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Food composition and food consumption of the Rook *Corvus frugilegus* in agrocoenoses in Poland

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Throughout the year Rooks take vegetable and animal food in nearly equal proportions. Vegetable food consists mainly of grains, and animal food of insects. The author has used a new method for estimating weight proportions of different food items, a method which takes into consideration digestion time for different food types. A high percentage of pests have been found in the Rook's diet. One Rook takes annually about 13 kg of grain and 16 kg of animal food.

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Состав пищи и пищевые потребности грача *Corvus frugilegus* в агроценозах Польши.

На протяжении всего года грачи питаются как растительным, так и животным кормом, причем оба рода пищи потребляются в сходных количествах. Растительная пища состоит главным образом из зерен злаковых, животная – из насекомых. Автором применен новый метод оценки весовых пропорций отдельных пищевых компонентов в диете птиц, который позволяет учесть период переваривания разного рода кормов. Высокий процент в диете грача составляют вредители растений. Один грач съедает на протяжении года 13 кг зерна и 16 кг животных.

INTRODUCTION

The object of the study was to determine the composition of the food eaten by the Rooks in Poland, to estimate the percentage of different types of food in their diet, and the value of their annual food requirement.

There have been conflicting opinions concerning the economic role of the Rooks in agriculture. For this reason, Rooks are one of those animal species in which Man has been interested for a long time. As grain-eaters, the Rooks found themselves in conflict with farmers (MURTON 1971). It was only after the first analyses of the food composition had been carried out at the end of the last century (RÖRIG 1898, 1900) that a somewhat more objective consideration of the Rook was possible. This did not, however, change the generally unfriendly attitude of people towards this bird species. Some hunters hold the opinion that the Rooks reduce the population of small game (ADAMKIEWICZ 1954, PĘKAŁA 1954), but their statements are based on sporadic observations.

In European literature several dozen papers can already be found dealing, to a greater or lesser extent, with the food of the Rook. The composition of the food of these omnivorous birds depends on the agricultural structure of the given area, type of landscape and soil, climate etc. Agrocoenoses represent habitats readily penetrated by the Rooks in search of food. They find in them both vegetable and animal – mainly insect food. In the relevant literature, the fact is stressed that the Rooks eat large numbers of crop pests. In most papers the statement has been repeated that the economic role of the Rooks varies with the parts of an area occupied by them. For this reason it seems aimless to carry out detailed studies of the food composition for the whole area where the species occurs, and it is impossible to draw unequivocal conclusions from the comparison of the benefits and the damages done by these birds. The role of birds, beneficial or harmful, must be assessed for each landscape and zone separately, because the living conditions vary (GOLOVANOVA 1972). Rooks are generally considered to be beneficial birds. Such opinions prevail in both the Soviet literature relating to regions with the highest density of these birds and at the same time a high production of grain and maize (RAŠKEVIČ, DOBROVOLSKIJ 1953, BUDIČENKO 1957, EJGELIS 1961), and the literature concerning western Europe (FEIJEN 1976).

Distinct as against the rich European literature dealing with the food of the Rook is a complete lack of studies from Poland. Only in RÖRIG's (1898, 1900) papers some data can be found on the food composition of the Rooks in areas now constituting part of Poland (Mazury, Pomorze Zachodnie). Polish views on the food composition are based on data from foreign literature (PINOWSKI 1956).

Although many opinions considering the Rook as harmful are based on inaccurate data, these birds have been persecuted by Man over a large part of the area of their occurrence. In Poland, the Rook is one of the four bird species the shooting of which is allowed throughout the year. For the last twenty years the Rooks have been rapidly reduced in number, and their reduction continues throughout Europe (MALMBERG 1973, FEIJEN 1976, JABŁOŃSKI 1977). In connection with this, the conservation of this species has become an urgent problem.

MATERIAL AND METHODS

The present paper is based on an analysis of the contents of 1651 gizzards of adult Rooks shot down in two lowland areas in Poland — in Wielkopolska (the Plateau of Kościan) and in Mazowsze between June 1972 and December 1974. The birds were shot outside dwelling areas, mainly in the vicinity of cropfields.

The Kościan Plateau region represents a typically agricultural area with a high standard of agriculture. Most of the area is occupied by state-owned large-acreage grain- and root-crop fields. The remainder of the arable land there consists of private, peasants' holdings, where there is a great diversity of crops. A certain proportion of the area is occupied by meadows stretching mainly along the river Obra and its tributaries. Small woods are found there, as well as mid-field wooded areas typical of this region.

In Mazowsze, the material was collected from a much larger, and thereby a more varied area. The western part of this region is characteristic for the numerous medium-size cropfields and orchards, and a small area of meadows and compact timber. The eastern part of Mazowsze is characterized by a considerable patchiness of cropfields, a considerable diversity of soil richness, and by a large number of meadows in river valleys. There are no larger forest complexes.

The gizzards, removed from the birds immediately after their killing, were injected with 90 % alcohol, to stop the processes of digestion which may continue in the gizzard for several dozen minutes following the bird's death (Koersveld 1950). After a detailed labelling, the gizzards were placed in jars, filled with 70 % alcohol, where they remained until the time of the detailed analysis of their contents. During the storage period, the alcohol in the jars was changed several times.

After being removed from the gizzards the contents were at first grossly divided into animal and plant remains and then, using a dissecting microscope, the taxonomic identity of the isolated pieces was determined. Where this was possible, the number was recorded of the specimens representing the taxonomic units identified, and the degree of their crushing and digestion.

In any analysis of the gizzard contents it is difficult to establish the taxonomic identity of all the organic particles isolated. The cause of the difficulty lies primarily in the fact that food pieces are crushed in the gizzard, and in the case of the Rook the vegetable food is mixed with animal food. If cereal grains, more or less crushed, were present in the gizzards, it was usually easy to identify the species of the cereal, but in a number of gizzards only small grain hulls were found which were not further analysed, because of technical difficulties. The same situation arose in the case of very small casing particles and small plant parts. The contents of a small number of gizzards represented a ground substance and it was even impossible to establish the animal and vegetable proportions in it.

The proportions of the different food items in the diet of the Rooks were determined by using two indices: 1. the frequency index expressed as a per cent ratio of the gizzards in which the given item was found to the total number of gizzards gathered, 2. the weight rations between the individual components; the latter method is described on pages 11-12.

Table 1. Number of Rook gizzards analysed; *a* – number of gizzards taken for frequency analysis, *b* – number of gizzards taken for weight analysis.

Region of the country		Months												Total
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Wielko-	*a*	47	50	50	47	218	75	8	13	8	8	61	31	616
polska	*b*	32	32	33	37	112	47	7	11	5	6	41	26	389
Mazowsze	*a*	39	13	32	112	481	219	22	9	12	12	51	33	1035
	b	18	8	17	29	202	114	8	6	9	6	24	21	462
Total	*a*	86	63	82	159	699	294	30	22	20	20	112	64	1651
	b	50	40	50	66	314	161	15	17	14	12	65	47	851

The analysis of the material was made by the month, separately for Wielkopolska and Mazowsze, but without breaking down by the year, because the numbers of gizzards collected in the particular months in each of the three study years were very different. Table 1 presents, arranged by the month and separately for each of the study regions, the numbers of gizzards that have been analysed.

The method of calculating the food consumption of the Rooks has been described on pages 15-18.

At this point I wish to express my cordial thanks to all those who have participated in the collecting and elaboration of the material. Thanks are due in particular to Dr. B. Jabłoński, who organised the collecting of gizzards by hunters and has imparted to me some of the observations gathered during his long-term studies on the Rooks. I wish to extend my thanks to Mrs. K. Zawalska and Mrs. E. Jankowiak, and to Mr. B. Galer for the tedious work with the gross sorting of the gizzard contents. My thanks are further extended to Dr. Z. Wójcik for the identification of most of the weed seeds and of other plant remnants, to Dr. A. Ruprecht for the identification of the remains of vertebrates, and to R. Hołyński, M. Sc., for the indentification of some of the beetles. I wish to express my thanks also to all my colleagues for the valuable comments which they have made after reading the typescript, and particularly to Dr. M. Gromadzki and Dr. J. Weiner.

FOOD COMPOSITION

Throughout the year the diet of the Rook contains vegetable and animal items, the frequency of the vegetable items being on the average higher than

that of animal items (Fig. 1). Only in the months from April to July does the frequency of animals reach the level of plants (above 80 %) or is even higher. For Wielkopolska and Mazowsze similar pictures of this were obtained. However, it must be noted that among the percentages presented in the figure the values for some months (July to October) are based on a small number of gizzards (Table 1).

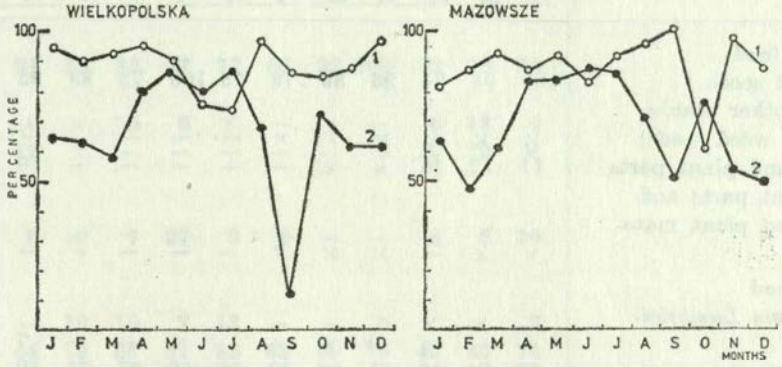

Fig. 1. Seasonal variations in the frequency of vegetable (1) and animal (2) food in the diet of Rooks in two areas during the year.

A detailed list of the plant and animal species found in the gizzards analysed, including also the value of frequency, has been appended separately (Appendices 1 and 2).

Vegetable food. About 90 % of the gizzards analysed contained the seeds of crop plants, mainly the grain of the cereals: wheat, barley, oats, rye and maize (Appendix 1, Table 2). The seeds of other plants (sunflower, cucumber, weeds) and other plant remains were found in much smaller amounts. In the gizzards of the Rooks shot down in freshly ploughed fields, or fields being ploughed, horse-tail *Equisetum arvense* rhizomes were often found, the frequency of which attained in some periods a level of over 30 %.

The gizzard contents sometimes contained also pieces of fruits and fruit pips and stones (apple, cherry), pieces of potatoes, beets, as well as small amounts of human food of vegetable origin (bread, noodles), and plant remains the type of which could not be determined.

Animal food. The animal food of the Rook is characterized by a much greater species diversity relative to the vegetable food. About 100 animal genera and species have been found represented in the contents of the gizzards examined. Most frequently found were insects (Appendix 2, Table 2). Their frequency in the total material was above 70 %. In about 50 % of the gizzards beetles (*Coleoptera*), much less often muscoid flies (*Diptera*) and butterflies (*Lepidoptera* — mainly their larvae), and representatives of other orders were found. The most frequently encountered beetles included the Colorado Beetle *Lep-*

Table 2. Seasonal variations in the frequency of occurrence of different food items

Type of food	Wielkopolska												
	Months												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	$\bar{x}$
Vegetable food													
Crop-plant seeds	100	98	94	96	89	79	75	100	75	88	92	94	91
Seeds of other plants (including weed seeds)	×	×	×	×	×	×	—	—	—	—	—	10	×
Underground plant parts	11	12	36	×	×	—	—	—	—	—	10	16	7
Other plant parts and unidentified plant material	×	×	—	×	×	×	—	—	—	—	—	—	×
Animal food													
Earthworms *Lumbricidae*	—	—	×	9	×	×	—	8	—	—	7	—	3
Insects *Insecta*	40	54	46	81	88	80	88	69	25	75	52	48	70
Muscoid flies *Diptera*	19	20	8	9	11	16	38	31	25	13	18	23	15
Butterflies *Lepidoptera*	×	12	10	26	12	7	—	8	—	38	11	10	11
Beetles *Coleoptera*	21	28	42	81	75	75	33	23	13	63	38	32	56
Other insects	×	—	×	×	6	×	13	—	13	—	5	×	×
Unidentified insects and chitinous material	11	18	18	26	42	45	38	31	—	25	23	19	31
Other invertebrates (*Gastropoda, Diplopoda*)	—	—	×	×	×	×	—	—	—	—	5	—	×
Vertebrates *Vertebrata*	—	×	—	9	6	13	13	—	—	—	×	6	5
Amphibians *Amphibia*	—	—	—	—	×	—	—	—	—	—	—	—	×
Birds *Aves*	—	—	—	—	—	—	×	—	—	—	—	—	×
Mammals *Mammalia* (Rodents *Rodentia*)	—	×	—	×	1	12	13	—	—	—	×	6	4
Organic unidentified matter and dump garbage	×	14	26	×	7	×	—	—	—	13	20	26	8
Inorganic remains	×	—	—	—	—	—	—	—	—	—	—	6	×

tinotarsa decemlineata, the weevils *Curculionidae* (with *Otiorrhynchus* spp. dominating), species of the family *Scarabaeidae* (the Cockchafer *Melolontha melolontha*, coprophagous species), and the click beetles *Elateridae* (mainly those of the genus *Agriotes* and *Selatosomus*).

Other invertebrates, except the earthworms (*Lumbricidae*), were only sporadically represented in the food. The earthworms deserve special attention. On the whole, they were not frequently found in the gizzards (most often in Mazowsze, up to 13 % in July). Their body is digested very quickly (see page 11), and only the chaetae remain in the gizzard for a longer time, being detectable only under the microscope.

in the diet of the Rook, × – frequency below 5%.

Mazowsze												
Months												
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Okt.	Nov.	Dec.	$\bar{x}$
87	85	91	83	89	77	77	68	92	100	92	76	**86**
18	23	6	×	5	6	×	–	–	–	8	13	**6**
23	23	16	×	–	–	–	–	–	8	12	19	**×**
5	8	6	10	7	27	9	5	–	–	6	8	**10**
–	8	–	10	10	7	13	–	–	8	×	×	**8**
51	46	44	79	81	81	82	63	50	75	43	43	**76**
15	15	9	12	16	7	23	15	8	8	2	24	**13**
8	–	6	9	10	7	14	10	25	8	6	8	**9**
28	38	25	71	70	79	59	37	58	58	20	22	**64**
×	–	–	×	6	12	32	15	8	8	8	×	**7**
23	8	–	22	33	28	36	42	25	25	17	19	**28**
–	–	–	×	×	×	×	10	–	8	–	×	**×**
–	–	6	×	5	×	×	–	8	–	×	–	**4**
–	–	–	–	×	–	–	–	–	–	–	–	**×**
–	–	–	×	×	–	–	–	–	–	–	–	**×**
–	–	6	×	5	×	×	–	8	–	4	–	**4**
36	23	13	×	×	×	–	5	–	–	16	11	**5**
–	–	–	–	–	–	–	–	–	–	×	–	**×**

In his material, Fog (1963) found earthworm chaetae in 50% of gizzards, while grossly visible remnants occurred in only 10% of gizzards. The investigations here presented did not include a detailed microscopic analysis making it possible to detect the above-mentioned fragments, so it may be presumed that the actual proportion of earthworms in the diet of the Rooks in Poland is much greater than has been found.

Two gizzards were found to contain fragments of amphibians, 3 contained remnants of birds (in one case the piece found represented the partridge), 1 contained fragments probably belonging to the family *Leporidae*, whereas in 59 gizzards rodent fragments were found, with the Field Vole *Microtus arvalis*

clearly dominating. Although the frequency of this species was not high (on the average about 4%), the weight proportion, as will be described further in the paper, especially in some months, was fairly large.

Apart from this, in the gizzards various types of food of animal origin were found, most probably gathered from rubbish heaps and from the direct vicinity of human dwellings. They included pieces of bones of large animals, pieces of boiled meat, sausage remnants. In gizzards from Wielkopolska fairly specific animal remnants were found which it was impossible to identify. They were of a fibrous form, and often resembled torn entrails of small animals, with no traces of bones, feathers or hair.

In about 100 gizzards pieces of birds' egg shells were found. They were exclusively poultry egg shells, mostly chicken egg shells, and in several gizzards from Mazowsze — duck eggs. On the basis of the presence of egg shells in the gizzards, some authors suggest that the Rooks destroy birds' eggs (RÖRIG 1900, VERTSE 1943), but these suggestions are not convincing. In the gizzards from Wielkopolska and Mazowsze egg shells were found throughout the year, being much frequent in the autumn-winter months. They were, therefore, collected primarily from the rubbish heaps, mainly to supplement calcium supplies in

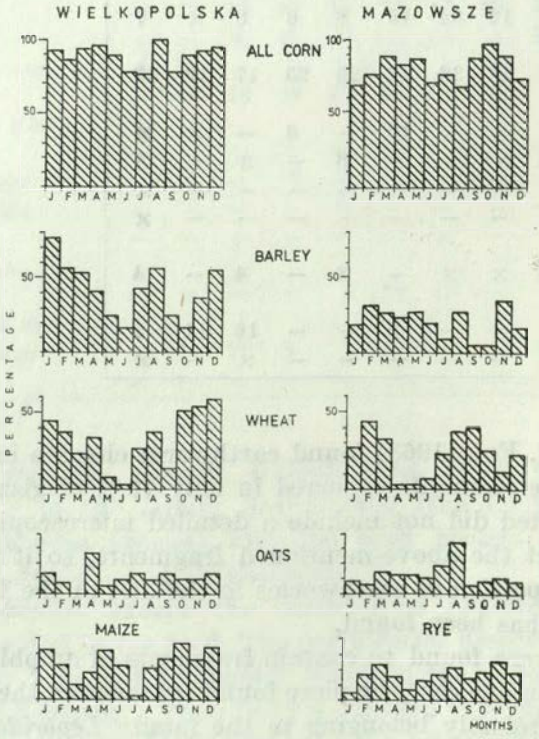

Fig. 2. Seasonal variations in the frequency of different crops.

the Rook's body. For this reason eggs have not been considered to be a food item.

Almost all gizzards contained smaller or larger numbers of gastrolites, which have not been included in the food item summaries in the tables. Nor have the inorganic remnants such as pieces of rubber, string, aluminium or plastic foil. They were found sporadically, and probably got to the gizzards by accident.

Local and seasonal changes in food composition. Seasonal variations in the frequency of occurrence of the various types of vegetable and animal food in the Rooks' diet in the two study regions can be followed in Table 2. During the year, the frequency of grain varied between 75 % and 100 %. Barley and wheat were most often found, throughout the year, in the food of Rooks from Wielkopolska (Fig. 2). Maize and oats were found more rarely, rye hardly ever occurred. In Mazowsze no clear preference for one cereal species was seen. In Mazowsze barley was most often encountered (Appendix 1), but this has been determined by the data for one month — May (almost 50 % of the gizzards were collected in that month — Table 1) when barley was the dominant grain in the food (Fig. 2). In the food from this region, maize was hardly ever found, while rye was rather frequent. In Mazowsze, the Rooks seasonally fed on buckwheat grain while the Rooks in Wielkopolska did not gather this cereal.

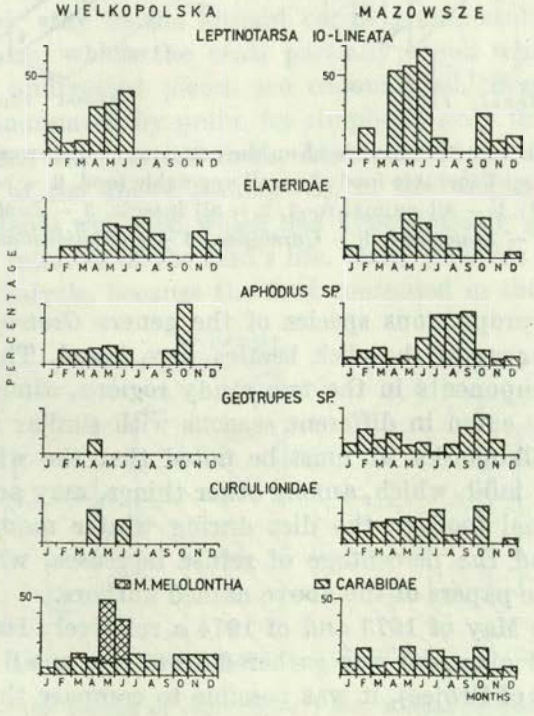

Fig. 3. Seasonal variations in the frequency of different species and groups of insects.

The diets of the Rooks in Wielkopolska and in Mazowsze differ also in respect of the animal food (Fig. 3). In Wielkopolska cockchafers, and especially their larvae, were eaten in large numbers; in May, their frequency was 40%. In Mazowsze Cockchafers were gathered sporadically (Appendix 2), while Colorado Beetles were often present. This species (only adult insects were found) was found in the food of the Rooks mainly in the spring-summer period, but it also occurred in the food in winter, especially when the birds were feeding in freshly ploughed fields. In Mazowsze the Rooks also more often caught

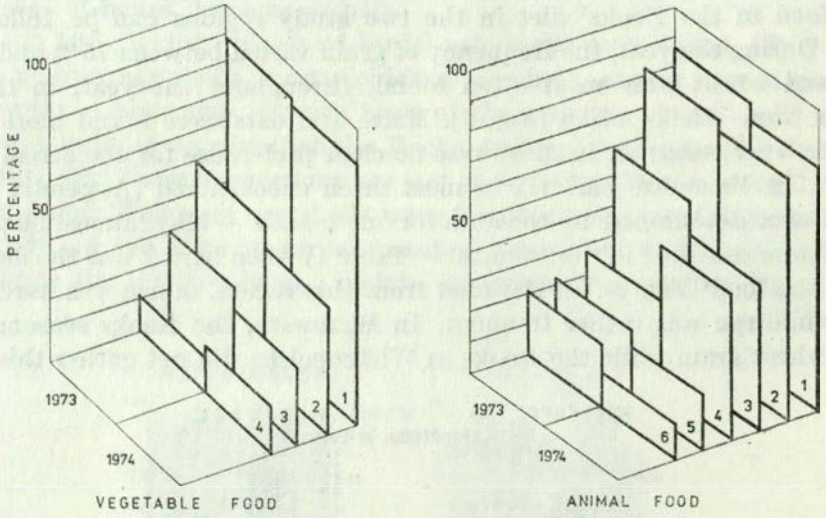

Fig. 4. Frequency of different kinds of food on the same area (Mazowsze near Grójec) in May in two consecutive years. Vegetable food: 1 — all vegetable food, 2 — crop seeds, 3 — barley, 4 — oats. Animal food: 1 — all animal food, 2 — all insects, 3 — *Leptinotarsa decemlineata*, 4 — *Elateridae*, 5 — *Carabidae*, 6 — *Curculionidae*.

weevils and the coprophagous species of the genera *Geotrupes* and *Aphodius*. Both adults and larvae of the click beetles were found. They appeared to be permanent diet components in the two study regions, almost throughout the year. Rodents were eaten in different seasons with similar frequencies in Mazowsze and in Wielkopolska. It must be noted that the winters 1972/73 and 1973/74 were fairly mild, which, among other things, may account for the high percentage of animal food in the diet during winter months. On the other hand, in this period the percentage of refuse increases, which fact has been reported also by the papers of the above named authors.

Because in the May of 1973 and of 1974 a relatively large amount of material (195 and 184 gizzards) was gathered from one small area in Mazowsze (the former district of Grójec), it was possible to compare the frequency of the main food items in the food in the two years (Fig. 4).

WEIGHT RATIOS OF VEGETABLE TO ANIMAL ITEMS IN THE DIET

The assessment of the weight ratios between the individual components of the Rooks' food has been made on the basis of the known rate of digesting different food types by these birds.

The data reported by RÖRIG (1903) indicate that earthworms become digested by the Rooks within 15 minutes, beetle larvae can be recognized in the gizzards for about 1 hour, and adult beetles for 4.5 hours from the time they find themselves in the gizzard; hard chitinous elements remain in the gizzard for up to 6 hours. Plant seeds, including cereal grain, are digested at a much slower rate and they may persist in the gizzard even for up to 15 hours. Similar digestion rates have been reported by KOERSVELD (1950), CUSTER and PITELKA (1975), and LUNIAK (1977). The estimation, presented below, of the weight ratios has been made on the basis of the data on the digestion rate in the Rooks, taken mainly from the last-named publication.

It has been assumed that for 30 minutes following their getting into the gizzard, animals, chiefly invertebrates, remain in the form of complete, or slightly crushed specimens, with no traces of an intensive digestion. With this assumption it must be expected that some very delicate animals (e.g. earthworms, some muscoid flies etc.) will not be detected, because they will have been digested by that time. It has further been assumed that for the first 30 minutes of their stay in the gizzard cereal grains remain uncrushed, and in the case of maize, which the birds partially break with their bills before swallowing, large undigested pieces are encountered. Because the vegetable food was clearly dominated by grain, for simplicity only this part of the vegetable food was taken into account in the discussion of the weight ratios.

On the basis of the above assumption, in the weight analysis that part of the gizzard contents was used which had hypothetically got into the gizzards during the last 30 minutes of the bird's life. Many gizzards have been excluded from the weight analysis, because the food contained in them was found to be

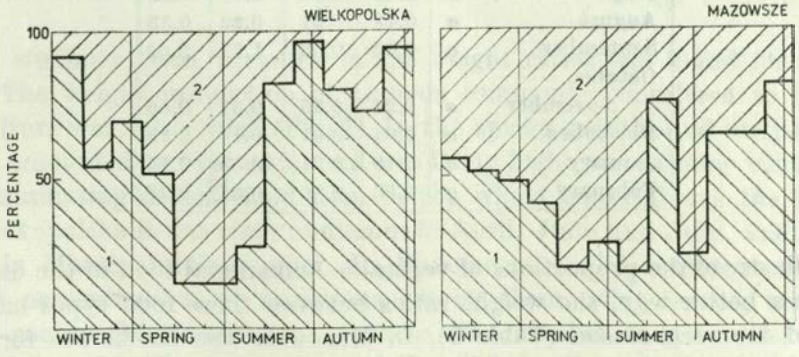

Fig. 5. Comparison of the weight of vegetable (1) and animal (2) food in the diet of Rooks in two areas during the year.

crushed considerably, even if it could be precisely identified. In the analysis the contents of a total of 852 gizzards were used (Table 1).

At the time of determining the gizzard contents the cereal grains and animals contained in each gizzard were counted, and the number of grains and of animal specimens was multiplied by the mean dry weight of an individual of each of the animal species and of grain (the author's own data, unpublished). As a result, the dry weight was obtained of the grain and animals found in a food portion eaten by the individual birds during 30 minutes. It was assumed that fresh grain contains 40 % of water, and the animal body – 60 % (the author's own data, unpublished). On the basis of this assumption the dry weight was converted to wet weight. Using the above procedure, the weight proportions were computed of the different types of food in the Rook's diet throughout the year. The results of the calculations have been presented in Figure 5. Rooks eat on the average almost as much vegetable food as animal food; in Wielkopolska the amount of fresh vegetable food slightly exceeds 50 %, whereas for Mazowsze a slight predominance of animal food was found.

Table 3. Seasonal weight ratio of animal food to vegetable food; *a* – adults, *b* – nestlings, *k* – ratio of dry weight of animal food to vegetable food, k_1 – ratio of wet weight of animal food to vegetable food.

Months		Wielkopolska		Mazowsze	
		k	k_1	k	k_1
March	*a*	0.35	0.42	0.69	1.03
April	*a*	0.61	0.92	0.96	1.44
May	*a*	3.32	5.00	2.33	3.49
	b	–	–	21.85	67.25
June	*a*	3.35	5.00	1.63	2.50
July	*a*	2.41	2.56	2.77	4.15
August	*a*	0.13	0.21	0.22	0.33
September	*a*	0.02	0.06	1.73	2.62
October – November	*a*	0.24	0.35	0.37	0.56
December	*a*	0.04	0.07	0.14	0.22
January	*a*	0.16	0.21	0.55	0.82
February	*a*	0.59	0.89	0.63	0.98

To illustrate the proportions of vegetable and animal food in the diet of the Rooks in a better way, the weight ratios between these food types have been calculated for each season (Table 3). In Mazowsze the Rooks ate for several months more animal than vegetable food, while in Wielkopolska animal food clearly predominated only from May to July.

The weight ratios between cereal species found for Wielkopolska were quite different from those calculated for Mazowsze (Fig. 6), the changes in the weight proportions showing tendencies somewhat similar to those of the changes in frequency. In Wielkopolska, in May, the Rooks ate the largest amounts of maize, in July — barley, and in autumn and winter — wheat. In Mazowsze in late autumn rye predominated by weight in the food, in August and September — wheat, in July — oats, and in winter and spring — wheat and barley.

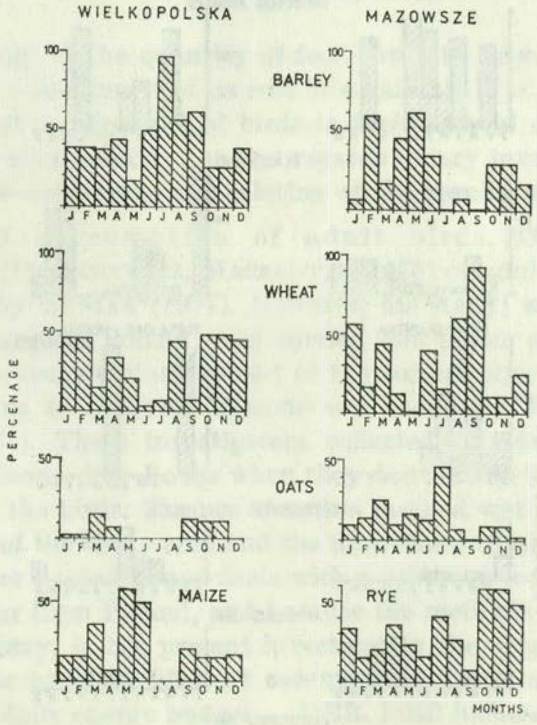

Fig. 6. Seasonal variations in the weight ratios of different crop (all crop — 100%).

A similarly great variation in the weight ratios was found for the animal food. The weight proportion of animals commonly considered to be pests in agriculture was fairly high (Fig. 7). In the spring months and early in the summer it amounted to over 80 %, and was fairly high even in some winter months. The dominating animal food item in the whole material was the Field Vole. In Wielkopolska it was most numerous in April, June and July, and in Mazowsze — in March and September. In Mazowsze the click beetles represented the largest percentage, most numerous among them being larvae, mainly those of the genera *Selatosomus* and *Agriotes*. The number of larvae in one gizzard added up to 95. The percentage of the click beetles was particularly high in the autumn-winter months when numerous Rooks fed in fields that were being

ploughed or in freshly ploughed fields. In Wielkopolska, from January to June the Rooks collected large numbers of cockchafers, and especially their larvae. In May, that is, during the feeding of nestlings, the weight proportion of cockchafer grubs amounted to 50 % of all the animal food (up to 20 grubs were found in one gizzard). Of other insects, there occurred seasonally larger numbers of *Tipulidae* larvae, and regularly, though in very small numbers — larvae of *Lepidoptera*.

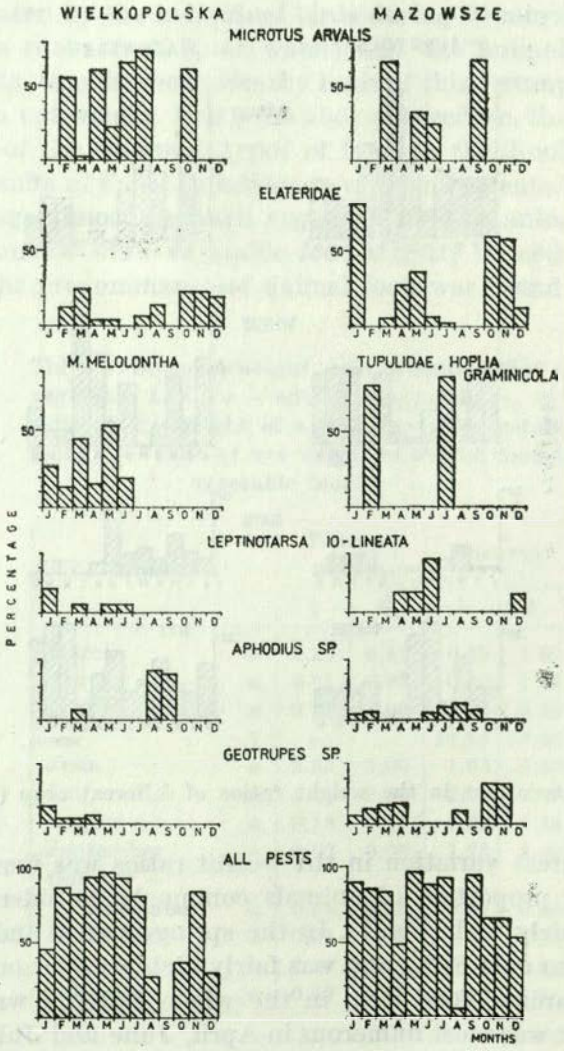

Fig. 7. Seasonal variations in the weight ratios of different animals (all animal food — 100%).

As has been mentioned earlier on, in the food of the Rooks coprophagous species of the genus *Aphodius* and *Geotrupes* were fairly often found. In Wielkopolska the Rooks ate more beetles *Aphodius* spp., and in Mazowsze more

Geotrupes spp. Of the *Carabidae*, whose proportion in some months came up to 13% (May in Mazowsze), the largest numbers were eaten of beetles of the genus *Ophonus*. Other insect species and groups and the invertebrates representing the remainder of the food were found in small numbers. No weight analysis was made of the part of food gathered from rubbish heaps, nor of the earthworms – because of the methodical difficulties discussed earlier on.

FOOD CONSUMPTION

The knowledge of the quantity of food eaten by an animal species is very important for the assessment of its role in a habitat. It is usually very difficult to study the food requirement of birds in their natural conditions first of all because of their high mobility, and as regards aviary investigations, there will always be doubts concerning the relating of the results to natural conditions.

Individual consumption of adult birds. The food requirement or consumption (PETRUSEWICZ, MACFADYEN 1970) of adult Rooks has recently been estimated by LUNIAK (1977). However, his study, which deals only with the birds wintering in Poland, was carried out under aviary conditions. In Scotland, a more complete assessment of the consumption of the Rooks under natural conditions in different seasons was made by FEARE, DUNNET and PATTERSON (1974). These investigators collected the data during binocular observations of the feeding Rooks when they determined the quantity and type of food eaten by the birds. The use of such a method was possible owing to the specific features of the study area and the unwariness of the birds feeding there. Because the paper quoted above deals with a different rook population (BUSSE 1969), in areas far from Poland, and because the methods applied could not be used in this country, in the present investigation the requirement of food was calculated on the basis of different assumptions. Consumption was estimated from the known daily energy budget – DEB. DEB includes all energy expenditure of a bird living at large except the cost of migration. Its value for *Passeriformes* is determined by means of the following formulae suggested by KENDEIGH et al. (1977), separately for the breeding and moulting periods and for the remainder of the year:

1. for the breading and moulting periods:
   at extern. temp. 30°C; DEB $= 0.2168\ W^{0.621}$,
   at extern. temp. 0°C; DEB $= 0.7601\ W^{0.530}$;
2. for the remainder of the year:
   at extern. temp. 30°C; DEB $= 0.2259\ W^{0.621}$,
   at extern. temp. 0°C; DEB $= 0.6669\ W^{0.530}$.

The daily energy requirement of Rooks of the given body weight "W" at a given external temperature was calculated on the basis of a rectilinear relationship between DEB and temperature (KENDEIGH 1969). In the calcu-

lations average body weights of the Rooks in the individual months were used (JABŁOŃSKI mat. unpubl.) and average monthly temperatures in Wielkopolska and Mazowsze (KWIECIEŃ, TARANOWSKA 1974) (Table 4).

Table 4. Seasonal variations in daily energy requirement (DEB); *a* – spring migrants, *b* – breeding birds, *c* – autumn migrants, *d* – wintering birds, *A* – adults, *Y* – young.

Months	Kind of birds	Average body weight (g)		Average air temperature (°C)		DEB (kcal/bird × day)			
						Wielkopolska		Mazowsze	
		A	*Y*	Wielkopolska	Mazowsze	*A*	*Y*	*A*	*Y*
March	*a*	502	–	2.5	1.0	121.6	–	123.5	–
	b	440	–	2.5	1.0	138.9	–	142.6	–
April	*b*	470	–	8.0	7.0	130.1	–	132.6	–
May	*b*	452	–	13.0	13.0	115.1	–	115.1	–
June	*b*	439	392	16.5	16.0	104.9	98.1	106.1	99.3
July	*b*	460	420	18.5	18.0	102.5	97.3	103.7	98.5
August	*b*	480	444	17.0	17.0	109.0	104.4	109.0	104.4
September	*b*	459	418	13.5	13.0	100.1	94.8	100.8	95.5
October – November	*c*	511	–	5.0	5.0	119.3	–	119.3	–
December – February	*d*	519	–	−1.5	−2.5	130.3	–	131.9	–

As the DEB does not take into account the cost of migration, the presumed energetic cost of migration of Rooks of a known body weight at a specified distance was calculated by using the equation suggested by TUCKER (1971, quot. KENDEIGH et al. 1977) and making the assumptions, discussed below, concerning the flight rate (Table 5).

Table 5. Energy requirements in preparation for migration.

Average body weight (g) – W		500
kcal/g/km*		0.00146
Assumed length of daily migration (km)		60
Total energy expenditure of daily migration	kcal	44
	fat**(g)	11
Energy expenditure in building up fat reserves (kcal)***		66
Food requirement connected with the building up of fat reserves necessary for covering daily migration (kcal)****		88

* Calculated on the basis of the equation: log kcal/g/km = −2.2221 − 0.227 log W.
** With the assumption that the catabolism of 1 g of fat provides 4.0 kcal.
*** The anabolism of 1 g of fat requires 6 kcal
**** The coefficient of food assimilation equals 0.75.

Rooks flying from their breeding areas in Poland to their winter quarters in autumn, and returning from them in spring cover a distance of about 1250 km (BUSSE 1969). They fly over that distance in stages. On the basis of the study carried out by WIELOCH (mat. unpubl.) it has been assumed that the Rooks cover each day a distance of 60 km, from which it follows that to fly over the distance of their migration they would need 21 days. The accuracy of this assumption has been confirmed by the recoveries reaching the Gdańsk Ornithological Station, which indicate that the autumn migration to the winter quarters lasts 3–4 weeks. It is a known fact that the spring migration of birds lasts a shorter time than the autumn migration, that is to say, they must cover longer distances at each of the migration stages and each day, than in the autumn. However, because of the lack of information on the spring migration of the Rooks, it has been assumed that they cover the same distance a day in spring as in autumn. To simplify the calculations, it has also been assumed that the average body weight of a migrant bird is 500 g, although according to the data obtained by JABŁOŃSKI (mat. unpubl.) the body weight of migrant Rooks, in both the spring and autumn, is somewhat greater than that. In making the above assumption the fact was taken into account that among the migrating birds there are also young birds which are lighter than the old ones (weighing on the average 450 g) and that this difference in weight persists throughout the migration.

It has been estimated that during their migration the Rooks must accumulate daily 11 g of fat each, that is, they must eat additionally, relative to the period prior to the migration, an amount of food equivalent to 88 kcal (Table 5).

From the daily energy budget, using a food assimilation factor of 0.75 (TOMEK 1976, KENDEIGH et al. 1977), and adding to the DEB during migrations

Table 6. Seasonal variations in food requirement (kcal/bird × day). For letter symbols – see Table 4.

Months		Food requirement			
		Wielkopolska		Mazowsze	
		A	*Y*	*A*	*Y*
March	*a*	279.4	–	281.9	–
	b	184.7	–	189.7	–
April	*b*	173.0	–	176.4	–
May	*b*	153.1	–	153.1	–
June	*b*	139.5	130.5	141.1	132.1
July	*b*	136.3	129.4	137.9	131.0
August	*b*	145.0	138.8	145.0	138.8
September	*b*	133.1	126.1	134.1	127.0
October – November	*c*	276.3	–	276.3	–
December – February	*d*	173.3	–	175.4	–

the additional cost, the daily food consumption of the Rooks was determined for the whole year (Table 6). Subsequently a calculation was made to find out how much of the energy ingested with food during a day was of vegetable origin and how much of animal origin [1], and then the daily quantities of fresh vegetable and animal food eaten were calculated (Table 7). Depending on the season, a Rook eats from 10 to 70 g of grain, and from 15 to 70 g of animals a day. The values calculated for Wielkopolska differ slightly from those for Mazowsze.

Table 7. Seasonal variations in vegetable (*VF*) and animal (*AF*) food intake (g of wet food/bird × day). For letter symbols – see Table 4.

Months	Kind of birds		Fresh food intake					
			Wielkopolska		Mazowsze		Average	
			VF	*AF*	*VF*	*AF*	*VF*	*AF*
March	*A*	*a*	64.2	54.4	49.8	80.1	57.0	67.2
		b	42.4	34.6	33.4	54.1	37.9	44.4
April	*A*	*b*	32.3	46.0	26.3	58.9	29.3	52.4
May	*A*	*b*	6.7	75.1	12.6	66.9	9.6	71.0
June	*A*	*b*	8.8	68.6	15.2	57.8	12.0	63.2
	Y		8.2	64.1	14.2	54.1	11.2	59.1
July	*A*	*b*	10.9	62.8	10.1	65.2	10.5	64.0
	Y		10.3	59.6	9.5	61.5	9.9	60.5
August	*A*	*b*	41.3	12.5	37.6	19.3	39.4	15.9
	Y		39.5	12.0	36.0	18.5	37.8	15.2
September	*A*	*b*	43.1	2.0	13.9	55.9	28.5	29.0
	Y		40.8	1.9	13.1	53.0	27.0	27.5
October – November	*A* + *Y*	*c*	70.2	39.3	62.4	53.8	66.3	46.5
December – February	*A* + *Y*	*d*	44.5	23.9	40.3	32.9	42.4	28.4

Individual consumption of nestlings. On the basis of the relevant data obtained by TOMEK (1976) the consumption of nestlings was calculated for five-day periods of their stay in the nest. The values thus obtained were then adjusted to weight units by the method described for adult birds (Table 8). TOMEK's study indicates that the species composition of the food of nestlings is similar to that of adult birds, but the weight proportion of grain in the nest-

[1] The following equations were used in the calculations:

$$ZP = xa + xb, \quad x/y = k,$$

where ZP – food requirement in calories, a – calorific value of 1 g of dry animal food = 5.5 kcal/g, the same quantity for grain = 4.3 kcal/g (calorific data taken from the Laboratory of Bioenergetic of the Institute of Ecology PAS and Department of Agroecology PAS), x – vegetable food eaten, in g dry weight, k – dry weight ratio of animal food to vegetable food (Table 3).

lings' diet is much smaller (Table 3). During its stay in the nest, a nestling receives about 35 g of vegetable food (grain) and about 1750 g of animal food (mainly insects).

Table 8. Food requirement of Rook nestlings in consecutive five-day periods of the growing season

Five-day periods	Food requirement		
	kcal/nestling × period (according to TOMEK 1976)	g of wet food/nestling × period	
		Vegetable food	Animal food
1–5	270	3.1	158.0
6–10	450	5.2	263.3
11–15	540	6.2	315.9
16–20	540	6.2	315.9
21–25	600	6.9	351.1
26–30	600	6.9	351.1
Total	3000	34.5	1755.3

DISCUSSION OF RESULTS

In respect of its specific composition, the food eaten by the Rooks in Poland is similar to that eaten by these birds in other countries. The amounts of the individual cereal species in the Rooks' diet vary from area to area depending on the types of crop prevailing in the given area. In countries where maize is grown on a large scale it is often a very frequent or even the dominant item in the vegetable food (VERTSE 1943, PIVAR 1964, RJABOV 1970, FOLK, BEKLOVA 1971).

In most European countries the Rooks most often eat various insects, and especially beetles (RÖRIG 1900, 1903, VERTSE 1943, RAŠKEVIČ, DOBROVOLSKIJ 1953, EJGELIS 1961, ROOSIMAA 1961, PIVAR 1965, FOG 1963, FOLK, TOUŠKOVA 1964, OSMOLOVSKAJA 1967, FEIJEN 1976). In Great Britain the Rooks catch large numbers of earthworms, *Tipulidae* larvae and caterpillars (COLLINGE 1924, LOCKIE 1959, HOLYOAK 1972, FEARE, DUNNET, PATTERSON 1974). The latter two insect groups are also numerous in the food eaten by the Rooks in Holland (FEIJEN 1976). In south-eastern Europe the Rooks eat large numbers of *Orthoptera* (VERTSE 1943, RAŠKEVIČ, DOBROVOLSKIJ 1953, RJABOV 1970). Some investigators regularly encountered rodents in the food (RÖRIG 1900, VERTSE 1943, GAGARINA 1958, HERRLINGER 1966, FOLK, TOUŠKOVA 1964).

When feeding in cropfields and in grassland habitats, the Rooks eat large numbers of animals which are, from the point of view of agriculture, considered to be pests (click beetles, Colorado Beetle, Cockchafer, Field Vole). Ac-

cording to EJGELIS (1961), they clearly respond to variations in numbers of the soil insects, and they feed gregariously at the sites of their focal occurrence. During the outbreak of the Field Vole in Wielkopolska in 1966, Rook flocks were often seen catching these rodents in places of their occurrence (GROMADZKI, personal communication). The numbers reducing effect of the Rooks on the Field Voles, especially in periods of their outbreaks, has also been pointed by GOSZCZYŃSKI (1976).

Interesting information on the preference shown by the Rooks in relation to various vertebrate species as food can be found in the paper by LUNIAK (1977). In his aviary experiments the Rooks very readily ate small rodents of the body-size of the mouse but they did not catch animals of the size of a small hare (Syrian Hamster *Mesocricetus auratus*). In the material examined during the present investigation no fragments of game were found. The above-presented data contradict the opinion that the Rooks are a menace to the stock of game.

The differences in food composition found between the Rooks from Mazowsze and those from Wielkopolska seem obvious when the differences in crop structure between these two regions are taken into account. Because in Mazowsze, light soils are found over a larger surface area than in Wielkopolska, more rye is grown there, whereas in Wielkopolska more wheat and maize is grown. This situation is reflected in the percentage of these cereals in the Rook's diet (Table 2, Fig. 2). Because click beetles of the genus *Agriotes* and *Selatosomus* occur primarily in regions where large areas are covered by light soils (GILJAROV 1964, DOLIN 1965), the proportion of the click beetles in the food of the Rooks from Mazowsze was much higher relative to the food of the Rooks from Wielkopolska (Figs. 4, 7). LOCKIE (1959) noticed quantitative and qualitative differences in food composition between different Rook colonies in the same year and in the same colonies between different years. The differences concerned the presence of both invertebrates and grain.

Differences of a similar type were observed in Rook colonies in the USSR (SOLOMATIN 1972) and in colonies of the Starling *Sturnus vulgaris* in the Vistula Delta (GROMADZKA, GROMADZKI 1978).

An assessment of the weight proportions of the particular food items has shown that the picture provided by the frequency is similar to that obtained on the basis of the weight analysis only in those cases where the food items compared did not differ much in size and numbers of specimens found in the gizzards. This is true of grain (Figs. 2, 6). In the case of animals, the individual species of which differ considerably by size, and thereby also by weight, the estimation based on these two methods resulted in two fairly different pictures (Figs. 3, 7). Similar differences can be seen when total vegetable food and total animal food are compared (Figs. 1, 5).

Frequency is an index relatively easy to calculate and, therefore, most often given in papers containing analyses of birds' food composition. However,

this index only informs of the presence or absence of an item, but it does not take into account the quantity. In the case of the Rook which eats both vegetable and animal food, an analysis of the real proportions of the different food items based only on the analysis of frequency would lead to erroneous conclusions; in such an analysis the percentage of vegetable food, digested much longer than the animal food, will always be overestimated. The authors of some papers on the food of the Rook based their estimation of the weight proportions of the individual items on measurements of the dry weight or of the volume of the food contained in the gizzards examined (RÖRIG 1900, FOLK, TOUŠKOVA 1966); such analysis also shows a considerable predominance of vegetable food.

The different rates of digestion of the various types of food by the Rooks were noticed already by RÖRIG (1900). However, until the middle of the seventies of this century no papers could be found which would consistently and convincingly present the real proportions of individual items in the diet of the wild birds. Recently, CUSTER and PITELKA (1975) have taken up a wider discussion on digestion rates. They suggest that in the assessment of the ratios of the individual food items corrections should be applied, taking into account differences in the rate of digestion of the different items. The above authors also point out that in the gizzards of starved birds the food is digested faster, and that birds of different taxonomic groups digest the same food at different rates.

The assessment, presented in this paper, of the weight ratios, taking into account differences in the rate of digesting vegetable and animal food, seems to provide a fairly true reflection of the real ratios between different food types.

The method used in this paper for the calculation of consumption (Table 4–6) is based on principles different from those employed by other investigators estimating the food requirement of the Rooks (FEARE, DUNNET, PATTERSON 1974, LUNIAK 1977). In spite of this, the values obtained do not differ much from those found in the papers quoted, and they are calculated more precisely for the different seasons. The individual consumption values presented (Table 7) can be used for the calculation of the total quantity of food eaten by one bird during a year or the quantity of food eaten by a group of birds during their stay in an area. For instance, one adult Rook eats yearly about 13 kg of grain and 16 kg of animals. These numbers seem to indicate that vegetable and animal food represent similar quantities in the diet of the Rooks. However, when assessing the pressure of the Rooks on the population of animals representing an item of their diet, the fact must be taken into account that during the breeding period when the nest population is the largest numerically, animal food predominates in the Rook's diet.

When interpreting the quantities of grain eaten by the Rooks from the point of view of possible losses to Man's economy, it must be borne in mind that although these birds eat grain throughout the year, this is not in all the

seasons connected with losses to Man (e.g. grain eaten in stubble fields, on roadsides, from fodder left after animal feeding, and the like).

Data on the composition of food and the consumption of the Rook will become particularly important when they are combined with data concerning the numbers and periods of occurrence of these birds in the given areas.

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STRESZCZENIE

[Skład pokarmu i zapotrzebowanie pokarmowe gawrona *Corvus frugilegus* w agrocenozach Polski]

Celem badań było poznanie składu pokarmu gawronów w Polsce, ocena udziału różnych rodzajów pokarmu w ich diecie oraz określenie wielkości zapotrzebowania pokarmowego w ciągu roku.

Skład pokarmu oceniono na podstawie analizy zawartości 1650 żołądków dorosłych gawronów zastrzelonych w okresie od czerwca 1972 do grudnia 1974 na Wysoczyźnie Kościańskiej w Wielkopolsce oraz w różnych rejonach Mazowsza. Udział poszczególnych składników pokarmowych w diecie określono przy pomocy dwóch wskaźników: 1. frekwencji, wyrażonej procentowym stosunkiem liczby żołądków, w których wystąpił dany rodzaj zdobyczy, do ogółu zebranych żołądków oraz 2. wskaźnika wagowego, który obliczono uwzględniając różną szybkość trawienia pokarmu roślinnego i zwierzęcego. Oceny zapotrzebowania pokarmowego ptaków dorosłych dokonano drogą obliczenia dobowego zapotrzebowania energetycznego — DEB, przy uwzględnieniu współczynnika przyswajalności pokarmu. W okresie wędrówki obliczono poprawki uwzględniające zwiększenie zapotrzebowania pokarmowego, spowodowane gromadzeniem przez ptaki rezerw tłuszczowych.

W diecie gawronów pokarm roślinny i zwierzęcy występuje przez cały rok. Frekwencja składników roślinnych jest zazwyczaj wyższa, jednakże udział wagowy obu tych składników jest mniej więcej jednakowy. Pokarm roślinny stanowią najczęściej ziarna zbóż, pokarm zwierzęcy — owady. Dzienne zapotrzebowanie pokarmowe jednego gawrona wynosi (w zależności od pory roku) 10 do 70 g ziarna zbóż oraz 15 do 70 g pokarmu zwierzęcego. Jest ono najwyższe w okresach wędrówek. Jeden dorosły gawron zjada rocznie około 13 kg ziarna i 16 kg zwierząt; pisklę w okresie przebywania w gnieździe zjada około 35 g pokarmu roślinnego i 1750 g zwierząt.

Rozważając problem szkodliwości gawronów należy pamiętać, że zjadanie przez nie ziarna nie zawsze jest sprzeczne z interesami człowieka (ziarno zbierane na ścierniskach, przydrożach, wybierane z nawozu oraz z odpadów po karmieniu zwierząt gospodarskich) oraz że wśród zjadanych przez niego zwierząt zdecydowanie dominują zwierzęta uznawane za szkodniki rolnicze.

Appendix 1. Plant species presented in the food of the Rooks, frequency of separate units; × – frequency below 2%.

Plant species	Frequency (%)	
	Wielkopolska	Mazowsze
Seeds of crop plant	**91**	**86**
Avena sativa	8	13
Secale cereale	×	11
Triticum vulgare	22	8
Hordeum vulgare	31	23
Zea mays	26	×
Panicum miliaceum	–	×
Unidentified grain of cereals	17	33
Fagopyrum sp.	–	2
Helianthus annuus	2	×
others (*Pisum sativum, Cucumis sativum, Cucurbita* sp.)	2	×
Seeds of weeds and other plants	**×**	**6**
Polygonum sp.	×	3
Polygonum persicaria	–	×
Polygonum tomentosum	–	×
Polygonum nodosum	×	×
Polygonum aviculare	×	×
Polygonum convolvulus	–	×
Chenopodium album	×	×
Stellaria media	–	×
Agrostemma githago	–	×
Trifolium campestre	–	×
Pisum arvense	–	×
Galeopsis tetrahit	×	×
Plantago lanceolata	×	–
Picris echioides	–	×
Centaurea cyanus	–	×
Taraxacum officinale	×	–
Raphanus raphanistrum	–	×
Underground plant parts	**7**	**4**
Equisetum arvense	7	4
Cirsium arvense	–	×
Fruits and stones (*Pirus malus, Prunus avium*)	3	2
Roots (*Solanum tuberosum, Beta* sp.)	**×**	**8**
Unidentified plant material	4	3

Appendix 2. Animal species presented in the food of the Rooks, frequency (%) of separate units; × — frequency below 2%, i — imagines, l — larvae, p — pupae.

Animal species	Developmental stage	Frequency (%)	
		Wielkopolska	Mazowsze
1	2	3	4
Annelida — *Lumbricidae*		3	8
Arthropoda			
Myriapoda		×	×
Arachnoidea		×	2
Insecta		70	76
Orthoptera	i	×	×
Gryllotalpidae	i		
Gryllotalpa gryllotalpa	i	×	×
Acrididae	i	—	×
Chorthippus sp.	i	—	×
Dermaptera	i	×	—
Forficula auricularia	i	×	—
Neuroptera	i	—	×
Lepidoptera	i	×	×
	l	11	6
	p	×	×
Hymenoptera	i	—	4
Formicidae	i	—	3
Hymenoptera	p	—	×
Formicidae	p	—	×
Diptera	i	3	7
Tipula sp.	i	—	×
Syrphus sp.	i	×	—
Scopeuma stercorarium	i	×	—
Tabanus sp.	i	—	×
Diptera	l	4	4
Bibionidae	l	—	×
Syrphidae	l	×	—
Tipulidae	l	—	×
Diptera	p	8	3
Coleoptera	i	47	62
Carabidae	i	6	12
Cicindella sp.	i	—	×
Carabus sp.	i	×	4
Carabus cancellatus	i	×	×
Carabus granulatus	i	×	×
Carabus arvensis	i	—	×
Clivina fossor	i	—	×
Broscus cephalotes	i	—	×
Bembidion femoratum	i	×	×
Bembidion properans	i	×	—
Pterostichus niger	i	—	×
Poecilus sp.	i	×	×

1	2	3	4
Cetonia aurata	i	–	×
Potosia sp.	i	–	×
Dermestidae	i	–	×
Byrrhidae	i	–	×
Byrrhus sp.	i	–	×
Elateridae	i	8	10
Lacon murinus	i	×	×
Corymbites sp.	i	×	×
Selatosomus aeneus	i	×	×
Selatosomus latus	i	×	3
Agriotes sp.	i	2	2
Agriotes obscurus	i	×	×
Agriotes lineatus	i	×	×
Agriotes sputator	i	×	×
Agriotes ustulatus	i	×	×
Limonius sp.	i	×	×
Melanotus sp.	i	–	×
Dolopius marginatus	i	–	×
Coccinellidae	i	×	×
Coccinella sp.	i	×	×
Tenebrionidae	i	–	×
Opatrum sabulosum	i	–	×
Cerambycidae	i	–	×
Leptura livida	i	–	×
Chrysomelidae	i	22	23
Leptinotarsa decemlineata	i	21	23
Chrysomela sp.	i	–	×
Phyllodecta sp.	i	–	×
Cassida sp.	i	2	×
Cassida nebulosa	i	×	×
Curculionidae	i	12	15
Otiorrhynchus sp.	i	6	×
Otiorrhynchus ligustici	i	5	×
Otiorrhynchus multipunctatus	i	×	×
Trachyphloeus sp.	i	×	–
Phyllobius sp.	i	×	×
Barynotus obscurus	i	×	–
Polydrosus sp.	i	×	×
Strophosomus sp.	i	–	×
Philopedon plagiatus	i	×	–
Sitona sp.	i	×	×
Tanymecus palliatus	i	×	×
Cleonus piger	i	×	×
Hylobius sp.	i	–	×
Phytonomus sp.	i	–	×
Coleoptera	1	29	19
Carabidae	1	4	×
Staphylinidae	1	2	×
Scarabaeida	1	19	×

1	2	3	4
Melolontha melolontha	1	19	–
Dermestidae	1	–	×
Elateridae	1	13	18
Corymbites sp.	1	×	×
Selatosomus sp.	1	5	12
Agriotes sp.	1	8	3
Chitinous elements and unidentified insects		31	25
Mollusca – Gastropoda		×	×
Vertebrata			
Amphibia		×	×
Aves		×	×
Mammalia		5	4
Insectivora		×	–
Sorex minutus		×	–
Rodentia		4	4
Microtus sp.		4	4
Microtus arvalis		×	×
Apodemus flavicollis		×	–
Mus musculus		–	×
Micromys minutus		–	×
Unidentified (probably *Leporidae*)		×	–

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