps partly of muscles. This enables a nestling to make up arrears in a short time as soon as it receives normal quantities of food. No change in the growth rate of the bill and tarsometatarsus was found in response to slight disturbances in feeding (e.g. on the 10th day of life mentioned above).

Still another fact deserves special attention here. It is generally accepted that a nestling which does not receive its normal quantity of food (e.g. the one bred in a house) dies soon. It now appears that the appropriate amount of heat is more important to the young nestling than food, naturally with regard to a short period of time. The starved nestling received the amount of heat necessary for life from the other nestlings and in the night also from the female. The received amount of heat was quite sufficient for the nestling to keep alive for nearly two days even though it was completely deprived of food.

X. CONCLUSION

The graph in Fig. 8, aiming at a comparison of the results of this investigation with the results of similar studies on the food of the Starling's nestlings, provides also information about variation in the food composition in relation

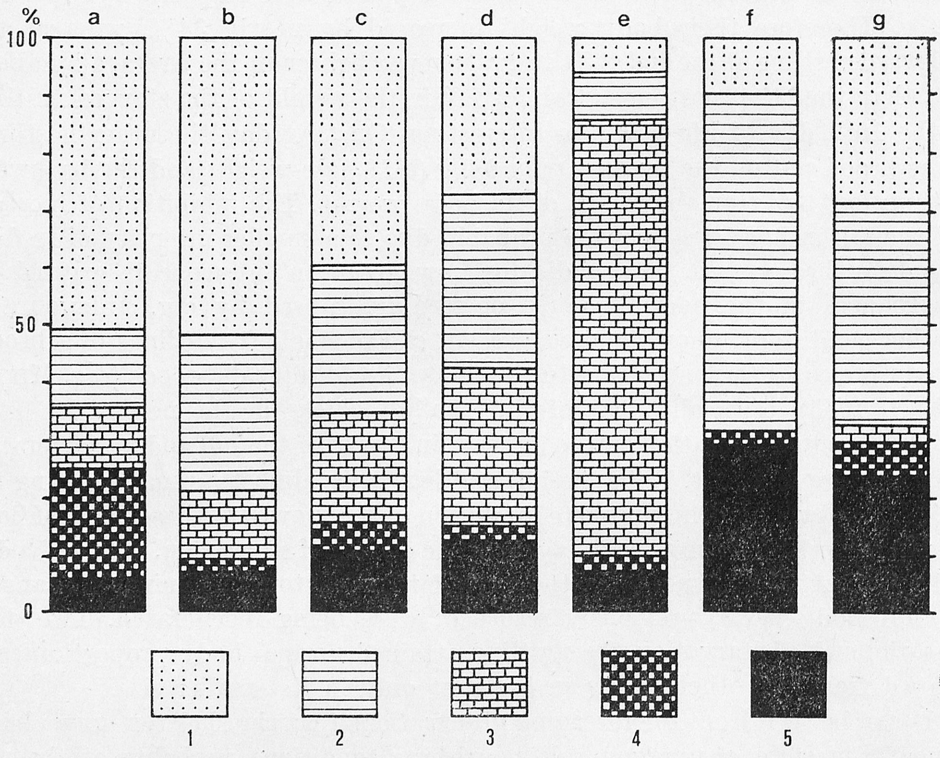

Fig. 8. Differences in food composition of Starling nestlings. a — orchard in Germany (Görnandt, 1959b); b — agricultural region in Poland (Gromadzki, 1969); c — meadows and pastures in Holland (Kluijver, 1933); d — pine wood in Germany (Mansfeldt, 1961); e — forest infested by *Tortrix viridana* in Germany (Pfeifer and Keil, 1958); f — forest near Leningrad (Pokrovskaya, 1956); g — residential quarter near meadows and pastures (own investigation). Food items: 1 — *Diptera*, 2 — *Coleoptera*, 3 — *Lepidoptera*, 4 — *Araneae*, 5 — Varia

to breeding environment. As regards the orders included in the graph these differences chiefly concern quantitative relations. It may be stated that the proportional shares of specimens belonging to the orders which are the most frequent in the food of the Starling's nestlings vary from environment to environment. E.g. the Starlings observed by PFEIFER and KEIL (1958, 1959) foraged in a forest infested by *Tortrix viridana* L. and it was these butterflies that predominated in their food. In the food of Starlings nesting in a pine forest (MANSFELD, 1961), the *Lepidoptera* also constituted one of the abundant food items. The complete lack of lepidopters in the food of the Starlings nesting in the region of Leningrad is no less interesting (POKROVSKAYA, 1956). Thus, the possibility of occurrence of big differences in comparison with the results obtained with other materials should be allowed for in the studies of food composition in starlings as well as that in other polyphagous species. Each new environmental situation may cause the appearance of new food items or at least the presence of items found before but in different quantitative proportions.

An analysis of the dependence of the composition of food brought to nests upon different environmental situations suggests that in order to obtain a possibly full picture, in the studies of food samples must be taken in such a manner that they cover different stages of the development of nestlings, different periods of day, at least several nests, different breeding seasons, etc. Moreover, the analysis of the material collected should include not only the number of specimens in particular groups of foods, but also other parameters, e.g. mass, volume, or calorific value. As I have already emphasized several times, the consideration of only one quantitative parameter may lead to false conclusions. HARTLEY (1948) attracted attention to this fact long ago, but only few studies, e.g. that by GROMADZKI (1969), have included more than one quantitative parameter of food.

Translated into English
by Jerzy ZAWADZKI

Laboratory of General Zoology,
Adam Mickiewicz University
Fredry 10, 61-701 Poznań, Poland

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STRESZCZENIE

Prace terenowe związane z badaniami nad składem pokarmu piskląt szpaka *Sturnus vulgaris*, LINNAEUS, 1758, prowadzono w Puszczykowie, w Wielkopolskim Parku Narodowym, w latach 1962 i 1963. Obiektem badań było 16 gniazd (w 1962 r. — 9 gniazd zawierających łącznie 42 pisklęta, w 1963 r. — 7 gniazd z 29 pisklętami). Badania prowadzono stosując metodę ucisku szyjnego. W okresie dwuletnich prac zebrano łącznie 260 jednogodzinnych prób pokarmu, z których wypreparowano 4142 okazy, głównie różnych grup stawonogów (Tabela I).

Zebrany materiał scharakteryzowano pod względem jakościowym. Analiza jakościowa obejmowała: częstotliwość (wyrażoną w %) występowania poszczególnych rodzajów pokarmu w próbach, liczbę okazów oraz ich objętość (w cm³).

Cały pokarm pogrupowano wg następujących kryteriów: pierwsza grupa (dla ilości — pokarm dominujący, dla częstotliwości — pokarm stały) obejmuje te komponenty pokarmu, których wartości procentów udziału są najwyższe, a łączna suma tych procentów wynosi około 68; druga grupa (dla ilości — pokarm uzupełniający, dla częstotliwości — pokarm częsty) obejmuje składniki pokarmu, o następnych z kolei wartościach udziału, a których suma wynosi około 27%; do trzeciej grupy (dla ilości — pokarm śladowy, dla częstotliwości — pokarm sporadyczny) należą pozostałe składniki pokarmu. Taki podział na trzy grupy jest uzasadniony naturalnym podziałem populacji liczb na zakresy wyznaczone krotnościami standardowego odchylenia. Dalsze grupowanie składników pokarmu miało na celu określenie ich roli w diecie szpaka. Uwzględniano wszystkie trzy (częstotliwość, liczebność, objętość) aspekty ilościowe łącznie (Tabela II). Pokarm zasadniczy grupuje te składniki, które ani razu nie znalazły się w grupie trzeciej, a przynajmniej raz zaliczone były do grupy pierwszej. Pokarm podrzędny, to te składniki, które znalazły się w grupie drugiej, a pokarm przypadkowy tworzą takie składniki, które co najwyżej raz znalazły się w grupie drugiej. Po takim podziale najbardziej urozmaiconym gatunkowo jest pokarm przypadkowy, ale jego ilość (liczebność i objętość) nie przekracza 5% całego pokarmu.

Skład pokarmu szpaków gnieżdżących się w tej samej kolonii w różnych sezonach lęgowych nie jest jednakowy (Tabela III). Obserwuje się nieraz dość znaczne różnice zarówno w składzie jakościowym (głównie na poziomie gatunków), jak i ilościowym pokarmu przynoszonego pisklętom. Największe wahania obserwuje się wśród tych komponentów pokarmu, które w przyrodzie występują nieregularnie lub w nierównych ilościach w poszczególnych latach (Tabela IV). Liczebność okazów przynoszonych do gniazd była w 1962 roku o 30% większa niż w roku następnym, ale jego objętość różniła się tylko o 3%. Pomimo znacznego zróżnicowania liczby okazów ich łączna objętość nie ulega więc zasadniczym zmianom.

W miarę rozwoju piskląt zmienia się również skład ilościowy (Tabela V, Ryc. 1) i jakościowy (Tabela VI) podawanego im pokarmu. W pierwszych dniach karmienia młode szpaki otrzymują głównie pokarm miękki (różne larwy, muchówki) i wysokokaloryczny (pająki), a dopiero później otrzymują coraz to większe ilości okazów o twardej powłoce ciała (chrząszcze) (Ryc. 2). Zmiany te są szczególnie wyraźne w przypadku pająków (Tabela VII). Zmienia się również wielkość okazów zdobyczy przynoszonych do gniazda. Na 1 cm^3 objętości pokarmu piskląt w wieku do 5 dni życia przypada przeciętnie 7,2 okazów, od 6 do 9 dnia życia — 4,6 okazu, a u piskląt 10—13 dniowych tylko 3,4.

Różnice w składzie pokarmu, zachodzące w trzech podstawowych porach dnia, warunkowane są głównie różną aktywnością dzienną potencjalnych zdobyczy szpaka. Niektóre rodzaje pokarmu szpaki zbierają częściej i w większej ilości rano (chrabąszcz majowy), inne zaś w południe (prostoskrzydłe, błonkówki) lub po południu (pająki) (Tabela VIII). Ilość okazów pozostaje w ciągu całego dnia mniej więcej w jednakowej proporcji do ich objętości (Tabela IX, Ryc. 3).

Najwięcej okazów w jednej próbie pokarmowej stwierdzono w gniazdach z 4 pisklętami. Próby te równocześnie były najmniejsze (Tabela X). Poszczególne pary szpaków gnieżdżące się w tej samej kolonii, a więc żerujące w większości przypadków na tych samych żerowiskach, przynoszą do gniazd pokarm dość znacznie różniący się składem jakościowym i ilościowym (Tabela XI). U niektórych par nie znaleziono nawet bardzo licznie występujących w pokarmie szpaka składników pokarmu (np. ryjkowców, chruścików). Chociaż liczba okazów przynoszonych w ciągu godziny jest w poszczególnych lęgach dość silnie zróżnicowana, to jednak sumaryczna ich objętość pozostaje na mniej więcej jednakowym poziomie (Ryc. 4).

Na przykładzie chrabąszcza majowego wykazano, że w miarę rozwoju piskląt dorosłe szpaki coraz to mniej uszkadzają ciała przynoszonych do gniazd zdobyczy (Tabela XII). Do drugiego dnia życia włącznie wszystkie chrabąszcze pozbawione były pygidium, do trzeciego — nie miały skrzydeł, do czwartego — wszystkie miały poodrywane głowy i nogi i aż do 8 dnia karmienia — całkowicie pozbawione były pokryw.

Na krótkotrwały (nocny) brak pokarmu pisklęta reagują zahamowaniem przyrostu masy ciała lub nawet znacznym jej ubytkiem (Ryc. 5). Jedno pięciodniowe pisklę było całkowicie pozbawione pokarmu przez 36 godzin (dwa dni i jedna noc). Pisklę przeżyło, lecz straciło 24% masy ciała (Ryc. 6), a w stosunku do normalnie rozwijających się pozostałych piskląt w gnieździe — około 30%. Zahamowanie przyrostu szkieletu (mierzonego długością dzioba i skoku) nastąpiło dopiero po 2—3 dniach od zakończenia głodówki (Ryc. 7). W 15 dniu życia pisklę owo pod względem rozwoju fizycznego dogoniło rodzeństwo. Dowodzi to, że dla małego pisklęcia, oczywiście na krótką metę, ważniejszy jest stały dopływ odpowiedniej ilości ciepła z zewnątrz (od rodzeństwa i samicy) niż pożywienie.

Wykres na ryc. 8 ilustruje zmienność w proporcjach najliczniejszych grup zwierzęcych, stwierdzonych w pokarmie piskląt szpaków gnieżdżących się w różnych środowiskach. W badaniach nad pokarmem należy uwzględniać nie tylko liczebność poszczególnych rodzajów pokarmu, ale także jego masę, objętość, wartość kaloryczną i częstotliwość jego pobierania.

РЕЗЮМЕ

Полевые исследования связанные с изучением состава пищи птенцов скворца обыкновенного *Sturnus vulgaris*, Linnaeus, 1758, проводились в Пущикове, в Велькопольском Национальном Парке, в 1962 и 1963 гг. Объектом исследований было 16 гнёзд (в 1962 г. — 9 гнёзд, в которых находилось в сумме 42 птенца, в 1963 г. 7 гнёзд с 29 птенцами). Исследования проведено применяя метод шейного нажима. На протяжении двух лет собрано в сумме 260 одночасовых проб пищи, из которых извлечено 4142 экземпляра, главным образом, различных групп членистоногих (Таблица I).

Собранный материал определено в качественном отношении. Качественный анализ охватывал: частоту (выраженную в %) нахождения отдельных видов корма в пробах, количество экземпляров, а также их объём (в см³). Весь корм сгруппировано по следующим критериям: первая группа (для количества — доминирующий корм, для частоты — постоянный корм) охватывает те компоненты корма, которых величина процентного удела является наиболее высокой, а общая сумма этих процентов составляет около 68; вторая группа (для количества — дополнительный корм, для частоты — частый корм) охватывает составные части корма со следующими стоимостями удела, сумма которых составляет около 27%; к третьей группе (для количества — ничтожная величина корма, для частоты — спорадический корм) принадлежат остальные составные части корма. Такое разделение корма на три группы обосновано естественным разделением популяции чисел на диапазоны установленные кратными стандартного отклонения. Дальнейшая группировка составных частей корма состояла в определении их роли в диете скворца. Учитывались все три количественные аспекты (частота, количество, объём) вместе (Таблица II). Основной корм группирует те составные части, которые ни один раз не нашлись в третьей группе и хотя один раз были засчитаны к первой группе. Второстепенный корм, это те компоненты, которые нашлись во второй группе, а случайный корм образуют такие компоненты, которые не больше одного раза нашлись во второй группе. После такого деления, наиболее разнообразным, в видовом отношении, является случайный корм, но его количество (численность и объём) не превышает 5% всего корма.

Состав корма скворцов, гнездящихся в одной колонии в различные выводковые периоды, не одинаков (Таблица III). Наблюдаются иногда довольно большие разницы, как в качественном (главным образом на уровне видов), так и в количественном составе корма, приносимого птенцам. Наибольшие колебания наблюдаются среди тех компонентов корма, которые отмечаются в природе нерегулярно или в различных количествах в отдельных годах (Таблица IV). Количество экземпляров, приносимых в гнёзда было в 1962 г. на 30% больше, чем в следующем году, но объёмом он отличался лишь на 3%. Несмотря на значительную дифференцировку количества экземпляров, их общий объём в основном не изменяется.

По мере развития птенцов, также меняется количественный (Таблица V, Рис. 1) и качественный (Таблица VI) состав приносимого корма. В первых днях кормления молодые скворцы получают, главным образом, мягкий корм (различные личинки, двукрылые) и высококалорический (пауки), позже получают всё большее количество экземпляров с твёрдым покровом тела (жуки) (Рис. 2). Эти изменения являются особенно отчётливыми в случае пауков (Таблица VII). Меняется также величина экземпляров добычи приносимой в гнездо. На 1 см³ объёма корма птенцов в возрасте до 5 дней, в среднем, приходится 7,2 экземпляра, в возрасте от 6 до 9 дней — 4,6 экземпляра, а у птенцов в возрасте 10—13 дней лишь 3,4.

Разницы в составе корма, происходящие в трёх основных периодах дня, обусловлены, главным образом, различной дневной активностью потенциальной добычи скворца. Некоторые виды корма скворцы собирают чаще и в большем количестве утром (майский жук), другие же в полдень (прямокрылые, перепончатокрылые) или после обеда (науки) (Таблица VIII). Количество экземпляров на протяжении целого дня находится в более менее одинаковой пропорции к их объёму (Таблица IX, Рис. 3).

В одной кормовой пробе отмечено наибольшее количество экземпляров в гнезде с 4 птенцами. Одновременно эти пробы были наименьшими (Таблица X). Отдельные пары скворцов, гнездящиеся в одной колонии, то есть, питающиеся в большинстве случаев в одинаковых местах, приносят в гнездо корм отличающийся количественным и качественным составом (Таблица XI). У некоторых пар не найдено даже очень многочисленных в корме скворца компонентов корма (на пример долгоносиков, ручейников). Хотя количество экземпляров, приносимых в течение часа у отдельных выводков является сильно дифференцированным, то, однако, суммарный их объём остаётся на почти одинаковом уровне (Рис. 4).

На примере майского жука доказано, что по мере развития птенцов, взрослые скворцы всё менее разрушают тела приносимых в гнездо экземпляров (Таблица XII). До второго дня жизни включительно все майские жуки были лишены пигидия, до третьего — крыльев, до четвёртого — все имели оторванные головы и ноги и до 8 дня кормления — были лишены надкрылий.

На кратковременное (ночное) отсутствие корма, птенцы реагируют приостановлением прироста веса тела или даже значительным его убытком (Рис. 5). Один пятидневный птенец был полностью лишён корма в течение 36 часов (два дня и одну ночь). Птенец остался живым, но потерял 24% веса тела (Рис. 6), а в отношении к нормально развивающимся остальным птенцам в гнезде — около 30%. Заторможение прироста скелета (измеряемого длиной клюва и плюсны) произошло лишь за 2—3 дня после голодовки (Рис. 7). На 15 день жизни этот птенец физическим развитием догнал собратьев. Это доказывает, что для малого птенца, конечно, на небольшое время, более важным является постоянный приток соответствующего количества тепла снаружи (от собратьев и самки) чем пища.

График на рис. 8 иллюстрирует изменчивость в пропорциях наиболее многочисленных групп животных, отмеченных в корме птенцов скворцов, гнездящихся в различных средах. В исследованиях корма следует учитывать не только численность отдельных видов корма, но также его массу, объём, калорийность и частоту его приёма.

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