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Nesting of the Members of the *Corvidae* in Poland

[Pp. 583—666, pls. XXXVIII—XLVI and 3 text-figs.]

Gnieżdżenie się polskich przedstawicieli rodziny *Corvidae*

Гнездование видов из семейства *Corvidae* в Польшы

Abstract. Nesting of 7 species of the family *Corvidae* — *Garrulus glandarius*, *Pica pica*, *Nucifraga caryocatactes*, *Corvus monedula*, *Corvus frugilegus*, *Corvus corone* and *Corvus corax* — is dealt with. The nest site (height and type of site), material used for building, and the shape and size of nests are discussed for each of these species. A key to their nests has been made. A comparison with the descriptions of nests of other genera of the *Corvidae* permits the determination of a general scheme of their nest structure and suggests some phylogenetic relationships between particular genera.

CONTENTS

I. INTRODUCTION

The purpose of this work was to investigate the structure of nests in seven species representing the family *Corvidae* in the avifauna of Poland. The characterization of nests has been based on an analysis of their situation, building material, shape and size, allowance being made for their variation and the adaptive capacity of the given species. This provides the basis for the determination of the structural characters of nests typical of particular species and thus permitting their identification, and makes it possible to acquire information as to the general type of the structure of nests characteristic of this family as a whole. For this purpose they have, in addition, been compared with the descriptions of nests of other species, derived from literature.

II. MATERIAL AND METHOD

The material for this study was collected chiefly in the south-eastern part of Poland in 1964—1969. Each nest found was described on a separate nest-card, including the data on the habitat, nesting height, and type of site, and, if the author was in a position to examined the specimen closely, its building material, method of building and dimensions. Four basic measurements were taken, i. e., those of outer diameter, inner diameter, height and depth, the diameters being measured twice, crosswise. The arithmetic mean was calculated from the two measurements and used in further statistical computations. In series of nests, up to 30 specimens, the standard deviation and coefficient of variation (v) were calculated for all these measurements. Since it was not always possible to carry out full examination and take all the measurements, the numbers of nests examined within series of a given species often differ from each other.

III. JAY *GARRULUS GLANDARIUS* (LINNAEUS, 1758)

Own material

The study material consists of 31 Jay nests examined closely, and it is complemented with additional data concerning the nesting height and site of other 12 nests. The material was collected chiefly in the Kraków Province and partly in the Rzeszów and Katowice Provinces, and represents the nominative form *Garrulus glandarius glandarius* (LINNAEUS, 1758). Nests were gathered in various habitats: at the edge of and inside forests, in wooded areas situated among fields, and in parks and cemeteries, both isolated, distant from human settlements, and those lying within the bounds of towns. All these habitats differ rather much from each other in biotopic conditions, but none of them could be distinguished as a particularly preferred one.

The nesting height of 43 nests of the Jay is presented in Table I. It ranges from 1 to 13 m above the ground, showing a tendency to occur in larger numbers in the height groups 2—6 m. It is difficult to point at any concrete factors that condition the situation of nests at some heights, for nests situated at extreme heights are met with beside each other in both different and similar habitats. Convenient conditions of placement and nest safety certainly play an important role, but in some cases seem to have been neglected.

Table II gives a list of species of trees and shrubs in which the nests were placed. The shares of deciduous and coniferous trees are nearly equal, the pine

Table I

Nesting heights of the Jay *Garrulus glandarius*

Height, in m.	Number of nests	%
1·0—1·99	2	4·65
2·0—2·99	9	20·93
3·0—3·99	9	20·93
4·0—4·99	5	11·63
5·0—5·99	4	9,30
6·0—6·99	3	6·98
7·0—7·99	3	6·98
8·0—8·99	2	4·65
9·0—9·99	1	2·32
10·0—10·99	2	4·65
11·0—11·99	2	4·65
12·0—12·99	1	2·32
Total	43	100·00
Mean height 5·26 m		

and oak being the most numerous and, among the shrubs, the hawthorn. However, these data allow no conclusions concerning preference; it should rather be assumed that there is no preference in this respect at all.

The nests are positioned in trees in rather various manner, which is illustrated in Fig. 2, and Table XXIX. They are most often placed on several thin lateral branches of offshoots, close to the trunk (Fig 2 B_1, B_2) and irrespective of the species of the tree they are sited in the lower and middle portions of the crown, the trees being in the age group from 30 to 70 years. In the material under study this type of position includes about 40% of the total of nests. The position of nests in the top whorls or forks of young coniferous and deciduous trees is also relatively numerously represented (about 27% of nests — Fig 2 A_1, A_2). The third type comprises nests situated in the terminal forks of lateral

horizontal branches, at a distance from the trunk (Fig 2 C_1, C_2). In this case the nest rests with its whole base on several horizontal crossing twigs and, in addition, leans against one or several vertical branches. Analogous placements of nests are also encountered in shrubs, e. g. the hawthorn or blackthorn. A general characteristic of all the types of nest sites is that the nests rest on relatively thin and numerous branches, thus having many points of support and attachment, which, in turn, results in their great stability. A nest placed in

Table II

Species of trees and shrubs in which the nests of the Jay *Garrulus glandarius* were found

Species of trees and shrubs	Number of nests	%
Pinus silvestris	7	17·0
Quercus robur	6	14·6
Larix sp.	4	9·9
Crategus oxyacanta	3	7·3
Abies alba	3	7·3
Carpinus betulus	3	7·3
Betula verrucosa	3	7·3
Fagus silvatica	3	7·3
Picea excelsa	2	4·8
Pinus strobus	1	2·4
Cupressus sempervirens	1	2·4
Acer platanoides	1	2·4
Salix cinerea	1	2·4
Alnus incana	1	2·4
Prunus spinoza	1	2·4
Total	41*	100·0

* Two nests were sited in rock crevices.

a recess in a willowtree and another at the top of a ladder leaning againts the wall of a hunting-box inside a forest represent exceptional nest sites. Nesting on rocks is also relatively rare. Out of the two nests found, one was situated in a rocky cleft and additionally leaned against a young tree, growing in front of it, on one side, and the other was in a small niche in a steep slope grown over with low shrubs and grass.

Seen from the outside, the nest of the Jay somewhat resembles the nest of the Hooded Crow, from which it however differs in a number of characteristics, especially those of the structure and building material. The outermost layer of the nest, constructed of sticks and twigs in all cases, forms its covering (Fig. 3:1). The length of pieces ranges from more than ten to several tens of centimetres (averaging 30 cm) and their thickness is mostly 0·5 cm (0·3—1·5 cm).

The material reveals a regularity, which consists in the maintenance of the definite mass of individual sticks and twigs, that is, the shorter a twig, the thicker it is. Most thin twigs are, in addition, forked at ends. The species of the tree from which the building material is derived is probably of little importance, since we meet with nests built of material representing one species (both a deciduous and a coniferous one) or of mixed material containing two or more species, generally those growing in the vicinity of the nest. The ratio of fresh to dry twigs is approximately as 70 to 30. The side-walls of the nest together with its base form the covering layer and are built of identical material arranged similarly, which in the upper portion occasionally shows a slight tendency to the form of a circle. In these cases the external layer is particularly compact and the material is arranged so that the thickest pieces lie on the outside and become thinner and thinner towards the inside of the nest. Similarly, the thickness of the pieces of material changes with the height of their position in the nest, being the largest in the base and decreasing gradually in the upper portions. Sometimes, especially when the nest is stuck in a compact whorl, this layer is fragmentary, vestigial, or extends only halfway up the nest. The next layer, quite distinct in most nests, is the twiggy one. It is a single circular layer of thin and flexible twigs and rather thick rootlets, which form a sort of basket lining the inside of the external layer. The material used for this layer may derive from the same species of trees as those occurring in the covering layer, or from different ones, the main criterion of choice being its flexibility. The twiggy layer is built mostly of thin twigs of the hazel, birch and hornbeam, averaging 30 cm in length and 0·2—0·3 cm in thickness. The third, inner, layer of the Jay's nest is its lining. It is usually made of homogeneous material, e. g. rootlets or bast, but occasionally mixed material may be used, that is, the combination of rootlets and plant stalks or dry grass, vegetable fibres and bast. The lining material is arranged in a distinct circle and the whole is relatively well joined together. In most nests the bottom portion of the lining contains small amounts of additional components, like tufts of moss, dead leaves, grass rootlets and bark. They are situated in the same place as the layer of clay is in the nests of the Crow or Rook and perhaps are its equivalent. Exceptionally, single twigs, bramble shoots, or couch-grass rhizomes also occur in the lining. The upper portion of the lining differs from the lower and middle portions in its much softer and more carefully woven material, sometimes also in its composition. It may contain different admixtures, like feathers, animal hair (e. g., horse hair) or threads. Two parts can be distinguished in the lining, an inner and an outer part. The thickness of the lining averages 4 cm, of which about 1 cm falls to the outer layer.

The results of a qualitative analysis of the material used to build 27 nests of Jays are presented in Table III. Sticks and twigs, which make the more or less compact covering layer, occur in all nests. Thin rootlets of trees and shrubs and bast, which are main components of the lining, are fairly characteristic elements and were found separately or together in each nest examined. The nests

with blades and stalks of grasses were relatively numerous and formed 55·5% of the total, but the quantitative share of this material in particular nests underwent rather marked fluctuations. Moss occurred as a small admixture in the lining. The other materials were rarely used in particular nests and only as an addition, having no influence on the character and method of construction. Thus, it may be assumed that the Jays use a limited number of sorts of material

Table III

The qualitative analysis of the material used to build 27 nests of the Jay *Garrulus glandarius*

Material	Number of nests	%
Vegetable materials		
sticks and twigs	27	100·0
rootlets of trees and shrubs	23	85·1
bast	17	62·9
blades of grass	15	55·5
moss	10	37·0
rootlets of grass	7	25·9
thick stems of plants	6	22·2
vegetable fibres	6	22·2
dead leaves	6	22·2
bark	4	14·8
sprouts of blackberry	2	7·4
rhizomes of couch grass	2	7·4
Animal materials		
feather	4	14·8
hair of roe deer	1	3·7
horsehair	1	3·7
Artificial materials		
threads	1	3·7

to build their nests, confining themselves practically to four main ones, i. e., twigs and sticks, rootlets, bast and grass stalks, the last three sorts being complemented with and exchanged for each other according to their availability.

The external shape of the nest of the Jay is more or less stable and only to a low degree depending on the site conditions. In outline it resembles a hemisphere with a strongly flattened base. Only its size is variable, because the outer diameter and the height are correlated with each other to some extent; this also brings about the constant shape and form of the nest. The differences in size between individual nests are caused by the variable thickness of the external layer, which in turn is conditioned by the manner in which they are positioned. The thickest external layer occurs in the nests placed on horizontal branches at a distance from the trunk, whereas in those positioned in tight

whorls or in dense offshoots by the trunk it is, as a rule, thinner, owing to which the nests are smaller.

The range of the measurements, as well as their arithmetic means, standard deviations and coefficients of variation for 31 nests of the Jay are given in Table IV. As will be seen from the data included in it, the most stabilized measurement of the nest is the inner diameter. It ranges between 10·5 and 15·7 cm, the mean being 12·5 cm and the coefficient of variation 8·91. The nest depth

Table IV

Survey of nest measurements of the Jay *Garrulus glandarius*, showing their ranges, means, standard deviations and coefficients of variation

Measurement	Number of nests	Range in cm.	Mean	Standard deviation	Coefficient of variation
Inner diameter	31	10·5—15·7	12,56	1·12	8·91
Outer diameter	31	16·0—33·5	23·47	5·66	24·11
Depth	31	5·0—9·5	6·50	1·07	16·46
Height	31	8·5—26·0	15·75	4·48	28·44

is somewhat less stabilized and its coefficient of variation comes to 16·46. However, the nest height shows the greatest fluctuations. This measurement lies within limits of 8·5 and 26·0 cm, averaging 15·75 cm, and its coefficient of variation is 28·44. It must be assumed, in general, that the size of the Jay's nests undergoes great fluctuations, their outer measurements being to some extent dependent on the situation of the nest, whereas the differences in their inner measurements are probably related to the sort of building material used, which does not usually form a stiff and compact construction and, consequently, shows a tendency towards deformations.

Discussion

The basic nesting habitat of the Jay are various types of forest, the character of which may be very varied, as has also been recorded by other authors (EJGELIS, 1970; HALLADIN, 1935; KEVE, 1969; KOBAYASHI, 1932—1940; NAUMANN, 1905; NIETHAMMER, 1937). In addition, the Jay nests also readily in such urbanized habitats as parks and gardens in towns and villages and even in closely built-over town areas devoid of green (GOODWIN, 1951, 1953; PIECHOCKI, 1956a, b; RINGLEBEN, 1958; TUTT, 1953).

The range of the nesting height of the Jay is fairly precisely defined in literature. According to KEVE (1969) it is from 2 to 11 m, with a mean of 4·24 m. The height given by EJGELIS (1970) ranges between 0·6 and 12 m, concentrating about 5 m. Several nests recorded by HOLYOACK (1967) were situated over 9 m

above the ground and most of the nests mentioned by NIETHAMMER (1937) were at a height of 4—5 m. Similarly, according to Halladin, the Jay's nests are most often found at a height of 3—4 m, and out of the 27 nests described by MALCHEVSKI (1959) from the European part of Russia, 20 lay between 1·5 and 2 m. KOBAYASHI (1932—1940) gives the nesting height of 2—10 m for Japan. On this basis it may be assumed that the Jay nests relatively low, most of the nests being placed between 2 and 6 m above the ground.

MALCHEVSKY'S (1959) list of trees and shrubs in which he found the Jay's nests shows a variety of species similar to that observed in my investigation, the largest number of nests being found in pine-trees. The data given by EJGELIS (1970) also indicate that Jays nest readily and in abundance in young pine woods. In Finland the spruce is chosen most frequently (HAARTMAN, 1969). These data refer chiefly to forest environments, since in town areas the Jay may nest in different species of fruit-trees, like apple- or pear-trees (TUTT, 1953), or in decorative shrubs (HOLYOACK, 1967; GOODWIN, 1953).

Analysing the situation of the Jay's nests in trees and shrubs, GOODWIN (1956) gives several variants, which coincide fairly closely with the nest-sites reported in the present paper. At the same time he emphasizes the lack of any definite factors that would condition a given type of nest-site. According to HALLADIN (1935) and HAARTMAN (1969), the nests are most often placed in a whorl, close to the trunk, or among dense offshoots. The nesting of a Jay in a recess in a tree, mentioned above on the basis of my own material, is not an isolated case, for similar types of nesting are recorded by GOODWIN (1956), TUTT (1953), PIECHOCKI (1956a, b) and MALCHEVSKY (1959). The Asiatic subspecies *Garrulus g. paldifrons* KURODA nests in shallow holes and chinks in trees as often as it does on branches (KOBAYASHI, 1932—1940; GIZENKO, 1955). The nesting of the Jay on rocks, mentioned in this paper, is rather rarely observed; there is only one such case, besides ours, described in literature (HAARTMAN, 1969). Since about the middle of the present century, however, the nesting of the Jay on and inside houses of different types has been recorded pretty often (BOYD, 1929; BOUTINOT, 1958; GOODWIN, 1951; KEVE, 1969 OLLSSON, 1957; PIECHOCKI, 1956a, b; RINGLEBEN, 1958), and it corresponds with the nesting on rocks. The nesting in such unusual and vicarious places is not, however, as it might seem to be, connected with the lack of natural places for nesting typical of this species, but with a great plasticity of its nesting instinct, which makes it easy for the birds to adapt themselves to new conditions. This statement is supported by such facts as the nesting of a Jay on a rung of the ladder leaning against the wall of a hut in the forest, described in this paper, and the description of two nests built on the wooden lattice construction of a fire-watch-tower situated in a forest, quoted by MALCHEVSKY (1959, after KADOKHNIKOV).

The character and structure of the Jay nests analysed by EJGELIS (1970) and HALLADIN (1935) agree, as a rule, with the data given in the present paper, although there are some small differences in the composition of the lining material; these, however, lie within the limits of variation resulting from the diffe-

rences between the environments inhabited by the birds. Other, rather vague, descriptions of nest structure and material, existing in literature, also present them similar as regards characteristics and composition. In north and middle Asiatic subspecies — *G. g. paldifrons* KURODA, *G. g. japonicus* SCHLEGEL (KOBAYASHI, 1932—1940) and *G. g. taivanus* GOULD (YAMASHIMA and YAMADA, 1937) — moss is one of the basic building materials, whereas in the European forms it occurs irregularly as an additional component. According to KOBAYASHI (1932—1940), in *G. g. japonicus* a layer of material mixed with earth clods is, in addition, present at the bottom of the nest, which is not observed in the other European and Asiatic forms.

The data concerning the size of the Jay's nests presented in literature are unfortunately too scanty and unreliable to be used for statistic-comparative purposes. The inner diameter of these nests is 10—13 cm according to EJGELLIS (1970), 10—15 cm according to HALLADIN (1935) and 10—11 cm according to FEDUSHIN and DOLBIK (1967), which agrees with the results given in Table IV. However, according to the last two studies, the nest-depth was very small, from 3 to 4 cm and from 2 to 3 cm, respectively, the height being 9·5 and 7—8·5 cm. The measurements were supposedly taken on old nests or those with grown nestlings and thus reflected the deformations that they had undergone. On the other hand, the nest measurements in the subspecies *G. g. taixanus* GOULD (YAMASHIMA and YAMADA, 1937) and *G. g. japonicus* Schlegel (KOBAYASHI, 1932—1940) lie within the range of the results obtained for the nominative form on my own material.

IV. MAGPIE *PICA PICA* (LINNAEUS, 1758)

Own material

My data concern 45 nests, chiefly from southern Poland, belonging to the nominative form *Pica pica pica* (LINNAEUS, 1758), which inhabits throughout Europe, not excluding the British Isles. Detailed descriptions of these nests are complemented with quite a number of data on their habitats and nesting site and height.

The material represents various environments like suburbia, town gardens, gardens and other groups of trees in the proximity of country houses, single roadside trees distant from buildings, small woods in river valleys, groups of trees and shrubs amidst fields, and edges of forests. Each of these environments is represented by more or less the same number of nests examined. However, the Magpie is a very synanthropic species and so the habitats preferred are village and suburbian areas with a small number of houses and a comparatively large number of trees. It may be stated in general that the density of nests diminishes proportionally to the distance from these two typical environments.

The nesting-heights of 146 nests of Magpies are given in Table V. This measurements is characterized by its great range, from 1 to 30 m, there being a tendency towards nesting in definite groups of heights, since about 60% of the nests were situated between 3 and 11 m above the ground. However, the nesting-height depends greatly on the local environmental conditions, mostly on the nature of the tree groups or shrubberies and the degree of safety ensuring the

Table V

Nesting heights of the Magpie *Pica pica*

Height, in m.	Number of nests	%
1·0—1·99	6	4·1
2·0—2·99	4	2·7
3·0—3·99	15	10·2
4·0—4·99	11	7·5
5·0—5·99	10	6·8
6·0—6·99	11	7·5
7·0—7·99	13	8·9
8·0—8·99	10	6·8
9·0—9·99	8	5·4
10·0—10·99	12	8·2
11·0—11·99	2	1·3
12·0—12·99	8	5·4
13·0—13·99	4	2·7
14·0—14·99	2	1·3
15·0—15·99	8	5·4
16·0—16·99	1	0·6
17·0—17·99	2	1·3
18·0—18·99	4	2·7
19·0—19·99	—	—
20·0—20·99	7	4·7
24·0—24·99	3	2·0
25·0—25·99	2	1·3
28·0—28·99	1	0·6
29·0—29·99	1	0·6
30·0—30·99	1	0·6
Total	146	100·0
Mean height 9·53 m		

successful breeding. The latter factor seems to be even more important, because in most cases it is the one which determines the height of nesting. It is hard to say that the birds show any distinct preference for definite trees and shrubs that they use for nesting, which is illustrated in Table VI. Deciduous trees and

shrubs form a vast majority — 21 species, 141 nests. The remaining trees belong to three coniferous species (7 nests) and make rather sporadic cases. The poplar and willow-tree are represented most numerously of the deciduous trees and the blackthorn of the shrubs. The nests placed at the tops of tall poplars and willows and those in dense prickly shrubs are the most difficult of access and, consequently, they are the commonest as well, for the safety of a nest may be secured by its situation either in a place visible but difficult of access as in the cases discussed above or in a place which though easy of access is invisible.

Table VI

Species of trees and shrubs in which the nests of the Magpie *Pica pica* were found

Species of trees and shrubs	Number of nests	%
Salix sp*	22	14·8
Populus sp.**	18	12·0
Betula verrucosa	12	8·0
Prunus spinoza	12	8·0
Prunus padus	11	7·4
Alnus glutinosa	10	6·7
Fraxinus excelsior	9	6·0
Tilia cordata	9	6·0
Robinia pseudoacacia	6	4·0
Pirus communis	5	3·3
Acer platanoides	4	2·7
Quercus robur	4	2·7
Malus silvestris	4	2·7
Larix sp.	4	2·7
Prunus domestica	3	2·0
Prunus cerasus	3	2·0
Carpinus betulus	3	2·0
Ulmus campestris	3	2·0
Picea excelsa	2	1·3
Pinus silvestris	1	0·6
Prunus avium	1	0·6
Morus nigra	1	0·6
Crategus oxycantha	1	0·6
Total	148	100·0

* morphologically differentiated trees and willow shrubs.
** *P. tremula* var. *italica*, *P. nigra*, *P. alba*.

This may explain why the Magpies relatively often build their nests in the bird cherry and birch-tree, belonging to the species that are the first in the spring to develop their full foliage which hides the nests from sight.

Although the Magpies nest in different species of trees with different morphological types of crowns, the manners of placement of their nests are, in general, similar. These birds most readily and frequently build their nests in the top portion of the crown, in the many-pronged top crotches of the main trunk or in the vertical terminal ramifications of the side boughs (Fig. 2D.). The main points of support of the nest placed in such a crotch are at its sides, because the conical shape of the nest fits the deflected branches exactly. The supporting branches, up to 4 cm thick, may also be built into the walls of the nest. In shrubs and close thickets the Magpies' nests are also situated in their upper portions, in most cases at the very centre (Fig. 2:F). In this type of placement the nest rests on many branches, thin and extending in all directions, and the points of support are distributed both at the sides and at the bottom of the nest, but the main weight always bears on the side walls.

The Magpie's nest is a fairly compact and strong structure. On the outside it is whole surrounded exclusively with dry twigs and sticks, averaging 0·6 cm in thickness and 45 cm in length. They form the external layer of the nest (Fig. 3:2), built apparently rather loosely and chaotically, but in fact strongly framed. The impression of a loose structure of this layer is caused by numerous ends of sticks and twigs, sticking out on the outside and forming a characteristic "brush" round the nest. In the bottom and side portions of the nest part of the external layer intertwines with the twigs supporting the nest to form a sort of basket, in which the main bulk of the nest is placed. The external layer extends upwards beyond the edge of the nest and forms a protective cupola, which covers the nest from above. The compactness and thickness of the external layer are very different according to the local conditions. Although the protective cupola is united with the external layer in most cases, these two elements differ somewhat in the composition and quality of material. Thin forked twigs, on the average 60 cm long and 0·4 cm thick, derived mostly from thorny species like blackthorn, hawthorn, or plum-tree, predominate in it. In one case most of the material of the cupola consisted of dry stalks of the bramble. If the cupola is not joined directly to the nest, it assumes the form of a loose roof situated about 30 cm above the nest. Out of the 45 nests of the material analysed, 28 had a compact and full cupola joined to the external layer of the nest, 3 had some roofing only, and 4 nests had no protection at all from above. In these last four cases, however, there was a natural cover of dense branches among which the nest was hidden. In the nest which has a full and compact cupola, there is one or two entrance openings in it, situated generally just above the edge of the nest. The situation of the openings with reference to the four quarters and their number show no regularities.

The clay layer, which is the next to the external one, constitutes the main bulk of the nest. It consists, as a rule, of a great number of clay clods interspersed with thin twigs and sticks arranged in different directions. Thick stalks of plants, rather thick rootlets and even straw are sometimes met with in it instedad of sticks and twigs. This layer is then very compact and the stalks and

rootlets are arranged circularly. Thin twigs, up to 0·4 cm in thickness, are placed similarly, whereas all the thicker elements, which predominate in this layer, lie in a disorderly manner. In one case a considerable number of pebbles was found in the bottom of the clay layer; they were probably used as an additional weight in the nest. At the edge of the nest the clay layer forms a distinct rim, in which there is sometimes an addition of fresh thin twigs (most often those of the birch and hornbeam) or relatively thick rootlets. In most of the nests examined a third layer rests directly on the clay layer. It is made of thin elastic twigs or of twigs with an admixture of rootlets and grass stalks. They are stuck directly to the clay, with which they form a whole. The inside of the nest has a layer of lining, which is fairly distinctly differentiated into two parts. The first part, lying deeper, directly on the layer of twigs, is for the most part made of rather thick rootlets woven circularly. There may besides be small numbers of very thin twigs, rhizomes of couch grass, grass blades, strips of cloth, paper, dead leaves, feathers and sheep wool. The other, external, part of the lining differs from the former chiefly in its more delicate material. It is usually thinner but more tightly woven circularly. Its basic material consists also of fine rootlets with occasional additions of rhizomes of couch grass, grass blades, horse-hair and even threads.

A close analysis of the material used to build 33 nests is presented in Table VII. Besides sticks, twigs, clay and rootlets, which are main materials in each

Table VII

The qualitative analysis of the material used to build the nests of the Magpie *Pica pica*

Material	Number of nests	%
Eearth	33	100·0
Vegetable materials		
sticks and twigs	33	100·0
roots of trees and shrubs	33	100·0
roots of grass	28	84·8
blades of grass	16	48·4
stems of plants	8	24·2
rhizomes of couch grass	5	15·1
dead leaves	2	6·0
dead sprouts of blackberry	2	6·0
stems and inflorescences of hop	1	3·0
straw	1	3·0
Animal materials		
horsehair	4	12·0
feather	3	9·0
wool of sheep	1	3·0
Artificial materials		
rags	1	3·0
tissue paper	1	3·0
threads	1	3·0

of these nests, grass blades occur comparatively often (in 48·4% of the nests). In about a quarter of the total of nests examined stalks (mostly lignified) of herbs were also found in the clay layer and the internal part of the lining. The remaining materials are represented in small amounts and in single nests, and they constitute a small additional proportion of the building material. It is worth mentioning that although the Magpies nest in the close neighbourhood of people's houses, they hardly ever use man-made materials to build their nests.

The external layer of the Magpie's nest and its cupola give it a shape resembling a globe. However, the form of the proper nest, that is that of its clay part is similar to a cone, rounded and turned upside down, the diameter of its base being nearly equal to the height. There are only slight deviations from this form, whereas the external shape of the nest may be different if its external layer is only poorly constructed or there is no cupola. Although this basic form of the nests is stable, their measurements show fairly conspicuous fluctuations, as illustrated in Table VIII. The inner nest diameter or the diameter of the nest-cup fluctuates least, its mean value being 17·2 cm, with the standard deviation

Table VIII

Survey of nest measurements of the Magpie *Pica pica*, showing their ranges, means, standard deviations and coefficients of variation

Measurements	Number of nests	Range in cm.	Mean	Standard deviation	Coefficient of variation
Inner diameter	45	15·0—21·5	17·28	1·63	9·43
Outer diameter	45	18·5—35·0	24·07	3·42	14·20
Depth	45	9·0—16·0	12·20	1·92	15·73
Height	45	18·0—29·0	23·51	3·14	13·25

equal to 1·63 and the coefficient of variation to 9·43. The highest coefficient of variation is that for the nest-cup depth, whereas the greatest standard deviation is shown by the values of the outer diameter. This comparatively great fluctuation of the outer diameter (from 18·5 to 35·0 cm) seems to be connected with the mode of placement of the nest, since the Magpie probably adjusts the width of the nest to the angle of the crotch gape. As the nest width: height ratio is more or less constant, there are similarly great fluctuations in the height. In addition, the outer diameter and height, including the projecting free ends of the sticks and twigs or the above-mentioned "brush", were measured only on 13 nests. The outer diameter ranges between 34·0 and 75·0 cm and its mean is 52 cm. As regards the height, the range of the values is from 35·0 to 62·5 cm, the mean being also 52 cm.

Discussion

Nearly all the authors who describe the nesting habitats of the Magpies, emphasize the wide range of possibilites of choice. Most of them lay stress also on the tendency towards a greater density of nests in partly urbanized areas. Only STRAWIŃSKI (1963) reports the absence of Magpies from the suburbia of Toruń. In his observations made in poorly populated areas of the Hortobágy puszta in Hungary and on the northern coast of Norway, NAGY (1943) pays special attention to the particularly close relations between the occurrence of Magpies and the presence of people's houses. On the other hand, KLEJNOTOWSKI (1971a) emphasized the fact that the Magpie avoids large forests and even fairly large groups of trees among the fields.

The different and unusual placements of nests are connected with the variety of environments inhabited by the Magpies. HILGERT (1928) and NAGY (1943) describe their nesting on electric and telegraph poles and GAVRILOV (1986) on triangulation towers. Nesting on buildings has been recorded by GAVRILOV (1968), HAARTMAN (1969), NAGY (1943) and RINGLEBEN (1959), and in clefts by HOLYOACK (1967) and NAGY (1943). Fairly numerous cases of the nesting of Magpies in tufts od dry reed are also known (NAGY, 1943; SCHENK, 1929). POTTER (1927) describes a nest situated in the structure of a bridge and GROEBBELS (1937) that built in a pile od dry branches. There are also records of nests placed directly on the ground (FELTON, 1969; NAGY, 1943; PAESSLER, 1928).

The data concerning the nesting height obtained from literature (BÖHRMANN, 1952; KLEJNOTOWSKI, 1971b; MALCHEVSKY, 1959; REJMERS, 1966; ERPINO, 1968) show clearly that the Magpie places its nest at different heights in dependence on the local environmental conditions and that no narrow group of nesting-heights charactetistic of this species can be distinguished.

Neither are there any generally characteristic and preferred species of trees and shrubs in which these birds build their nests, but a local specialization can be observed in particular biotopes, which is supported by the results of studies reported by KLEJNOTOWSKI (1971b) and the data presented by HAARTMAN (1969), MALCHEVSKY (1959), REJMERS (1966) and BÖHRMANN (1952).

The lack of accurate descriptions of the mode of placement, structure and building material of the Magpie's nests does not allow any detailed comparisons or generalizations. The only, fairly close data are presented in the papers by BENT (1946) and ERPINO (1968) on the subspecies *P. p. hudsonia*. In general, they agree with the description of the placement and structure of nests given in this paper. As a curiosity, it is worth mentioning that, according to BENT (1946), clay in the nest can sometimes be replaced by fresh cow dung. An interesting description of nests from the northern Norwegian coast is also presented by NAGY (1943). These nests were whole built of pieces of wire and steel band, their lining being of scraps of fishing nets, grass blades and moss. HOLYOACK (1967) found 8 nests devoid of cupolas, 3 of them in deciduous trees and 5 in thorny thickets, and he claims, after GOODWIN, that the cupola occurs where

it is necessary to protect the nest from danger. This seems to agree with my observations, in which all the four nests without a protective cupola were situated in a dense growth of blackthorn shrubs, guarding the nest in a natural way.

V. NUTCRACKER *NUCIFRAGA CARYOCATACTES* (LINNAEUS, 1758)

Own material

The nesting of the Nutcracker is here discussed on the basis of 8 nests examined, 5 from the Low Beskids and 3 from the Nowy Sącz Beskids (one of them described earlier by LUBICZ-NIEZABITOWSKI in 1903 and now in the Museum of the Babia Góra National Park). The poverty of material is due to the insular occurrence of Nutcrackers in Poland (Carpathians, Świętokrzyskie Mts., Mazurian Lake District and Białowieska Forest) and the early breeding season, during which the field conditions, especially those in the mountains, are still very severe and make the search after and observation of their nests impossible.

The nests from the Low Beskids were found in mixed fir-beech forests and those from the Nowy Sącz Beskids in fir-spruce forests. It is characteristic that all these nests were collected at the edge of clearings and meadows situated in forests or in the vicinity of roads in 30—70-year-old stands of trees of a relatively little density and with abundant undergrowth.

The heights at which the Nutcrackers' nests were situated are given in Table IX. In order to complement the material and demonstrate it better, the data obtained from other authors' reports and papers on the nests of the nominative form *N. c. caryocatactes* (LINNAEUS, 1758) and the Siberian subspecies *N. c. macrorhynchos* BREHM, 1823 have been included in it. The nesting-height of the nominative form ranges from 2 to 11 m, the height group from 3 to 8 m, with the mean of 5·6 m, being the most numerous. The nesting-height of *N. c. macrorhynchos* is as a rule similar (mean — 6·3 m) but its range is larger, from 0 to 10 m. However, the scanty material allows no far-reaching conclusions.

A list of tree species and sites in which the Nutcracker's nests were built is given in Table X. It also includes some comparative data gathered by other authors. All the nests of the nominative form examined indicate its nesting exclusively in coniferous trees, of which the fir is most readily chosen and followed by the spruce and pine. The Siberian subspecies *N. c. macorhynchos* resembles it in nesting chiefly in coniferous trees, but, according to VOROBEV (1963), it may also build its nests in deciduous trees.

The Nutcracker's nests are most often placed on thin side offshoots or branches, close to the trunk (Fig 2:B_1). The nest rests on varying numbers of branches (from 2 to 5) and the rather poor attachment of its structure to the branches is characteristic. Thus situated nests may be encountered in both older and younger (more than ten years old) trees, always, in the upper or middle portion of the crown. In one case the nest was placed on side offshoots of two neighbour-

Table IX

Nesting heights of the Nutcracker *Nucifraga caryocatactes*, as indicated by the data from literature concerning concrete nests of *N. c. caryocatactes* (BANNERMAN, 1953; BARTELS, 1929; GASOW, 1957; GEBHARDT, 1951; MATZ, 1967; NAUMANN, 1905) and *N. c. macrorhynchos* (BERND, SEVERIT, 1958; KARPUKHIN, 1962; REJMERS, 1959; VOROBEV, 1962; WÜNST, 1955)

Height, in m.	*N. c. caryocatactes*				*N. c. macrorhynchos*	Total	
	Own material	Data from literature	Total		Data from literature	Number of nests	%
			Number of nests	%			
0—0·99	—	—	—	—	1	1	4·54
1·0—1·99	—	—	—	—	1	1	4·54
2·0—2·99	—	1	1	7·69	—	1	4·54
3·0—3·99	2	—	2	15·38	1	3	13·63
4·0—4·99	2		2	15·38	—	2	9·09
5·0—5·99	1		1	7·69	1	2	9·09
6·0—6·99	1	2	3	23·07	2	5	22·72
7·0—7·99	—		—	—	—	—	—
8·0—8·99	—	1	1	7·69	—	1	4·54
9·0—9·99	—	1	1	7·69	2	3	13·63
10·0—10·99	—	1	1	7·69	1	2	9·09
11·0—11·99	1	—	1	7·69	—	1	4·54
Total	7	6	13	100·00	9	22	100·00
Mean nesting height	5·5 m	5·7 m	5·6 m		6·3 m	5·9 m	

Table X

Species of trees and places in which the nests of the Nutcracker *Nucifraga caryocatactes* were found, as indicated by the data from literature concerning concrete nests of *N. c. caryocatactes* (Bannerman, 1953; Bartels, 1929; Fischer, 1967; Gasow, 1957; Haartman, 1969; Matz, 1967; Naumann, 1905), and *N. c. macrorhynchos* (Berndt, Severit, 1958; Karpukhin, 1962; Rejmers, 1959; Vorobev, 1963; Wünst, 1955)

Species of trees	*N. c. caryocatactes*				*N. c. macrorhynchos*	Total	
	Own material	Data from literature	Total		Data from literature	Number of nests	%
			Number of nests	%			
Abies alba	6	2	8	42·1	3	11	37·9
Picea excelsa	1	7	8	42·1	1	9	31·1
Pinus silvestris	—	3	3	15·8	—	3	10·3
Larix sp.	—	—	—	—	2	2	6·9
Pinus cembra	—	—	—	—	3	3	10·3
Alnus incana	—	—	—	—	1	1	3·5
Total of nests in trees	7	12	19	100·0	10	29	100·0
Other nest-sites							
On rock	—	—	—	—	1	1	—
Inside a house	—	—	—	—	1	1	—
Total	7	12	19		12	31	

ing young firs in such a manner that its sides leaned against their trunks, and in another case it lay in the top whorl of a young fir. A rarer placement of a nest is that between the horizontal ramifications of a branch, at a distance from the trunk. However, even then, relatively thin and not very numerous twigs constitute the support for the nest.

The external appearance of the Nutcracker's nest resembles that of the Jay's nest. The whole makes the impression of a loose and disorderly structure, which is chiefly due to the ends of sticks and twigs projecting to the outside. A three--layered structure was found in all the five nests examined closely. The first, external, layer (Fig 3:3), which forms the base and the side walls of the nest is constructed of thin twigs of different trees, 0·2—0·6 cm thick and 15—30 cm long, in most cases interwoven with green shoots of the bramble. The share of the bramble shoots may even reach up to 30% of the total mass of material of the external layer. All the twigs are fresh (some of them even with leaves and buds) and about half of them are forked at ends. In the base of the nest they are arranged obliquely or transversely to each other and the longer ones are folded so as not to exceed the desired length. In the side portion of the external layer the material is arranged more or less parallel. Amidst the main material, i. e., fresh sticks, twigs and bramble shoots there may also be short dry twigs (up to 10 cm long), small pieces of rotten wood and a small number of dead leaves, which probably are used as stuffing material. The external layer is comparatively thick and though its structure is not compact, it makes a satisfactory base and guard for the nest. The next layer, which is cup-shaped and made of clay or pieces of rotten wood, lies inside the external layer. In the nests examined the material was clay in three cases, rotten wood with an admixture of clay in one case, and rotten wood only in another. In the middle portion it is about 2 cm thick, being considerably thinner at the edge. The inside of the nest is all over covered by the third, distinctly delimited layer or lining. Its structure is more accurate and compact, and it is woven circularly of fresh bast (mostly from the sallow), containing additionally small pieces of rotten wood, stalks and blades of grass, tufts of moss, bark and dead leaves. The outer portion of this layer is woven particularly carefully and evenly of very delicate fibres of bast and grass blades and additionally there may also be lichens and feathers. In the two nests from the Nowy Sącz Beskids moss was, however, the dominating material throughout the lining.

Table XI gives the materials used to build 8 nests of Nutcrackers (the data concerning two of them are incomplete). The basic material, present in each nest, consists of sticks and twigs, of which the external layer is built. The other main components are, successively, bast, rotten wood, stalks and blades of grass, and moss. This last component may occur as a small admixture but it may also constitute the main bulk of the lining. Perhaps, where bast is unavailable, it is replaced by moss. The same may also concern the occurrence of clay, which is not always available towards the end of the winter, when the Nutcrackers build their nests.

Table XI

Analysis of material used to build 8 nests of Nutcracker *Nucifraga caryocatactes*

Material	Number of nests	%
sticks and twigs	8	100·0
bast	6	75·0
rotten wood	6	75·0
stalks and blades of grass	6	75·0
moss	6	75·0
fresh sprouts of bramble	5	62·5
clay	4	50·0
dead leaves	3	37·5
bark	2	25·0
lichens	2	25·0
feathers	2	25·0
grass rootlets	1	12·5

The voluminal share of particular components in two nests is given in percentages in way of example.

I.
bast (of sallow) — 50%
twigs and shoots of bramble — 20%
rotten wood — 15%
additional material (grass blades, leaves, clay, lichens) — 15%

II.
twigs and shoots of bramble — 35%
moss — 20%
bast — 15%
rotten wood — 10%
clay — 10%
additional material (grass blades, leaves, feathers, rootlets) — 10%

In outline, the Nutcracker's nest is cup-shaped or resembles a hemisphere flattened largely at the bottom. The difference between the width and the height of the nest is strikingly great, augmented, in addition, by the ends of twigs and sticks projecting beyond the side walls. Contrary to the more or less circular outline of the nest cup, the outer contour of the nest is often irregular owing to the various thickness of the walls, which is dependent on the local conditions. Where the nest leans against the branches or trunk, its walls are much thinner, hardly 1 cm in thickness, whereas the mean thickness of free walls comes up to 6 cm.

The measurements and their means for 7 nests were used to construct Table XII. The inner diameter of the nest is the comparatively most constant measurement and the deviations from the mean do not exceed 1 cm. The depth

Table XII

Survey of the ranges and means of measurements in 7 nests of the Nutcracker *Nucifraga caryocatactes*

Measurement	Number of nests	Range in cm	Mean
inner diameter	7	13·0—15·5	14·10
outer diameter	7	22·0—38·0	26·42
depth	7	7·0—10·0	7·64
height	7	12·0—16·0	14·50

and height of the nests show somewhat greater fluctuations, but they do not deviate much from the mean, either. On the other hand, big differences characterize the outer diameter, because, as has already been mentioned, its size depends largely on the situation of the nest and the varied thickness of the walls connected with it.

Discussion

As regards nesting habitats and the situation of nests in them, my observations coincide fairly closely with the data presented in literature (BARTELS, 1929; FISCHER, 1967; GASOW, 1957 and 1963; GEBHARDT, 1951; HAENESL, 1970; LUBICZ-NIEZABITOWSKI, 1903). Both all these authors and some other ones (BANNERMAN, 1953; MATZ, 1967; NAUMANN, 1905; SWANBERG, 1956) report the nesting of Nutcrackers exclusively in coniferous trees, mostly in firs and spruces.

The data concerning the nest-sites, found in literature (BANNERMAN, 1953; BARTELS, 1929; FICHER, 1967; GASOW, 1957; NAUMANN, 1905). show that nests are most frequently placed on offshoots or branches, close to the trunk, and much more rarely in top whorls of the crown, which confirms my observations. All the authors emphasize that the nests are built rather low, generally between 3 and 8 m above the ground (cf. Table IX).

Most of the authors (BANNERMAN, 1953; GASOW, 1957; GEBHARDT, 1951; FISCHER, 1967; MATZ, 1967; NAUMANN, 1905) distinguish three main layers in the Nutcracker's nest, which corresponds to the data given in the present paper. Only the BARTELSES (1929) mention four layers; according to these authors, under the external layer there is a tightly packed layer of lichens with a small admixture of single leaves and fresh spruce twigs; its thickness ranges from 1·5 to 3 cm. This layer may well have been produced because of the lack of other sorts of materials used generally to make the external layer tight, or it was misinterpreted as a separate layer, because in those nests lichens were also the main component of lining, which is usually bipartite (Fig. 3:3). As may

be seen from all the available descriptions of nests, their external layer is always made of thin twigs; according to some authors (GEBHARDT, 1951; NAUMANN, 1905), they are exclusively dry twigs, whereas other authors (BARTELS, 1929; BANNERMAN, 1953; FISCHER, 1967) find a greater share of fresh twigs. As regards the structure of the second layer, the data from literature (BARTELS, 1929; GASOW, 1957; HAARTMAN, 1969; NAUMANN, 1905) corroborate the possibility, expressed in this paper, of its being made exclusively of clay or rotten wood, or of both these materials mixed together. The specific composition of the material used for the lining may show some differences between nests obtained from different regions or environments. Most of the authors (GASOW, 1957; GEBHARDT, 1951; HAARTMAN, 1969; MATZ, 1967; NAUMANN, 1905) mention dry grass blades as the fundamental component of this layer, but the BARTELSES (1929) stress the dominant role of lichens and FISCHER (1967) writes about lining made of forked fir twigs. In six of the nests examined by me bast was the main material of this layer and in two moss. Since it is hard to admit any local specialization, it must be supposed that the Nutcracker uses material ava lable in the close vicinity of the nest at the time of its building to make the lining.

Thus, it may generally be assumed that the three-layered structure with a characteristic second layer in the form of cup-shaped pugging of clay or rotten wood is typical of the Nutcracker. The use of rotten wood as building material is a distinctive characteristic of the nest of this species, since it not only goes to the making of this layer, but also occurs as a regular component of the other layers.

Only few other authors took measurements of Nutcrackers' nests and even then they measured only a small number of specimens. According to NAUMANN (1905) and GASOW (1957) the nest cup diameter ranges between 12 and 16 cm, whereas the BARTELSES (1929), basing themselves on four nests, found it to be 12·2—13·5 cm. The results obtained on my own material lie between 13 and 15·5 cm and, therefore, they do not differ from the data from literature. The nest heights given by the BARTELSES (1929), MATZ (1967) and GASOW (1957) are, respectively, 18·5 (mean), 10, and 7—13 cm, and they indicate great variation in this measurement, which has not been found in my material, where the nest height ranges from 12 to 16 cm.

The descriptions of the nesting of the Siberian subspecies *N. c. macrorhynchos*, given in literature, as a rule show no essential differences from those of the nominative form in the selection of breeding habitats, tree species, and the mode of placement of the nests (BERNDT and SEVERIT, 1958; KARPUKHIN, 1962; REJMERS, 1959; VOROBEV, 1963; WÜNST, 1955). As regards this last character, some interesting data are given by VOROBEV (1963). He mentions several unusual nest-sites, e. g. those between the roots of a stone pine, in a rock recess, and inside an abandoned building, which suggest a plasticity of the Nutcracker's nesting instinct and its adaptive capabilities. The structure of nests and the composition of building material also correspond fairly closely to those recorded for the nominative form. Thus, the nests are three-layered,

only REJMERS (1959) describes a four-layered structure analogous to that reported by the BARTELS (1929) in connection with the nominative form. Lichens are a constant component of the building material in the nests of *N. c. macrorhynchos*, but they are not in the nests of the nominative form. There are no essential differences in the size of nests between these two subspecies. The cup diameter of the nests of *N. c. macrorhynchos* is 12—14 cm according to KARPUKHIN (1962), 11 cm according to REJMERS (1959), 12—14 cm according to VOROBEV (1963) and 13 cm according to WÜNST (1955). The nest depth, as given by the first three authors, is respectively, 8, 7 and 6 cm, which coincides fairly closely with the mean depth from the 7 nests described in this paper (7·64 cm).

VI. JACKDAW *CORVUS MONEDULA* LINNAEUS, 1758

Own material

The nesting of the Jackdaw is here discussed on the basis of 31 nests analysed closely and complemented with observations on the nest-site and nesting-height of another 267 nests.

Most of the material comes from Southern Poland, i. e. from the Kraków, Rzeszów, Lublin and partly Kielce Provinces, or from the areas lying along the border line between the ranges of two subspecies, *C. m. soemmerringii* FISCHER, 1811 and *C. m. spermologus* VIEILLOT, 1817.

The Jackdaw is the only member of the family *Corvidae* in this country that builds its nests chiefly in closed places, revealing its great plasticity in this respect and adaptive capabilities as regards both environmental conditions and the localization and mode of placement of nests. Nests were, therefore, found in trees and on buildings both in towns, suburbs and villages and in single roadside trees, in forests, rocks and ruins at a considerable distance from people's houses. Most of the nests examined, about 70% of them, come from typical urban and rural environments, the nest on buildings predominating in the urban group and those in trees in the rural one.

Table XIII gives the nesting-height of Jackdaws' 298 nests divided into nests placed in tree-holes and nesting-boxes and those built on buildings and rocks. As will be seen from the data presented in it, there are some differences in mean nesting-heights between the nests relative to their situation. The mean nesting-height for 163 nests in tree-holes and nesting boxes is 9·41 m, whereas the values of individual heights range between 2·0 and 30·9 m and in 84·7% of the total of nests lie within the 5·0—12·9 m interval. The nests on buildings have a somewhat wider range of nesting-heights, from 3·0 to 35·9 m and, as regards their distribution in particular intervals, they show a slightly marked tendency to group between 6 and 10 m and between 25 and 33 m. The mean nesting-height for 78 nests of this category is 20·7 m. The nests on

rocks were situated at heights from 6·0 to 25·9 m, being more or less uniformly distributed in particular intervals. The mean nesting-height calculated from the measurements of 57 nests is 15·3 m. The mean nesting-height from all 298 nests is 13·5 m; it does not, however, agree with the distribution curve (modal),

Table XIII

Nesting heights of the Jackdaw *Corvus monedula*

Height in m	Tree-holes and breeding boxes		Buildings		Rocks		Total	
	n	%	n	%	n	%	n	%
2·0—2·9	2	1·2	—	—	—	—	2	0·6
3·0—3·9	7	4·2	2	2·5	—	—	9	3·0
4·0—4·9	9	5·5	—	—	—	—	9	3·0
5·0—5·9	12	7·3	2	2·5	—	—	14	4·6
6·0—6·9	17	10·4	5	6·4	4	7·0	26	8·7
7·0—7·9	21	12·8	7	8·9	7	12·2	35	11·7
8·0—8·9	17	10·4	3	3·8	3	5·2	23	7·6
9·0—9·9	22	13·4	2	2·5	—	—	24	8·0
10·0—10·9	12	7·3	5	6·4	7	12·2	24	8·0
11·0—11·9	10	6·1	2	2·5	3	5·2	15	5·0
12·0—12·9	17	10·4	—	—	—	—	17	5·7
13·0—13·9	2	1·2	—	—	—	—	2	0·6
14·0—14·9	5	3·0	2	2·5	2	3·5	9	3·0
15·0—15·9	1	0·6	2	2·5	10	17·5	13	4·3
16·0—16·9	2	1·2	—	—	2	3·5	4	1·3
17·0—17·9	—	—	—	—	—	—	—	—
18·0—18·9	2	1·2	—	—	—	—	2	0·6
19·0—19·9	—	—	—	—	—	—	—	—
20·0—20·9	—	—	2	2·5	6	10·5	8	2·6
21·0—21·9	—	—	—	—	—	—	—	—
22·0—22·9	—	—	—	—	—	—	—	—
23·0—23·9	1	0·6	—	—	3	5·2	4	1·3
24·0—24·9	—	—	—	—	3	5·2	3	1·0
25·0—25·9	1	0·6	8	10·2	7	12·2	16	5·3
26·0—26·9	—	—	7	8·9	—	—	7	2·3
27·0—27·9	—	—	5	6·4	—	—	5	1·6
28·0—28·9	1	0·6	2	2·5	—	—	3	1·0
29·0—29·9	—	—	2	2·5	—	—	2	0·6
30·0—30·9	2	1·2	5	6·4	—	—	7	2·3
31·0—31·9	—	—	5	6·4	—	—	5	1·6
32·0—32·9	—	—	—	—	—	—	—	—
33·0—33·9	—	—	7	8·9	—	—	7	2·3
34·0—34·9	—	—	—	—	—	—	—	—
35·0—35·9	—	—	3	3·8	—	—	3	1·0
Total	163	100·0	78	100·0	57	100·0	298	100·0
Mean nesting height	9·41		20·74		15·34		13·51	

the peak of which lies between 5·0 and 12·9 m. This is naturally connected with the relatively great range of nesting-heights and ununiform distribution of nests in particular intervals.

The preferred places for nesting are undoubtedly both natural and artificial tree holes and niches, tree holes formed in a natural way (owing to decay) being chosen in the first place, then those hewn out by woodpeckers and, at last, nesting boxes. The species of trees, the height at which the entrance opening is situated, its size and orientation, and the length of the entrance passage seem to have no major effect on the choice. Thus, Jackdaws occupy large tree holes with large openings equally readily as they do small and narrow ones, hardly corresponding to the size of their bodies, in which the distance of the nest from the entrance sometimes exceeds 1 m.

Nesting in open unguarded places is a very rare phenomenon. One such nest was found in a small group of trees situated in the close vicinity of some buildings. The nest was placed on a dense lattice formed of horizontal branches, 50 cm from the trunk, in the top portion of a young pine (5 m above the ground).

The nests built on houses also show a high degree of differentiation in so far as their site is concerned. They are most often placed in chimneys, the distance of the nest from the entrance opening ranging from 50 to 100 cm. The Jackdaws often nest also in all sorts of recesses and holes in walls, gaps under eaves or gutters, and even in the gutters themselves. Where there are sufficiently large ventilating apertures or holes in the roof, they make their nests on the floor of the attic, either in partly screened and confined places (under a beam, in a corner of the attic) or in an entirely open and unrestricted area. In the natural environment the nests on rocks are tallies of those on buildings. They, too, are made in different sorts of holes and clefts, both vertical and horizontal ones, with an entrance passage, up to some dozens of centimetres long, leading to it. The most characteristic nest-sites of Jackdaws in different environments are shown in Fig 2 and in Table XXIX.

Jackdaws' nests show fairly essential differences in structure and materials relative to their situation and habitat. The nests in large and deep vertical tree holes (Fig. 3:4b) have a substantial base and external layer of sticks and twigs of different tree species, 15—50 cm long (averaging 25 cm) and 0·3-1 cm thick, the half-centimetre thickness being predominant. Dry stricks and twigs, which the birds pick up from the ground, form about 60% of the total material. The arrangement of material is disorderly and the height of the whole layer often reaches some dozens of centimetres, This is so because in the first phase of nest building the Jackdaws throw sticks and twigs into the hole until they catch on its walls by themselves and form a strong and stready base. The bottom of the nest, therefore, does not always rest on the floor of the tree hole and the nest is often as if hung. On the other hand, in the terminal phase of construction of this layer the Jackdaws arrange the material in an orderly manner, placing it chiefly along the walls of the tree hole and thus forming a cup-shaped depression in the middle, in which they next lay down material

for the lining. This material is arranged circularly and, as a rule, it may be divided into two distinct parts, i. e., the inner lining and the relatively thin outer lining. The specific composition of the inner lining is very varied and it changes according to the habitat. In most cases it is a mixture of bast, grass stalks, dead leaves and moss with an addition of paper scraps and other material, the amount of which depends upon its availability in the close vicinity of the nest. At the bottom of this layer there are sometimes clods of earth with plant rootlets. The outer lining is characterized by its more delicate material and more compact arrangement. There are generally rather numerous feathers and much animal hair and wool in it. The thickness of the whole lining fluctuates between 2 and 5 cm.

The nests situated inside long and narrow tree holes very often lack the fundamental material, i. e. sticks and twigs, at all and they consist only of a scanty amount of lining material (Fig 3:4e). Sometimes the eggs lie directly on the floor of the tree hole and the lining material forms a symbolic ring imitating the nest edge. In some cases the passage leading to the nest is lined all round with twigs, which, however, are lacking in the base and external layer of the nest.

The nests in nesting-boxes look somewhat differently and they also vary to some extent within this group according to habitats. The nests placed in boxes situated in human settlements or in their neighbourhood have usually their external layer scanty and arranged in the corners of the box and close to its walls. The share of twigs and sticks is, however, very small and the material characteristic of the proper lining in the tree-hole nests rather prevails (Fig 3:4c). Next to this fragmentary and atypical external layer is a very well-developed clay layer, 1—3 cm in thickness, which in its bottom portion is often mixed with some elements of the external layer. However, the clay of this layer does not occur in such dense and compact mass as it does in the nests of the Magpie and Crow; its consistency is rather dusty. The layer of lining placed directly on it is comparatively thick (3—7 cm), has a circular arrangement, and is constructed of very varied material, which always includes paper, bast, stalks and rootlets of plants, rotten wood, and in its superficial portion also hair of mammals or feathers.

In contradistinction to the nests from the nesting-boxes situated in inhabited areas, those examined in several boxes in forests showed no differentiation into distinct layers (Fig 3:4d). The whole nest is composed of lining material lying rather chaotically, especially in its lower and middle portions. It consists mostly of bast, dead and fresh leaves, moss, lichens, grass blades, bark and single short sticks (both dry and fresh ones with leaves). The superficial portion of the lining is made more carefully and shows a tendency to a circular arrangement. It includes delicate fibres and grass blades, sometimes also feathers. In one case there was a large number of aspen inflorescences and fresh fir wisps. Two nests built freely on pine branches had their bases and external layers of thin, mostly dry twigs and sticks distributed in a rather disorderly manner.

Lining material lay directly on them and formed an abundant layer composed chiefly of dead leaves, moss, and stalks and rootlets of grass. Paper scraps, sheep wool and duck down occurred in it as admixtures. In general, in structure these nests resembled those from large tree holes or niches.

Between nests situated on or in buildings, as between those in trees, there occur differences in structure owing mainly to the differences in the size and nature of the sites. The very common nests in chimneys are identical with those in large and deep vertical tree holes in respect of their structure and material. They are, therefore, generally high nests of a great amount of basic material, i. e., sticks and twigs, the length of which fits the size of the free area. Thin twigs are often folded to fit it. In most of these nests there is no distinct clay layer separating the basic material from the lining, and only occasionally a few clods of earth with plant rootlets occur where these two layers meet. The nests built in attics and towers, lying in an unlimited or only partly limited area, have a completely different appearance (Fig 3:4c). Also in these nests sticks and twigs of different length and thickness (0·2—1·5 cm thick and averaging 25 cm in length) are used as basic material. They lie rather loosely and in disorder, but form a relatively thin layer (up to 6 cm). Next the sticks and twigs are interspersed with abundant and varied material used for stuffing, like bast, paper, straw, oakum, horse dung, grass stalks, etc. The sort and amount of individual components vary from nest to nest. The whole of this mixed layer, constituting the basic mass of the nest, is usually separated from the lining by a clay layer, which is sometimes additionally separated from the basic material by a thin layer of some other material, e. g., dry horse dung. The clay layer is, however, never homogeneous, but it always contains some other additional components, e. g., grass blades or straw, usually the materials which also occur in the next layer, that is, the lining. The arrangement of this additional material in the clay layer is always visibly circular. The lining is made of varied material, which most frequently in its composition corresponds to the material of the basic layer of the nest. In the lining it is, however, more compact and more closely bound together, and the long elements, like plant stalks or bast fibres, are placed clearly in a circular manner. The thickness of the lining is on the average 3·5 cm and in exceptional cases it may reach 10 cm. Where the layer of lining is thicker, one can observe its differentiation into an inner (essential) and a superficial part, in which paper, wool scraps, animal hair and feathers are predominating elements.

Nests on rocks do not stand out for any specific structural characteristics. The number of sticks and twigs in them may change according to the size and direction of the cleft or openining in rock, and these nests have rarely a distinct clay layer.

The Jackdaw's nest is conspicuous for its particularly great variety of material used. This is illustrated in Table XIV, which shows the results of a close analysis of 31 nests from different habitats. The commonest materials are bast (found in 87% of the nests) sticks and twigs (83·8%), paper (83·8%) and dead

Table XIV

Analysis of material used to build the nests of the Jackdaw *Corvus monedula*

Material	Number of nests	%
Clay	15	48·3
Vegetable material		
bast	27	87·0
sticks and twigs	26	83·8
dead leaves	18	58·0
grass blades	18	58·0
horse dung	14	45·1
straw	13	41·9
moss	13	41·9
bark	11	33·3
grass rootlets	7	22·5
cattle dung	7	22·5
rotten wood	6	19·3
stalks of herbs (thick)	5	16·1
wood sharings	4	12·9
inflorescens of tree	2	6·4
rhizomes of couch grass	2	6·4
fresh sprouts of bramble	1	3·2
Animal material		
feathers	14	45·1
sheep wool	7	22·5
human hair	5	15·1
cattle hair	4	12·9
hare hair	3	9·6
fragments of rabbit fur	3	9·6
leather fragments	3	9·6
bone fragments	2	6·4
cat hair	2	6·4
pig hair	2	6·4
rabbit paws	1	3·2
horsehair	1	3·2
Artificial material		
paper	26	83·8
cotton wool	8	25·8
oakum	7	22·5
pieces of cloth	7	22·5
carboard	6	19·3
wadding	6	19·3
string	6	19·3
wood wool	3	9·6
building paper	2	6·4
glass wool	2	6·4
pieces of china	2	6·4
thread	1	3·2
pieces of glass	1	3·2

leaves and grass (58% either). Such components as clay, horse dung, straw and moss are relatively often met with, being present in 40% of the nests. The quantitative share of given components, both basic ones, occurring in most of the nests examined, and the remaining ones, found more rarely, fluctuates considerably relative to the situation of the nest and its environment. This is, above all, true of the material used for the base of the nest, i. e., sticks and twigs, which may be quite absent or occur in very small numbers. The amounts of other materials which go to the making of the nest depends fairly clearly on their availability in the close vicinity of the nesting-site.

The shape and size of the nest, being usually adjusted to the magnitude of the space the birds have at their disposal, are also closely connected with the situation of the nest. Thus, nests built in large vertical tree holes and rock clefts and in chimneys are for the most part high (15—100 cm) and their outer diameter corresponds closely to the size of the space. Nests in tree niches and nesting-boxes are much lower (8—15 cm) and their outer diameter also depends on the size and shape of the space at their disposal. In oblique or horizontal tree holes and rock clefts and in similar places in buildings the nests are rather low (10—20 cm) and their outer diameter is small. Since in such places all the material is brought in by the birds actively, frequently through a long entrance passage, which makes their work particularly difficult (especially when they carry sticks and twigs), its amount is often reduced to the minimum. Nests placed in unlimited or partly limited areas, e. g. in attics and towers, have, as a rule, a very broad base and a relatively small height. In partly limited areas the nest base has often the shape of a triangle or sector, its cup being

Table XV

Survey of the ranges of measurements, their means, standard deviation and coefficient of variation in the nests of the Jackdaw *Corvus monedula*

Measurement	Group of nests	Number of nests	Range in cm	Mean	Standard deviation	Coefficient of variation
Inner diameter	fresh nests	22	9·0—14·0	11·09	1·64	14·78
	old nests	9	9·0—23·0	14·55	—	—
	Total	31	9·0—23·0	12·09	3·17	26·22
Outer diameter	fresh nests	22	16·0—95·0	31·04	6·45	20·77
	old nests	9	26·5—100·0	56·63	—	—
	Total	31	16·0—100·0	38·47	7·71	20·04
Depth	fresh nests	22	4·0—8·0	5·22	1·43	27·39
	old nests	9	3·0—5·0	3·83	—	—
	Total	31	3·0—8·0	4·82	1·51	31·32
Height	fresh nests	22	8·0—45·0	19·54	3·89	19·85
	old nests	9	7·0—100·0	37·00	—	—
	Total	31	7·0—100·0	24·61	6·67	27·10

generally situated in the vertex portion close to the limiting walls. In an unlimited area the nest base is usually more or less polygonal and exceptionally circular. Such nests sometimes cover a very large area, up to 1 sq. m, their height being from a dozen to several dozen centimetres. They are often occupied for several seasons and some material is added each year so that the area covered by the nest increases; a new nest cup is also formed. Hence, a nest may have two or three cups, of which only one is used in the given season.

Great differences in size and shape between Jackdaws' nests are illustrated by the measurements of 31 nests (22 fresh and 9 old ones) given in Table XV. All the four main measurements fluctuate within a wide range, the depth and diameter of the nest cup being the least variable. However, even here the differences reach 100% of the measurement, and so the coefficients of variation are rather high. The height and outer diameter change freely according to local conditions. A comparison of the mean measurements of fresh and old nests reveals their higher values for the latter except the nest cup depth, the values of which are lower. This indicates that the period of breeding of the young brings about the widening and shallowing of the nest, which is connected with its relatively loose structure, readily undergoing deformations.

Discussion

Numerous data from literature fully confirm the adaptive capabilities of the Jackdaw in choosing habitats and nesting-sites. In general, three main types of nesting-sites may be distinguished:

1) Nesting in different types of tree holes is common in all habitats, even deep inside large forests, which is particularly interesting in view of the outstanding synanthropic dispositions of this species. In addition to my own observations, there are also references to this fact in literature (ABDREJMOV, 1968; SCHINDLER, 1949; STRAUTMAN, 1963; ZIEMMERMANN, 1931).

2) Nesting in rocks is also fairly often observed, as witnessed by reports of different authors (DOHNE, 1952; FOLK, 1968; SHNITNIKOV, 1949; SZULC, 1961), and nesting on and in buildings is equally frequent as that in trees.

3) Nesting in burrows and holes in the ground is met with more rarely and only in definite environments. Steep clayey river banks or walls of loess ravines suit this purpose best and Jackdaws more often than not make their breeding burrows in them by themselves (FOLK, 1968; NAUMANN, 1905; after REISER; NAZARENKO, 1957; STRAUTMAN, 1963; SHNITNIKOV, 1949). NIETHAMMER (1973) and MAKATSCH (1957, after WIGMAN) describe the nesting of Jackdaws in rabbit burrows.

Nests placed freely on tree branches and the use of an old nest of a Rook belong to exceptional types of nesting. Several cases of the nesting of Jackdaws on tree branches are mentioned by OWEN (1931), HARTMAN (1969) and HOLYOACK (1960). This last author describes also the nesting of Jackdaws in

abandoned nests of Rooks and Crows, and, in addition, after Wolls-Bladen, in those of Magpies and a Heron. FEDUSHIN and DOLBIK (1967), GAVRILOV et al. (1968) and SHNITNIKOV (1949) record also some cases of the nesting of Jackdaws in old nests of Rooks, and EJGELIS (1958) mentions, in addition, two nests of Jackdaws in the walls of the nests of Storks. BRIDGMAN (1962) writes about the nesting of Jackdaws in unused aeroplanes left for repair.

The height of Jackdaws' nests above the ground is very variable even within the same type of habitat. There are, however, some height groups which contain much larger numbers of nests than the others. In my materials 84% of the nests built in trees were at heights between 5·0 and 12·9 m. EJGELIS (1958) and FOLK (1968) obtained similar results. So far as the nests placed on buildings and rocks are concerned, the nesting height obtained on the basis of my observations corresponds in general with that given by FOLK (1968).

Great differences in the structure of nests and the amount and sort of building material, stated in this study, are also emphasized by quite a number of authors (EJGELIS, 1958; EMMENT, 1933; FOLK, 1968; NIETHAMMER, 1937; OWEN, 1930, 1931; ZIEMMERMANN, 1931, 1951). OWEN (1930, 1931) describes interesting cases of a Jackdaw's nest inside a loose pile of branches in a fork of a trunk and another one in a tree hole with a protective cupola as in the Magpie's nest. The same author and EJGELIS (1958) report nests in tree holes, with no building material and eggs laid directly on rotten wood on the floor of the hole.

A full list of materials used by Jackdaws to make their nests is given by EMMENT (1933), who mentions 28 different sorts, of which some are rather unusual, e. g., pieces of rubber and metal. ZIEMMERMANN (1951), too, mentions pieces of glass and iron and other things, like clasps of underwear, found in nests. Glass and metal may have been brought to the nests not as building materials but in consequence of the well-known fondness of the *Corvidae* for all sorts of glittering objects. EJGELIS (1958), FOLK (1968), NIETHAMMER (1937) and ZIEMMERMANN (1951) point to clay as one of the building components of the nest, but the last two authors add that it occurs irregularly in the bottom part of the nest. Animal hair used to line the nest cup is occasionally plucked by Jackdaws directly from the backs of domestic animals (BUB, 1957; EJGELIS, 1958).

According to FOLK (1968), the mean nest cup diameter calculated from 39 nests is 14·54 cm and, according to ZIEMMERMANN (1951), it ranges between 14 and 16 cm. The results obtained on my material are somewhat lower (12·09 cm), which is undoubtedly due to the fact that measurements were taken mostly on fresh nests and so undeformed by the nestlings. This is confirmed by the measurements of 9 old nests, the mean from which is 14·55 cm. The maximum height of the nests measured by FOLK (1968) was 170 cm and the maximum outer diameter 135 cm, and EJGELIS (1958) described a nest which was 3·5 m high.

VII. ROOK *CORVUS FRUGILEGUS* LINNAEUS, 1758

Own materials

The nesting of the Rook has been analysed on the basis of 50 nests examined closely and additional data concernig the nesting-height, site and structure of another 840 nests. All the nests examined and observed come from the Kraków and Rzeszów Provinces, i. e., from Southern Poland, and belonged to the nominative form *Corvus frugilegus frugilegus* LINNAEUS, 1758.

The nests under description were situated in very various environments, like parks and gardens in towns and their suburbs, villages, old manorial parks, cemeteries and wooded areas of various size lying a long way from human settlements. The presence of isolated groups of tall trees is an essential

Table XVI

Nesting heights of the Rook *Corvus frugilegus*

Height in m	Number of nests	%
7·0—7·9	3	0·3
8·0—8·9	2	0·2
9·0—9·9	4	0·4
10·0—10·9	6	0·6
11·0—11·9	10	1·1
12·0—12·9	25	2·8
13·0—13·9	33	3·7
14·0—14·9	65	7·4
15·0—15·9	77	8·8
16·0—16·9	68	7·7
17·0—17·9	76	8·6
18·0—18·9	66	7·5
19·0—19·9	58	6·6
20·0—20·9	74	8·5
21·0—21·9	52	5·9
22·0—22·9	44	5·0
23·0—23·9	40	4·5
24·0—24·9	53	6·0
25·0—25·9	47	5·3
26·0—26·9	21	2·4
27·0—27·9	19	2·1
28·0—28·9	11	1·2
29·0—29·9	12	1·3
30·0—30·9	8	0·9
Total	874	100·0
Mean height 19·40 m		

factor in choosing a place for nesting. The Rook is, in turn, fairly closely associated by its food with agriculture and, consequently, it does not occur in large numbers in the regions in which wooded areas predominate, nor does it nest in large forests. On the other hand, the Rook nests readily in towns, because it finds enough natural food in the surrounding suburbian areas and there are additional possibilities for it to feed in refuse dumps or on garbage available in the town.

Rooks' nests are placed exclusively in old and high trees regardless of the habitat in which they are situated. The quantitative distribution of the nests with respect to their height above the ground is presented in Table XVI. Despite the wide range of nesting heights (7—30 m), it may be assumed in general that a vast majority of nests lie between 14 and 25 m above the ground, for the nests lying within these limits form 82·37% of the whole material. The mean for 874 nests analysed is 19·01 m.

The Rook shows a fairly wide range of possibilities in its selection of tree species for nesting. It will be seen from Table XVII that among the 15 species of trees the deciduous species (13 genera) prevail decidedly, and of these the poplar and alder are preferred, since altogether 50% of the nests examined were found in them. This is most likely so because these very species occur most often as small isolated groups of old trees, which are so readily occupied

Table XVII

Species of trees and shrubs in which the nests of the Rook *Corvus frugilegus* were sited

Species	Number of nests	%
Populus sp.*	231	26·4
Alnus glutinosa	115	13·0
Acer pseudoplatanus	105	12·0
Alnus campestris	86	9·8
Quercus robur	52	5·9
Pinus silvestris	43	4·9
Tilia cordata	42	4·8
Betula verrucosa	38	4·3
Populus tremula	31	3·5
Fraxinus excelsior	30	3·4
Aesculus hippocastanum	28	3·1
Salix sp.	27	3·0
Larix sp.	22	2·5
Fagus silvatica	10	1·1
Platanus orientalis	8	0·9
Carpinus betulus	6	0·6
Total	874	100·0

* *P. tremula*, var. *italica*, *P. nigra*, *P. alba*.

by Rooks. In habitats in which different species of trees, but representing a similar degree of fitness for building nests in, grow side by side, such species as the sycamore maple, elm and lime-tree are, however, preferred. These trees are chosen for their advantageous arrangement of branches, providing good conditions for fixing a nest.

The commonest nest sites of Rooks are those in many-pronged vertical crotches in the upper portion of the crown (Fig. 2:D). The nests situated in them rest on the base of the crotch and, in addition, their sides lean against its single branches, which are often included in the nest walls. This type of nesting sites was found in abont 60% of the nests examined and its share in indivi-ual colonies was similar. A variety of this type consists of nests placed on horizontal branches in the upper portion of the crown, only the shoots and secondary brenches among which the nest is built are directed upwards. Another type of nest sites, observed much more rarely, is that in which nests are situated on horizontal branches and on one side lean against the tree-trunk or a thick bough. Also these nests occur in the upper portion of the crown. All the departures from the basic type of nests are caused by lack of suitable places in a given colony. This is confirmed by the observations made in the initial period of the breeding season, when pairs fight for particularly advantageous places for neing. Even having lost two or more such fights, a pair of Rooks do not move to another tree, but persist in attempting to build a nest in the once chosen tree. A phenomenon difficult to account for in a species with so strong social inclinations are single nests sometimes met with up to several kilometres from the nearest colony.

As in the previously discussed species, the first, external, layer of the Rook's nest (Fig. 3:5) is composed exclusively of sticks and twigs, the arrangement and size of which are different in its different parts. About 70% of the material consists of fresh sticks and twigs, which the birds break off the nearest trees. Their length ranges from 20 to 80 cm (averaging 45 cm). The differentiation of the material with respect to thickness presents itself as follows: twigs and sticks with a diameter of 0·3—0·5 cm — 5%, 0·5 cm — 15%, 1·0 cm — 70% and 2·0 cm — 10%. In the classic nesting site, i. e., in many-pronged vertical crotch the first portion of material, which forms the nest base, is arranged in the form of a triangle. After placing more than ten sticks in this manner, the birds reverse the arrangement, although they keep up the form of a triangle.

In this part of the external layer thicker sticks and twigs, up to 2 cm in diameter and 20—50 cm in length, prevail. Successive portions of material are placed in the form of a square or polygon, and a tendency to its circular arrangement appears half-way up the nest walls. The sort of material also changes, because in the upper portions flexible thin twigs are a dominant element. The arrangement of material in the external layer in which the ends of most twigs and sticks project on the outside of the nest and form a "brush" is a characteristic of the Rook's nest. In most of the nests the second layer is woven circularly of thin and elastic twigs, averaging 40 cm in length and 0·2—0·5 cm in

thickness. The thickness of this layer is not uniform; at the bottom of the nest it is formed of hardly single twigs and it reaches a thickness of 2 cm only about half-way up the walls. At the edge of the nest this layer forms a distinct and fairly thick rim, which covers the first layer from above. If there are any birch- or willow-trees in the vicinity of the nest, the material of this layer consists exclusively of their twigs. If pine-trees grow in the close neighbourhood, their fresh twigs are often placed loosely on the edge of the nest. In exceptional cases the nests in which thin and elastic material prevails in the external layer may lack the second layer with its rim in a well-defined and distinct form. The third layer is a compact mass of moss and rootlets of plants mixed up with clay in the form of a small cup, which lines the bottom of the previous layers, being sharply separated from them, and reaches a third or a half of the way up the nest walls. It is on this cup that the next layer or lining is laid, being sometimes differentiated into two distinct portions, the inner lining and the superficial lining, differing somewhat from the former in its composition of materials. The lining material consists mostly of several components, of which one or two predominate in quantity. In all the nests examined this layer always contained thicker stalks of herbs and grass blades, used to bind together the components of the material. In some nests this function is vicariously fulfilled by bast. Out of the remaining components, moss and dead leaves are used most frequently. In all the nests from town areas the lining contained many paper scraps and in those situated in pine-trees a great quantity od dry pine needles was found. In the whole lining its material is arranged circularly, it is tightly packed and fairly closely bound together, and the mean thickness of this layer is about 7 cm.

Table XVIII presents an analysis of the materials used to build 34 nests of Rooks. Sticks and twigs, as constant components of the external layer, and stalks of herbs and grass blades, as main elements of the lining, occur in all the nests examined. Other materials, in order of frequency, are dead leaves (in 97·0% of the nests), grass rootlets (88·2%), moss and earth (85·2% either) and bast (41·1%). The remaining sorts of materials are only incidental additions and not constant components of nests, except for needles and paper, the occurrence of which is associated with specific environments.

The Rook's nest has generally the shape of a regular hemisphere, which may be somewhat flattened or slightly ovate according to the conditions of the site. The form of a flattened hemisphere most often characterizes the nests built close to the trunk on a horizontal branch and in top crotches with branches departing at obtuse angles. Where the angles of departing branches are less obtuse, the nest has an ovate shape. The measurements of 50 nests of Rooks are presented in Table XIX. The most invariable measurements are the nest-cup diameter and the depth and, therefore, the range of the values obtained for them from particular nests are the smallest, and so is the coefficient of variation. This is connected with the strong and compact structure of the lining, which is not liable to deformations. However, in comparison with the cup diameter

Table XVIII

Analysis of material used to build the nests of the Rook *Corvus frugilegus*

Material	Number of nests	%
Clay	29	85·2
Vegetable material		
sticks and branches	34	100·0
grass blades	34	100·0
stalks of herbs	33	97·0
dead leaves	33	97·0
grass rootlets	30	88·2
moss	29	85·2
bast	16	41·1
dry conifer needles	13	38·2
bark	10	29·4
straw	7	20·5
reed	1	2·0
Animal material		
feathers	11	32·3
sheep wool	3	8·8
Artificial material		
paper	13	38·2
fragments of cloth	4	11·7
wood wool	3	8·8
pieces of rope	1	2·0
oakum	1	2·0

the remaining measurements are more variable, the ranges of the values obtained for them are rather wide, and the coefficient of variation high. The often observed occupation of the last year's nests by Rooks has no essential influence on the measurements of the nests, because the external layer, if destroyed, is restored to its original size and the lining is always exchanged irrespective of its state.

Table XIX

Survey of the ranges of measurements, their means, standard deviation and coefficient of variation in the nests of the Rook *Corvus frugilegus*

Measuremtnt	Number of nests	Range in cm	Mean	Standard deviation	Coefficient of variation
Inner diameter	50	16·0—30·5	19·75	3·06	15·49
Outer diameter	50	26·5—85·0	41·81	10·62	27·18
Depth	50	7·0—19·0	12·14	1·57	12·93
Height	50	17·0—60·0	31·16	9·75	30·70

Discussion

As will be seen from studies published by different authors (BOYD, 1933; BULL, 1957; GERBER, 1956; PARATH, 1964; WASSENICH, 1968; WATSON, 1967; VOROBEV, 1963), the Rook has similar environmental requirements throughout the area of its occurrence in the breeding season. Small groups of tall trees and the neighbourhood of open areas put under cultivation are necessary for the Rook to nest. Unlike other species of the family *Corvidae*, the Rook is, above all, a typical inhabitant of lowlands and colonizes mountainous regions rarely and in small numbers.

The lists of tree species chosen by Rooks for nesting given by different authors differ from each other (BOYD, 1933; PARATH, 1964; WASSENICH, 1968; WATSON, 1967). According to DYRCZ (1966), in Poland the greatest number of nests occur in poplars and pines. In the eastern range of their distribution, i. e., in Sakhalin, the Rooks nest exclusively in birches and larches (GIZENKO, 1955). In New Zealand, to which Rooks were brought a comparatively short time ago, they first nested only in the top parts of *Eucalyptus globulus* where, however, strong winds destroyed their nests continually. Then the birds began to nest in pines (BULL, 1967). Consequently, it is difficult to distinguish any tree species preferred by Rooks throughout the area of their distribution. The specific membership of the tree does not seem to be so essential as the morphological type of its crown, its age group and situation in a definite environment. Nesting of single pairs of Rooks a long way from any colonies, observed by me, has also been noted by other authors (MATOUŠEK, 1956; ROZENBERG, 1956; SIBSON, 1963; WATSON, 1967). However, it is unknown whether this is a relic of the original habit of nesting in isolation, or the first signs of change in the present practice of nesting in colonies.

In some cases the Rook can also nest in completely different conditions. Such exceptions are the nests on buildings (towers and belfries) reported from Czechoslovakia (ČERNY, 1951), Germany (MELCHIOR, 1955), England (MASEFIELD, 1929) and Russia (GALUSHIN and KARPOVICH, 1960). TAAPKEN (1952) describes the nesting of Rooks in a steel lattice structure in Holland and GERBER (1956) cites after HEIKE a colony on a transmission tower. HOLYOACK (1957) also writes, after COVIN, about nests on transmission towers and gives his own observations on the nesting of Rooks on the ground. ČERNY (1951, after EYKMAN) mentions some cases of Rooks' nesting on the ground and in low bushes in Holland. All these facts indicate some plasticity of this species so far as the selection of a site for nesting is concerned. In analysing the material used to build nests BUSSE (1961) states that on the average 62·1% of it are dry branches, which does not agree with the results obtained in the present investigation, according to which the dry material constitutes only about 30%. The difference is probably due to the fact that BUSSE (o. c.) based himself chiefly on samples of the material dropped to the ground by the building birds and such material is already selected to a certain degree. On the other hand, COOMBS's

(1969) observations on the phases of nest building confirm the presence of nest layers and the sorts of building materials distinguished in this study. The general data concerning the building material of the nest given by GERBER (1956) and HAARTMAN (1969) agree with the present results. HIBBERT-WARE (1930) found very numerous pieces of different sorts of rubber in the nests of an urban colony. This phenomenon is analogous to the general use of paper as building material in the nests in a town area described in this paper. The use of vicarious building materials points at great adaptive possibilities of the Rook.

VIII. CROW *CORVUS CORONE* LINNAEUS, 1758

Own materials

The data on the nesting of the Crow are based on 31 nests examined, derived for the most part from southern Poland and belonging to the Hooded Crow *Corvus corone cornix* LINNAEUS, 1758. They are complemented with the observations on the nesting height and site of several additional nests.

Most of the Crow nests examined and observed were found in breeding habitats characteristic of this species, i. e., small groups of trees amidst a cultivated area, small riverside woods, and the margins of forests. One of the conditions of the nesting of Crows in a given habitat is the presence of old high trees in it. All the nests but one, which was situated in a suburbian area, were built in groups of trees lying relatively far from human settlements. The smallest distance of a nest from the buildings was 150 m, the largest 4·5 km, the mean distance being about 1·5 km.

The nesting heights are given in Table XX. Apart from one nest which was found very low, the other Crow nests were situated from 9 m upwards, mostly (61 % of the total) between 10 and 15 m. The mean nesting height for 36 nests was 14·0 m.

Table XXI gives a list of tree species in which the Crows nested. Out of the coniferous trees, the pine and fir were chosen most frequently, and the nests built in them were mostly met with at the margins of both coniferous and mixed forests. The choice of these trees is presumably connected with the fact that they provide good conditions for the birds to hide their nests. Out of the deciduous trees, the poplar came in first decidedly and was followed by the willow and alder. These trees were chosen chiefly in wooded areas stretched along rivers and streams, in which environment they, besides, occur most numerously. The other species of trees were represented less numerously, and the nests encountered in them were generally situated in clumps of trees scattered among fields.

The sites of nests are to some extent connected with the specific membership of the trees in which they are placed. The majority of the nests of the Crow are situated in the top and middle portions of the tree-crown (Fig. 2: A_1 and A_2 —

Table XX

Nesting heights of the Crow *Corvus corone*

Height in m	Number of nests	%
1·0—1·99	1	2·8
9·0—9·99	2	5·5
10·0—10·99	7	19·4
11·0—11·99	3	8·3
12·0—12·99	5	13·8
13·0—13·99	3	8·3
14·0—14·99	1	2·8
15·0—15·99	3	8·3
16·0—16·99	1	2·8
17·0—17·99	1	2·8
18·0—18·99	3	8·3
19·0—19·99	—	—
20·0—20·99	2	5·5
21·0—21·99	—	—
22·0—22·99	—	—
23·0—23·99	2	5·5
24·0—24·99	—	—
25·0—25·99	2	5·5
Total	36	
Mean height 14 m		

old trees, B_2), their placement in a many-progned or single fork of the trunk or its boughs being a basic variant. In this case the considerable thickness of the branches among which the nest is built and which support it at sides is an essential character. The bulk of the nest, however, rests on its base on the wide platform of the fork. Out of the 36 nests examined, as many as 28 belonged to this group. They were situated almost exclusively in poplars and willows. Some of these nests are also placed in top crotches, but only in many-pronged ones, which are, consequently, much thinner. Here, the sides of the nest lean on the branches, the nest itself looks as if hanging from them, for its base does not touch the place where the branches part. Such placements of nests are most often seen in top whorls of pines and in top crotches of alders. In the material studied it is represented by 10 nests.

The second type of sites embraces the nests situated close to the trunk in the middle and lower portions of the tree-crown. It also splits into two variants. In the first variant the bulk of the nest rests on one or two thick horizontal branches, leaning against the trunk on one side. Sometimes there are still additional side supports in the form of thin vertical shoots. The nests of the second variant of this type are based on several thinner horizontal branches, which support them at the sides and, partly, from below. In most cases, however,

the main weight of the nest rests on the side points of support. Seven nests of this type were found, of which 4 were in firs and 3 in deciduous trees. Two nest sites differed somewhat from the types distinguished. One of them was placed in a cluster of blackthorn, based on a great many thin branches directed all ways (like a Magpie's nest described above). The other was on a nearly horizontal thick bough of a willow-tree, 3 m from the trunk. This nest was supported

Table XXI

Species of trees and shrubs in which the nests of the crow *Corvus corone* were sited

Species	Number of nests	%
Populus nigra	8	22·2
Pinus silvestris	6	16·6
Salix cinerea	5	13·8
Alnus glutinosa	5	13·8
Abies alba	4	11·1
Fagus silvatica	3	8·3
Acer platanoides	1	2·8
Carpinus betulus	1	2·8
Tilia cordata	1	2·8
Larix sp.	1	2·8
Prunus spinoza	1	2·8
Total	36	100·0

at sides by thin vertical shoots. It is characteristic that all the nests of Crows are, as a rule, very well hidden and, in comparison with those of the other species of the *Corvidae* building their nests in trees, not very easy to see.

The Crow's nest has an evident four-layered structure (Fig. 3:6). Dry branches and sticks are the main components of the external layer. Their arrangement and size differ between particular parts, being, as it were, a reflection of the building stages. The base of the nest is composed of sticks arranged obliquely to each other at varying angles. They are all dry and their mean thickness is about 1 cm and mean length 30 cm. In the side walls thinner twigs (0·2—0·5 cm) form a higher percentage of the material of the external layer and their share increases proportionally to the height at which they occur. The arrangement of material also changes, becoming more circular with height. The external layer makes the impression of a loose and disorderly structure, and this is so mainly owing to its projecting sticks and twigs. On the inside the bottom of the external layer is covered by a clay layer shaped into a cup. The clay is often mixed with other material like grass rootlets, bast, or dead leaves. The thickness of this layer is rather considerable, as it fluctuates between 1·5 and 3·5 cm. The cup itself is not high, it does not reach half-way up the walls. The third layer, which is thin and composed of fresh elastic twigs, 0·2—0·3 cm thick

and arranged circularly, adjoins the external layer on the inside, from the edge of the clay cup upwards. It is turned down in the form of a distinct ring over the edge of the external layer and fresh leaved twigs of the birch or pine are sometimes woven into this ring. The last layer of the Crow's nest is the lining, which on account of, among other things, its clear-cut differentiation of material is divided into the inner and the outer lining. The main material of the inner lining is bast, which in some cases forms as much as 90% of the total. It is always fresh, often torn off together with the adjoining bark, most frequently

Table XXII

Analysis of material used to build the nests of the Carrion Crow *Corvus corone*

Material	Number of nests	%
Clay	26	100·0
Vegetable material		
sticks and branches	26	100·0
bast	26	100·0
grass blades	21	80·7
moss	19	73·0
lignified stalks of plants	17	65·3
rootlets of trees and shrubs	16	61·5
bark	13	50·0
plant rootlets	12	46·1
rhizomes of couch grass	10	38·4
dead leaves	10	38·4
inflorescens of trees	5	19·2
inflorescens of grasses	4	15·3
lichens	2	7·6
fresh sprouts of raspberry	1	3·8
Animal material		
sheep wool	11	42·3
feathers	9	34·6
horsehair	8	30·7
hare hair	6	21·5
cattle hair	5	19·2
unidentified hair	2	7·6
roe-deer hair	1	3·8
(wool and hair together)	26	100·0
Artificial material		
paper	13	50·0
cordboard	3	11·1
fragments of cloth	3	11·1
string	2	7·6
woolen yarn	1	3·8
thread	1	3·8
cotton wool	1	3·8
wood wool	1	3·8

from the willow or poplar, alder and hazel. The length of a strip of bast is 10—60 cm and the piece of bark attached to it reaches 16 cm in length and 4 cm in width. Single delicate twigs, which render this layer rather elastic, bark, dead leaves, tufts of animal hair, scraps of paper and cardboard occur in this layer as additional materials. Bast combined with rootlets or with rootlets and grass stalks is fairly often the most important material of the lining. The outer surface of the nest cup is lined carefully with very fine material, which includes grass blades, bast fibres, sheep wool and other animals' hair, and, in addition, moss tufts, feathers and paper. The share of particular sorts of materials varies in quantity, but fine grass blades and hair are always present. The whole of the nest is woven circularly, tied closely together and very elastic. The outer lining does not generally reach the edge of the nest, but only forms a shallow cup at its bottom.

A close analysis of the material used to build 26 Crow nests is shown in Table XXII. In addition to sticks and branches, bast, clay and animal hair were materials that occurred in each of the nests examined. In most nests there were also grass blades (80·7%), moss (73·0%), lignified plant stalks (65·3%) and rootlets of trees and shrubs (61·5%). Out of the vegetable materials, bark was, besides, fairly frequent, since it occurred in 50% of the nests examined. Paper scraps (pieces of newspapers and various wrappage) were similarly often met with among the nest materials.

The general appearance and shape of the Crow's nest are in some measure dependent on its site. In shape the nest most often resembles a hemisphere, which is slightly flattened at the bottom, but it may also have a conical form. All the nests supported from below are, as a rule, hemispheric, irrespective of the fact whether they rest on one thick branch or on several thin ones. The nests of which only the side walls rest on the branches are more or less conical in shape.

Table XXIII gives a close analysis of the measurements of 31 fresh nests. All the measurements exhibit relatively great fluctuations, the nest cup diameter and depth appearing to be the most constant of them. On the other hand, the outer diameter is subject to the greatest fluctuations, its maximum value

Table XXIII

Survey of the ranges of measurements, their means, standard deviation and coefficient of variation in the nests of the Carrion Crow *Corvus corone*

Measurement	Number of nests	Range in cm	Mean	Standard deviation	Coefficient of variation
Inner diameter	31	15·5—25·0	19·41	1·95	10·04
Outer diameter	31	22·5—42·5	29·85	7·81	26·16
Depth	31	8·0—15·0	10·35	1·88	18·16
Height	31	16·0—28·0	20·79	3·17	15·24

may be nearly twice as great as the smallest one and, as a result, the standard deviation is high (7·81 cm) and so is the coefficient of variation (26·16). This is connected with the difference between the nest sites and, consequently with different shapes of the nests. The nests supported at the sides only are adjusted in their overall size to the distance between the branches and to their angle. The nest age may also have an effect on the size of particular nests, but it is difficult to estimate in most cases.

Discussion

In Central Europe the Crow nests chiefly in its typical habitats, like groups of trees among fields, small oak-dominant woods, and margins of forests (author's materials; ABSHAGEN, 1963; KONSTANTINOV, 1967; WITTENBERG. 1968) and, in addition, in town areas (HAVERSCHMIDT, 1937; KUHK, 1931), The foregoing concerns both European subspecies, *Corvus corone cornix* and *C. c. corone*, which do not differ from each other in structural details of their nests. This is why they are discussed together here. On the south-eastern coasts of Finland, Norway and Sweden the Crow inhabits the rocky seashore and poorly wooded or treeless islands (BERGMAN, 1939; TENEVUO, 1963). It nests in similar habitats on the coast of the White Sea (BIANKI et al., 1967). According to GAVRILOV (1968), GIZENKO (1955), STEINBACHER (1926), SHNITNIKOV (1949) and REJMERS (1966), the Asiatic subspecies *C. c. orientalis* EVERSMANN, 1841 nests in forest environments as well as in dry steppes, desert areas, vicinity of lakes and orchards near inhabited buildings.

The height of Crows' nests above the ground depends on the habitat and nest site. WITTENBERG'S (1968) data for Germany coincide generally with my materials. For the European part of the central U.S.S.R. the nesting beight lies between 10 and 12 m according to CHMITOVA (1953) and between 2·5 and 30 m, with a vast majority of them in the 6—10-metre group, according to KONSTANTINOV (1967), whereas MALCHEVSKY (1959) writes after POPOV that in thickets in the valleys of rivers Crows often nest very low, from 2 to 3 m above the ground. In Japan KOBAYASHI (1932—1940) observed Crows' nests at heights ranging from 3 to 40 m. The data presented by BERGMAN (1939), HAARTMAN (1969), TENEVUO (1963) and BIANKI et al. (1967) indicate that the nesting-height varies with habitat (taiga, tundra, rocky shore, coastal islands), from 0 to 25 m, most nests being situated between 5 and 15 m.

The Crow attempts to place its nest, above all, in a tree, which seems to have been its original nesting-site. Although TENEVUO (1963) suggests that the plumage colour points to the primary adaptation of the Crow to nesting on rocks, he admits that regardless of habitat, wherever there are trees, it nests exclusively in them. All the other nest-sites, e. g. on rocks or shrubs, on the ground or artificial elevations and buildings, have been reported from treeless regions.

The lists of tree species in which the Crow nests in various geographical regions differ somewhat from each other owing to the specific differences between the stands characteristic of the given climatic zones or to the floral differences between particular habitats (ABSHAGEN, 1963; BIANKI et al., 1967; CHMITOVA, 1953; GIZENKO, 1955; HAARTMAN, 1969; KOBAYASHI, 1932—*h*940; KONSTANTINOV, 1967; MALCHEVSKY, 1959; TENEVUO, 1963; WITTENBERG, 1968). The Crow nests in trees of all species, but in the habitats in which besides deciduous trees there are also coniferous ones it rather chooses the latter, especially the pine. In treeless areas, e. g., steppes, deserts, extensive cultivated fields, rocky islands or seashore there occur nests on telegraph-poles and transmission towers (AMANN, 1949; DAVIS, 1944; SHNITNIKOV, 1949; WITTENBERG, 1968), triangulation signs and towers, and sea signs (BIANKI et al., 1967; GAVRILOV et al., 1968; TENEVUO, 1963). WALFORD (1930) mentions a nest on a factory chimney and TENEVUO (1963) found a nest in a fisherman's abandoned cottage and in a shed of hay. The frequent nesting of these birds on rocks was observed on the shore of the White Sea (BIANKI et al., 1967), in Finland (BERGMAN, 1939; TENEVUO, 1963) and Scotland (TENEVUO, 1963, after BAXTER and RINTAUL). In the regions devoid of trees and other natural or artificial elevations, the Crow can occasionally nest directly on the ground (BANNERMAN, 1953; GAVRILOV et al., 1968; STEINBACHER, 1926, after ZARUDNY; HOLYOACK, 1967) and on tufts of dry reeds (GAVRILOV et al., 1968; STEINBACHER, 1926).

The types of the nest-sites distinguished for the Crow in this study and the suggestions as to the connections between the manner of placement of a nest and the specific membership of the tree agree, as a rule, with the observations of other authors (ABSHAGEN, 1963; BIANKI et al., 1967; KONSTANTINOV, 1967; WITTENBERG, 1968). It may be assumed in general that in deciduous trees the Crow mostly places its nest in a tree fork or on thick boughs; then the weight of the nest rests on its base. In coniferous trees the nests are most often placed between several branches, close to the trunk, and their points of support are at their sides.

WITTENBERG (1968), analysing the position of nests in deciduous trees in relation to the height of their crowns, found that most of them, as many as 49%, lie in the middle, 36% in the upper portion, and 15% in the lower one. BIANKI et al. (1967), in turn, state that in coniferous trees most nests are situated in the upper portion, 1—2 m from the top. KONSTANTINOV'S (1967) results indicate a somewhat greater proportion of the nests situated in the upper portion of the crown.

Both the general and detailed information obtained from literature as to the material and structure of nests (ABSHAGEN, 1963; BIANKI et al., 1967; CHMITOVA, 1953; HAARTMAN, 1969; KOBAYASHI, 1932—1940; KUHK, 1931; REJMERS, 1966; TENEVUO, 1963; WALFORD, 1930; WITTENBERG, 1963, 1968) coincides in outlines with the results described in this paper. Analysing the structure of nests from Germany, ABSHAGEN (1963), and those from the south-eastern coast of Finland, TENEVUO (1963) distinguish four main layers in the

nest, i. e., the external layer, the binding or twig layer, the load or clay layer and the lining, which quite agrees with the present results. There are, however, some slight differences in the composition of materials used to built the particular layers. In the nests from the Finnish coast (TENEVUO, 1963) juniper twigs predominate in the external layer and, where there grow pines, the percentage share of their twigs is equal to that of juniper ones, whereas in rocky islands, poor in trees and vegetation, this layer is chiefly composed of grass stalks, lichens and mosses. NIETHAMMER (1937) claims that in the mainland the Crow uses exclusively pine branches to construct its nest, which does not agree with my observations that in the nests built in mixed forests the shares of branches of pines and deciduous trees are the same. ABSHAGEN (1963) mentions a nest in the external layer of which there was much wire and WALFORD found a nest built mostly of wire and rabbit bones. The use of mammalian and fish bones as building material is also mentioned by BIANKI et al. (1967) and TENEVUO (1963), who, after RENDHALL, describes the nests made entirely of algae on the northern coast of the Atlantic. Differences in material may also be found in the twig layer. In the nests analysed by ABSHAGEN (1963) it consisted chiefly of couch-grass rhizonmes, reed and bast, whereas according to the data given by TENEVUO (1963) and my own observations, it is made up of delicate and elastic twigs of deciduous trees. The lining in the Crow's nest is characterized by a great variety of materials, of which one, most often bast, however, prevails. Both in my materials and in the nests from Finland (TENEVUO, 1963) bast occurred in each specimen and its share came up to 90% of the total amount of material of the lining. Only in the nests from pine forests, examined by ABSHAGEN (1963), rootlets were the main material of the lining, which was probably due to the deficiency of bast in this habitat. The descriptions of nests from urban areas (KUHN, 1931) show that the Crow may succeed in using vicarious materials, e. g., strings, cloth, paper, and oakum, to make the lining. The share of animal wool or hair in the outer lining of the nest cup is emphasized in all the descriptions of nests. Feathers are used in large numbers as lining material rather more in northern regions (BIANKI et al., 1967; CHMITOVA, 1953; TENEVUO, 1963) and even there only when wool and hair are lacking.

The comparative juxtaposition (Table XXIV) of the mean measurements calculated on the basis of my materials (cf. Table XXIII) and the corresponding means from papers by ABSHAGEN (1963) and TENEVUO (1963) gives an idea of the size and variation of Crows' nests. The values of the cup diameter, which, besides, is the most constant magnitute in the nest, differ least from each other. There are also small differences between the nest cup depths, though the means obtained by ABSHAGEN and TENEVUO are greater. The marked difference between the values of the outer diameter results probably from a different method employed by these authors, i. e., the inclusion of the projecting sticks and twigs, forming a "brush", in measurements. In addition, the outer diameters and heights of nests are very variable, in which they are dependent upon the site of the nest and the duration of its use, for the Crow relatively often

uses a nest for two or more breeding seasons, which is recorded by some authors (ABSHAGEN, 1963; HAVERSCHMIDT, 1937; KUHK, 1931; TENEVUO, 1963; WITTENBERG, 1968). According to KRAUZ (1930) and WITTENBERG (1968), in singular cases the Crow may occupy an old nest of a Buzzard, making only the lining

Table XXIV

A comparison of the mean measurements of the nests of the Carrion Crow *Corvus corone* obtained on the basis of the author's own material (cf. Table XXIII) and the means given by ABSHAGEN (1963) and TENEVUO (1963)

Measurement	Own materials		ABSHAGEN (1963)		TENEVUO (1963)	
	Mean	Number of nests	Mean	Number of nests	Mean	Number of nests
Inner diameter	19·41	31	20·46	26	19·8	70
Outer diameter	29·85	31	41·34	26	47·1	70
Depth	10·35	31	12·68	25	12·6	70
Height	20·79	31	—	—	33·0	70

in it. ABSHAGEN (1963) writes that, occupying an old nest, the Crow adds only a part of the external layer and the lining and WITTENBERG (1968) believes that only the lining is supplemented. This fact, in addition to some deformations of the nest caused by its use in the preceding year, partly changes its proportions and appearance.

IX. RAVEN *CORVUS CORAX* LINNAEUS, 1758

Own material

The nesting of the Raven is analysed on the basis of 15 nests examined closely and additional data concerning the habitat, nesting height and site of another 38 nests. The relatively small number of the nests that were closely examined results chiefly from the fact that they are difficult of access and that these birds are rather scarce in Poland. The study material comes mainly from Lublin, Kielce and Rzeszów provinces, which areas are regarded by DOBROWOLSKI et al. (1962) as those colonized most numerously by Ravens in Poland.

A vast majority of the nests from the Lublin and Kielce provinces, which make up the main bulk of my material, are derived from identical habitats, i. e., from lowland pine forests on a sandy or marshy substratum. Only a few nests are from pure deciduous or mixed forests. The sites of nests in these environments are also similar, for the most commonly inhabited biotopes are thinned and translucent stands of trees, 60 or more years of age, adjacent to large open areas, e. g., meadows, marshes, clearings, young wood plantations and fields. Only in one case a nest was situated in a lonely pear-tree among the fields,

2·5 km away from a forest and 1·5 km from human houses. There seems to be no relation between the situation of the nest and the distance from human settlements. The nearest nest was situated 200 and the farthest one 7 km from houses. In most cases the distance was 1·5 km. The safety of the nest, achieved by building it in a place very difficult of access, and the nearness of areas abounding in food are essential factors influencing the choice of nest-site. Usually both these conditions are fulfilled and the birds extremely seldom resign of one of them in favour of the other.

The nests of the Raven are as a rule placed high, as can be seen from Table XXV. The nesting-heights range from 13 to 31 m, the mean calculated for 50 nests being 21·68 m. The distribution of the nests according to their height above the ground shows no clear preference of the birds for any height group. It may, however, be stated in general that more than half the nests

Table XXV

Nesting heights of the Raven *Corvus corax*

Height in m	Number of nests	%
13·0—13·99	1	2·0
14·0—14·99	—	—
15·0—15·99	1	2·0
16·0—16·99	—	—
17·0—17·99	2	4·0
18·0—18·99	4	8·0
19·0—19·99	5	10·0
20·0—20·99	7	14·0
21·0—21·99	5	10·0
22·0—22·99	6	12·0
23·0—23·99	3	6·0
24·0—24·99	2	4·0
25·0—25·99	4	8·0
26·0—26·99	3	6·0
27·0—27·99	—	—
28·0—28·99	1	2·0
29·0—29·99	4	8·0
30·0—30·99	2	4·0
Total	50	100·0
Mean height 21·68 m		

were placed between 18 and 23 m. This is only natural, if we keep in mind that the average age of the trees in which the nests were found was 90 years and the nests were situated in the top and middle portions of the crown.

Table XXVI shows the species of trees in which the nests were placed and their number. As most the nests examined were from pine forests, the domi-

nant species is the pine. Even in deciduous forests Ravens most readily build their nests in pines, which is probably connected with their typical arrangement of branches, providing firm support to the nests and the fairly high trunk void of branches, which in turn makes the nests difficult of access.

Out of the 53 nests examined 34 were situated close to the trunk on its branches in the top portion of the crown (Fig. 2: C_1, C_2), 13 in the central whorl or top fork (Fig. 2: A_1, A_2), 5 in the middle portion of the crown but in branch

Tabela XXVI

Species of trees in which the nests of the Raven *Corvus corax* were sited

Species	Number of nests	%
Pinus silvestris	43	86·0
Betula verrucosa	3	6·0
Fagus silvatica	1	2·0
Quercus robur	1	2·0
Populus tremula	1	2·0
Pirus communis	1	2·0
Total	50	100·0

forks 50—150 cm away from the trunk, and 1 on a branch at the top but at a distance from the trunk (Fig. 2: C_1, C_2). The nest usually rests on several thick horizontal branches, which support it from below, and leans with its side against the trunk. If it is placed in the central whorl or top fork, the weight of the nest is evenly distributed and the nest is supported both at the sidest and at the bottom. The nests placed far from the trunk, lie on thick horizontal forked branches, often unsupported at the sides.

At a first sight the Raven's nest present itself as a mass of dry sticks and twigs, arranged in different directions and interlaced, which form the external layer of the nest (Fig. 3: 7), constituting its main structural body. In pine forests this layer is constructed nearly exclusively of dry pine branches and sticks, 30—80 cm long and 0·4—2·5 cm thick. In mixed forests material was derived from both deciduous and coniferous trees. The composition of the material, however, does not seem to be quite dependent on what the bird can find in the close vicinity, since, for instance, in one nest in a pine forest 90% of the material were branches of deciduous trees, which grew at the margin of the forest, at a considerable distance from the nest. The material of the external layer is tightly interwoven, usually at an acute angle, and forms a sort of basket in which other layers are placed successively. In addition to the dry thick branches which make the basic material, there are thin fresh twigs of deciduous and coniferous trees which strengthen the basket structure. In the nest base the material is usually arranged so as to form a triangle, which shape is sometimes kept

for more than ten centimetres, whereas higher up it assumes a more circular form. No free ends of sticks and branches project beyond the walls of the nest, which differs it from the nests, similar in size, of brids of prey, e. g., those of the Buzzard. The thickness of the external layer averages 20 cm. The second layer is made of circularly arranged thin twigs, on the average 35 cm long and 0·4 cm thick. They are, for the most part, fresh twigs, forked at ends, of deciduous trees, like the birch or hazel. At the edge of the nest they often form a ring, which reaches half-way across the thickness of the external layer. The material of which the ring is built may, however, differ from that of the rest of the second layer, because it often contains twigs of coniferous trees, like the pine or larch. The next element is a clay layer in the form of a shallow bowl. It may be of pure clay or clay mixed with bunches of rootlets, or even clay with horse dung. The thickness of this layer is 1—3 cm. Nevertheless, it must be mentioned that only in some nests it is fully formed and in many it is lacking at all. The inside of the nest is covered with the lining layer, which may be divided into two parts. The first, inner, part is fairly loosely constructed of very various materials, showing no definite structure. It is generally composed of moss, bast, grass stalks, rootlets, and dead leaves mixed together, paper, cloth, string and tufts of animal hair being additional materials. The percentage share of these materials in individual nests is different and depends upon their availability in the vicinity. The outer layer of the lining is more compact and differs somewhat in the composition of its material. It generally consists of animal hair, sheep wool or horse hair, with an addition of fine grass blades. However, it may also be made exclusively of vegetable materials like grass stalks and bast, with feathers, paper scraps, cotton-wool, etc. as additional materials. The average thickness of both parts together is about 15 cm, of which 2·5 cm falls to the outer portion. Owing to its structure and materials the lining is characterized by its great elasticity and good thermal insulation, which is particularly important, because the Raven's breeding season occurs early.

A close analysis of the material used to build 14 nests of Ravens is given in Table XXVII. In addition to the basic materials, i. e. sticks and branches, moss, being a constant component of the lining, occurred in all the nests examined. Bast, which in the lining is the element that binds all the materials together, also occurred very often (in 92·8% of the nests). Out of the other components, grass stalks (64·2%), grass rootlets, lignified stems of plants, horse hair and clay (50% each), sheep wool and paper (35·7%) are fairly abundant. Animal hair also occurs in varying amounts in the outer lining of nearly all the nests. Other materials occur in smaller quantities and they may be numbered among the accidental and uncharacteristie elements.

The shape of the nest is, to a certain degree, dependent on its site. The nests placed on boughs, close to the trunk, and those on side branches have their diameter at the base only slightly smaller than the greatest outer diameter; as a result, they resemble flat-bottomed bowls in shape and differ from each other only in height. The nests in whorls and top crotches resemble a low cone

Table XXVII

Analysis of material used to build the nests of the Raven *Corvus corax*

Material	Number of nests	%
Clay	7	50·0
Vegetable material		
sticks and branches	14	100·0
moss	14	100·0
bast	13	92·8
stalks of herbs	9	64·2
grass rootlets	7	50·0
heather stalks	7	50·0
dead leaves	4	28·5
grass blades	3	21·4
rootlets of trees and shrubs	2	14·2
horse dung	2	14·2
Animal material		
horsehair	7	50·0
sheep wool	5	35·7
feathers	4	28·5
hare hair	3	21·4
cow hair	2	14·2
roe-deer hair	2	14·2
fox hair	1	7·1
dog hair	1	7·1
boar bristles	1	7·1
Artificial material		
paper	5	35·7
string	3	21·4
cotton wool	2	14·2
fragments of cloth	2	14·2
gauze	1	7·1
wadding	1	7·1

turned upside down, the diameter and height of which are determined by the angle at which the branches part. The age of the nest is not unimportant to its shape and size. The nests used for several consecutive years have generally a greater height, which changes their proportions and appearance. However, the adding of new material to the nests used from year to year is not a rule; hence, there are rather big differences in height between the nests which are similarly situated and used for the same number of seasons.

Table XXVIII gives a comparison of the measurements of 15 Raven nests examined. Their number is too small to allow any statistical conclusions, but throws some light on the variation of individual measurements. They are all very variable, as the largest values of a measurement are about twice as large as the smallest ones. The relatively most constant is the nest-cup diameter,

which ranges between 19·5 and 36·5 cm, averaging 27·60 cm. However, the differences in this measurement occur both in the nests with eggs and newly hatched nestlings and in those with birds advanced in growth. The greatest differences are observed in the outer diameter, which fluctuates between 42·5

Table XXVIII

Survey of the ranges of measurements, their means, standard deviation and coefficient of variation in the nests of the Raven *Corvus corax*

Measurement	Number of nests	Range in cm	Mean	Standard deviation	Coefficient of variation
Inner diameter	15	19·5—36·5	27·60	3·79	13·73
Outer diameter	15	42·5—92·5	70·16	12·95	18·45
Depth	15	8·0—16·0	11·06	2·28	20·61
Height	15	26·0—65·0	44·60	11·38	25·51

and 92·5 cm, the average being 70·16 cm. The standard deviation is here very high, up to 13 cm, and so is the coefficient of variation (18·45). The values obtained for the height of the nests examined present themselves similarly. Both the last measurements are strongly influenced by the site and age of the nest.

Discussion

The nesting habitats of Ravens in Central Europe, Scandinavia, Great Britain, Asia and North America, described by different authors, indicate invariable environmental requirements of this species. GOTHE (1961, 1965) states that the Raven's optimum habitat in Germany are thinned forests, resembling parkland in character, and that the nests are rather placed at the margin of forests. This agrees with my observations and those of other authors (BODE, 1967; EMEIS, 1951; FALTER, 1938; RUTHKE, 1930; WARNCKE, 1960). The data obtained from Byelorussia (FEDUSHIN and DOLBIK, 1967), Central Russia (LIKHACHEV, 1951) and Siberia (REJMERS, 1966) also show that Ravens inhabit only forest environments and nest in trees. There are descriptions of the nesting of Ravens exclusively on rocks (mountains and seashore) in the Alpine area belonging to Germany (WÖRNER, 1962), the central part of the Swiss Jura (HAURI, 1966), Yugoslavia (RUCKNER, 1967) England (HEATHERLEY, 1909), Sakhalin (GIZENKO, 1955) and North America (BOWLES and DECKER, 1930; TYNE and SUTTON, 1937). On the other hand, nesting both in trees and on rocks in the same biotope was observed in some parts of the Alps (WÜNST, 1952; HAURI, 1956), Eastern Carpathians (STRAUTMAN, 1963), Sweden (BLOMGREN, 1965), Finland (HAARTMAN, 1969), England (NETHERSOLE-TOMPSON, 1932), Yakutsk region (VOROBEV, 1963), North America (BENT, 1946; BOWLES

and DECKER, 1930) and west-central Africa (ARCHER and GODMAN, 1961). Nests on straw heaps and in low shrubs in the steppes of eastern Russia (EMEIS, 1951, after GROTE) are examples of exceptional habitats and sites. So are the nests built on abandoned houses and other buildings (even inside an empty building), telegraph-poles, transmission towers, derricks and bridge spans encountered on the plains and plateau of the state of Washington in North America (BOWLES and DECKER, 1930). HAARTMAN (1969), too, mentions nests constructed on houses in Finland. Frequent cases of the nesting of Ravens on oil-well derricks are known from California (BENT, 1946). BLOMGREN (1965) quotes, after ROSENIUS, several interesting examples of the nesting of Ravens on church towers in Russia and Siberia and in ruins of buildings and on sea-marks in Germany. He also cites RYVES'S description of Ravens' nests on pit shafts and chimneys and SALOMONSEN'S statement about their nesting in big colonies of sea-birds in Greenland. Finally, NIETHAMMER (1937) writes about the nesting of Ravens in the colonies of Herons and Rooks. Nevertheless, most of these exceptional nest-sites may be reckoned in two basic groups, i. e., nests on rocks and those in trees. Thus, it may be assumed in general that regardless of latitude the Raven inhabits the edges of old coniferous and deciduous forests and steep rocky slopes in the mountains and on the seashore (cliffs). Exceptionally it also lives in open areas of steppes and semideserts, on condition that it finds a natural or man-made elevations to build its nest on.

In different geographical regions Ravens show a tendency to build their nests in definite species of trees. In Germany they nest nearly exclusively in beeches and only occasionally in oaks, pines, firs and spruces (EMEIS, 1926, 1951; GOTHE, 1961; LOOFT, 1967; WARNCKE, 1960). According to BLOMGREN (1965), in the times when Ravens were common in southern Sweden, they built their nests in beeches and oaks, nowadays however they nest chiefly in pines and exceptionally in spruces. In England they also show preference for coniferous trees (ALLIN, 1968). The pine is the commonest species chosen for nesting in southern Poland (cf. Table XXVI), Byelorussia (FEDUSHIN and DOLBIK, 1967) and Finland (HAARTMAN, 1969). In parkland environments in the southern part of central Russia the nests of Ravens were found only in deciduous trees, i. e., oaks, lime-trees and aspens (LIKHACHEV, 1951), whereas in the taiga of central Siberia they nest both in deciduous and coniferous trees (REJMERS, 1966). BENT (1946) mentions the spruce as the species that is most frequently chosen for nesting in North America. The choice of a given tree species for nesting was probably conditioned to a great extent by the specific composition of forests, although it may well be that there exist some local specializations of Ravens.

The results obtained by different authors (FEDUSHIN and DOLBIK, 1967; GOTHE, 1961; LIKHACHEV, 1952), analysing the nest-sites in trees, agree as a rule with the descriptions of the types of nest-sites presented in this paper. On account of the weight of the nest the Raven places it most readily on thicker branches close to the trunk, or in top crotches, and only exceptionally on side

branches, at a distance from the trunk. If we take into account the difference in the nature of branches and the arrangement of the crown, it becomes natural that the nests in pines are generally situated in the top portion, whereas in spruces and deciduous trees they lie in the middle and lower portions of the crown. The descriptions of nests on rocks (NETHERSOLE-THOMPSON, 1932; BLOMGREN, 1965) show that they are most readily built in various niches, depressions, fissures and on rocky shelves, often under overhanging rocks, being thus sheltered from above. All the authors are in principle concordant as to the general appearance of the nest and materials used to build it (BENT, 1946; BOWLES and DECKER, 1930; BURNS, 1895; EMEIS, 1926, 1951; FEDUSHIN and DOLBIK, 1967; GOTHE, 1961; GROEBBELS, 1942, 1950; GWINNER, 1965; NIETHAMMER, 1937; NETHERSOLE-THOMPSON, 1932; WARNCKE, 1960), and their descriptions agree with the data given in this paper. In exceptional cases the birds use a vicarious material to construct the external layer of the nest, e. g., roots and bones of larger mammals, as recorded in Greenland (BLOMGREN, 1965, after SALOMONSEN) or wire, sheep ribs and cattle bones observed in some nests in North America (BOWLES and DECKER, 1930). The existenxe of the layer of twigs has been clearly stated only by BLOMGREN (1965), whereas GWINNER (1965) does not mention it in his analysis of the nests built by Ravens in aviaries, though he describes a thick ring constructed of fine and elastic twigs at the edge of the nest. Clay is regularly used as a building material only in the nests from England (BLOMGREN, 1965, after RYVES). In Germany no authors but NIETHAMMER (1937) and GWINNER (1965) state its occurrence in Ravens' nests, and it never occurs in them in Sweden (BLOMGREN, 1965). Hence, it may be supposed that clay is used in the regions where at the time of nest building the ground is not covered with snow or frozen. As will be seen from the reports published by many authors (BENT, 1946; BLOMGREN, 1965; BOWLES and DECKER, 1930; EMEIS, 1926; 1951, FEDUSHIN and DOLBIK, 1967; NIETHAMMER, 1937; NETHERSOLE-THOMPSON, 1932; WARNCKE, 1960), the materials most commonly used for the lining are various animal hair, sheep wool, moss, bast, rhizomes and stems of grass, and scraps of different materials, like paper, string, and cloth. Horse hair, bark, fine twigs, algae and feathers are found comparatively rarely. In the nests from the north of Sweden, Russia and North America the lining regularly contains various quantities of lichens.

The measurements of nests given in this paper (cf. Table XXVIII) agree as a rule with those found by WARNCKE (1960) in 11 nests from northern Germany and by GWINNER (1965) in 7 nests built by Ravens in the aviary. The means of their measurements lie within the ranges of the measurements of nests from Poland and in some cases are even identical. Similarly, however, the ranges of individual measurements, especially those of the height and outer diameter are strikingly wide. The nests from Sweden (BLOMGREN, 1965) differ slightly in size from those included in Table XXVIII, whereas the nests from North America are considerably higher (BENT, 1946) in contradistinction to the nests from Byelorussia (FEDUSHIN and DOLBIK, 1967), the height of which

is 17—25 cm. Keeping in mind the fact that the Raven sometimes occupies an abandoned nest of the Crow (BLOMGREN, 1965; after ROSENIUS; WARNCKE, 1960), we must regard it possible that the lower limit of the range of heights for the nests from Byelorussia represents this very case. In the nests used for many years the outer diameter and height may sometimes be simply imposing. BENT (1946) writes about a nest on a cliff, 1·21 m in diameter, and BLOMGREN (1965) about another, 1 m high. RUTHKE (1930), too, describes a nest which was 1·5 m across and 1 m high. According to EMEIS (1926), the shape and size of the nest cup also change in the nests used from year to year. The cup becomes flatter and broader, which accounts partly for the comparatively wide range of the nest-cup diameter and depth.

X. GENERAL DISCUSSION

The above-discussed seven Polish species of the family *Corvidae* in principle do not constitute a compact ecological group.

In considering the nesting-height of the species under study (Fig. 1), we can see that the values of this parameter are relatively much differentiated as regards both their ranges and mean values. The Raven has the narrowest range of the nesting-height (13—30 m) in the genus *Corvus* but, at the same time, the greatest mean value (about 21 m) of all the birds discussed. The Rook is also characterized by its relatively great mean nesting height (19 m), the values of which range from 7 to 30 m. The Crow and Jackdaw have similar nesting-heights (14 and 13·5 m, respectively), but the latter shows a great fluctuation of this parameter (2—35 m) in connection with its nesting in various environments. The Magpie holds an intermediate position between the species of the genus *Corvus* and the Jay and Nutcracker, which most resemble each other in respect of both the range and mean value of the nesting-height and are besides characterized by the lowest indices of all the species discussed. In comparing the lists of tree and shrub species and other sites used by particular bird species for nesting, we can hardly find any common features. The Nutcracker's list contains the fewest items, this bird being associated almost exclusively with coniferous trees, especially the fir. Another species having a short list of trees (6) in which its nests were found is the Raven; 80% of its nests were in pines, which, however, does not indicate any preference, but is rather due to the domination of this tree in the stands from which the material examined was obtained. The Crow, Rock, Jay and, especially, Magpie nest both in deciduous and coniferous trees and shrubs belonging to many different species, but only the Rook shows a clear tendency towards nesting in poplars.

As regards nest-sites, including all their aspects, like the species and age of the tree or shrub, the thickness and number of the branches on which the nest rested, and the position of the nest within the crown, it should be stated that no sites common to all the bird species discussed can be distinguished.

The number of nests of examined species according to types of nest-sites

Species	Types of nest-sites on the basis Fig. 2																	
	A_1	A_2	B_1	B_2	C_1	C_2	D	E	F	G	H	I	J	K	L	M	Total	Others
Garrulus glandarius	11	1	12	6	1	5	—	5	1	—	1	—	1	*	—	—	44	inside building
%	25·0	2·2	27·4	13·8	2·2	11·4	—	11·4	2·2	—	2·2	—	2·2	—	—	—	100·0	
Pica pica	12	41	4	2	—	—	63	24	—	—	*	—	*	*	—	—	146	on electric pylons, derrick bridge-spans, in red, on the ground
%	8·2	28·2	2·7	1·3	—	—	43·2	16·4	—	—	—	—	—	—	—	—	100·0	
Nucifraga caryocatactes	1	—	5	—	—	—	—	—	—	—	*	—	—	—	—	—	8	between roots of stone pine, inside an uninhabited hut
%	11·3	—	66·5	—	22·2	—	—	—	—	—	—	—	—	—	—	—	100·0	
Corvus monedula	—	—	1	—	1	—	—	—	44	119	2	38	17	9	47	22	299	in holes and burrows, in nests of other birds (rook, crow, heron, white stork)
%	—	—	0·3	—	0·3	—	—	—	14·7	36·4	0·6	38	5·6	3·0	15·7	7·3	100·0	
Corvus frugilegus	15	21	22	204	2	95	515	—	—	—	—	—	—	—	—	—	874	on church towers, turrets, belfries, high-voltage pylons, on ground
%	1·8	2·5	2·6	23·8	0·2	8·8	59·3	—	—	—	—	—	—	—	—	—	100·0	
Corvus corone	5	5	6	18	—	1	—	1	—	—	*	—	—	—	—	—	36	on electric pylons, church towers, geodesic sings and sea-sings on factory chimneys, inside buildings, on tufts of dry reed, on ground
%	13·2	13·2	16·6	50·0	—	2·5	—	2·5	—	—	—	—	—	—	—	—	100·0	
Corvus corax	10	3	31	3	5	1	—	*	—	—	*	—	*	—	—	—	53	on electric pylons, derrick bridge-spans, church towers, sea-sings inside and on buildings
%	18·8	5·7	58·5	5·7	9·5	1·8	—	—	—	—	—	—	—	—	—	—	100·0	

* — This nest-site was quoted in one of the papers referred to in the discussion on the species.

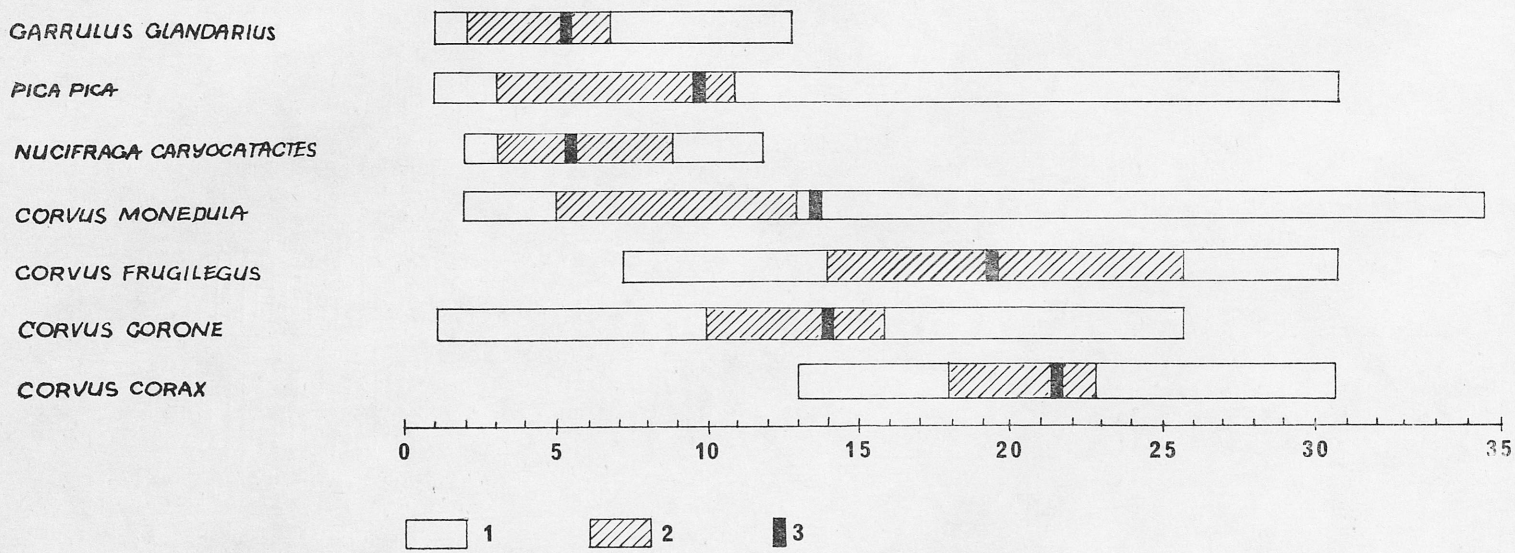
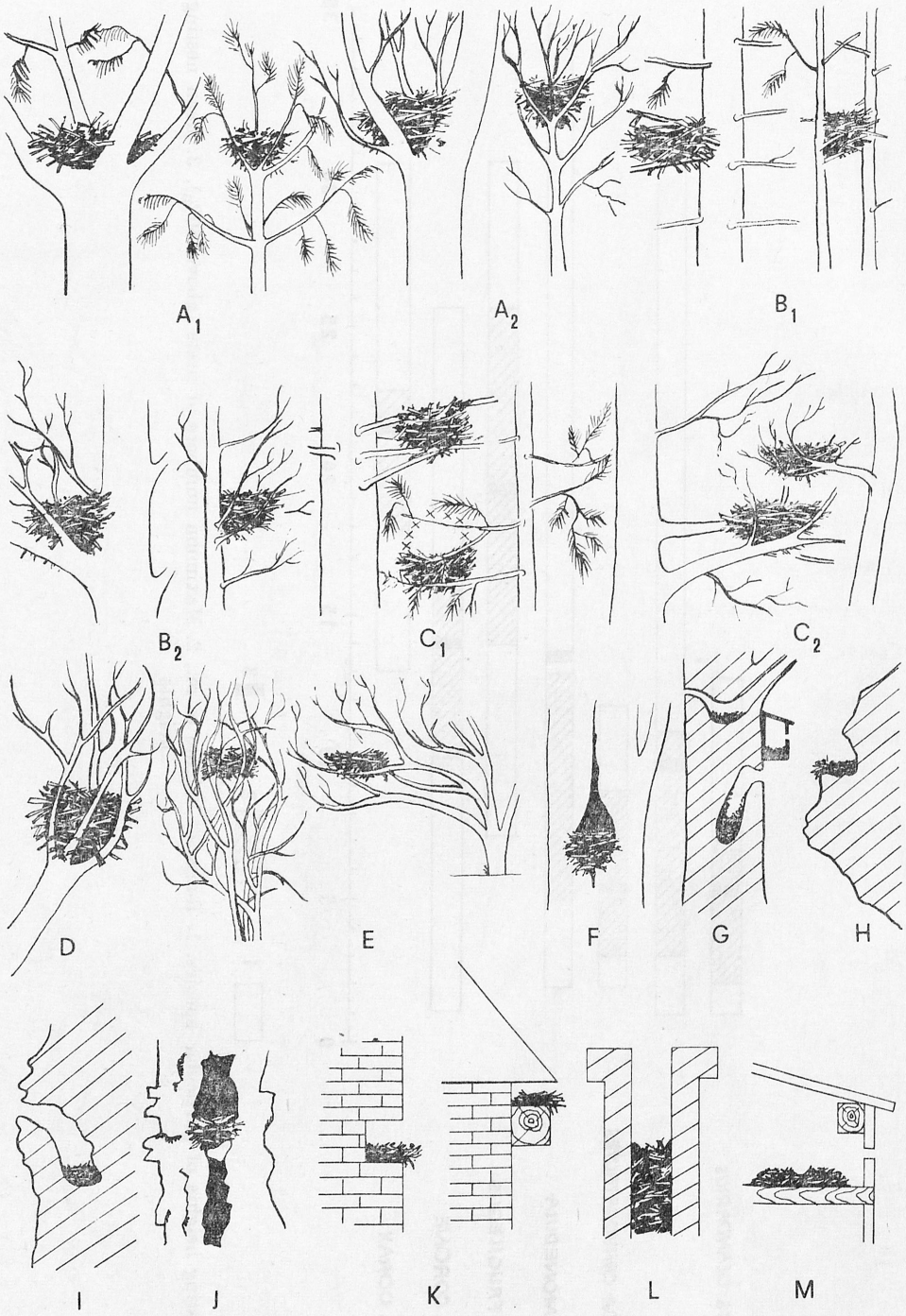


Fig. 1. Nesting heights of particular species. 1. Range of heights in m., 2. Maximum numbers of nests (above 50%), 3. Mean nesting heights


A1
A2
B1
B2
C1
C2
D
E
F
G
H
I
J
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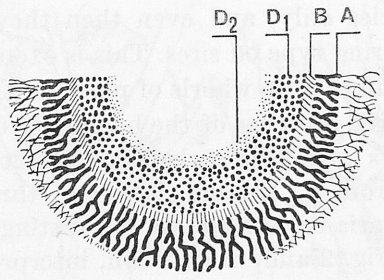
L
M

There are analogies between individual species only, and even then they do not always concern the most frequently occurring type od sites. This is exemplified by the nests of Ravens and Crows placed in the top whorls of pines, or those of Rooks and Magpies in the top many-pronged crotches of the boughs of deciduous trees. Analogously, the nests of Jays and Nutcrackers are built on branches, close to the trunk or at a distance from it. Having, however, thrown off all the previously mentioned details and variants of sites, we can distinguish their essential types. They are illustrated in Fig. 2 and, in addition, interpreted in Table XXIX, which shows the quantitative and percentage share of the nests of particular species falling to a given site type. In order to manifest their adaptive possibilities better, the data from literature concerning the site types (mostly single cases) unencountered during the present study are included in the table. These data show that all the species under study build their nests on one or two branches close to the trunk (Fig. 2:B_1) or in top whorls or crotches (Fig. 2:A_1). The other types of sites occur more rarely, some of them only singly, e. g., nesting of the Jackdaw in deep tree-holes, holes in rocks, and chimneys. The Jackdaw, in addition, presents as many as 10 types of sites, and so does the Jay, which suggests the particularly great adaptive abilities of these species. The Nutcracker, which has the smallest adaptive abilities (3 types of sites), seems to be the most conservative species, although the small number of the nests examined does not allow definitive conclusions.

More characters common to the birds under study may be found in the structure of their nests, since these characters are not only innate and pertaining to individual species but also to genera, which has been stated by different authors (Bocheński, 1968; Lack, 1956; Mayer and Bond, 1943).

Cumulative Table XXX, is the data given in Tables III, VII, XI, XIV, XVIII, XXII and XXVII so that all sorts of the materials used to build nests are given quantitatively according to their origin. They are also divided into basic materials, i. e., those occurring in at least 50% of the nests of the series examined and common materials, found in the series of nests of particular species. As will be seen from these data the vegetable material is present in the largest quantities in the nests of all the species and constitutes the bulk of the nest structure. The materials of animal origin and the artificial ones are usually additions, which occur in various amounts in the nests of particular species; nevertheless, they are often their characteristic indicators, e. g., wool and hair of animals, which occur

Fig. 2. Main types of nest sites: A1 — in top whorls and crotches of old and young coniferous trees, A2 — in top crotches of old and young deciduous trees, B1 — on branches, close to trunk, in old and young coniferous trees, B2 — on branches, close to trunk, in old and young deciduous trees, C1 — on branches, distant from trunk, in old and young coniferous trees, C2 — on branches, distant from trunk, in old and young deciduous trees, D — in peripheral forks of branches, E — in shrubs, F — in shallow tree-holes, G — in tree-holes and breeding boxes, H — in niches and on rock shelves, I — in rock holes, J — in rock clefts, K — in niches of house walls and on different projections under eaves, L — in chimneys, M — in attics of houses



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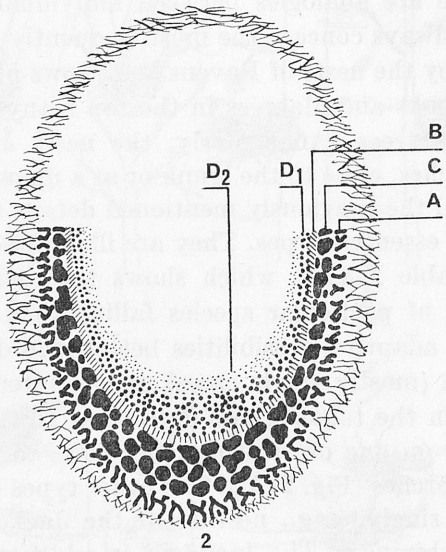

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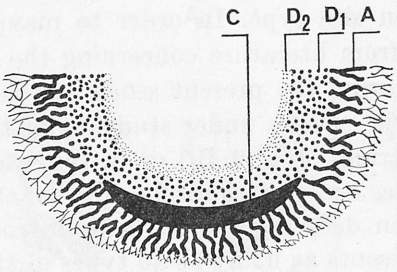

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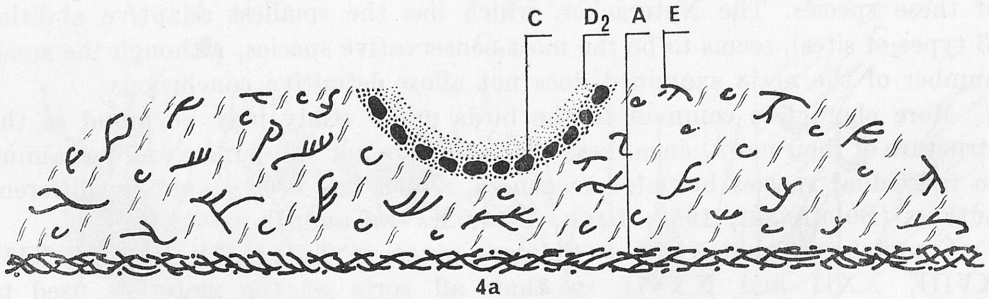
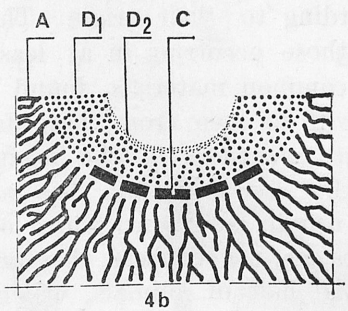


4a



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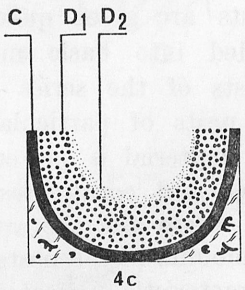

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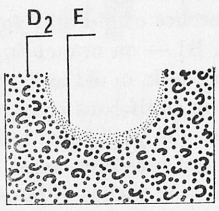

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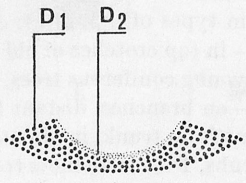

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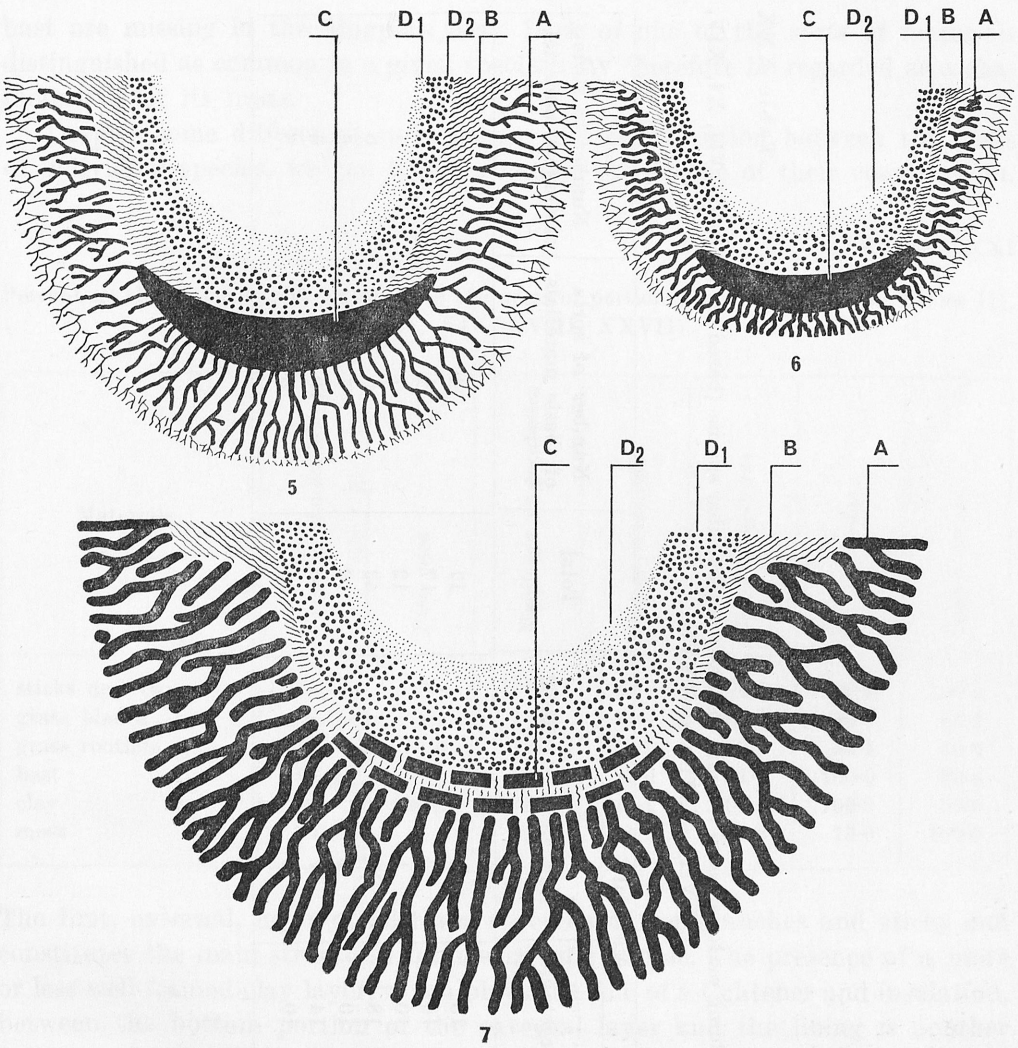

Fig. 3. Diagrammatic drawings of the nests of the species under study, showing their stratified structure. 1. *Garrulus glandarius*, 2. *Pica pica*, 3. *Nucifraga caryocatactes*, 4. *Corvus monedula*, 5. *Corvus frugilegus*, 6. *Corvus corone*, 7. *Corvus corax*. A. External layer, B. twig layer, C. clay layer, D1. inner lining, D2. outer lining, E. external-lining mixed layer

regularly in the outer lining of the Raven's nest, paper in the Jackdaw's nest, or the complete lack of artificial materials in the Nutcracker's nest. An analysis of the percentage share of common materials in the nests of singular species (Table XXXI) shows that they are at the same time basic materials in most cases, which points at similarities in the choice of building materials in the examined group of birds. This occurs particularly distinctly in the species of the *Corvus*, with which the Nutcracker has, in turn, the most characters in common. The Jay differs from the rest in the lack of clay in its nest, whereas moss and

Table XXX

A comparison of the numbers of sorts of building materials used to build the nests of particubar species (based on Tables III, VII, XI, XIV, XVIII, XXII and XXVII)

Species	Material				Total	Number of sorts of basic materials	Number of sorts of common material
	clay, earth	Vegetable	Animal	Artificial			
Garrulus glandarius	—	13	3	1	17	4	5
Pica pica	1	10	3	3	17	4	5
Nucifraga caryocatactes	1	10	1	—	12	7	5
Corvus monedula	1	18	12	12	43	7	6
Corvus frugilegus	1	10	2	5	18	7	6
Corvus corone	1	14	7	8	30	10	6
Corvus corax	1	10	9	6	26	8	6

bast are missing in the Magpie's nest. Lack of one of the sorts of materials distinguished as common in a given species may therefore be regarded as a characteristic of its nests.

Despite some differences in structure and stratification between the nests of individual species, we can find a common stereotype of their construction.

Table XXXI

Percentage share of common materials in the nests of particular species (based on Tables III, VII, XI, XIV, XVIII, XXVII)

Materials	*Garrulus glandarius*	*Pica pica*	*Nucifraga caryocatactes*	*Corvus monedula*	*Corvus frugilegus*	*Corvus corone*	*Corvus corax*
sticks and twigs	100·0	100·0	100·0	83·8	100·0	100·0	100·0
grass blades	55·5	48·4	75·0	58·0	100·0	80·7	64·2
grass rootlets	25·9	84·4	12·5	22·5	88·2	46·1	50·0
bast	62·9	—	75·0	87·0	41·1	100·0	98·8
clay	—	100·0	50·0	45·1	85·2	100·0	50·0
moss	37·0	—	75·0	41·1	85·2	73·0	100·0

The first, external, layer of all these specimens is of branches and sticks and constitutes the main structural framework of the nest. The presence of a more or less well-framed clay layer, which plays the role of a tightener and insulation, between the bottom portion of the external layer and the lining is another common characteristic. The Jay is an exception in this respect, since there is no clay at all in its nest, instead of which different vicarious materials are accumulated at the bottom between the external layer and the lining, as if they were an equivalent of the clay layer. The next layer common to all the species is the relatively thick and rich lining, which always differs from the rest of nest material in composition. In most cases it is divided into two parts, an inner lining and an outer lining, which is more compact and built of finner material. The nests of the species under study, except those of the Jackdaw and Nutcracker are, in addition, marked by a layer of twigs, which in many specimens passes into a fairly characteristic ring.

The measurements of nests undergo remarkable fluctuations in all the bird species under study, which is well illustrated in Table XXXII. The data presented in it show that the least variable measurements are the inner diameter and depth, which define the size of the nest cup, and this, on the other hand,

Table XXXII

The ranges and means of measurements and nest cup indices of the nests of the species examined

Species	Number of nests	Inner diameter from — to	Mean	Outer diameter from — to	Mean	Depth from — to	Mean	Height from — to	Mean	Nest cup index
Garrulus glandarius	31	10·5—15·7	12·56	16·0—33·5	23·47	5·0—9·5	6·50	8·5—26·0	15·75	193·2
Pica pica	45	15·0—21·5	17·28	18·5—35·0	24·07	9·0—16·0	12·20	18·0—29·0	23·51	141·6
Nucifraga caryocatactes	7	13·0—15·5	14·10	22·0—38·0	26·42	7·0—10·0	7·64	12·0—16·0	14·50	184·5
Corvus monedula	31	9·0—23·0	12·09	16·0—100·0	38·47	3·0—8·0	4·82	7·0—100·0	24·61	250·8
Corvus frugilegus	50	16·0—30·5	19·75	26·5—85·0	41·81	7·0—19·0	12·14	17·0—60·0	31·16	162·6
Corvus corone	31	15·5—25·0	19·41	22·5—42·5	29·85	8·0—15·0	10·35	16·0—28·0	20·79	187·5
Corvus corax	15	19·5—36·5	27·60	42·5—92·5	70·16	8·0—16·0	11·06	26·0—65·0	44·60	249·4

corresponds to the size of the bird and reflects the method of its formation. The identical observation on the birds of other genera and orders (Bocheński, 1957, 1961, 1962, 1966, 1968; Kulczycki and Mazur-Gierasińska, 1968) confirm this statement. In order to demonstrate the differences between particular species more closely, a nest cup size index, calculated by the formula $\frac{\text{inner diameter} \times 100}{\text{depth}}$, has been used in Table XXXII. This index may, however, be applied only if mean values are substituted, since for individual nests of different species it may appear identical in the case of extreme values. The other measurements, e. g., the outer diameter and height of the nest, have a much wider range of variation, which is due to many factors, but chiefly to the mode of its placement and site and, in nests used for several years, their age.

Since the measurements cannot be used as the only criteria to distinguish the nests of particular species of the *Corvidae* from each other, a key has been worked out for the identification of abandoned nests. on the basis of the essential characteristics of their structure and the composition of building material

KEY

Four-layered nest structure I
Three-layered nest structure II

I

1. Sticks and branches of external layer interwoven fairly closely and forming compact basket with only slight number of free ends projecting outside. Some sticks and branches exceed 2 cm in diameter, their minimum length being about 30 cm. Outer diameter from 42·5 to 92·5 cm . . . . . *Corvus corax*

— Sticks and branches of external layer with ends projecting outside and forming characteristic "brush". Elements of external layer not exceeding 2 cm in diameter. Outer diameter from 18·5 to 55·0 cm 2

2. Clay layer thick and solid, forming stiff body of nest and reaching so high as to turn over its edge. Building material without bast and moss. Rootlets always present as basic element of lining . . . . . *Pica pica*

— Clay layer forming sort of bowl at bottom and reaching at most half-way up the nest. Building material includes bast and moss 3

3. Fresh bast always present in inner lining and forming at least 50% of material of this layer. Outer lining containing considerable amounts of sheep wool or other animal hair . . . . . *Corvus corone cornix*

— Plant stalks and grass blades always present as basic materials in inner lining. Outer lining containing no or only insignificant amounts of sheep wool or other animal hair . . . . . *Corvus frugilegus*

II.

1. Twig layer and ring over nest edge well framed. No clay layer 2

— No twig layer and ring. Clay layer present or missing in singular cases . . . 3
2. Nest cup diameter between 10·5 and 15·7 cm . . . . . *Garrulus glandarius*
— Nest cup diameter between 19·5 and 36·5 cm . . . . . *Corvus corax*
3. External layer chiefly of fresh twigs, 0·2—0·5 cm thick. Bast and moss are basic materials of lining. Nest material always containing large amounts of rotten wood, of which the cup at the bottom of the nest is built, if clay is lacking . . . . . *Nucifraga caryocatactes*
— Some sticks and twigs of external layer exceeding 1 cm in diameter. Arrangement of material disorderly. Lining containing various materials, of which none decidedly prevalent. Large amounts of materials of artificial origin are as a rule present both in external layer and in lining (some of the nests built in tree-holes and breeding boxes lack the external layer or have it in a reduced form). . . . . *Corvus monedula*

XI. CHARACTERISTICS OF NEST STRUCTURE IN SOME GENERA OF THE FAMILY *CORVIDAE*

Lack of data concerning the structure of nests of most corvid genera makes a close comparative study of this group impossible. Nevertheless, it seems possible roughly to define the scheme of the structure of their nests, and to establish the intergeneric similarities and differences on the basis of the available literature containing (mostly general) descriptions of the nests of 28 species (11 genera) and my own materials. As in the discussion of my own materials, the genera included will be arranged according to VAURIE'S (1962) systematics.

Gymnorhinus WIED, 1841

According to BENT (1946), the external layer of the nests of *Cyanocephalus* (*Gymnorhinus*) *cyanocephalus* WIED, 1891 is composed of branches and lignified stalks of plants with an addition of bark and rootlets. There is no clay layer and the lining is chiefly made of dry grass with an addition of vegetable fibres rootlets, leaves, hair and feathers.

Cyanocitta STRICKLAND, 1845

The nests of *Cyanocitta stelleri* (GMELIN, 1788) and *Cyanocitta cristata* (LINNAEUS, 1758), described by BENT (1946) and GODFREY (1966), have many characteristic in common and a three-layered structure: the external layer of sticks and branches, the clay layer, which is very thick and forms the bulk of the nest in *C. stelleri*, and the lining, the main material of which consists of rootlets.

Aphelocoma CABANIS, 1851

On the basis of the data given by AMADON (1944b), BENT (1946), GROSS (1949) and TYNE and SUTTON (1937) for the nests of *Aphelocoma ultramarina* (BONAPARTE, 1825), *A. caerulescens* (BOSE, 1795) and *A. sordida* (BAIRD, 1858), the three-layered nest structure may be assumed to be typical of this genus. The first, external, layer is of rather thick sticks and branches, arranged fairly chaotically. It is followed successively by the twig layer, woven of thin and fine twigs, and the lining, the inner portion of which is generally made of rootlets only, whereas hair of horses and other animals and grass blades are found in its outer portion.

Cyanocorax BOIE, 1826

The only information about the nests of this genus will be found in a paper by BENT (1946) and concerns the Central American species *Xanthoura* (*Cyanocorax*) *yncas* (BODDAERT, 1783). The flimsy external layer of its nest is made of fine twigs, its interior being filled with rootlets and, additionally, vine sprouts and tufts of moss. Dry grass and leaves are also sometimes present. According to Bent, the nest lacks the clay layer.

Garrulus BRISSON, 1760

As will be seen from the data presented by KOBAYASHI (1932—1940), the nests of the species *Lalocitta lidthi* (BONAPARTE, 1851) included by VAURIE (1962) in the genus *Garrulus* have a somewhat different structure from that described in the nests of *G. glandarius* on the basis of my materials. Their external layer is built of sticks and branches with the clay (humus) layer resting on it inside. The lining consists of vine sprouts, bark, moss and dead leaves. The nests placed in tree-holes are often reduced to the lining only.

Perisoreus BONAPARTE, 1831

According to different authors (CARPELAN, 1929; NAUMANN, 1905; REJMERS, 1966; VOROBEV, 1963) the nests of *Perisoreus* (*Cractes*) *infaustus* (LINNAEUS, 1758) have the external layer of fine twigs of coniferous trees. This layer is relatively thin and loose. The next, thick and sealing, layer consists of grass blades, moss, lichens, bast and rotten wood with an addition of cocoons of spiders and insects. The lining is also thick and abundant, mostly of feathers or animal hair, and sometimes of both these components together. The data presented by BENT (1946), GODFREY (1966) and RANDALL (1931) show that the nests of *P. canadensis* (LINNAEUS, 1758), too, have the external layer of thin and dry twigs, but their second layer lacks rotten wood, which is here replaced by bark. The inner portion of the lining is composed chiefly of grass blades and bark, and its outer portion consists, as in the previous species, of a thick layer of feathers or animal hair.

Cyanopica BONAPARTE, 1831

The information about the nest structure of this genus concerns two subspecies: East-Asiatic *Cyanopica c. cyanus* (PALLAS, 1776) and Spanish *Cyanopica c. cooki* (BONAPARTE, 1850). According to JAHN (1942), KOBAYASHI (1932—1940), STARKOV (1958) and VOROBEV (1954), the external layer of the nests of *C. c. cyanus* is constructed of dry sticks and branches, its whole internal surface being pugged with clay. The inner portion of the lining is made chiefly of moss, dry grass, rootlets and vegetable fibres, and its outer portion of animal hair, sometimes with an addition of fine rootlets. The description of the nest of *C. c. cooki* given by Dr BOCHEŃSKI on the basis of two specimens in the possession of the British Museum at Tring shows that it differs somewhat from the nests of the previous subspecies. The external layer is made up of thick plant stalks and a slight amount of small sticks and rootlets (chiefly in its bottom portion). The next layer is composed of plant stalks (*Filago* sp.) plucked fresh, as evidenced by the flowers dried up with them. The lining is very tightly packed, made of hair and wool, pieces of string being also found in one of the nests. It should be assumed that the clay layer exists in the nest, because clods of earth spilt from it.

Podoces FISCHER, 1821

The information about the nesting of this genus contained in papers by SOPYEV (1964) and SHNITNIKOV (1949) concerns only one species, *Podoces panderi* FISCHER, 1821. As will be seen from the descriptions, the nests have a loose and carelless external layer of dry twigs, the ends of which stick out on the outside and form a typical "brush". According to SHNITNIKOV (o. c.), the second layer is in the form of a clay bowl, which is not mentioned at all by SOPYEV (1964). The lining is made of rather various material consisting of fine twigs, inflorescences of grass, stalks of plants, leaves, rootlets, fibres and bark. In the outer portion of the lining there are, in addition, animal hair, cobweb, and sometimes feathers and paper.

Nucifraga BRISSON, 1760

The data given by BENT (1946), DIXON (1934), GODFREY (1966) and MEWALDT (1956) show that the nests of *Nucifraga columbiana* (WILSON, 1811) differ somewhat from those of *N. caryocatactes* described on the basis of my materials. To be true, they have the external layer of twigs, but neither rotten wood nor clay occurs in their inner layers. The inside wall of the nest is built chiefly of fine fibres of bast with an addition of grass blades and, sometimes, conifer needles. GODFREY (1966) makes mention also of hair, but BENT (1946) denies its occurrence decidedly.

Pyrrhocorax TUNSTALL, 1771

The available descriptions of the nests of *P. graculus* (LINNAEUS, 1766) and *P. pyrrhocorax* (LINNAEUS, 1758) show that they closely resemble each other in structure (BOHAM, 1970; NAUMANN, 1905; SCHIFFERLI and LANG, 1940, 1946). In dependence on their site, these nests either have or not the external layer, which, besides, varies in its material composition from specimen to specimen. Thus, it may be composed of sticks and branches, roots, rather thick stalks of plants, or all these materials together. In the nests of *P. pyrrhocorax* the external layer is occasionally followed by the clay layer, which, however, is never encountered in *P. graculus*. The inner walls of the nests of both these species is built of the same sorts of materials, i. e., thin stalks of plants, dry grass and fine rootlets, but in the nests of *P. graculus* this layer is more compact. Similar materials are also observed in the outer portion of the lining in both nests; it consists chiefly of sheep wool and hair of various animals, but sometimes it may also be made of moss or fine grass blades.

Corvus LINNAEUS, 1758

In the light of the data provided by literature (ALDOUS, 1942; ARCHER and GODMAN, 1961; BENT, 1946; CLANCEY, 1964; EMLEN, 1942; GIZENKO, 1955; GODFREY, 1966; HILL, 1967; KOBAYASHI, 1932—1940; LIKHANOV, 1967; LAMBA, 1963, 1965; PARMELEE, 1952; SKEAD, 1952; SOPYEV, 1966) the nests of 14 species (*C. splendens* VIEILLOT, 1817, *C. capensis* LICHTENSTEIN, 1823, *C. macrorhynchos* WAGLER, 1827, *C. bennetti* NORTH, 1901, *C. coronoides* VIGORS & HORSFIELD, 1827, *C. ossifragus* WILSON, 1812, *C. caurinus* BAIRD, 1858, *C. brachyrhynchos* BREHM, 1822, *C. albus* MÜLLER, 1776, *C. ruficollis* LESSON, 1830, *C. cryptoleucus* COUCH, 1854, *C. rhipidurus* HARTERT, 1918, *C. albicollis* LATHAM, 1790, *C. levaillantii* BONAPARTE, 1851) come near each other in the general type of their structure. In all these species the first, external, layer is built of sticks and branches, then very often comes the well-framed twig layer. The basic material of the lining are grass stems and bast, and its outer portion is nearly always lined with animal hair. The clay layer is mentioned as present in the nests of several species (*C. brachyrhynchos*, *C. bennetti*, *C. coronoides*). This, however, does not determine its lack in the nests of the remaining species, as their descriptions are for the most part based on their external appearance. The nest of *C. capensis* is to some extent exceptional because, according to SKEAD (1952), the first layer, constructed of sticks and branches, has no bottom and, in consequence, it is a sort of cylinder, in which the second layer, built analogously of grass stems and rootlets, is placed. It is only the inner space of this cylinder that is filled up with the third layer, the lining. Some amounts of earth may occur in such nests but, in SKEAD'S opinion, it is brought into the nest on the grass rootlets and does not form a se-

parate layer. The nests of *C. monedula*, *C. frugilegus*, *C. corone* and *C. corax*, described in this paper on the basis of my materials, correspond therefore with the general structural scheme of the nests of this genus.

In considering the nest structure as a criterion of the degree of relationship, some groups characterized by a similar type of nest structure can be distinguished among the genera under study, which would indirectly point to their evolutionary lines. The first, fairly distinctive, group includes the genera *Gymnorhinus*, *Aphelocoma*, *Cyanocorax* and *Garrulus*. Their nests are generally marked by a three-layered structure, the clay layer being never present. The composition of materials of particular layers is very similar in all their species, and rootlets are a typical material used for the lining. In accordance with AMADON'S (1944a) principles of the phylogeny of the *Corvidae* all the above-mentioned genera are the oldest and most primitive forms of this family, which in turn would authorized us to assume their type of nest structure as the basic one. However, the nests of *Lalocitta lidthi*, included by VAURIE (1962) relatively recently in the genus *Garrulus*, differ from this scheme, since they contain clay. Thus, they rather resemble the nests of the North-American Jays of the genus *Cyanocitta*, in which the clay layer is particularly well formed. Since the genus *Cyanocitta* is also numbered among the oldest forms of the family *Corvidae*, it might be supposed that two types of nest structures developed among the primitive *Corvidae*, one of them characterized by the presence of the clay layer and the other by its lack.

Perisoreus, *Podoces* and *Nucifraga* form another group of genera, the nest structure of which is to a certain degree similar to the original type of nests. In this group the nest structure is also three-layered, although it may be four-layered in some cases. The clay layer (or its equivalent of rotten wood or bark) occurs in the nests of most species and it has the shape of a shallow bowl resting directly on the bottom of the external layer. The structure of the nests of *Nucifraga columbiana*, which never have the clay layer or its equivalent built of other sorts of materials, provides some evidence of the relationship of this group, especially the genus *Nucifraga*, to the original group of Jays.

The nests of the genus *Cyanopica* hold an intermediate position between those of the genera *Cyanocitta* and *Pica*, and they combine the structural characteristics and components of building material of both these genera. This suggests their common evolutionary line, the genus *Pica* being the most specialized form of them.

On the other hand, there are no connections between the above-mentioned groups and the genera *Pyrrhocorax* and *Corvus*. According to AMADON'S (1944a) phylogeny of the family *Corvidae*, these two genera departed from the common stem fairly early and form separate specialized groups. This opinion is supported by the structure of their nests, for the genus *Pyrrhocorax*, despite some resemblances it bears to the genus *Corvus* (chiefly to *C. monedula*), has no essential characters common with this genus. The genus *Corvus* therefore forms a fairly

distinct group, most species of which are characterized by a four-layered nest structure with a conspicuous clay layer. The building material always includes some common elements, e. g., bast, dry grass and those of animal origin.

The division of the genera into groups with common structural characteristics of nests, applied in t is section, and the suggestions concerning their relationships are, with small exceptions, confirmed by the systematics of this family and correspond, in general, to its phylogenetic relations. This indicates the usefulness of this sort of investigation as providing additional criteria for the systematics of birds.

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STRESZCZENIE

Zawarte w obecnej pracy opisy gnieżdżenia się siedmiu gatunków z rodziny *Corvidae* dotyczą usytuowania ich gniazd, materiału i sposobu budowy oraz kształtu i wielkości. Dla każdego z omawianych gatunków podana jest również krótka charakterystyka środowisk lęgowych. Gniazda badanych gatunków pochodzą głównie z południowo-wschodnich rejonów Polski.

Garrulus glandarius. Wysokość umieszczenia nad ziemią 43 gniazd sójki jest przedstawiona w tabeli I. Większość gniazd skupia się w przedziałach między 2 a 6 m, przy średniej wysokości położenia 5,26 m. Tabela II przedstawia zestawienie gatunków drzew i krzewów, na których umieszczone były gniazda. Z drzew najliczniej reprezentowane są sosna i dąb, a z krzewów głóg. Wśród różnych sposobów umiejscawiania gniazd (Fig. 2, tabela XXIX) najczęściej spotykane są gniazda położone tuż przy pniu, na kilku cienkich, bocznych odgałęzieniach bądź odrostach (Fig. 2:B_1, B_2). Stosunkowo licznie bywają też umiejscawiane gniazda w szczytowych okółkach bądź rozwidleniach młodych drzew liściastych i iglastych (Fig. 2:A_1, A_2). Schemat budowy gniazda sójki jest przedstawiony na Fig. 3:1. Jest ono trójwarstwowe. Pierwszą, zewnętrzną warstwę stanowi obudowa z patyków i gałęzi, a po niej występuje warstwa gałęzista, ułożona okółkowo z cienkich i elastycznych gałązek lub korzonków. Wnętrze gniazda wypełnia warstwa trzecia — wyściółka, zbudowana najczęściej z drobnych korzonków lub łyka z dodatkiem innych rodzajów materiału. Ze względu na zróżnicowanie wyściółki pod względem jakości i układu materiału można podzielić ją na dwie części, tj. wyściółkę wewnętrzną i zewnętrzną. Wyniki analizy jakościowej materiału zużytego do budowy gniazd sójki ilustruje

tabela III. Gniazda zbudowane są z czterech podstawowych składników, tj. gałązek i patyków, korzonków, łyka i źdźbeł traw. Wymiary badanych gniazd są zestawione w tabeli IV. Najbardziej stałym wymiarem jest wielkość średnicy wewnętrznej, której średnia wynosi 12,5 cm (przy rozpiętości od 10,5 do 15,7 cm), a najmniej stałym wymiarem — wysokość (rozpiętość od 8,5 do 26,0 cm).

Pica pica. Gniazda sroki znajdowane były na wysokości od 1 do 30 m (tabela V), a średnia wysokość dla 146 gniazd wynosi 9,53 m. Większość gniazd znajdowała się na topolach i wierzbach, a z krzewów najliczniej reprezentowana była tarnina (tabela VI). Najchętniej i najczęściej gniazda umiejscawiane są w wierzchołkowej partii korony, w wielokrotnym szczytowym rozwidleniu głównej strzały pnia, bądź w końcowych, pionowych rozwidleniach bocznych odnóg (Fig. 2:A_3, D). Gniazdo ma budowę czterowarstwową (Fig. 3:2). Z zewnątrz otacza je warstwa obudowy (patyki i gałęzie), która od brzegów gniazda, wzwyż, przechodzi w kopułę ochronną, przykrywającą gniazdo od góry. W nielicznych przypadkach kopuła jest fragmentaryczna lub sporadycznie jej w ogóle brak. Zasadniczą masę gniazda tworzy kolejna po obudowie warstwa gliniasta, tworząca na brzegach gniazda charakterystyczny pierścień. Na warstwie gliniastej spoczywa warstwa gałęzista, ułożona z cienkich i elastycznych gałązek lub gałązek z dodatkiem korzonków i łodyg traw. Wnętrze gniazda wypełnia wyściółka, dość wyraźnie zróżnicowana na dwie części. Podstawowym materiałem tej warstwy są korzonki. Analiza materiału zużytego do budowy 33 gniazd jest przedstawiona w tabeli VII. Podstawowym materiałem spotykanym w każdym gnieździe są patyki i gałązki, glina i korzonki. Stosunkowo często (w 48,4% gniazd) są używane również łodygi traw. Zasadniczy kształt gniazda ma postać zbliżoną do zaokrąglonego i odwróconego stożka, którego średnica podstawy jest prawie równa wysokości. Wymiary badanych gniazd są zestawione w tabeli VIII. Najmniejsze wahania wykazuje średnica wewnętrzna, której średnia wynosi 17,2 cm, a największe średnica zewnętrzna, co związane jest z dostosowywaniem szerokości gniazda do kąta rozwarcia rozgałęzień.

Nucifraga caryocatactes. Ze względu na nieliczny materiał własny (8 gniazd) dane do gnieżdżenia się orzechówki uzupełniono opisami konkretnych gniazd, zaczerpniętymi z literatury, dotyczącymi formy nominatywnej i podgatunku *N. c. macrorhynchos*. Rozpiętość wysokości położenia gniazd formy nominatywnej mieści się w granicach od 2 do 11 m (średnia 5,6 m), a *N. c. macrorhynchos* od 0 do 10 m (średnia 6,3 m). Gniazda są zakładane wyłącznie na drzewach iglastych (tabela X) — najchętniej na jodłach i świerkach. Najczęściej spotyka się gniazda umieszczone na bocznych, cienkich odrostach bądź odgałęzieniach, tuż przy pniu (Fig. 2:B_1). W analizowanych gniazdach stwierdzono budowę trójwarstwową (Fig. 3:3). Pierwszą warstwą jest obudowa z patyków i gałęzi z dodatkiem świeżych pędów jeżyny i niewielkich ilości próchna oraz świeżych liści. Wyściółka zbudowana jest zwykle ze świeżego łyka lub mchu. W tabeli XI zestawione zostały materiały użyte do budowy gniazd orzechówki. Do głównych składników budulcowych należą: patyki i gałązki, łyko, próchno, łodygi i liście traw oraz mech. Wyniki pomiarów 7 gniazd są zestawione w tabeli XII. Sto-

sunkowo najbardziej stałą wielkością jest pomiar średnicy wewnętrznej, przy którym odchylenia od średniej wahają się w granicach 1 cm.

Corvus monedula. Wyniki badań nad wysokością położenia 298 gniazd kawki są przedstawione w tabeli XIII. Średnia wysokość położenia 163 gniazd w dziuplach i skrzynkach lęgowych wynosi 9,41 m, dla 78 gniazd na budynkach — 20,70 m, a średnia dla 57 gniazd na skałach wynosi 15,30 m. Średnia arytmetyczna wszystkich 298 gniazd wyraża się liczbą 13,5 m. Do najbardziej ulubionych miejsc służących do gnieżdżenia się należą dziuple i półdziuple. Gatunek drzewa, wysokość położenia otworu wlotowego, jego wielkość i usytuowanie w stosunku do stron świata nie odgrywają przy wyborze większej roli. Znaleziono dwa gniazda wolno stojące na bocznych odgałęzieniach młodej sosny i świerka. Gniazda kawek wykazują dość istotne różnice w budowie w zależności od ich lokalizacji (Fig. 3:4a, b, c, d, e). Typowa jest budowa trójwarstwowa (obudowa, warstwa gliniasta i wyściółka), ale zdarza się dwu i jednowarstwowa (brak warstwy gliniastej lub występowanie samej wyściółki). Wyniki analizy materiału zużytego do budowy 31 gniazd są przedstawione w tabeli XIV. Do najczęściej używanych materiałów należą: łyko (stwierdzone w 87% gniazd), patyki i gałęzie (83,8%), papier (83,8%), oraz suche liście i trawy (po 58%). Kształt i wielkość gniazda pozostają w ścisłym związku z jego lokalizacją, gdyż jest ono zazwyczaj dostosowywane do wielkości pomieszczenia. Duże zróżnicowanie gniazd kawki pod względem wielkości i kształtu obrazują zestawione w tabeli XV wyniki pomiarów 31 gniazd. Najbardziej stałymi okazują się być głębokość i średnica wewnętrzna gniazda, chociaż i przy tych wymiarach różnice w ich rozpiętości sięgają 100%. Porównanie średnich pomiarów gniazd świeżych i starych wykazuje, iż okres wychowu młodych ma wpływ na poszerzenie i spłycenie gniazda.

Corvus frugilegus. Wysokość położenia 874 gniazd gawrona jest przedstawiona w tabeli XVI. Największa ilość gniazd znajduje się w przedziałach między 14 a 25 m, a średnia arytmetyczna wysokości położenia wszystkich gniazd wynosi 19,01 m. Z tabeli XVII wynika, że z 15 gatunków drzew, na których znaleziono gniazda gawrona, najchętniej wybierane są topola i olcha (50% badanych gniazd). Podstawowym sposobem umiejscawiania gniazd przez gawrony (59,3% badanych przypadków) jest umieszczanie ich w wielokrotnych, pionowych rozwidleniach szczytowych odgałęzień (Fig. 2:D). Gniazdo zbudowane jest z 4 warstw: obudowy, warstwy gałęzistej, warstwy gliniastej i wyściółki Fig. 3:5). Tabela XVIII przedstawia szczegółową analizę materiału zużytego do budowy 34 gniazd. Materiałom występującym w 100% badanych gniazd są patyki i gałęzie jako stały składnik obudowy, oraz łodygi roślin zielnych i źdźbła traw jako główny materiał wyściółkowy. Kolejno najliczniej występują suche liście (w 97,0% gniazd), korzonki traw (88,2%), oraz mech i ziemia (po 85,2%). Wyniki pomiarów 34 gniazd zostały zebrane w tabeli XIX. Najbardziej stałą wielkością jest średnica wewnętrzna gniazda, której średnia arytmetyczna wynosi 18,67 cm.

Corvus corone. Zebrane materiały dotyczą wyłącznie podgatunku *C. c. cornix*.

Wyniki pomiarów wysokości położenia 36 gniazd zostały zebrane w tabeli XX. Większość gniazd znajduje się między 10 a 15 m (61% ogółu gniazd), a średnia wysokość położenia wszystkich gniazd wynosi 14,0 m. W tabeli XXI zestawiono rodzaje drzew, na których były położone gniazda wrony. Z drzew iglastych najczęściej wybierane są jodła i sosna, a z liściastych topola, wierzba i olcha. Gniazdo wrony ma wyraźną budowę czterowarstwową (Fig. 3:6). Pierwszą zewnętrzną warstwą jest obudowa z patyków i gałęzi. Od wewnątrz na jej spodzie spoczywa warstwa gliniasta, uformowana w postaci płytkiej czarki. Od brzegów czarki, wzwyż, na ścianach obudowy znajduje się warstwa gałęzista, a wnętrze gniazda wypełnia wyściółka. Analiza materiału zużytego do budowy 26 gniazd jest przedstawiona w tabeli XXII. Materiałami występującymi w każdym z badanych gniazd są, prócz patyków i gałązek, łyko, glina i wełna lub sierść zwierzęca. W większości gniazd występują też źdźbła traw (80,7%), mech (73,0%), zdrewniałe łodygi roślin (65,3%) oraz korzonki drzew i krzewów (61,5%). Analizę pomiarów 31 gniazd ilustruje tabela XXIII. Charakterystyczne są duże wahania rozpiętości poszczególnych pomiarów. Średnia arytmetyczna średnicy wewnętrznej wynosi 19,41 cm.

Corvus corax. Gniazda kruka są umieszczane z reguły bardzo wysoko (od 13 do 31 m), a średnia wysokości położenia 50 gniazd wynosi 21,68 m (tabela XXIV). Gatunki drzew, na których były umieszczone gniazda, są zestawione w tabeli XXV. Gatunkiem dominującym jest sosna. Najwięcej gniazd było umiejscowionych na odgałęzieniach bocznych, przy pniu, w górnej bądź środkowej partii korony. Schemat budowy gniazda kruka ilustruje Fig. 3:7. Występujące tu kolejne warstwy to: obudowa, warstwa gałęzista, warstwa gliniasta i wyściółka. W większości gniazd warstwa gliniasta jest jednak słabo wykształcona, a w wielu przypadkach w ogóle jej brak. Tabela XXVI przedstawia analizę materiału zużytego do budowy 14 gniazd. We wszystkich gniazdach występują patyki i gałęzie, tworzące warstwę obudowy, oraz mech będący stałym składnikiem wyściółki. Prawie w każdym gnieździe w zewnętrznej partii wyściółki występuje w mniejszej lub większej ilości sierść zwierzęca. Równie często, bo w 92,8% badanych gniazd, występuje łyko. Zestawienie wymiarów 15 gniazd jest przedstawione w tabeli XXVII. Wszystkie wymiary wykazują bardzo dużą rozpiętość. Stosunkowo najbardziej stałym jest wymiar średnicy wewnętrznej, którego średnia wynosi 27,60 cm. Średnica zewnętrzna i wysokość są w pewnej mierze uzależnione od sposobu umiejscowienia i wieku gniazda.

Omawiane tu kolejno gatunki z rodziny *Corvidae* nie stanowią wyraźnie zwartej grupy ekologicznej. Różnią się one środowiskami lęgowymi, wysokością położenia gniazd (Fig. 1), jak również gatunkami drzew i krzewów oraz miejscami służącymi do gnieżdżenia się. Można jednak wyróżnić pewne zasadnicze typy umiejscowień gniazd. Ilustruje je Fig. 2, a dodatkowo objaśnia tabela XXIX, w której zostały również uwzględnione dane z literatury odnośnie do typów umiejscowień, nie reprezentowanych w materiałach własnych. Największe możliwości przystosowawcze pod tym względem wykazują kawka i sójka, a gatunkiem najbardziej konserwatywnym jest orzechówka. Więcej cech wspól-

nych, łączących omawiane gatunki, można znaleźć analizując materiał do budowy gniazd oraz sam sposób ich budowy. W tabeli XXX przedstawiono ilościowo rodzaje materiałów używanych do budowy gniazd, typując wśród nich materiały podstawowe (występujące w co najmniej 50% gniazd badanych serii) oraz określając ilość materiałów wspólnych stwierdzonych w seriach gniazd poszczególnych gatunków. Przy analizie udziału procentowego materiałów wspólnych w gniazdach poszczególnych gatunków (tabela XXXI) widać, że w większości przypadków są one również materiałami podstawowymi, co wskazuje na podobieństwo w doborze materiału budulcowego u badanej grupy ptaków. Pomimo pewnych różnic w strukturze i budowie warstwowej gniazd poszczególnych gatunków można stwierdzić pewien wspólny stereotyp ich budowy. Pierwotny jest jak się wydaje układ trójwarstwowy, tj. obudowa, warstwa gliniasta (lub gałęzista) i wyściółka. Warstwy gliniastej nie spotyka się tylko w gniazdach sójki, a gałęzistej brak natomiast u kawki i orzechówki. Tabela XXVIII ilustruje różnice w wielkości gniazd poszczególnych gatunków. Wszystkie ulegają dużym wahaniom i nawet w przypadku średnicy wewnętrznej i głębokości, które wykazują najmniejszą zmienność, nie stanowią wystarczających kryteriów do odróżnienia gniazd poszczególnych gatunków. Dla umożliwienia oznaczenia gniazd opuszczonych ułożono klucz, oparty na istotnych i charakterystycznych cechach budowy gniazd oraz składzie materiału budulcowego (s. 645).

W celu zorientowania się w ogólnym schemacie i podobieństwach w budowie gniazd w obrębie rodziny *Corvidae* przeprowadzono na podstawie literatury porównanie, obejmujące dane do budowy gniazd dalszych 29 gatunków z 11 rodzajów: *Gymnorhnius*, *Cyanocitta*, *Aphelocoma*, *Cyanocorax*, *Garrulus*, *Perisoreus*, *Cyanopica*, *Podoces*, *Nucifraga*, *Pyrrhocorax* oraz *Corvus*. Biorąc pod uwagę schemat budowy gniazda jako kryterium stopnia pokrewieństwa można wyciągnąć następujące przypuszczenia i wnioski:

1. Wśród pierwotnych *Corvidae* rozwinęły się dwa typy budowy gniazd, z których jeden cechuje się obecnością warstwy gliniastej, a w drugim jej brak.

2. Rodzaje *Gymnorhnius*, *Aphelocoma*, *Cyanocorax* i *Garrulus* tworzą wyraźnie wyodrębnioną grupę, odznaczającą się między innymi brakiem w ich gniazdach warstwy gliniastej.

3. Gniazda gatunku *Lalocita lidthi*, zaliczanego do rodzaju *Garrulus*, odbiegają zasadniczo od schematu budowy charakterystycznego dla tego rodzaju i grupy, a nawiązują raczej do gniazd rodzaju *Cyanocitta*, mających silnie rozwiniętą warstwę gliniastą.

4. Kolejną grupą rodzajów, posiadającą wspólny plan budowy gniazd, są *Perisoreus*, *Podoces* i *Nucifraga*. Nawiązują one w dużym stopniu do pierwotnej grupy sójek, nie mających w swych gniazdach warstwy gliniastej.

5. Budowa gniazd rodzajów *Cyanopica*, *Cyanocitta* i *Pica* sugeruje ich wspólną linię rozwojową.

6. Rodzaje *Pyrrhocorax* i *Corvus* stanowią odrębne, wyspecjalizowane grupy i brak wyraźnych połączeń między nimi a wymienionymi uprzednio grupami.

РЕЗЮМЕ

Содержащиеся в настоящей работе описи гнездования семи видов из семейства *Corvidae* касаются расположения их гнёзд, материала и способа строения, а также формы и величины. Для каждого обсуждаемого вида даётся краткая характеристика биотопов гнездования. Гнёзда исследованных видов главным образом происходили из юго-восточных районов Польши.

Garrulus glandarius. Высота размещения над землёй 43 гнёзд сойки представлена в таблице I. Большинство гнёзд концентрируется в пределах 2—5 м, при средней высоте размещения 5,26 м. В таблице II представлено виды деревьев и кустарников, на которых были размещены гнёзда. Из деревьев наиболее часто встречались сосна и дуб, а из кустарников боярышник. Среди различных способов расположения гнёзд (фиг. 2, таблица XXIX) наиболее часто встречаются гнёзда размещённые у ствола, на нескольких тонких, боковых ответвлениях, или отростках (Фиг. 2: B_1, B_2). Относительно многочисленно бывают также локализованы гнёзда в верхушечных мутовках или разветвлениях молодых лиственных и хвойных деревьев (Фиг. 2: A_1, A_2). Схема строения гнезда сойки показана на фиг. 3:1. Оно состоит из трёх слоёв. Первый, внешний слой — корпус построен из прутьев и веточек затем идёт ветвистый слой, уложенный мутовчато из тонких и эластичных веточек или корешков. Внутреннюю часть гнезда наполняет третий слой — подстилка, состоящая главным образом из мелких корней или лыка с прибавлением иного рода материала. По отношению качества и структуры материала подстилку можно разделить на две части: внутреннюю и внешнюю. Итоги качественного анализа материала, употребляемого для строения гнёзд сойки представлено на таблице III. Гнёзда построены из четырёх основных слагаемых, то есть веточек и прутьев, мелких корней, лыка и стеблей трав. Величины исследованных гнёзд сопоставлены в таблице IV. Наиболее постоянной величиной является величина внутреннего диаметра, которая в среднем составляет 12,5 см (при размахе от 10,5 см до 15,7 см), а наименее постоянной величиной является высота (размах от 8,5 см до 26,0 см).

Pica pica. Гнёзда сороки были найдены на высоте от 1 до 30 м (таблица V), а средняя высота для 146 гнёзд составляет 9,53 м. Большинство гнёзд находилось на тополях и ивах, а из кустарников на тёрне (таблица VI). Наиболее охотно и часто гнёзда располагаются в верхушечной партии кроны, в многократном верхушечном разветвлении главного штамба, или в концевых, вертикальных боковых разветвлениях ветвей (фиг. 2: A_2, D). Гнездо состоит из четырёх слоёв (фиг. 3:2). Верхний слой построен из прутьев и веточек и образует в виде свода крышу, прикрывающую гнездо сверху. Иногда гнездо имеет только фрагменты куполообразной крыши, а спорадически её вовсе нет. Основную часть гнезда составляет второй слой — глинистый, образующий на краях гнезда характерное кольцо. На глинистом слое лежит ветвистый слой, образованный из тонких и эластичных веточек или веточек с мелкими корнями и стеблями травы. Внутреннюю часть гнезда заполняет подстилка довольно отчётливо дифференцирована на две части. В основном этот слой состоит из мелких корней. Анализ употреблённого материала

на построение 33 гнёзд представлен в таблице VII. Основным материалом встречаемым в каждом гнезде являются прутья и веточки, глина и мелкие корни. Относительно часто (у 48,4% гнёзд) употребляется также трава. Основная форма гнезда имеет вид закругленного, перевёрнутого конуса, которого диаметр основания почти равен высоте. Величины исследованных гнёзд сопоставлены в таблице VIII. Незначительные колебания имеет внутренний диаметр, средняя величина которого составляет 17,2 см, а довольно большие наружный диаметр, что связано с приспособлением ширины гнезда к величине угла разветвлений.

Nucifraga caryocatactes. Личный материал по гнездованию кедровки (8 гнёзд) дополнено описью конкретных гнёзд с литературы, касающимися номинативной формы и подвида *N. c. macrorhynchos*. Гнёзда номинативной формы размещены на высоте от 2 до 11 м (в среднем 5,6 м), а *N. c. macrorhynchos* от 0 до 10 м (в среднем 6,3 м). Гнёзда строятся исключительно на хвойных деревьях (таблица X) — наиболее охотно на пихте и ели, на боковых, тонких ветках или ответвлениях у ствола (фиг. 2: B_1). В анализированных гнёздах констатировано трёхслойное строение (фиг. 3:3). Наружная часть его состоит из сучьев и веток переплетённых свежими побегами ежевики и небольшого количества трухи, а также свежих лисьев. Средний слой обычно построен из свежего лыка или мха. В таблице XI сопоставлен материал, который употребляет кедровка на построение гнёзд. Главным строительным материалом является: сучья и ветки, лыко, труха, стебли и листья трав, а также мох. Итоги измерений 7 гнёзд представлено в таблице XII. Наиболее постоянной величиной является внутренний диаметр, которого среднее арифметическое колеблется в границах 1 см.

Corvus monedula. Итоги исследований над высотой расположения 298 гнёзд галки представлено в таблице XIII. Средняя высота размещения 163 гнёзд в дуплах и гнездовьях составляет 9,41 м, для 78 гнёзд на здания — 20,70 м, а средняя для 57 гнёзд на скалах составляет 15,30 м. Среднее арифметическое всех 298 гнёзд выражается числом 13,5 м. К наиболее излюбленным местам для гнездования принадлежат дупла и полудупла. Вид дерева, высота расположения входного отверстия, его величина в отношении сторон света не играют особенного значения. Найдено два, свободно стоящие гнёзда на боковых ответвлениях молодой сосны и ели. Гнёзда галок имеют различное строение в зависимости от их локализации (фиг. 3: 4a, b, c, d, e). Типичным является обычно трёхслойное строение: первый — наружный слой (глинистый слой и внутри-подстилка), но встречается двух- и однослойное строение (отсутствие глинистого слоя или наличие одной лишь подстилки). Итоги анализа материала, употребляемого для построения 31 гнезда галок представлено в таблице XIV. К наиболее часто применяемым материалам относятся: лыко (отмеченное у 87% гнёзд), сучья и ветки (83,8%), бумага (83,8%), а также сухие листья и трава (по 58%). Форма и величина гнезда остаётся в тесной связи с его локализацией, так как его обычно приспосабливают к величине помещения. Большую дифференциацию гнёзд галки в отношении величины и формы представляют сопоставленные в таблице XV результаты измерений 31 гнезда. Наиболее постоянными являются глубина и внутренний диаметр гнезда, хотя и при этих размерах разницы в их размахе доходят до 100%. Срав-

нение средних размеров свежих и старых гнёзд указывает, что период выведения молодых имеет влияние на расширение и обмеление гнезда.

Corvus frugilegus. Высота расположения 874 гнёзд грача показана в таблице XVI. Наибольшее количество гнёзд находится в пределах высот от 14 до 25 м, а среднее арифметическое высоты расположения всех гнёзд составляет 19,01 м. Из таблицы XVII следует, что из 15 видов деревьев, на которых найдено гнёзда грача, наиболее охотно выбирались тополь и ольха (50% исследованных гнёзд). Грачи в большинстве случаев (59,3%) локализируют гнёзда в многократных, вертикальных разветвлениях верхушечных ответвлений (фиг. 2: D). Гнездо состоит из 4 слоёв: внешнего-корпуса, ветвистого, глинистого и подстилки (фиг. 3:5). Таблица XVIII представляет детальный анализ материала употреблённого для построения 34 гнёзд. Все гнёзда были построены из сучьев и веток, как из постоянного крепёжного материала, а также со стеблей зелёных растений и трав, как главного материала для подстилки. Поочерёдно наиболее многочисленными были сухие листья (у 97,0% гнёзд), а также мох и земля (по 85,2%). Итоги промера 34 гнёзд сопоставлены в таблице XIX. Наиболее постоянной величиной является внутренний диаметр гнезда, среднее арифметическое которого составляет 18,67 см.

Corvus corone. Собранные материалы касаются исключительно подвида *C. c. cornix*. Результаты измерений высот расположения 36 гнёзд собрано в таблице XX. Большинство гнёзд находится на высоте от 10 до 15 м (61% общего количества гнёзд) то есть в среднем на высоте 14,0 м. В таблице XXI сопоставлены деревья, на которых найдено гнёзда вороны. Из хвойных деревьев наиболее предпочитаемыми были пихта и сосна, а из лиственных тополь, ива и ольха. Гнездо вороны имеет отчётливое, четырёхслойное строение (фиг. 3:6). Наружный слой состоит из сучьев и веток. Внутри, на его дне лежит глинистый слой в виде неглубокой чаши. Вверх по бокам чаши, на стенках первого слоя, находится ветвистый слой. Внутри гнезда находится подстилка. Анализ материала, использованного для построения 26 гнёзд, представлен в таблице XXII. В каждом гнезде кроме сучьев и веток, найдено лыко, глину и шерсть животных. В большинстве гнёзд найдено стебли трав (80,7%), мох (73,0%), одеревенелые стебли растений (65,3%), а также мелкие корни деревьев и кустарников (61,5%). Анализ измерений 31 гнёзд представлен на таблице XXIII. Здесь отмечено большие колебания размаха отдельных измерений. Среднее арифметическое внутреннего диаметра составляет 19,41 см.

Corvus corax. Гнёзда ворона, как правило, располагаются очень высоко (с 13 до 31 м), а средняя высот размещения 50 гнёзд составляет 21,68 м (таблица XXIV). Виды деревьев, на которых были размещены гнёзда представлены в таблице XXV. Доминирующим видом является сосна. Наибольшее количество гнёзд было найдено на боковых ветвях у ствола, в верхней или средней партии кроны. Схема строения гнезда ворона показана на фиг. 3:7. Оно состоит из следующих слоёв: наружного, ветвистого, глинистого и подстилки. У большинства гнёзд глинистый слой слабо заметный, а иногда совсем отсутствует. Таблица XXVI представляет анализ материала, употреблённого для построения 14 гнёзд. Во всех

гнёздах найдены сучья и ветки, образующие наружный слой, а также мох, который является постоянной составной частью подстилки. Почти в каждом гнезде, во внешней партии подстилки, имеется в большем или меньшем количестве шерсть животных. В 92,8% исследованных гнёзд находится лыко. Сопоставление размеров 15 гнёзд представлено в таблице XXVII. Все размеры гнезда имеют очень большой диапазон колебаний. Наиболее постоянным является величина внутреннего диаметра, среднее арифметическое которого составляет 27,60 см. Внешний диаметр и высота в некоторой степени зависят от способа локализации и возраста гнезда.

Рассмотренные здесь поочерёдно виды из семейства не составляют отчётливо плотной экологической группы. Они отличаются друг от друга гнездовыми биотопами, высотой расположения гнёзд (фиг. 1), а также видами деревьев и кустарников и местами, которые они используют для гнездования. Можно, однако, отличить некоторые основные типы размещения гнёзд. Они показаны на фиг. 2 и объяснены в таблице XXIX, в которой взяты также во внимание данные из литературы относительно типов размещений, отсутствующих в материалах автора. Наибольшие приспособительные возможности в этом отношении имеет галка и сойка, а наиболее консервативным видом является кедровка. Больше общих признаков, объединяющих эти виды можно найти, анализируя материал употребляемый для построения гнезда, а также способ строения. В таблице XXX представлено количество материала, употребляемого для построения гнезда, различая основные материалы (наличие которых отмечено, по меньшей мере, в 50% гнёзд исследованных серий), а также определяя количество общих материалов констатированных в сериях гнёзд отдельных видов. Анализируя процентную долю общих материалов в гнёздах отдельных видов (таблица XXXI) видно, что в большинстве случаев они являются также основными материалами, что указывает на сходство в подборе строительного материала у исследованной группы птиц. Несмотря на некоторое различие в структуре и слоистом строении гнёзд отдельных видов, можно констатировать некоторый общий стереотип их строения. Первичным является, по всей вероятности, трёхслойное строение, то есть облицовка (наружный строй), глинистый (или ветвистый слой) и подстилка. Глинистого слоя не обнаружено только в гнёздах сойки, а ветвистого нет у галки и кедровки. В таблице XXVIII показаны разницы в величинах гнёзд отдельных видов. Все они отчётливо отличаются друг от друга, и даже в случае внутреннего диаметра и глубины, которые проявляют наименьшую изменчивость, не представляют достаточных критериев для дифференциации гнёзд отдельных видов. Для возможности определения оставленных гнёзд составлен определитель, основанный на существенных и характерных признаках строения гнёзд, а также составе строительного материала (стр. 645).

Для ориентировки в общей схеме и сходстве строения гнёзд, в пределах семейства *Corvidae*, сделано, на основании литературы, сравнение охватывающее данные по строению гнёзд дальнейших 29 видов из 11 родов: *Gymnorhinus*, *Cyanocitta*, *Aphelocoma*, *Cyanocorax*, *Garrulus*, *Perisoreus*, *Cyanopica*, *Podoces*, *Nucifraga*, *Pyrrhocorax*, а также *Corvus*. Взяв во внимание схему строения гнезда,

как критерий степени родства, можно подвести следующие предположения и заключения:

1. Среди первичных *Corvidae* развились два типа строения гнёзд. Признаком одного типа является наличие глинистого слоя, а второго — его отсутствие.

2. Роды *Gymnorhinus*, *Aphelocoma*, *Cyanocorax* и *Garrulus* образуют отчётливо обособленную группу, которая характеризуется, между прочим, отсутствием глинистого слоя в их гнёздах.

3. Гнёзда вида *Lalocitta lidthi*, засчитываемого к роду *Garrulus*, отчётливо отличаются от схемы строения характерной для этого рода и группы, и навязывают, скорее всего, к гнёздам рода *Cyanocitta*, который имеет сильно развитий глинистый слой.

4. Следующей группой родов имеющей общий план строения гнёзд являются *Perisoreus*, *Podoces* и *Nucifraga*. Они навязывают в большой степени к первичной группе соек, которые не имеют в своих гнёздах глинистого слоя.

5. Строение гнёзд родов *Cyanopica*, *Cyanocitta* и *Pica* подсказывает на их общую линию развития.

6. Роды *Pyrrhocorax* и *Corvus* составляют отдельные, специализированные группы и нет отчётливых связей между ними и выше упомянутыми группами.

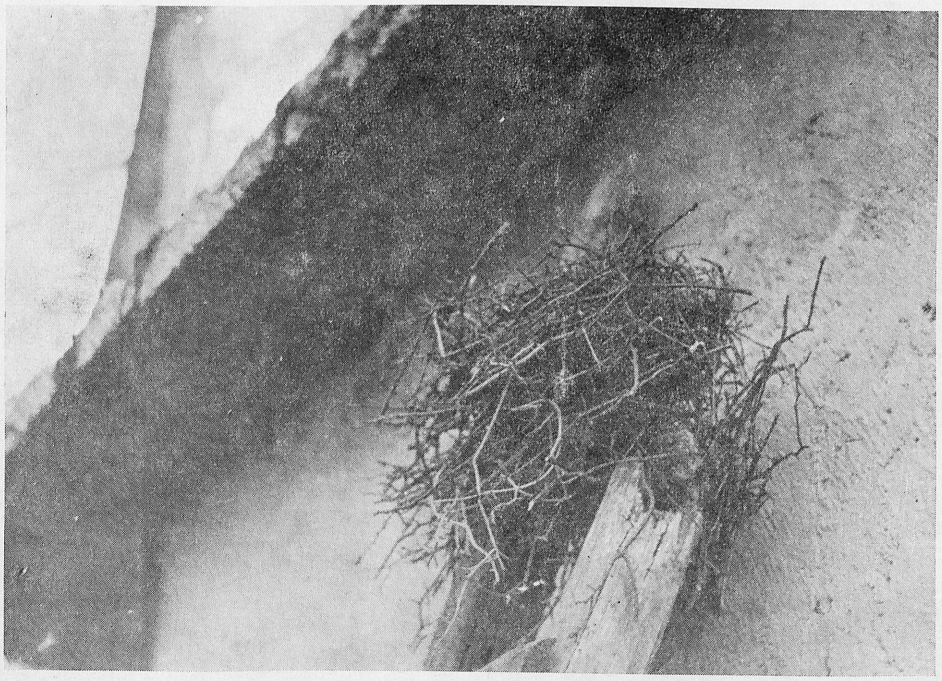
TABLICE

Plate XXXVIII

Phot. 1. The nest of a Jay *Garrulus glandarius* on a young pine. Site corresponding to type B1 in Fig. 2. (Phot. W. Puchalski)

Phot. 2. The nest of a Jay *Garrulus glandarius* placed at the top of a ladder leaning against the wall of a hunting-box. (Phot. B. Sovi'š)

Phot. 1



Phot. 2

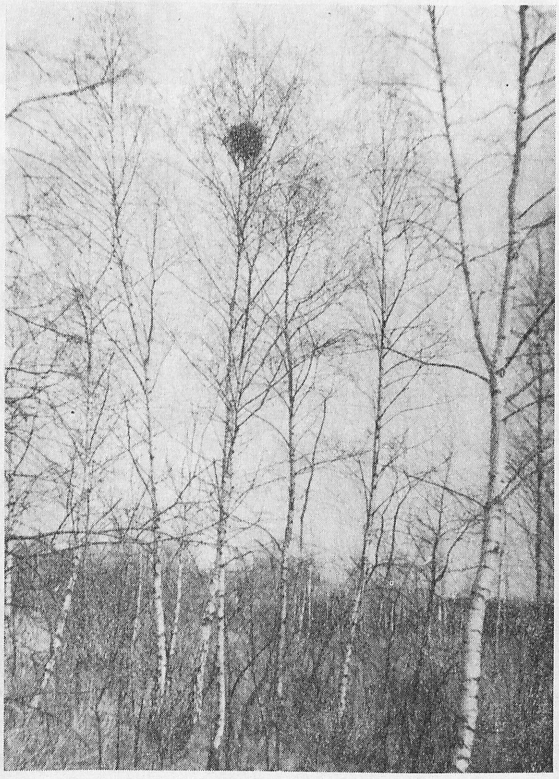
A. Kulczycki

Plate XXXIX

Phot. 3. The nest of a Jay *Garrulus glandarius*. Differences in thickness of the lining material (rootlets) the marginal region and between the bottom of the nest cup are visible. (Phot. M. Partyka)

Phot. 4. The nest of a Magpie *Pica pica* in the top crotch of a young birch. Site corresponding to type B2 in Fig. 2. (Phot. Author)

Phot. 3



Phot. 4

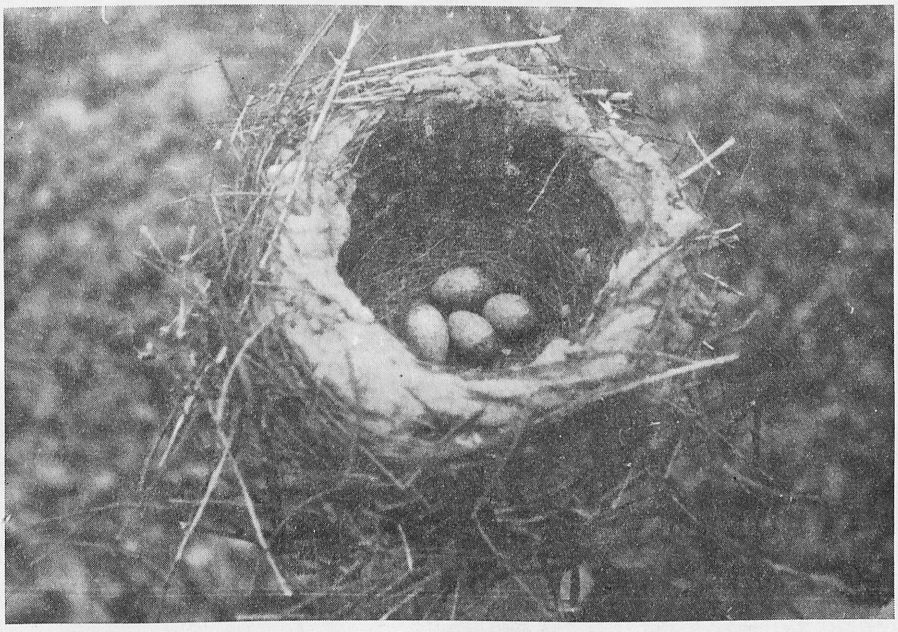
A. Kulczycki

Plate XL

Phot. 5. The nest of a Magpie *Pica pica* in the fork of a bough with its protective cupola. Site corresponding to type D in Fig. 2. (Phot. Author)

Phot. 6. The nest of a Magpie *Pica pica*. The photograph shows the clay layer, which forms a typical roll at the nest edge, and the lining of fine rootlets. (Phot. Author)

Phot. 5



Phot. 6

A. Kulczycki

Plate XLI

Phot. 7. The breeding biotope of the Nutcracker *Nucifraga caryocatactes* in the Niski Beskid region. The arrow indicates the site of the nest. (Phot. Author)

Phot. 8. The nest of a Nutcracker *Nucifaraga caryocatactes* placed on the branches of a young fir. Site corresponding to type B1 in Fig. 2. (Phot. Author)

Phot. 7

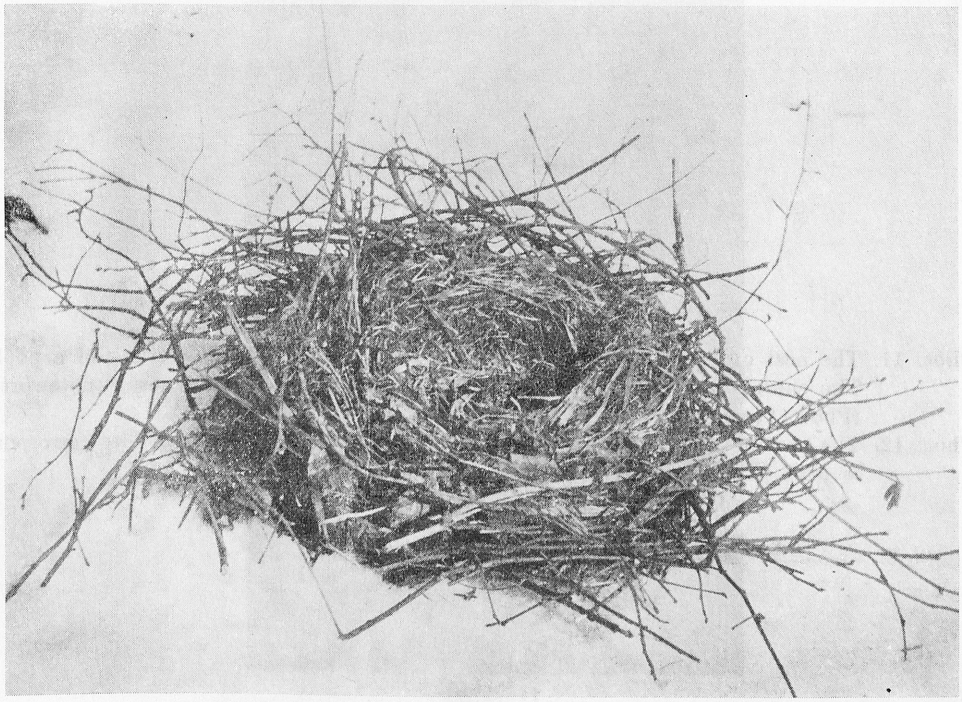
Phot. 8

A. Kulczycki

Plate XLII

Phot. 9. The nest of a Nutcracker *Nucifraga caryocatactes* isolated from its natural habitat. A large amount of bast is visible in the lining. (Phot. Author)

Phot. 10. Two common nest sites of the Jackdaw *Corvus monedula*: a breeding box and a shallow tree-hole. (Phot. Author)



Phot. 9

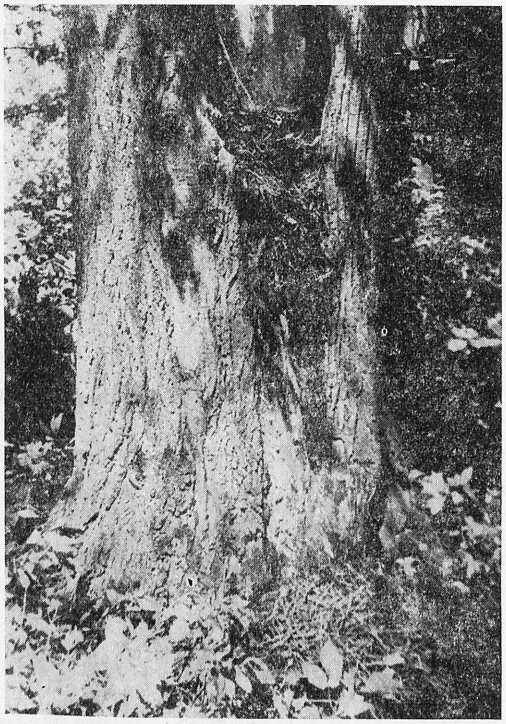
Phot. 10

A. Kulczycki

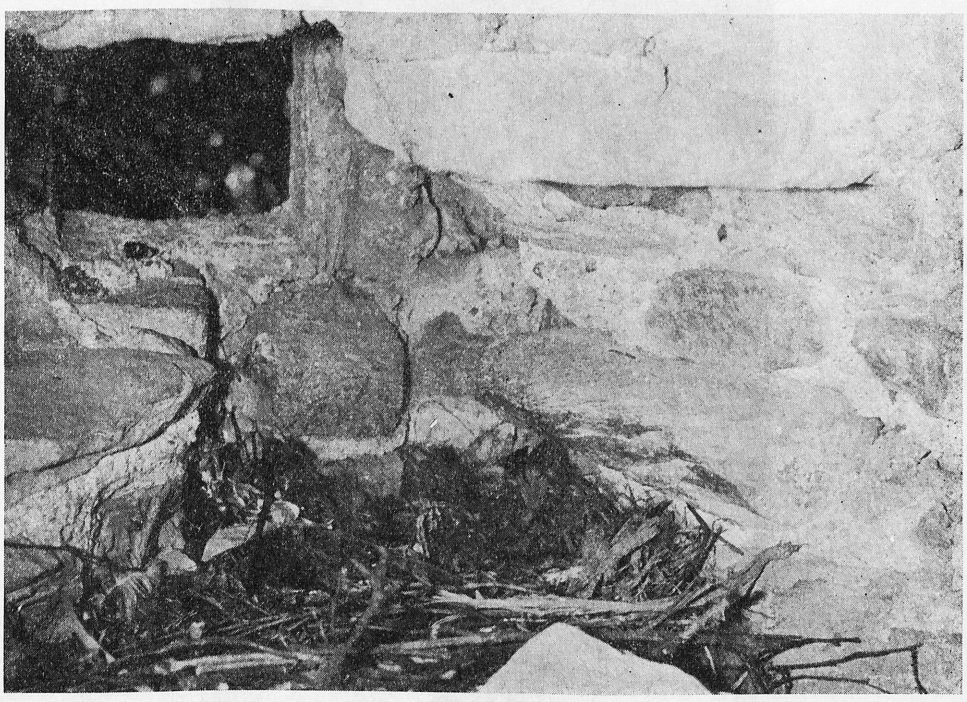
Plate XLIII

Phot. 11. The nest of a Jackdaw *Corvus monedula* placed in the hollow trunk of a poplar. The enormous amount of material that forms the base of the nest is noteworthy. (Phot. Author)

Phot. 12. The nest of a Jackdaw *Corvus monedula* in the attic of a church. Site corresponsd to type M in Fig. 2. (Phot. Author)



Phot. 11



Phot. 12

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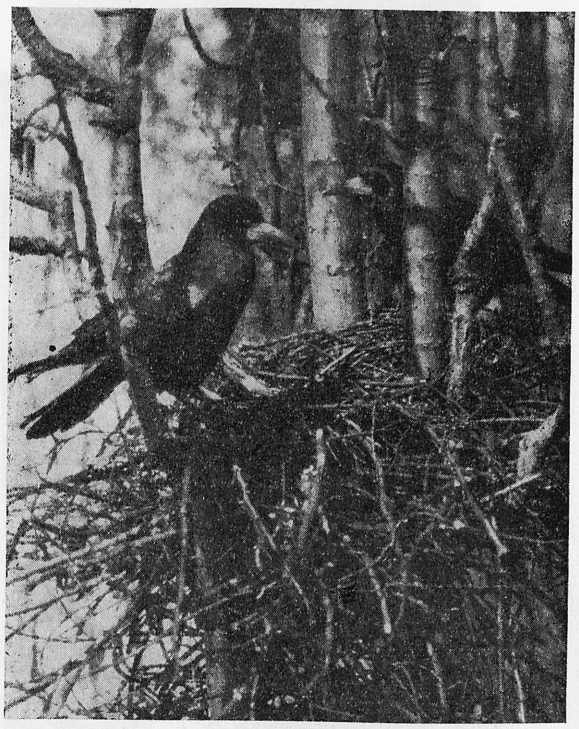
Plate XLIV

Phot. 13. A colony of Rooks *Corvus frugilegus*. Different types of nest sites are visible. (Phot. Author)

Phot. 14. The nest of a Rook *Corvus frugilegus* showing the commonest type of site of this species, i. e., type D in Fig. 2. (Phot. W. Puchalski)

Phot. 13



Phot. 14

A. Kulczycki

Plate XLV

Phot. 15. The nest of a Crow *Corvus corone* in the typical breeding biotope of this species. Site corresponds to type A1 in Fig. 2. (Phot. Author)

Phot. 16. The nest of a Crow *Corvus corone* placed on the branches of a pine. Site corresponds to type B1 in Fig. 2. (Phot. Author)

Phot. 15

Phot. 16

A. Kulczycki

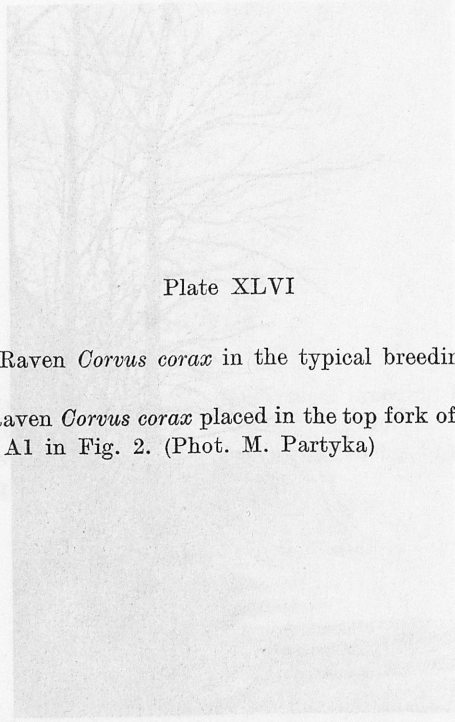


Plate XLVI

Phot. 17. The nest of a Raven *Corvus corax* in the typical breeding biotope of this species. (Phot. Author)

Phot. 18. The nest of a Raven *Corvus corax* placed in the top fork of an oak bough. Site corresponds to type A1 in Fig. 2. (Phot. M. Partyka)

Phot. 17

Phot. 18

A. Kulczycki

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