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Rooks *Corvus frugilegus* LINNAEUS, 1758, in One of the Cracow Parks

[Pp. 465—500 and 5 text-figs.]

Gawrony *Corvus frugilegus* LINNAEUS, 1758, w jednym z parków Krakowa

Грачи *Corvus frugilegus* LINNEAUS, 1758, в одном из Краковских парков

Abstract. The dynamics of nesting of a colony studied from the year of its origin (1969) to the spring of 1975 is presented. The rate of natural decay of its nests and also four phases of its rebuilding and development have been established. The full maintenance of the life cycle of the colony depends to a great extent 1) on the interest some Rooks take in the nests in autumn and winter and 2) on passive cooperation which forms a base for the drive that brings these birds to the park. The influence of the climate on the breeding season is discussed and the effect of the knocking-off of nests has been related to the hormonal state of the birds. Autumnal knocking-off of nests is proposed as a more humane attempt to liquidate annoying colonies.

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I. INTRODUCTION

Naturalist are concerned with different aspects of life of Rooks, which aspects might roughly be grouped in three large divisions. They would like to know, above all, what these birds do at different times of the day and in different

seasons of the year, e.g. what they eat and how they migrate. Investigators are perhaps still more interested in all questions connected with nesting. Finally, in order to understand the behaviour of these birds, they had to get an insight into what happens in them. The earliest observations concerned breeding colonies of Rooks, as the ones which are the most conspicuous. Censuses of Rooks were made over large areas or in particular localities. Later, naturalists attempted closely to determine the manner and conditions in which Rooks build their nests and how they behave in the mating season and bring up their young. These problems were related to their flights to roosting sites and, subsequently, to migrations to winter quarters. It became necessary to pass from field observations to laboratory studies to establish in what the essence of the internal regulation of these activities consists.

The present paper is designed to illustrate a full year's relationships between Rooks and one of the parks of Cracow, named Krakowski Park, and to present the beginning and formation of a rookery in it during several consecutive years (1969—1975). Here special care was taken to record the time and rate of nest-building and natural nest decay as accurately as possible. An attempt was made to determine the share of wintering Rooks in the development of the rookery and to estimate the approximate nest carrying capacity of the park and some of its trees. The influence of the climate of the environment and, within the Rooks themselves, that of neuro-endocrine and psychological factors, which condition their behaviour to a considerable degree, are also discussed.

II. KRAKOWSKI PARK AND ROOKS FEEDING IN IT

Krakowski Park, in which observations were made is situated at the boundary between the old part and the newer districts of Cracow. Its surface area is about five hectares and it is surrounded by areas densely built up with 4—6-stories houses. There grow about 450 trees, excluding shrubs, in this park, among which the birch and ash prevail (respectively, 111 and 99 trees). The maple, elm, poplar and chestnut occur in considerably smaller numbers (respectively, 47, 31, 25 and 24 trees). The rest is made up of 10 other tree species. As regards conifers, which are here represented mostly by distinctly younger specimens, there are larches, spruces, yews and pines. The trees, except those at the border of the park, grow wide apart. As there are only few shrubs and the lower branches of the trees are generally cut off up to a fairly large height, an observer standing in the middle of the park can take in nearly the whole park area with the eye. The Rooks, too, can see passers-by pouring out food even from afar and come flying to this place. A pond and a pool for children to paddle in provide the Rooks with water and the birds make use of them especially in the early morning.

Rooks constantly utilize Krakowski Park for more than nine months in the year, from the end of October to July. Here they feed for nearly five months,

from November to March, and nest from March to June, naturally roosting in the park in this period and returning to roost as late as July. Occasionally they appear here also in subsequent months. The number of Rooks in the park varied considerably in the years 1972—1974, which is illustrated by curves given separately for feeding Rooks and for nesting ones (Figs. 1 and 2). The graphs show also the maximum and minimum daily temperatures, snow cover, days with heavy fog and numbers of nests. Twenty-six percent of the feeding Rooks are members of the resident population of Poland, the rest being winter visitors (BUSSE, 1963, 1969).

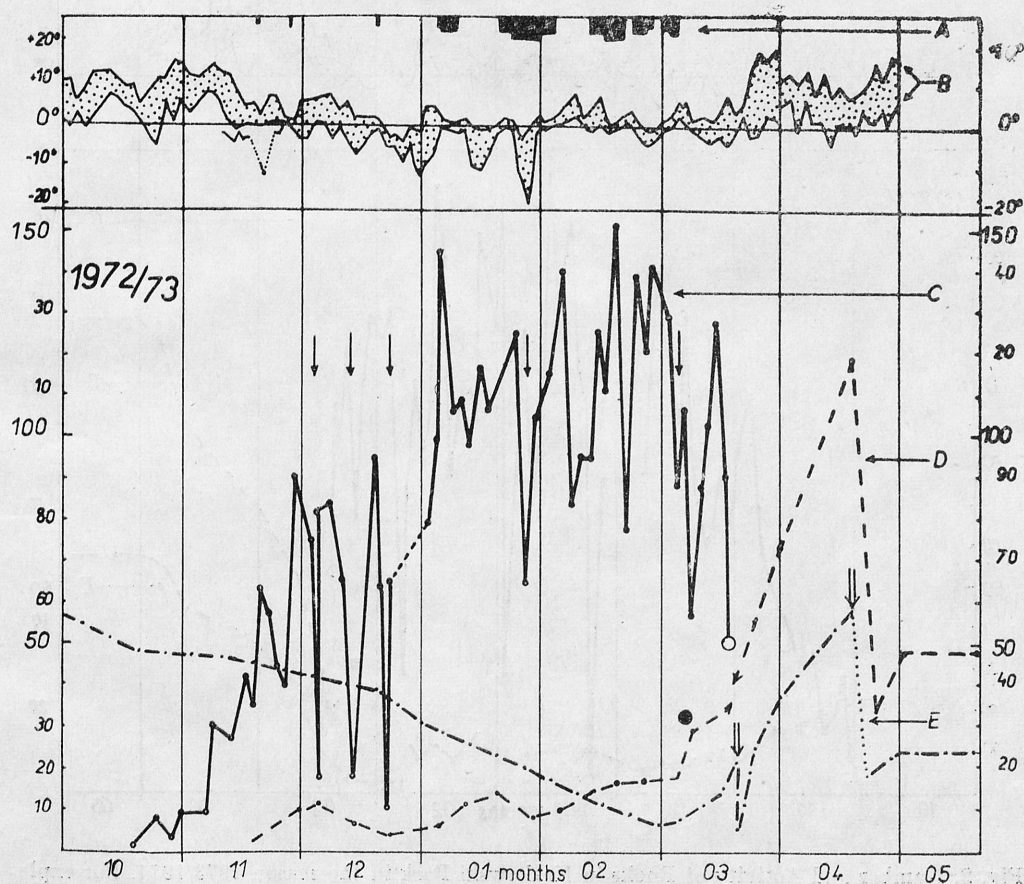


Fig. 1. Number and Activity of Rooks in Krakowski Park in the Season 1972/73 relative to snow cover and thermal conditions. A — days with different thickness of snow cover, B — daily temperature (maximum and minimum), C — number of Rooks feeding in the park; the arrows indicate the days on which fog made it difficult for the Rooks to come to the park; the open circle at the end of the curve in March represents the day on which the Rooks were for the last time present at feeding; D — numbers of Rooks occupying nest-sites from autumn to February, from March onward — number of nesting Rooks; E — number of nests: from October to February — decaying nests of last year, from March onward — nestbuilding interrupted twice by knocking-off of nests (double arrows). The black circle in March indicates the time when the Rooks begin to spend nights at the nests.

Rooks are social birds, but they do not form very close flocks. Although they roost together, while flying to their feeding grounds in cultivated fields or meadows, they break up into larger or smaller groups, which alight separately at different points of the route (GRODZIŃSKI, 1971). In October the Rooks begin to feed also among the houses in sparsely built-up districts of the town. It was not until the third decade of October that the first few specimens appeared in the park, in spite of the fact that the route of their everyday flights to and from

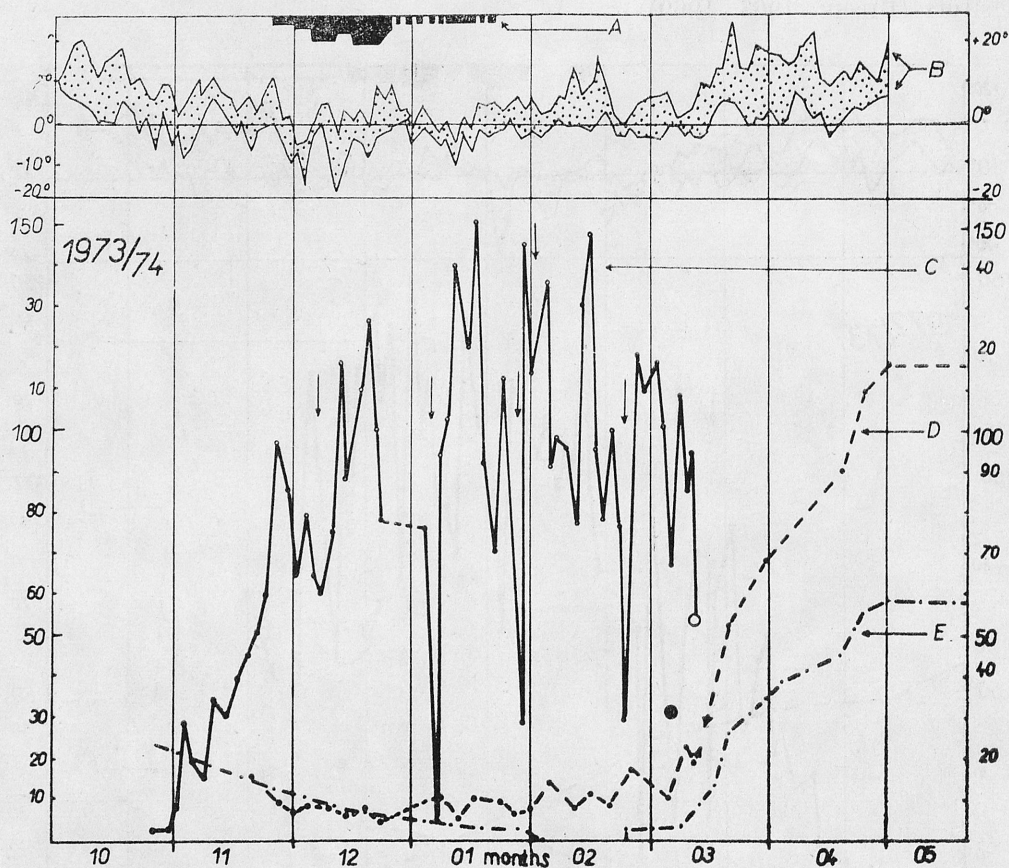


Fig. 2. Number and Activity of Rooks in Krakowski Park in the season 1973/1974. For explanations see Fig. 1

the feeding grounds had led over it for several weeks. Here they found natural food in large lawns. The number of Rooks feeding in the park increased rapidly in November (Figs. 1 and 2) and during the last days of that month it reached nearly 100 birds per day. The invasion of the park by Rooks in November proceeded similarly in both years. It was conditioned by frosty weather or night ground-frost, which reached 12° below zero in 1972. Frost made the Rooks change their feeding grounds.

Rooks feed on germinating seeds, young grass leaves and all species of animals that occur on the surface of the ground and in the upper layers of soil, digging them out with their beaks. Animals that come into question in November are chiefly those of the upper 10—15-centimetre layer of soil; earthworms predominate among them and form up to 60% of this underground fauna. The members of large lumbricid species go down their burrows to a depth of 2 m and at night crawl out on to the surface of the ground in warm and damp weather. Earthworms of small and medium-sized species feed in the upper soil layer, which they loosen (ZAJONC, 1970). In England 390—524 earthworms per 1 sq. m, weighing 52—120 g, were found in the upper layers of alkali soil of grassland (BURGES and RAW, 1971). A similar situation occurs in Krakowskie Błonia (the nearest grassland): 450—500 earthworms per 1 sq. m in the 20-centimetre soil layer (SKOCZEŃ, in prep.). Several authors confirm the opinion that earthworms, beside insects, prevail in the diet of Rooks in some seasons of the year (LOCKIE, 1955; MARSHALL and COOMBS, 1957; VERTSE, 1943; VOOUS, 1962). In cases in which no earthworms are found in Rooks' stomachs, this fact may be attributed to their extremely quick digestion of food. Only a few remains are left from cockchafer an hour after their being eaten up and the remains of a mouse disappear in two hours (RÖRIG, 1903). Rooks feed readily in areas which are sufficiently damp and note very densely overgrown by vegetation (PINOWSKI, 1959), but the cooling of the earth causes the earthworms to withdraw deeper and the freezing of its superficial layer makes it impossible for Rooks to reach them with the beak. This is why then these birds move to the close neighbourhood of houses and feed on garbage. It is well-known that Rooks readily shift over from vegetable diet to animal food (OSMOLOVSKAYA, 1972) or to feeding in refuse dumps. In Krakowski Park a layer of newly fallen leaves provided favourable microclimate for soil animals. The Rooks took advantage of this and assiduously turned over the leaves with their beaks in search of them. At the same time passers-by intensified the feeding of birds residing in the park, by which the Rooks benefited, too.

When however the surface of the ground froze and was covered with snow, the Rooks perched watchful upon the lower branches of the trees, ready to fly off in an appropriate direction the moment they saw someone pouring out food. In less than a minute 20—30 birds gathered at the available food. In addition to temperature, snow cover was another factor decisive of the number of Rooks feeding in the park.

A thick snow layer covered the park in December 1973, whereas the December of the previous year was practically snowless and less frosty. The number of Rooks approximated 90 specimens in snowless December and exceeded 120 in 1973. In January, with lasting frosty weather and similarly lasting snow cover, the number of Rooks was somewhat larger in 1974. Persisting weak night frost, high daily temperatures and lack of snow cover in February 1974 were responsible for the fact that there were fewer Rooks than in the previous year (Figs. 1 and 2).

The Rooks that fed but not nested in the park left it in March. This fell on March 16 in 1973 and on March 11 in 1974 (p. 473). Their departure was hastened quite distinctly, which was probably due to warmer and snowless weather in February and March 1974. The Rooks flew away from the park still earlier in 1975, i.e. on March 2, which should be referred to the exceptionally mild winter of that year.

In winter the Rooks utilized Krakowski Park not only as a feeding area but also as a rallying or resting place in their everyday flights from the roosting site situated east of Cracow (GRODZIŃSKI, 1971) to the feeding grounds. Generally speaking, the flights proceeded in a similar way in different years and months. There were differences in the timing of the flights by a watch and in the number of birds participating in them. The calls of the first Jackdaws flying over the park were heard at twilight early in the morning, at least half an hour before sunrise. A few minutes later they began to alight on different trees. A hundred or more birds gathered in this way in the park. Groups of Rooks appeared together with the last Jackdaws and they alighted on trees with and without nests in numbers considerably exceeding a hundred. It should be mentioned that most Rooks and Jackdaws flew over the park without stopping in it. A few minutes before sunrise most Jackdaws flew off westwards, soon followed by some of the Rooks. Only the members of the normal population of the park, or 120 birds, remained (observation on December 21, 1973).

The Rooks usually came very regularly from the roosting site, 14 km away, but fog and blizzards might cause remarkable disturbances. Table I illustrates such disturbances caused by fog. The numbers of the Rooks present in the park in the morning preceding or following a foggy day indicate that at the most about 50 % of the birds got to the park on foggy days, but there were also days with 20 % of the Rooks or, practically, without them. A blizzard (e.g. on December 7, 1973), like fog, had an effect on the arrivals of the Rooks in the park. These phenomena should be associated with the density of fog and the time of its enveloping the park and the whole Cracow trough. The birds circled in the fog or perhaps they only flew over the park, crowing loudly. If the fog cleared early enough, a more or less normal number of birds appeared in the park about midday.

The winter weather conditions determine the moving of Rooks from fields to the town and so also to Krakowski Park. Their great density in the 5-hectare area of the park is however dependent exclusively on the feeding of birds by people. I emphasized this in my previous paper (GRODZIŃSKI, 1971), while comparing the numbers of these birds in Krakowski Park and in Dr Jordan Park, situated not far from it, in which the birds were not fed. Similar conditions prevailed in these parks in the years 1972—1974. The numbers of Rooks in Jordan Park were always lower and did not exceed 30 % of those in Krakowski Park.

Passers-by traditionally feed Pigeons, Ring-doves and Sparrows in Krakowski Park with varied intensity all the year round. When the first Jackdaws and Rooks appear in the park, they feed feverishly in large lawns. Soon however they learn

Table I

Effect of Fog on the Morning Arrivals of Rooks in the Park. The numbers of Rooks observed in the park in the morning on foggy days are compared with those on the nearest, preceding or following, fine days. On 7 December 1973 a heavy blizzard had as similar effect to that of fog

Date		No. of Rooks	
		on foggy days	on nearest fine days
Winter 1972/73	5 Dec.	18	89
	13 Dec.	19	90
	21 Dec.	1	64
	26 Jan.	71	142
	5 March	59	104
Winter 1973/74	12 Dec.	60	116
	6 Jan.	2	110
	29 Jan.	26	121
	23 Feb.	25	195

to make use of the food offered by people. In winter, with the passage of time there is more and more food strewn under trees and placed on bird-tables. The Rooks sit on tree branches low above the ground on the watch for it and at once fly together where it is available. They drive the Pigeons and Jackdaws away from the food. As they are too big to get on to the bird-tables, they stay under them waiting for the pieces strewn by the feeding Jackdaws. The Rooks pull papers out of the park-tidies and tear them up in search of something to eat. They generally drink water from the paddling-pools and puddles. When water is frozen, they break off pieces of thin ice and swallow them, they also content themselves with iced snow.

The wintering Rooks were easily conditioned to a number of activities connected with feeding constantly at the same place (p. 472). Owing to this it was possible to determine exactly on which day the wintering Rooks appeared to feed for the last time and to find that they leave the park in a large group. The ones which remain build nests; they feed out of the park. In search of food they fly southwards to Blonia, 2—3 km away, but chiefly to the west to the meadows and cultivated fields at a distance of 4—6 km.

III. PREPARATION OF ROOKS FOR MATING SEASON

The nests built by Rooks in Krakowski Park do not generally persist throughout the year. After the breeding season their number decreases gradually, being reduced to several nests or even none at all in February. It may thus be assumed that the Rooks set up their colony anew every year. The very process of building is preceded by a surprisingly long period in which the birds get psychologically ready for it.

In the first days of November in 1972, 1973 and 1974, hardly a few days after the Rooks had come to the park as to their feeding area, some of them began to show signs of sexual behaviour. This was autumn display, which consisted in that single birds crowed in a low voice for a fairly long time, while perching on a tree branch. Simultaneously with the utterance of these calls, the Rooks rocked their bodies to and fro, spread their tails and held out the humeral part of their wings slightly apart from the trunk (BLUME, 1967). Such display abated considerably in the period from the second decade of December to the third decade of January. Towards the end of January and, especially, in February it increased in intensity, at any rate it became much commoner than it was in the autumn. In this period, displaying in pairs on the ground or in a tree, the birds seized each other by the beak and the males fed the females or only pretended to (TEMBROCK, 1954). During the autumn display it came only exceptionally to such close approaches.

As early as mid-November, and so 10—14 days after the commencement of display in the park, a few birds began to take interest in the nests. Everyday in the morning a few to more than ten birds appeared in the trees with nests. Starting from mid-January throughout February the number of these Rooks increased slowly (Figs. 1 and 2). They might be single birds but pairs predominated. These last as if tried if they fitted in the nest, that is one of the birds came on to the nest and settled as if to incubate the eggs, while the other stayed quietly on a branch beside. The single birds displayed or showed interest in what the other Rooks were doing in the nests.

It is in March that common nest-building begins. In this connection two questions arise: 1. when do Rooks begin to spend the nights by their nests and 2. what proportion of the nest-building birds do the birds wintering in the park form and what proportion the birds returning from their winter quarters?

It was possible to distinguish the Rooks wintering in the park either by marking them in colours or by differences in their behaviour. For technical reasons catching and marking Rooks was impracticable. However, they let themselves readily be conditioned to the way of feeding. The trained behaviour became a distinctive feature under definite conditions. During the autumn and winter the Rooks received bread cut into small pieces regularly at the same place and at the same time. For this purpose I established the following procedure of feeding. I went off the park path 25 steps towards a big tree (Fig. 4:12). Then 1—3 nearest Rooks flew over to the lowest branches of this tree. When I began to pour pieces of bread out of a nylon bag, always in the same manner, the Rooks came flying from all sides and alighted close by on the ground and in the tree. My return on to the path was a signal for the Rooks to snatch the pieces of bread ravenously. Having eaten up everything, 20—30 birds, forming a wide front, marched towards the path, where I was waiting for them. When they stopped at a distance of a few steps, I spilt the rest of bread. They had been waiting for it without unrest and, if the distance between us was sufficiently great, ate the bread quickly. However, the replacement of bread with suet or the offering o

food in the company of another person caused disturbances in the Rooks' trained behaviour.

In the very rainy and warm December of 1974 there were 50—60 Rooks in the park, but not later than the day after the outset of a cold spell (-6.8°C) on December 13 their number rose to about 100. That day my attempt to feed the Rooks was unsuccessful; they did not alight in the chosen tree before I started spilling bread, were very tardy in beginning to eat and would not come near the bench for the continuation of feeding. They were probably the birds which had come in a close group from the proximity of the park and took possession of its part so far loosely occupied by the Rooks which had been feeding there for several weeks. After a few days they learnt to avail themselves of feeding carried out in the way established previously.

In 1972/1973 and 1973/1974 I fed the Rooks everyday by the method described. The observations made in March 1973 are presented in Table II. The numbers of Rooks perching in the trees with nests in the morning hours — practically, we are here, above all, concerned with tree No. 2 — given in the left part of the table, are important to the problem under study. The number of these birds increases gradually from 16 to 40 and, excepting March 17, is higher than might be judged from the number of nests. This means that not all the pairs were busy building nests, but they rather occupied the site for the nest. Another important column — Feeding — gives the numbers of birds that came flying to the bread offered. There were days when 50 birds came, but the days with considerably smaller numbers predominated. Lastly, on 17 March the birds did not appear at all.

In 1974 the moment of departure was grasped more exactly. Feeding had proceeded according to the pattern established all through the winter up to 10 March inclusive. The next day (11 March) about 20 Rooks still came flying to the bread and began to eat as usual. However, when an equally large group of Rooks appeared with a big noise and alighted high up in a tree in the vicinity, they flushed interrupting feeding and alighted near them in another tree. After some time they flew away together with the newcomers. Apparently, the mood connected with spring migration won and induced their departure. The next day (12 March) none of the Rooks turned up for feeding. Their number in the park had also decreased. It may be claimed on the basis of the behaviour of the birds at feeding that in both seasons they were the ones which had been feeding in the park all through the winter and not chance visitors.

The right part of Table II. contains the evening observations which include the period of sunset and show what the Rooks were doing in the park at that time. A long time before sunset the birds, more than 100 in number, gathered in the trees, chiefly those with nests. Most of the Rooks flew away in a flock or two for roost to the east, probably to Łęg, an hour before sunset. On 3 March six Rooks remained in tree No. 2 and followed the flock half an hour later. The next day there were 20 such birds delaying in departing, and six out of them again stayed by the nests some time longer. On 5 March the last pair,

Table II

Observations of Rooks in Krakowski Park from 2 to 17 March 1973. The left part of the table gives the numbers of Rooks between 8 and 9 a. m.: a — present in park, b — perching in trees with nests, c — coming for feeding. The right side of the table shows how some Rooks delay their evening departures and when they begin to spend nights in trees with nests; the number of Rook pairs spending nights in the park grows unproportionally faster than does the number of nests constructed

Date	No. of Rooks between 8 and 9. a. m.			No. of nests	Evening departures		No. of Rooks spending night in park	Sunset
	a	b	c		collec- tive	delayed		
2.03	84	16	33	6	16 ⁰⁰	—	—	17 ²⁷
3.03	125	16	50	6	16 ⁰⁰	16 ³⁰ : 6 Rooks	—	
4.03	88	16	18	7	16 ²⁰	17 ²⁸ : 6 Rooks	—	
5.03	22	12	15	7	16 ⁴³	17 ⁴⁵ : 2 Rooks	—	
(fog)								
6.03	106	20	50	8	16 ⁴⁰	—	22	17 ³⁰
7.03	71	32	22	10	—	—	40	
9.03	72	42	20	12	—	—	50	
10.03	83	34	18	12	—	—	50	
12.03	99	35	30	13	—	—	64	17 ⁴⁶
13.03	108	31	18	13	—	—	60	
14.03	127	35	16	13	—	—	70	
15.03	118	37	18	14	—	—	68	
16.03	90	40	15	18	—	—	70	
17.03	39	30	—	19	—	—	70	

which probably belonged to this six, left as late as more than ten minutes after sunset. Finally, on 6 March the Rooks began to spend the night in the park constantly, their number increasing from 22 to 70, faster than did the number of the nests.

The questions put forward above may be answered as follows: 1) A part of the wintering Rooks troop away from the park at the same time, which seems to be dependent to a certain extent on the weather. In 1973, after frosty and snowy January and February, the departure occurred on 16 March and in 1974, in which January was mild and February snowless, on 11 March. 2) The other wintering Rooks become attached to the trees with nests starting from November and perch in them everyday throughout the winter. They begin to stay by the nests in the night in gradually increasing numbers. This markedly precedes the departure of the rest of the wintering birds (by 10 days in 1973). 3) It is difficult to determine how many nests are built by the wintering Rooks. If we regarded the birds which remain for night as potential nest-builders, 12 March, on which new Rooks arrived, might be thought to be a turning point. On that day conspicuously more birds appeared in the park in the morning and also distinctly more spent the night in it. About 60 Rooks might be regarded as win-

tering and next responsible for building about 30 nests. Since before its destruction on 19 April the colony consisted of 59 nests, the Rooks that had come from the south-west of Europe built a similar number of nests.

IV. NESTING DYNAMICS

In 1957 there was not yet a colony of Rooks in Krakowski Park (FERENS, 1957). I did not observe it there before the autumn of 1969, when the first two nests appeared. The next year there were already 19 nests, their number ranging from 60 to 70 in each of the following years (1970—1974; Fig. 3). After two years of development the colony therefore attained a very stable size and numbered 12—13 nests per hectare of the park. The state of repair, number and distribution of nests could be checked starting from autumn, when the trees began to lose their leaves, to spring, when the leaves hide the nests again at the beginning of May. In this period the nests underwent a partial or complete destruction and in the spring the Rooks rebuilt them again.

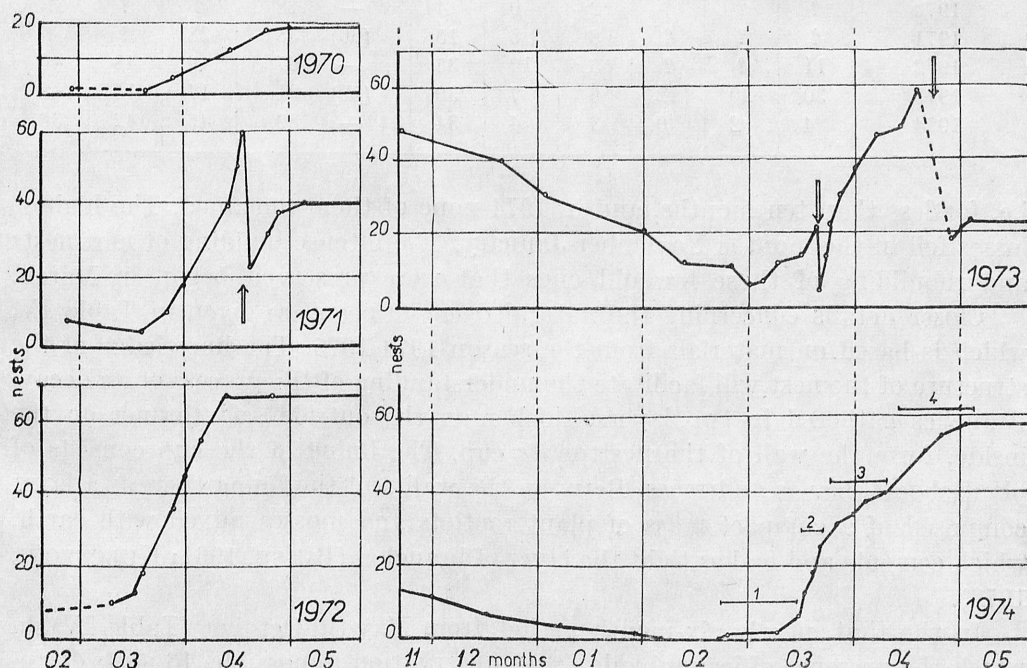


Fig. 3. The Fate of Nests in the Rookery in Five Consecutive Years (1970—1974). The graphs show the number of nests against the consecutive months of the year. The arrows indicate the days on which most of the nests were knocked off. The horizontal lines with the figures 1—4 represent the phases of the development of the rookery: 1 — occupation of site for nest-building, 2 — intense nest-building, 3 — low-rate nest-building, 4 — occupation of peripheral nest-sites by birds belated in breeding.

Several years' observation of the number of nests in the colony permits us to form a general opinion on the extent and rate of decay of the nests in the annual cycle. Table III. gives these observations arranged according to the years and within years according to the months. Each year the colony reached the largest size towards the end of April, if it had not been reduced by the park-keepers, who destroyed nests about the middle of that month. Very few of the nests, several out of several tens, subsisted to mid-February in the next year,

Table III

Fate of Nests Which Made Up the Colony in 1970—1974. The nests decay in natural way from October till February and are rebuilt by Rooks in March and April. The parenthesized figures in the column „April” represent the maximum number of nests in the colony before some of them had been knocked off. The other column of April data gives the numbers of nests used by Rooks to breed in

Month Year	January		February		March		April	End of		
	1— —15	16— —31	1— —15	16— —28	4	30		Oct.	Nov.	Dec.
1970	?	?	?	2	0	4	— 18	?	?	?
1971	?	?	?	8	6	15	(60) 38	28	?	?
1972	11	?	?	5	10	35	— 67	49	48	40
1973	30	20	12	6	7	30	(59) 21	17	15	8
1974	4	2	0	3	4	34	— 59	46	42	36

i.e. for less than ten months, and in 1974 none of them remained. The highest losses fell in the months November-January. The intense building of new nests and rebuilding of those few old ones that were preserved began in March.

Closer details concerning the natural decay of nests are given in Table IV, which is based on materials from the season 1974/1975. The knowledge of the structure of the nest will facilitate the understanding of the process of its decay. Branches gathered in two layers, thicker on the outside and thinner on the inside, form the wall of the nest or its cup. The lining of the cup consists of plant shoots, leaves and moss. Between the wall and the lining there is a layer composed of a compact mass of plant rootlets and mosses mixed with earth, which cements and makes tight the layer of branches (BUSSE, 1961; KULCZYCKI, 1973).

In the first, nearly six-month period, from May till October (Table IV), in which the presence of leaves made exact observation impossible, 13 nests disappeared completely, or there remained 46 out of 59 nests and seven of them were evidently damaged. The degree of damage was determined on the basis of the appearance of the cup, i.e. how much of it had been left: a half, a third or only a trace (1/5). The first signs of damage may be related to the final period of rearing and feeding the young, their agility and body growth. Winds and rains diminished the cohesion of nests, especially those which were poorly screened

Table IV

Analysis of Natural Decay of Nests in 1974/1975. The table illustrates how the nests of the park colony decayed quantitatively and qualitatively from October till March. The upper row of figures from 1 to 16 indicate the trees with nests, the situation and names of which can be found in Fig. 4. The state of the nest-cup is represented by the following symbols: A — cup complete, B — half of cup destroyed, C — a third of cup existing, D — remains of nest in the form of a bunch of sticks (1/5). The columns of symbols and the figures referred to them illustrate the decaying of nests in particular trees. The right side of the table summarizes this process. In the horizontal arrangement it gives the state of nests of the whole colony on a given day, vertically it shows how quickly the nests with whole cups disappear, how the number of damaged nests fluctuates and at what rate the number of nests diminishes

Date	Trees or groups of trees												Nests		
	1	2	3	4	5	6	7	9	10	11	14	16	whole	da- maged	Total
1974															
29.04	A—2	A—22	A—6	A—2	A—1	A—1	A—1	A—10	A—1	A—4	A—1	A—8	59	—	59
21.10	A—1	A—9 B—4 C—1	A—6	A—2	A—1	A—1	A—1	A—9	A—1	A—4	A—1	A—4 B—2	39	7	46
17.11	A—1	A—9 C—3	A—6	A—1 B—1	D—1	—	—	A—6 B—3	A—1	A—3 B—1	A—1	A—3 B—1 C—2	31	12	43
29.11	C—1	A—5 B—4 C—3	A—6	B—1 C—1	—	—	—	A—6 B—3	A—1	A—2 B—1 C—1	C—1	A—2 B—2 C—2	23	19	42
13.12	—	A—4 B—3 C—5	A—4 B—2	D—2	—	—	—	A—4 B—3 C—2	A—1	A—1 B—1 C—2	D—1	A—1 B—2 C—3	15	26	41
21.12	—	A—4 B—2 C—6	A—4 B—2	—	—	—	—	A—3 B—3 C—3	A—1	A—1 B—1	—	A—1 C—3 D—2	14	22	36
1975															
04.01	—	B—2 C—2 D—5	A—1 B—3 C—2	—	—	—	—	B—1 C—2 D—1	A—1	B—1	—	B—2 C—2 D—1	3	23	26
15.01	—	B—1 C—2 D—5	B—4 C—1 D—1	—	—	—	—	C—1	A—1	B—1	—	B—2 C—1 D—1	2	20	22
31.01	—	B—1 C—2 D—3	B—1 C—3 D—1	—	—	—	—	D—1	B—1	C—1	—	C—1 D—3	—	18	18
15.02	—	B—1 C—1 D—2	C—2 D—3	—	—	—	—	—	C—1	C—1	—	C—1	—	12	12
01.03	—	B—1 C—3 D—1	D—3	—	—	—	—	—	C—1	C—1	—	C—1	—	11	11

by a compact wall of leaves and branches or situated at the end of long horizontal branches. It may be that the Rooks demolished one of the unfinished nests to use its material for finishing another. Hence the losses in whole nests were high in comparison with the number of damaged nests (13:7).

In the second period of the season 1974/1975 extremely profuse rains in November (74.3 mm against the mean from many years of 40 mm) and only little less profuse in December (55.4 mm against the mean from many years of 34 mm — MERTA, 1974) completely destroyed the earth-plant layer, which had stuck the twigs of the cup together. The Rooks themselves, „trying if they fitted” in the nests impaired by the lack of cement, deformed them still more. Lastly, high winds, which occurred several times in December, augmented the destruction. In November and December 20 nests disappeared completely and out of the 39 undamaged ones only three persisted in that state. Nearly two-thirds of the damaged nests had the highest indices of destruction (1/3 and 1/5). In the third period, in January and February, the destruction of nests progressed quickly. The Rooks, which as early as February began to use material from some nests to repair the others, also contributed to their destruction. At the end of January there were still 18 damaged nests, of which only three with the index 1/2. In mid-February there were only 12 nests and at the beginning of March the birds began to build new nests and rebuild the existing nestcups (trees 2 and 11), which was connected with the demolition of some other nests (tree 3).

As far as the persistence of nests is concerned, also the species of trees in which they are placed seems to play a role. This may be its arrangement of branches, which form a support for the nests, their elasticity, or perhaps the suitable density of branches which together with leaves protect the nest against winds and rains. In Krakowski Park the nests in ash-trees were the first and quickest to disappear and the nests in birch-trees the last and slowest. In these last trees the nests placed on the forks of the top branches, which grew obliquely upwards (type A₂ of nesting-site according to KULCZYCKI, 1973), were particularly persistent.

The rate of nest-building may be discussed on the basis of the situation in 1974 (Table V). In that year nest-building began from the zeropoint and no human interference disturbed its normal progress. Life in the colony in that year may therefore be used as a model in discussing the observations from other seasons.

The remains of the last nest in the park, more accurately those in tree No. 2, disappeared completely on 5 February. Nevertheless, the Rooks, 5—8 in number, used to sit in that tree in the morning and towards the end of February they set up three new nests there in the form of low frameworks consisting of some dozen sticks each. These structures remained unchanged in shape for a week, during the next week they were formed into nest-cups to become full-sized nests on 12 March. Thus the building of the nest-cup from branches lasted 16—17 days, whereas at the height of the nest-building season it takes only 1—2 days. In tree No. 9 the last nest disappeared on 28 January and the beginning of a new one was not observed until 14 March.

Table V

Rate of Development of Colony in 1974. Four successive phases of nest building in the colony have been distinguished. They differ in their duration and in the quality of building

Phases of nest-building in colony	Duration	No. of		Formation of nests	
		days	nests	daily	%
1. Occupying of nesting-sites	24.02—13.03	18	4	0.22	7
2. Intense nest-building	14.03—22.03	9	23	2.55	40
3. Slow nest-building	23.03—9.04	18	15	0.83	26
4. Occupying of peripheral nesting-sites	10.04—1.05	22	17	0.77	27
Total	—	67	59	—	100

In Krakowski Park the Rooks began the nest-building season proper about mid-March and continued it till 1 May inclusive. The whole season however lasted 67 days and can be divided into four distinct phases. The first phase lasted from the laying of the foundations of the first three nests discussed above up to their more or less full completion. It might be called the phase of occupying the nesting-site. The next nine-day phase was that of intense nest-building, concluded in the completion of 40% of the nests of the colony. The third phase was characterized by a slow progress in the building of further nests, its continuity being interrupted several times by the days on which no new nests were begun. Finally, the fourth, longest phase belonged to the belated birds which started building their nests in new trees in 13 cases and only in three cases beside the nests already existing in the tree. For clarity the data given in the table do not refer to the state of nests in a given phase, i.e. whether they had attained their final appearance or were only in their initial stage; they only indicate the appearance of a nest.

An equally complete run of observations was carried out in the season 1972/1973 but it provided a somewhat different picture of the development of the colony. This was due to two factors. Firstly, at the beginning of the autumn there were 49 nests out of the 63 completed in April 1972. Secondly, the nests were twice knocked off in the spring. During the winter the number of nests decreased considerably, in December to 40, in January to 20 in February to 6 nests. On 4 March a new nest was added and vigorous nestbuilding began. On 19 March 17 nests were knocked off, 4 being left. Starting from that day the number of nests increased rapidly up to the next knocking-off, which occurred exactly one month later. Out of the 59 nests, 18 were left and 5 new ones were built by the first days of May. This state of the colony (23) persisted. The second blow given to the colony in the third decade of April was unluckily effective.

In the season 1970/1971 out of the 19 nests of the preceding year, 5 persisted till 18 March. Hasty nest-building was continued to 19 April, when the number of nests in the colony reached 60. Twenty-two nests were left after the remaining

ones had been knocked off. The Rooks partly made the losses up and the colony reached the number of 40 nests in two weeks' time.

The observations made in the season 1971/1972 are limited to the spring season. From March to May the number of nests increased uneventfully up to 65. It should be emphasized that the Rooks took three ready nests in tree No. 1 to pieces (Fig. 4) and transferred them elsewhere.

The observations concerning the season 1969/1970 are less complete. In 1969 there were only two nests, though they might have been more numerous in the spring but had decayed completely by the autumn. Anyway, towards the end of February 1970 the remains of two nests were present in two trees to disappear at the beginning of March. Nest-building was started in the second half of March and there were five nests in tree No. 1 and 14 nests in tree No. 2 in May.

The Rooks found building material for nests chiefly on the spot in the park. They picked thick sticks from the ground but mostly broke them off from the park trees or the trees growing by the neighbouring houses. Thin branches were derived from birch and willow-trees in the park. Wisps of grass and roots with earth attached to them were plucked out from the park lawns or brought in beaks from beyond the park area. In building the nest, the birds sometimes dropped both thick and thin branches. In the period of intense nest-building new sticks appeared under tree No. 2 everyday but I did not see the Rooks use them again.

In the breeding season egg shells, dead nestlings and food remains could be found under the nests. The year 1972 was particularly suitable for these observations, because the superficial layer of soil had been exchanged in the whole park and thus the development of grass was considerably procrastinated, leaving the ground brown with peat.

In 1972 I found eight egg shells with distinct remains of the vascularized foetal envelopes under the trees. The first eggshells occurred on 5 April, the last ones on 24 April. The Rooks usually eat up the shells left after hatching (YEATES, 1934), in our case the females must have thrown them out of the nests by chance. If we multiply the number of nests by the average clutchsize, which is given to be 4.4 eggs (OWEN, 1959), these shells will form less than 3% of the eggs laid. Fifteen nestling Rooks, naked or only partly feathered, these last at the most 25 days old according to the description given by the HEINROTHS (1926), were found under the nests from 21 April to 23 May. Between 24 April and 23 May I found remains of four young Jackdaws, one Swift and one Sparrow, and a fragment of a Mole, which were lost food lying under the nests.

Naturally, at first Rooks feed their young in the nests, which is accompanied by a great din. In 1972 the first feeding of four young birds on tree-branches out of the nest was seen on 24 May. Similar feedings were next continued in different places of the park up to the third decade of June inclusive. But as early as 2 June other families with 2 or 3 fledgelings used to perch on the roofs of the neighbouring houses and feed them there. Gradually, more and more fami-

lies flew farther and farther away from the park. At first they still returned for the night to the proximity of the nests, but in July they only gathered there and formed groups of more than ten to fly away to the roost in the town gardens in the centre of the town (GRODZIŃSKI, 1971).

Adult Rooks begin moult in the first days of May. At the time I saw old Rooks begin to lose their remiges, first from one wing. A few days later single remiges and retrices could be found on the ground. The rate of moult is not very high, for the large feathers take about 32 days to grow again (HEINROTH, 1926). In consequence, Rooks with some of their remiges in both wings and retrices missing can be seen in June and even in July. This however does not prevent them from bringing plenty of food to the young.

V. NEST-CARRYING CAPACITY OF THE PARK

While examining the park for the number of nests, I noted when and in which tree a nest had appeared or disappeared. Such examinations were carried out every several days and from the beginning of February to May nearly every-

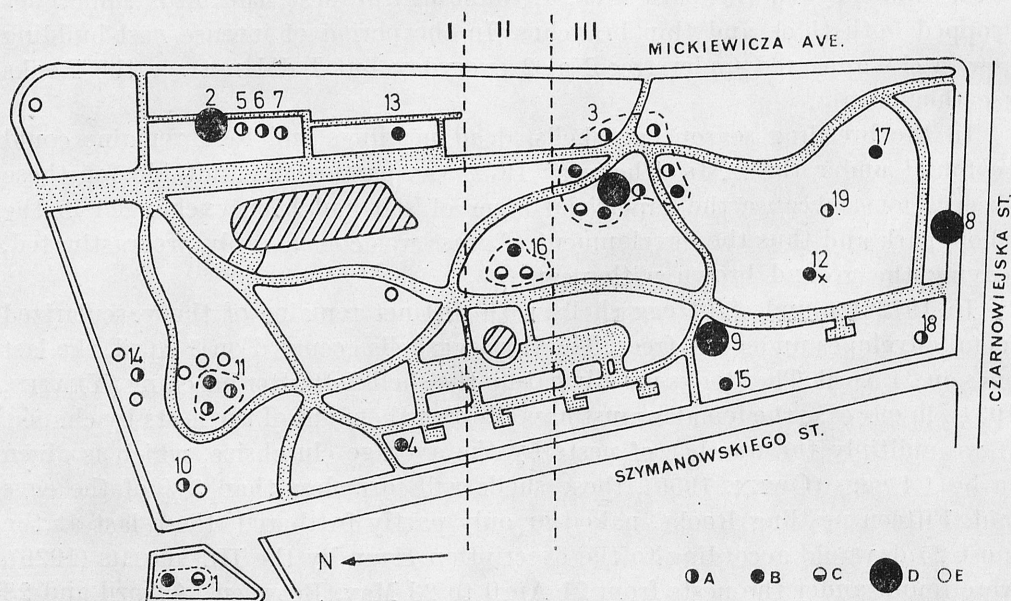


Fig. 4. The Distribution of Trees with Rook Nests in Krakowski Park. The following designations are used: a — dots for paths and small squares, b — parallel dashes for periodical water reservoirs, c — a cross for the place of constant feeding of Rooks. Two broken lines divide the park area into three zones: I, II and III. A — tree with one nest, B — tree with two nests, C — tree with three nests, D — tree with more than three nests, E — tree with nests built in spring 1975. The figures mark single trees with nests or their groups. 1 — *Populus tremula*, 2 — *Ulmus* sp., 3 — *Betula* sp., 4 — *Ulmus* sp., 5, 6, 7 — *Fraxinus*, 8 — *Populus nigra*, 9 — *Populus alba*, 10, 11 — *Betula* sp., 12 — *Ulmus* sp., 13 — *Aesculus*, 14 — *Fraxinus*, 15 — *Acer* sp., 16 — *Fraxinus*, 17 — *Ulmus* sp., 18, 19 — *Fraxinus*

day. They provided a basis for a map of the park (Fig. 4), on which the trees with nests recorded during the five-year observations were plotted, and for Table VI, which gives a list of these trees and the numbers of nests placed in them in particular years. They facilitate an insight into the spatial structure of the rookery and its transformation. In four cases (Nos. 1, 3, 11 and 16) we are concerned with clumps of several trees with nests, the crowns of which come close to each other. The symbols of the trees are five kinds of circles indicating how many nests occurred in them at the same time. How many times the Rooks nested in particular trees is shown in Table VI, which also gives how many nests were placed in a given tree or a group of trees in a given year. In the years in which the nests were knocked off appropriate figures express maximum numbers of nests.

The Rooks' favourite tree was the elm (No. 2), in which the rookery was initiated in 1969. There were 14—30 nests in this tree year in year out in spite of the threefold knocking-off of them in two different years. Another tree in which the Rooks built their nests, 7—11 in number, constantly but not before 1971 was poplar No. 9. These nests had decayed and disappeared without a trace at the latest by the end of January.

Special attention should be given to the group of poplars (No. 1) growing at the very border of the park, close to the street. There was one nest there as early as 1969 and in 1970 the number of nests increased to five, all of them built in April. Three pairs nested there in the next year. Two pairs occupied two old nests towards the end of February and they used two other nests for material to repair them. The third pair did not appear before late April and built a new nest. About mid-March 1972 the remains of these nests were used as building material for nests in another place of the park. Thus, the Rooks did not nest there in 1972 and 1973, and two pairs settled in that tree in 1974.

The history of nesting in poplar No. 8 was different. Eight pairs of Rooks built their nests in it in 1971. They were all knocked off in the second half of April and next three new nests were made. In the following year two pairs nested in this tree and in 1973 two nests were under construction towards the end of April, but they were taken to pieces perhaps before they had been finished. In May I could not see them for leaves and in October there was not a sign of them left. In the next year (1974) no Rooks appeared in this tree, not even those occupying a nest-site.

A group of trees designated as No. 3 consisted of some birches growing close to each other. The number of trees occupied for nests fluctuated from 4 to 9 in different years and the number of nests changed with them from 6 to 23. The smallest number, found in 1974, may be referred to the fact that the strongest tree, situated centrally and carrying up to five nests, had been broken by the wind. The birds did not decide to set up their nests in the changed set of trees before the beginning of April. The remaining trees of the rookery demand no detailed comment.

During the five years of investigation Rooks nested in hardly 31 trees out of the 450 growing in Krakowski Park, this number forming 6.8% of the total.

Table VI

Distribution of Rook Nests in Park Trees. During six years the Rooks built nests in 31 trees. These trees or groups of trees are denoted by numbers (1—19), which are plotted on the diagrammatic map of the park (Fig. 4), their scientific names being given there. The maximum numbers of nests built in a tree (or group of trees) are given in the blank appropriate to this tree and the year. On the right side of the table the total number of nests in May and the number of nests knocked off in particular years are given

Year	Trees or groups of trees																			Total of trees	No. of nests	
																					knocked off in May	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
1969	1	1																		2	—	
1970	5	14																		2	—	19
1971	3	22	12	3				8	11			2						2		12	28	40
1972	3	30	15					2	11			2			2				1	14	3	64
1973	—	27	23					2	7				2							12	17+41	23
1974	2	22	6	2	1	1	1		10	1	4			1		8				19	—	59

The nests occurred every year in one tree, four times in succession in three trees, two or three times in nine trees, once in 18 trees. The species of the tree was not decisive of its attractiveness as a nest-site to the birds: there were nests in 12 birches, 9 ashes, 3 elms, 4 poplars, 2 maples and 1 chestnut. In relation to the number of trees of the given species growing in the park, the birches, poplars, elms and ashes were only slightly more frequently chosen for nesting (respectively, 10.8, 16.0, 9.7 and 9.1 %).

The number of nests in a tree depends on its size and crown shape. The breast height circumference of the trees with nests was 470 cm in No. 8, 390 cm in No. 2, 360 cm in No. 9 and 110—200 cm in the remaining trees. If the size of the crown depends on the trunk diameter, its shape is as a rule a specific character. Elm No. 2 has unquestionably the most imposing, regular and full crown. Consequently, the birds built the most nests in it. Poplar No. 9 exceeds the other trees in height, but its very elongate branches form a relatively small and thin crown and the arrangement of its embranchments does not protect nests against destruction in winter. Poplar No. 8, lower than the preceding one, has a wider but still less full crown. For unknown reasons this tree has lost its privilege of bearing nests since 1972. The other trees with nests are considerably smaller or have small crowns (No. 1). Many other trees in the park exceed them in size but have not attracted any Rooks to nest in them so far.

The following conclusions may be drawn from the data presented: In the course of six-year observations, including 1975, the number of nests in the rookery in one year never exceeded 70. Two factors must certainly be excepted from the responsibility for the restriction of this number: 1) the lack of convenient places for nests and 2) the excessive density of nests. The points tried by Rooks as nest-sites were much more numerous, as they reached 148 in 40 trees in those years. This number is more than twice as large as the maximum number of nests built in one season. Thus, many places tried as nest-sites were afterwards left unoccupied. Neither does the excessive density restrict the size of a rookery. On the contrary, Rooks as gregarious birds willingly build nests close to each other. In Krakowski Park, especially in the years 1974 and 1975, the nests were accumulated mostly or almost exclusively in the northern part (Fig. 4, zone I), whereas the other part, more or less equal in area, was nearly empty (Table VI). The supposition arises that there were not enough Rooks in Cracow for colonizing the park. If it could be shown that in Cracow there were no major annual fluctuations in the total number of nesting Rooks, that supposition might possibly be regarded as well grounded. However, we have no such calculations at our disposal so far.

In Krakowski Park the nests are not, as yet, such a great size as are some nests of old rookeries, for here each nest is built anew every year and only a few ones left from the preceding seasons are rebuilt. It never comes here to the building of new nests on the bases of the old ones (YEATES, 1934).

Man's attempts to interfere directly with the life of the rookery only temporarily reduced the number of nesting birds. In the next breeding season similar

numbers of Rooks turned up again in the nesting area. During the six-year observations the rookery under study was destroyed four times with the help of implements of the Fire-Brigade in 1971, 1972 and 1975. The nests were knocked off once in the second decade of March and three times in the second decade of April (Fig. 3). The first intervention affected the second phase of formation of the rookery and the remaining ones the fourth phase. The March knocking off caused great losses (90% of nests) and disturbed the normal life of the colony for a day. However, the rebuilding and development of the rookery progressed quickly and it again attained the state approximating the maximum one. On the other hand, the April knocking off interrupted completely (1973, 1975) or at least limited the further development of the nesting colony (1971).

The direct reaction of the birds to the knocking off of their nests is illustrated by the observations from 19 March 1973. At 8 a.m. there were 21 nests in the park, of which 18 in tree No. 2. Three hours later there were only three nests left, one of them in tree No. 2. About 2 p.m. the Rooks, visibly excited, were sitting on the roofs of the nearest two houses. Suddenly, a group of 14 birds flushed with a big noise and circling approached tree No. 2. They alighted in it for a moment and again returned to the roof. After a few minutes another group came flying towards this tree, circled it many times and flew away. Such flights were repeated several times. It was clear that the birds were cowed and irresolute, whether or not to return to their destroyed nests. In the evening, just after sunset (5.56 p.m.), 40—50 Rooks altogether perched in groups in their own tree and in the neighbouring ones. They took wing loudly, circled, flew away and returned again. After 20 minutes about 30 birds were perching unquietly in tree No. 2 and a similar number in a neighbouring tree. Further pairs arrived singly. Particular groups flushed continually from the trees and returned in a little while. Uneasy voices and fluttering of wings could be heard.

The next morning (20 March) 32 Rooks bustled noisily in tree No. 2, there were also some pairs in trees Nos. 9 and 3. At 2 p.m. the beginnings of four new nests appeared beside the undestroyed old nest in the main tree and building was continued to sunset. About 40 birds worked and so somewhat more than the owners of the nests destroyed. In addition, about 15 birds settled in tree No. 9. The next day (21 March) was a day of normal though hectic work at nest-building. Thus, the birds would not be deterred by human interference. It however happens that the Rooks of a destroyed colony move to its neighbourhood (Dyrce, 1966).

I did not experience together with the Rooks the April day of destruction of their nests nor a few following days in 1971 and 1973. At any rate, most of the birds from the destroyed nests, if not all of them, left the rookery. In the morning of 4 April 1975 40 nests were knocked off from 13 trees, mostly those of the group including Nos. 11, 10, 1 and 4; 27 nests remained in 6 other trees. At 2 and 4 p.m. the Rooks flew about their trees or alighted in them, particularly numerous as regards trees No. 11. 16—22 birds, crowing little but frequently flying about, gathered there. Their unrest and agility were however incomparably

smaller than they were, as described above, after the interference in March 1973. After 5 p.m. 14 birds began to settle for the night in trees Nos. 11, four in No. 10 and two in No. 1. The next day (5 April) in the morning two birds appeared in tree No. 4, four in No. 10 and eight in No. 11. Out of these last, a pair constructed a nest-base of several sticks. In the evening this was the only pair perching at the partly built nest. No perching Rooks could be seen in the other trees deprived of nests either in the evening or on the next days. On the other hand, on 7 April the beginnings of a new nest appeared beside the almost ready nest in tree No. 11. It may therefore be said that 38 or 39 pairs left their nesting area.

The difference in behaviour between the birds whose nests were knocked off in March and those which lost them in April is due to the irreversible changes occurring in the secretion of the pituitary gland at that time. It secretes FSH (follicle stimulating hormone — LEHRMAN, 1959), which induces the ovary to produce eggs. Ovulation is released by the sight of a nest being built. When the female incubates the eggs it warms them with the naked and strongly congested skin of the ventral side of its body. The thermal and tactile stimuli coming from them begin to act upon the pituitary. As the female incubates, the production of FSH decreases gradually in favour of the secretion of prolactin, which controls the care and rearing of the young (LEHRMAN, 1959). If the nest of a Rook is destroyed in the period in which the pituitary still produces sufficient amount of FSH, there is a possibility for the bird to lay a new clutch. But in the prolactin stage the pituitary is unable to recover its previous stage.

In the case described from 1975 the pituitary glands of the Rooks must have been in the stage of prolactin secretion, although it was only the beginning of April. That was however a year of exceptionally mild winter and warm spring, which accelerated the reproduction cycle. On 13 March in that year the rookery already consisted of 41 nests. If we bear in mind that the embryonic development lasts 18 days (NIETHAMMER, 1937), on the day when the nests were knocked off (4 April) the young were about to hatch or they had already hatched. The state of the pituitary gland of the females would correspond with LEHRMAN'S (1959) fundamental principles. In the other four years (1971—1973) the pituitaries may have attained the stage of prolactin secretion much later, because on 13 March the number of nests in the rookery ranged between 4 and 11.

VI. DISCUSSION

a. Flock Structure

All the observers agree that Rooks are very social birds. They constantly live in a group, together set up breeding colonies of varying sizes, after rearing the young join together to form flocks in the common roosts, from which they fly off together to their feeding area. With all that the flocks of Rooks are not

marked by a great compactness. Small groups separate from the flock on the way to the feeding area and they stop at different places over the distance of several kilometres. These groups scatter further in accordance with the field conditions and individual specimens may forage 20—100 m apart. Compared with Rooks, the groups of feeding Jackdaws are characterized by a much greater compactness (PINOWSKI, 1959).

The return to the roost is not a repetition of the morning flight in an inverted order. Above all, it lasts twice as long. The Rooks gather in small groups, which on the way back stop in trees or in meadows and loudly call down the birds flying over them. Some of these last stop, the other ones fly on. The groups, increased in size, fly slowly to the pre-roosting place, which in summer is situated in the Planty in the centre of the town and in winter at Łęg (GRODZIŃSKI, 1971). The Rooks coming from an extensive area meet there and form a flock of several thousand. Above 10 minutes after sunset they move in 2—3 compact groups to the trees used for roosting.

The pre-roosting place at Łęg is utilized also by birds which in the spring migrate from their winter quarters to the east. On 16 February 1974 Rooks, judging by the number, not only those of Cracow, had already gathered at Łęg; some of them perched in trees of an abandoned orchard, the others in a ploughed field and large wet meadows. About 4.40 p.m. a flock of Rooks came flying very high from the west and after a few calls alighted in the rallying place. In the same way two other flocks arrived at intervals of several minutes. At 4.55 a group of birds flushed and flew forming a 500-metre-wide band towards the Vistula. New groups, flushing in turns, joined the band. The departure from the pre-roosting place, with tens of thousands of Rooks and Jackdaws taking part, lasted 10 minutes. Out of that crowd of birds, only two Magpies, insensitive to the calls of the departing birds, remained in a tree of the orchard. This proves that Rooks readily seek the company of their relatives. The sight of birds on the ground signaled a place suitable for alighting and attracted the Rooks which were flying over in the same way as feeding Rooks, suggesting the abundance of food, attracted the birds present in the neighbourhood. PINOWSKI (1959) analysed this phenomenon and termed it „passive cooperation”. The same type of cooperation is the rally of birds in the common pre-roosting place.

The formation of any hierarchic organization in a flock of Rooks, whose size may be almost unlimited, from several hundred to several thousand birds, is out of the question. They are united, loosely, to be sure, by their sense of sociability, which approves also of the presence of Jackdaws. The flock consists of weaker and stronger individuals; the stronger birds endeavour to deprive the weaker ones of the food found by them, in which they are often successful. Frequently, one or two stronger birds drive the weaker ones away from the food spilt by passers-by; they treat Ring-doves and Pigeons in the same manner. If a group of, say twenty Rooks perch in a tree and get ready to depart, one or two birds give signals for flight first by calling then by flushing from the branch.

The other birds or only some of them follow. If none of them takes wing, the initiators of the departure circle the tree several times and usually alight in it again. Rooks use vocal signals much more reticently than do Jackdaws, especially while feeding (PINOWSKI, 1959).

The relations between adult birds of both sexes present themselves less clearly and decidedly against their gregarious life than they do in Jackdaws. These last form permanent pairs and always keep close to each other both during rest and while feeding and even at the time of flight. On the contrary, it is hard to tell which birds form a pair in the flock of Rooks, especially in autumn, and if they form a pair at all, for they seek natural food either singly or, if in a group, mostly at great distances from each other. Even in flight an indubitable pair may be separated by a distance of 100—200 m, whereas the Jackdaws which form a pair always remain in a close neighbourhood. Female Rooks always copulate in the nest, not only before laying eggs but even in the hatching period. Only 12 out of the 77 copulations observed from a hide were with their own mates (MARSHALL and COOMBS, 1957). Promiscuity was observed also by YEATES (1934).

b. Plasticity of Behaviour

Rooks are characterized by their great plasticity of behaviour under changed environmental conditions. It is well illustrated by their urbanization in Poland in the last several tens of years. Omitting the causes and the course of this phenomenon, I will only signal a few manifestations of plasticity. Rooks eat everything that they can swallow, not excluding indigestible rubber and plastic objects. They feed on vegetable and animal food, dead and alive, garbage and carrion. They choose the sites for nesting according to criteria known only to themselves, but when at Christchurch in New Zealand the trees, *Eucalyptus globulus*, in which they had nested exclusively began to die out, they moved to coniferous *Pinus radiata* about 1926 (BULL, 1957). Rooks build their nests in trees at considerable heights, mostly between 14 and 25 m (KULCZYCKI, 1973), but in the steppe regions of Kazakhstan they content themselves with dwarfish birches (GAVRILOV et al., 1968; RIABOV, 1970) or sallow shrubs (DEMENTIEV et al., 1954).

Owing to their plasticity Rooks occur in large areas of Eurasia and have become, in dependence on climate, sedentary birds in some regions or birds which come to breed in others, and in still other regions part of the birds behave as residents and part as migrants. In winter when the weather conditions prevailing in a given region make it impossible for the Rooks to acquire natural food, they get over their shyness of people and crowd in areas inhabited by them. At that time they learn readily and quickly to avail themselves of food offered them even in a complicated way (p. 472). This is true of the whole group of birds, in which however some individuals decide sooner to shorten the „fleeing distance” (STRAWIŃSKI, 1971) and are quicker at retaining the circumstances accompanying the offering of food.

c. Nest-building Period

In Rooks nest-building and egg-laying fall in the early spring, which is true of sedentary specimens living in south-west England (Cornwall — MARSHALL and COOMBS, 1957), at Oxford (OWEN, 1959), in Central Europe (Cracow) and also between the rivers Volga and Ural in East Europe (Furmanovo — GAVRILOV et al., 1968). On the other hand, the Rooks acclimatized in New Zealand about a hundred years ago shifted the breeding season to August and September (BULL, 1957), i.e. to the spring in that area. The mechanism of this phenomenon, known as photoperiodism, consists in the action of the lengthening of daytime in the winter-spring transitional period. The action of sunrays reaches the pituitary gland through the retina and hypothalamus and stimulates it to produce gonadotropic hormones (LEHRMAN, 1959; MARSHALL, 1961; BERGER, 1961; WELTY, 1963).

Within the period determined by photoperiodism the exact time of nest-building and egg-laying is to a great extent dependent also on climate (Fig. 5). In southern England these activities fall mostly in March (MARSHALL and COOMBS, 1957; YEATES, 1934), in southern Poland (Cracow) they last from mid-March throughout April and at Furmanovo in the U.S.S.R. begin as late as the begin-

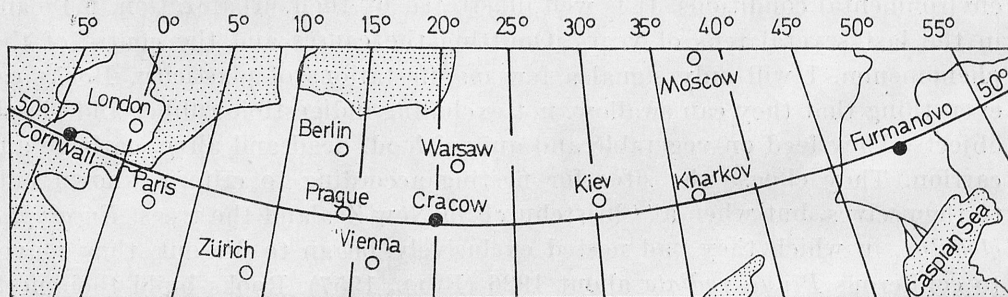


Fig. 5. Modifying Effect of Climate on the Nesting Season of Rooks. According to the principle of photoperiodism breeding should proceed in places situated close to 50° N latitude at the same time. However, nest-building occurs in Cornwall in March owing to its oceanic climate and at Furmanovo, in a continental climate, not before April. In Cracow with an intermediate climate nest-building is continued throughout March and April

ning of April (GAVRILOV et al., 1968). All these very remote nesting areas lie close to 50° N. latitude, that is, the day length increases at a similar rate in them. However, England has an oceanic climate, the Volga-Ural region an extreme continental climate, and Cracow an intermediate one.

Within these three climates there are annual fluctuations in weather, which may accelerate or delay the outset of the mating season. The exact time of egg-laying was noted for six years in the neighbourhood of Oxford. In the exceptionally warm year 1957 the first eggs were laid 16 days earlier than in the coolest year (OWEN, 1959). In Krakowski Park the beginning of nest-building also

underwent weather-induced fluctuations. On 13 March the number of set-up nests was 7 in 1971, 10 in 1972, 11 in 1973, 5 in 1974 and 42 in 1975. The year 1975 was marked by an exceptionally warm and fine prevernal period. Similarly, in the year 1973, cooler and more snowy, the Rooks which were not interested in nests disappeared 5 days later than in 1974. Migrations to breeding areas are also connected with the state of gonads, as has been proved by ROWAN (1931) by the example, among other birds, of *Corvus brachydactylos*, which in North America is a tally of our Rook.

In Cracow the nest-building and egg-laying period of Rooks is fairly considerably prolonged in comparison with this period in the other two regions. This is due to the fact that in Cracow, to be sure, the wintering Rooks begin to build nests at the beginning of March, but the birds which return successively from winter quarters proceed to work later and draw it out through a great part of April. The Rooks nesting in Cornwall are exclusively sedentary (MARSHALL and COOMBS, 1957) and they do not come into contact with the continental specimens at all. Rooks do not winter at Furmanovo. About mid-March they return from their winter quarters, from the Caucasus and Black Sea region and build their nests between 4 and 18 April (GAVRILOV et al., 1968). In the last two cases we are concerned with uniform populations.

d. Display Period

Unlike most birds, Rooks go through the preparatory sexual stage twice, once in the autumn, as if by way of experiment (MARSHALL, 1952) and for the second time, definitively, towards the end of the winter. In Cornwall the sedentary Rooks appear at the nests early in the morning as early as July. In August they begin to display. The display becomes more intense in September and October and is combined with the morning and evening visits to the nests. In the next two months the sexual behaviour subsides to revive in January and, above all, in February. Towards the end of February the birds begin to spend nights at the nests and to bring branches for building (MARSHALL and COOMBS, 1957). PORATH (1964) writes about autumnal (September-October) display in Schleswig-Holstein, where, too, we are concerned with a sedentary population.

Similar two seasons of preparations for nesting can also be distinguished in Cracow, but here the periods of display do not coincide with those in Cornwall and the intensity of autumnal display is considerably lower. Sporadic display begins as late as the beginning of November and increases in intensity towards its end. It is chiefly limited to soliciting calls and simple movements of the trunk, tail and wings. These signs wane clearly in December to reappear again, and then to a considerably higher degree, 5—6 weeks later. Along with display some Rooks begin to perch in most trees with nests, mainly at definite nests, as early as November. They are also seen to „be trying out if they fit in the nest”.

Both these preparatory sexual seasons correspond with the state of the sexual glands. MARSHALL and COOMBS (1957) examined their size, appearance

and histological structure in Rooks in the annual cycle. They found that in September and October the interstitial cells of the testes went through a period of secretion of sexual hormones and 13.6 % of males had bunches of ripe spermatozoa in their seminal canals. The ovaries of about 25 % of females had distinctly enlarged follicles of ova, but it did not come to ovulation. After a few weeks these processes were renewed and in March they attained a peak of activity (spermatogenesis, ovulation) in all the specimens examined. By analogy, it may be assumed that in Cracow the sexual hormones trigger sexual behaviour in a similar way in the autumn and induce a limited gametogenesis. Probably, they are also responsible for the interest a small percentage of the Rooks take in the nests throughout the winter.

The spring display and the whole breeding season should be related to the photoperiodism, whereas the factors releasing the autumnal preparatory sexual behaviour lie rather in the sphere of speculation. It is supposed that in birds the initiation of sexual rhythm is independent of external factors but only reflects the internal physiological rhythm (MARSHALL and COOMBS, 1957). BOULLOUGH (1945) writes about the Starlings residing in England, which have their sexual glands enlarged from September to November and form distinct pairs within a flock. On the other hand, the continental Starlings wintering in England do not attain this stage before the beginning of March, just before their return to the continent. He thinks that English Starlings, *Corvidae* and Tits are derived from the continental migrants which, attracted by the mild insular climate, settled there and whose pituitary gland induces the autumnal growth of the gonads.

Thus, it may be supposed that now the Polish Rooks split into two populations, a sedentary, some birds of which are capable of autumnal display, and a migratory, displaying only in the spring. However, BERESZYŃSKI'S (1974) approach to this phenomenon is different. According to him, there are two populations of Rooks, an urban and a non-urbanized. Only the urban Rooks occurred at the nests in the winter.

e. Significance of the Presence of Nests to Colony Development

The behaviour of the Rooks which perched at the nests in the winter of 1974 throws some light on the significance of nests to these birds in winter, for when the last of the more than twenty nests existing there in May disappeared at the beginning of February, the Rooks did not give up their watching in the tree. At the end of February, more than two weeks later, they built up the weak beginnings of new nests and perched at them sedulously. It was only a week later that they resumed work and continued building the nests. In this case they were not intent on building up the whole nest, this was rather an action symbolizing their choice of a tree and site for nesting. At any rate, the females did not act under the influence of ovaries with ripe eggs. The interest that Rooks

take in the nests starting from November is not caused by their complete physiological readiness for breeding but rather indicates their need to occupy a breeding territory.

Empty nests in trees attract some Rooks in the autumn and attach them to a tree throughout the winter. It might be conjectured that these are Rooks which occupied these nests in the spring and now return to them. However, it will be safer to assume that the Rooks interested in nests are those whose neurohormonal state has released the sexual rhythm section presented above. They may include also winter newcomers. After all, these birds form less than 10% of the individuals feeding in the park under study.

In setting up a nest, individual or in a colony, the Rooks act under the influence of neurohormonal stimuli, which govern their very complicated though automatized behaviour. At that, however, the birds retain a limited, to be sure, capability of individual decision as regards their behaviour. This is well illustrated by the instance of formation and development of the colony in Krakowski Park. This colony was initiated at two points at the opposite borders of the park. One of them are lofty and slender poplars (No. 1), whereas the crown of the other tree (elm No. 2) is globular in shape. The birds individually chose two types of trees which differ diametrically from each other in appearance. The elm (No. 2) became more attractive for these birds in the following years; they built 14—30 nests in it each year. Its globular crown and the arrangement of branches convenient for placing nests on them probably suited Rooks very well. Two poplars No. 1 proved to be a less felicitous choice. Because of their shape they had not enough room for a large number of nests; in addition, there must have been something unfavourable about them, since in 1972 the Rooks took to pieces three nests which had remained in them from the previous year and they did not even try to nest in these trees in the next year. Nevertheless, they built up their nests in them two years later, i.e. in 1974. This behaviour proves that the Rooks chose the nest-sites deliberately, but the criteria that they used in selecting them are unknown.

The development of the colony, from 1971 onward, must be referred to the presence of nests in these first trees. The sight of the nests and clamours birds bustling about at them in the leafless park attracted sociable Rooks flying over. They alighted in the park and built their nests, chiefly on tree No. 2, which was the primary site of nesting. In particular years the nests in this tree formed 40—50% of the colony. The birds also built nests permanently in other trees, namely, in tree No. 9 and in the trees of group No. 3. When the central and strongest tree of this group had perished in the winter of 1973, the number of the nests in this group was reduced to somewhat more than one-quarter of the previous number. Apparently, this group of trees had lost its attractiveness.

The map of the park (Fig. 4) gives an idea of the distribution of the trees in which Rooks had nests in different years. The distribution of nests in these years is presented in Table VII. However, an appropriate combination of these two different elements of information is necessary to show that during the several

Table VII

Distribution of Nests in the Zones of the Park. The colony originated in the northern part of the park (zone I). In the next years it rapidly grew in number in this zone and in the southern zone (III) of the park. In the last two years the Rooks recolonized zone I and nearly completely abandoned zone III. Intermediate zone II plays an important role in this process

Year	Zone I No. of		Zone II No. of		Zone III No. of	
	nests	trees	nests	trees	nests	trees
1970	19	2	—	—	—	—
1971	28	4	—	—	35	8
1972	33	2	—	—	34	12
1973	29	2	—	—	32	10
1974	35	12	8	3	16	4
1975	65	18	1	1	3	2

years of study the Rooks at first scattered their nests in different parts of the park and in the last two years accumulated them in its northern part.

For the purposes of these considerations I have divided the park, which extends north and south, into three zones. The middle zone, II, is a narrow strip perpendicular to the long axis of the park and including tree group No. 16. It separates the northern zone, I, from the southern one, III, which approximates zone I in area. Table VII shows how the number of nests and trees in which they were placed changed in the six-year period of study (1970—1975). The rookery in the park began in the northern zone (I), but as early as 1971 there were more nests in the southern zone and twice as many trees in which they were situated. In 1972 and 1973 the difference in the number of nests between these two zones diminished distinctly, whereas the number of trees with nests increased in the southern zone. The crucial year 1974 was characterized by the appearance of eight nests in the middle zone (II), a decrease in the number of nests by a half in the southern zone (III) and an increase in the northern zone (I). None-the-less the rise in the number of trees with nests from 2 to 12 in zone I and the drop from 10 to 4 in zone III are striking. This trend in changes reached its peak in 1975: 65 nests in zone I and only 4 in the other two, accompanied again by a marked increase in the number of trees with nests.

A close analysis of the relations in zone III throws some light at the mechanism of changes in the rookery. Here we are, above all, concerned with tree No. 8. In 1971 eight nests appeared at once in it and other four in trees Nos. 12 and 17 in its neighbourhood. It should however be added that tree No. 8 grows in the pavement at the edge of the park. In the next year there were only two nests in this tree and one in either of two neighbouring trees (Nos. 18, 19). Thus the number of nests was reduced both in the main tree and in the neighbouring ones. The year 1973 still augmented this fall in the number of nests. The bases of two nests were built up temporarily in the main tree and none at all in the

neighbouring trees. In 1974 a large section of zone III, up to tree No. 9, was without nests.

In birch group No. 3 the number of nests grew from 12 to 23 in 4 to 8 trees in 1971—1973. In 1974, after the strongest tree had been destroyed, it was not before the late spring that the Rooks built up six nests. In the next year there were only three nests in two trees and they were the only nests in zone III, because tree No. 9, carrying many nests (7—10) up to then, was not even visited by the birds occupying nest-sites early in the spring.

If in these considerations we omit zone II, as a transitional one, zone I is characterized by a conspicuous density of nest-sites in 1974 and 1975. The nests were concentrated in the vicinity of elm No. 2 and at the other end of the park near trees Nos. 14 and 11. In these places the Rooks began to perch in the trees with nests of the last year earlier than elsewhere and here they started to build new nests. In another 2—3 weeks new pairs appeared and built further nests in the same or neighbouring trees.

It is difficult to say what were the Rooks guided by when they colonized zone III and recolonized zone I. The abandonment of tree No. 8 and especially No. 9 may be explained by the lack of Rooks building nests in the neighbourhood. On the other hand, the Rooks busy building nests in zone I at that time unconsciously attracted (passive cooperation) other birds which were seeking nest-sites.

The setting up of one, two or even three nests in a new tree does not settle what will happen in it in the next year. In 1971—1973 there were seven such trees, growing singly, in Krakowski Park and Rooks nested once again only in one of them and only in the next year. Can therefore a single nest built outside the existing rookeries give origin to a new rookery? In the last two years in Cracow I observed two cases of single nesting, which disappeared completely in the next year. Out of the other Polish towns BERESZYŃSKI (1974) mentions Poznań with two such cases, Łódź with seven and Lublin with three. In only one of them, at Poznań, such a nest became the origin of a rookery, which after ten years consisted of 37 nests. This suggests that the individual choice of a tree for nesting may, but need not, attract another pair and incline it to nest together. The use of the same tree is rarely prolonged for the next year and the fixation of nesting and the development into a big rookery belong to exceptions. In addition to the sense of sociability and memory, some other reasons must be decisive of the site of a nest, e.g. the possibility of placing the nest firmly and the availability of building material. There is besides no certainty whether the builder of the previous year appeared at the same place in the next year.

The formation of a rookery at Wrocław may be used as an evidence that Rooks of different generations find a region of the town to be suitable for inhabitation independently of each other. In 1919 a rookery arose in Plac Teatralny and in 1943 in Podwale Świdnickie. In both cases the rookeries were immediately liquidated by people. In 1945 there was not a trace of them. Since 1950 and 1951 the Rooks nested in both these places and for good at that (SZARSKI, 1955; SEMBRAT, 1955; PRZYBYŁA and SZARSKI, 1957). SZARSKI (1955) emphasizes

the attractive effect of the nesting Rooks upon the other ones wandering about in the neighbourhood.

The period of nest-building is protracted for a fairly long time in Rooks, because they start it in groups at various times. In a rookery in south-eastern England the first series of nests arose about mid-March and the second in the first week of April (YEATES, 1934). In a Warsaw rookery BUSSE (1962) distinguished three terms at which successive flocks of Rooks, which came flying at fairly great intervals of time, enter upon building. After three years of further observations BUSSE (1965) stated his opinions more precisely. He distinguished four periods of development of a rookery: I — first nests, II — rapid growth in number, III — slow increase in number, IV — slight fall in number. He ascribed some nests, i.e. the first ones, to the wintering birds and the next ones to the birds returning from winter quarters from the west. In Cracow it was possible to distinguish similar four phases of development of the nesting colony: I — occupation of the rookery, site II — intense nest-building, III — slackened rate of building, IV — building by birds belated in the sexual cycle. Presumably half of the nests belonged to the wintering Rooks, the rest to those which had returned from winter quarters or to juvenile birds. If the delay of the second, third and fourth phases is ascribed to the arrivals from winter quarters, why some phases are also observed in the development of rookeries in England? A deeper cause must underlie this phenomenon. Perhaps these birds react differently, in a quantitative sense, to seasonal climatic stimuli and the phenology of nesting might differentiate Rook populations.

f. Regulation of Rook Populations in Towns

Town inhabitants treat Rooks in a various way. In winter they feed them, whereas in the breeding season regard them as a nuisance, whose uproar disturbs peace and faeces make the utilization of park paths and benches difficult. Hence the decision of knocking off the nests. If this is done in March, it is followed by the immediate restitution of the rookery. However, the same procedure carried out in April, when its victims are nests together with nestlings, destroys the terminal phase of reproduction in a drastic and irreversible way. However, it does not, for the most part, prevent the restoration of the rookery in the next year. If therefore the decision of liquidation of a rookery has been made, the attempt to remove the nests should be made in the autumn, after the trees have shed their leaves.

In the light of observations presented in this paper, empty nests attract their future users as early as November and attach them to the rookery for ever. There are only few such birds ready to watch at the nest-site, but they suffice to attract other Rooks seeking nest-sites by their presence and bustling near the nests in the spring. This happens on the principle of „passive cooperation”

according to PINOWSKI's (1959) terminology. The removal of the nests in the autumn will therefore destroy this link in the full-year cycle of rookery life and will be more humane at that.

Translated into English
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STRESZCZENIE

Park Krakowski zajmuje powierzchnię około 5 ha, otoczoną zwartą zabudową kilkupiętrowych domów. Gawrony żerują w nim przez pięć miesięcy jesienno-zimowych, od marca gnieźdzą się do czerwca, a w lipcu tylko nocują w drobnych

grupach. O liczebności żerujących gawronów decydują warunki klimatyczne — mrozy, śniegi (Ryc. 1, 2), ewentualnie mgła (Tabela I), a także dokarmianie przez ludzi. Liczba obecnych gawronów rośnie w październiku i listopadzie stopniowo i z wolna. Żerujące gawrony znikają natomiast koło połowy marca w dużej grupie, jak to wynika z obserwacji nad osobnikami, które zostały uwarunkowane na określony sposób dokarmiania (Tabela II).

Część gawronów zdradza od jesieni objawy płciowego pobudzenia; pojedyncze osobniki tokują w charakterystyczny sposób siedząc na drzewach, lub pary chwytają się za dzioby, względnie karmią nawzajem. Z końcem grudnia słabną te zapędy, z tym że w drugiej połowie stycznia zaczynają się wzmacniać. Gawrony mogą tokować zatem dwa razy w roku. Około 10% ptaków żerujących w Parku zaczyna już od połowy listopada interesować się gniazdami siadając obok nich lub w nich. Odwiedziny te przeważają w godzinach porannych i powtarzają się bez przerwy przez całą zimę. Od początku marca rośnie liczba takich gawronów w tempie przyspieszonym, przy czym niektóre próbują przejść na nocowanie przy gniazdach. Nocowanie rozpoczyna okres wzmożonego gromadzenia się na drzewach gniazdowych i budowy nowych gniazd (Tabela II, Ryc. 1, 2, 3). Gniazda kolonii parkowej są mniej więcej w połowie dziełem ptaków tu zimujących i w połowie powracających z zimowiska.

Kolonia gawronów w Parku powstała w r. 1969, a od roku 1971 co wiosną ptaki budowały 60—70 gniazd. Gniazda te niszczały od października do lutego w sposób naturalny, na skutek niekorzystnych warunków klimatycznych, jak wiatry, deszcze, mrozy, a przede wszystkim śniegi (Tabele III, IV, Ryc. 3). W lutym spadała liczba szczątkowych gniazd do kilku sztuk, w jednym roku do zera, a w najpomyślniejszym do 12. Można przyjąć, że gawrony w Parku co roku odbudowują swoją kolonię od nowa. W wiosennym okresie budowlanym kolonii można wyróżnić cztery fazy: 1 — pierwsze zajmowanie miejsc pod gniazda, 2 — intensywne roboty budowlane (powstaje 40% gniazd), 3 — powolne tempo budowlane i 4 — zajmowanie peryferyjnych lokacji przez ptaki z opóźnionym cyklem rozrodu (Tabela V, Ryc. 1, 2, 3).

Na terenie Parku gawrony założyły w ciągu siedmiu sezonów, licząc w to także wiosnę r. 1975, na drzewach spośród 450 rosnących (Tabela 6, Ryc. 4), w sumie 148 gniazd. Liczba ta przewyższa przeszło dwukrotnie roczne zapotrzebowanie na punkty lokacyjne. Rozkład gniazd na poszczególnych drzewach był bardzo nierówny (od 1—30 sztuk, Tabela VI), niezależny od gatunku drzew, lecz od rozmiarów i ukształtowania ich korony. Zaznaczają się także wyraźne fluktuacje w zagęszczeniu gniazd w różnych okolicach Parku (Tabela VII, Ryc. 4). Kolonizowanie zaczęło się od strefy „I” w północnej części Parku, ale już od r. 1971—1973 więcej niż połowa gniazd znalazła się w południowej części Parku w strefie „III”. W następnym roku zaczęła się rekolonizacja strefy „I”, wiążąca się z powstaniem strefy pośredniej „II”. Ten ostatni kierunek zmian doprowadził w r. 1975 do prawie całkowitego opuszczenia strefy „III” i „II”. Wiąże się to prawdopodobnie z tym, że więcej gniazd przetrwało zimę w strefie „I” niż w obu pozostałych (Tabela IV, Ryc. 4).

Fotoperiodyzm wyznacza czas pory godowej gawronów na początek wiosny; gawrony aklimatyzowane w Nowej Zelandii przesunęły czas godów o pół roku do okresu tamtejszej wiosny (BULL, 1957). Dokładny termin budowania gniazd w okolicach leżących w sąsiedztwie 50° szerokości geograficznej Europy waha się znacznie zależnie od klimatu. Lokalne wahania klimatyczne mogą jeszcze przesunąć o kilka dni czas znoszenia pierwszych jaj (OWEN, 1959). Gawrony osiadłe w Kornwalii o łagodnym klimacie oceanicznym zajmują się tym w marcu (MARSHALL i COOMBS, 1957), natomiast ptaki powracające z zimowiska do Furmanowa o klimacie skrajnie kontynentalnym — dopiero w kwietniu (GAVRILOV i in., 1968). W Krakowie o klimacie pośrednim pomiędzy obu poprzednimi budowa gniazd ciągnie się przez marzec i kwiecień, ponieważ uczestniczą w niej gawrony zimujące i powracające z zimowiska. Pod wpływem skrajnych klimatów powstały zatem w Europie dwie populacje gawronów, jedna osiadłych, a druga odlatujących na zimę. W naszych warunkach klimatycznych populacja rozszepia się obecnie na grupę osiadłą i odlatującą na zimę.

W kolonii parkowej niszczone znaczną część gniazd gawronów przez ich zrzucanie, raz w marcu (r. 1973) i trzy razy w kwietniu (r. 1972, 1973, 1975). Marcowe straty ptaki odbudowały natychmiast, kwietniowe natomiast tylko w minimalnym stopniu (Ryc. 3). Różnicę w skutkach tych ingerencji człowieka należy wiązać ze stanem neuro-hormonalnym samic, których przysadki mózgowe w kwietniu nie były już zdolne do produkcji hormonu FSH, wyzwalającego czynności jajnika (LEHRMAN, 1959). Niekompletne zrzucanie gniazd zamieszkałych przez gawrony nie zapobiegło temu, że w roku następnym kolonia się odtworzyła. Zniszczenie pustych gniazd w listopadzie usunęłoby ważne ogniwo w całorocznym cyklu życia kolonii; odpadłoby blokowanie przez szereg miesięcy miejsc lęgowych. Na wiosnę gawrony nie zgnęcone widokiem gniazd i ptaków zajętych nimi prawdopodobnie ominęłyby terytorium kolonii, albo zjawiłyby się nielicznie i w spóźnionym terminie. Są to bowiem ptaki, u których „bierna współpraca” (PINOWSKI, 1959) odgrywa w życiu społecznym podstawową rolę.

РЕЗЮМЕ

Краковский парк занимает площадь около 5 га и окружён плотными постройками многоэтажных домов. Грачи питаются здесь в течение пяти осенне-зимних месяцев, с марта по июнь гнездятся, а в июле лишь ночуют мелкими группами. О численности питающихся грачей решают климатические условия — морозы, снега (Фиг. 1, 2), вероятно туман (Табл. 1), а также докармливание населением. Численность грачей растёт в октябре и ноябре постепенно и медленно. Грачи, добывающие пищу исчезают около половины марта в большой группе, как это следует из наблюдений над особями, которые были обусловлены определённым способом докармливания (Табл. II).

Часть грачей с осени проявляет признаки полового возбуждения; отдельные особи токуют сидя на деревьях в характерной позе или пары хватаются за клювы или же кормят друг друга. В конце декабря это поведение слабнет, а во второй половине января усиливается. Таким образом грачи могут токовать два раза в году. Около 10 % птиц, добывающих корм в парке уже с половины ноября начинают интересоваться гнёздами, сидя около гнезда или в гнезде. Это происходит в утренние часы и повторяется непрерывно всю зиму. С первых чисел марта растёт количество таких грачей с увеличенной скоростью, причём некоторые пробуют ночевать у гнезда. Ночлег начинает период усиленного гомождения на деревьях с гнёздами и постройки новых гнёзд (Табл. II, Фиг. 1, 2, 3). Гнёзда парковой колонии почти в 50% сделаны зимующими здесь птицами, а остальные возвращающимися из зимовки.

Колония грачей в парке образовалась в 1969 г., а с 1971 г. каждой весны птицы строили 60—70 гнёзд. Эти гнёзда с октября по февраль естественным способом портились в результате неблагоприятных климатических условий таких, как ветры, дожди, морозы, а прежде всего снег (Табл. III, IV, Фиг. 3). В феврале уничтоженных гнёзд оставалось лишь несколько, в одном году гнёзд не было совсем, а в наиболее благоприятном году их было 12. Можно принять, что грачи в парке ежегодно отстраивают свою колонию вновь. В весенний строительный период можно выделить четыре фазы: 1 — захват мест на гнёзда, 2 — интенсивные строительные работы (создаётся 40 гнёзд), 3 — медленная постройка и 4 — захват периферийных мест птицами с замедленным циклом размножения (Табл. V, Фиг. 1, 2, 3).

На территории парка построили в течение семи сезонов, считая при этом также весну 1975 г., на 40 деревьях, среди 450 растущих (Табл. VI, Фиг. 4), в сумме 148 гнёзд. Это число почти вдвое больше годичного требования на локационные пункты. Размещение гнёзд на отдельных деревьях было очень неравномерным (от 1—30 штук, Табл. V), независимое от вида дерева, а от размеров и формы кроны. Резко видны также колебания в густоте гнёзд в различных окрестностях парка (Табл. VII, Фиг. 4). Колонизация началась с зоны „I” в северной части парка, но уже с 1971—1973 гг. более половины гнёзд было в южной части парка в зоне „III”. В следующем году началась колонизация зоны „I” вновь, связанная с образованием промежуточной зоны „II”. Это последнее направление изменений привело в 1975 г. к почти полному оставлению зон „III” и „II”. Это вероятно связано с тем, что больше гнёзд выдержало зиму в зоне „I”, чем в остальных зонах (Табл. IV, Фиг. 4).

Фотопериодизм определяет время брачного периода грачей в начале весны; грачи акклиматизированные в Новой Зеландии передвинули брачный период на пол года до периода начинающейся там весны (BULL 1957). Точный период постройки гнёзд в окрестностях расположенных в соседстве 50° географической широты Европы значительно колеблется в зависимости от климата. Местные климатические колебания могут передвинуть также на несколько дней откладку первых яиц (OWEN 1959). Оседлые грачи в Корнвалии с мягким климатом этим занимаются в марте (MARSHALL, COOMBS, 1957), зато птицы, возвращающиеся из зимовки в Фурманово с сильно континентальным климатом — лишь в апреле (Гаврилов и др. 1968). В Кракове с промежуточным климатом между упомянутыми выше постройка гнёзд продолжается в течение марта и апреля, так как в ней участвуют грачи остающиеся

на зиму и возвращающиеся из зимовки. Под влиянием крайних климатов в Европе образовались две популяции грачей: оседлых и улетающих на зиму. В наших климатических условиях популяция распадается в настоящее время на оседлую и улетающую на зиму группы.

В парковой колонии значительную часть гнёзд уничтожалось путём их сбрасывания раз в марте (1973 г.) и три раза в апреле (1972, 1973, 1975 гг.). В марте птицы отстроили гнёзда сразу, а разрушенные в апреле лишь в минимальной степени (Фиг. 3). Разницу в результатах влияния человека следует связывать из нервно-гормональным состоянием самок, которых передние доли гипофиза в апреле уже не продуцировали гормон ФСГ, вызывающий деятельность яичника (ЛЕНГМАН 1959). Неполное сбрасывание гнёзд занятых грачами не помешало восстановлению на следующий год колонии. Уничтожение пустых гнёзд в октябре устранило бы важное звено в годовом цикле жизни колонии; отпало бы блокирование ряд месяцев гнездовых мест. Весной грачи не прельщённые гнёздами и птицами, занятых ими вероятно обошли бы территорию колонии или появились бы в небольшом количестве и позже, так как это птицы, у которых „пассивное сотрудничество” (PINOWSKI 1959) в общественной жизни играет основную роль.

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