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PIOTR PROFUS

The breeding biology of White Stork *Ciconia ciconia* (L.) in the selected area of Southern Poland

Biologia rozrodu bociana białego, *Ciconia ciconia* (L.) na wybranym obszarze południowej Polski*

Abstract

Studies on the White Stork population in Upper Silesia revealed that in 1973-1988 the brood effectivity in Storks depended upon the date of springtime arrivals, conditions prevailing in breeding grounds, cluth-size, and density of breeding pairs. The highest values of reproduction indices (JZm = 3.24 young per pair with young) were found for nests with 5 eggs but the breeding success was highest (76.0%) in nests with 2 and 3 eggs. The hatching success was 90.3%. The breeding success was 60.4% for all the pairs with eggs and 65.3% for those pairs which raised independent young. In 1973-1978 the reproduction of Upper Silesian Storks was lower by 0.6-0.7 (20-26%) young per pair as compared with the years 1928-1932. This is likely an effect of the increase in population density (between 1928 to 1975 the population in Upper Silesia grew from 367 to 774 pairs), deterioration of feeding conditions in breeding grounds and higher proportion of younger Storks (producing less young than older birds) in a breeding population.

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I. Introduction and goal of the paper

For several decades the White Stork has been a subject of intense ecological and ethological investigations. Thereby it now belongs to the most comprehensively studied bird species. Its reproduction, behaviour, some mechanisms regulating population size, food, parasites, migrations, orientation on passages, and other aspects of its biology have been examined hitherto (Z i n k 1967). However, despite the further progress in studies on White Stork, particularly in the last quarter of our century, certain aspects of its ecology and reproduction have not satisfactorily been explained. This concerns, among others, variations in clutch-size, as well as in hatching and breeding success, occurring from year to year. The influence of population density on such important parameters as clutch-size, number of young raised by a statistical breeding pair, or proportion of pairs without young in relation to all the pairs occupying nests, is unknown, too. The present paper is an attempt at bringing together the results the author has obtained hitherto, both published (P r o f u s, M i e l c z a r e k 1981, P r o f u s 1982, 1986, 1990) and prepared for printing (P r o f u s, msc.). Besides, it is also a recapitulation of over a dozen of European publications concerning the breeding biology of the White Stork. The results of some of these publications have been critically reviewed.

The aim of the present paper was: 1) to assemble the author's previous observations and investigations of the reproduction of the White Stork population inhabiting the most transformed by man part of the country, i.e. Upper Silesia and the adjacent areas; 2) to know in detail certain mechanisms regulating population size in this species in its breeding grounds; 3) to compare the author's own results with the data reported by other authors for different areas lying within the geographical range of the species; 4) to explain a decrease in Stork reproduction that occurred in the last half-century in Upper Silesia and in the province of Opole.

II. Methods

1. Significance of symbols used in the text

A many years' methodical experience, gained during the White Stork censuses in Europe, was summed up by S c h ü z (1952), and the author made use of his publication (following also the recommendations given by the International Council for Bird Preservation ICBP 1972, 1983) while collecting material in the study area.

Systematic field studies were carried out in the years 1973-1988, but most data were gathered in 1980-1988. Investigations were conduced from mid March till the first few days of September, their peak intensity falling on May-July. A scheme comprising the results of field observations and symbols standing for individual parameters have been taken mainly from the publication by S c h ü z (1952). The significance of the symbols used is as follows:

HPa - breeding pairs occupying nests for a period of full one month between 14 April and 15 June
(HPa = HPm + HPo + HPx)

HPm - pairs which raised young
(HPm = HPm 1 + HPm 2 + HPm 3 + HPm 4 + HPm 5 + HPm x)

- HPm 1 - pairs which raised 1 young
- HPm 2 - pairs which raised 2 young
- HPm 3 - pairs which raised 3 young
- HPm 4 - pairs which raised 4 young
- HPm 5 - pairs which raised 5 young
- HPm x - pairs which raised an unknown number of young

HPo - pairs without flying young

% HPo - percentage of pairs without flying young
% HPo = (HPo x 100 %) : (HPm + HPo)

HPx - pairs of whose young nothing is known
HPx = HPa - (HPm + HPo)

JZG - total number of fledglings from all nests in which it was possible to count them

JZa - mean number of fledglings per nest occupied by a statistical breeding pair
JZa = JZG : HPa - (HPx + HPm x)

JZm - mean number of fledglings per nest occupied by a statistical breeding pair with flying young
JZm = JZG : (HPm - HPm x)

StD - density of breeding pairs (HPa) per 100 km^2 of the area

StB - density of breeding pairs (HPa) per 100 km^2 of feeding grounds (meadows, pastures, leguminaceous crops, marshes).

While collecting material in the investigated area, in some cases (about 2-3 %) the autor failed to obtain precise information on a manner of nest occupation by a pair (HPx) or on a number of raised young (HPm x). When the reproduction indices for the pairs HPx or/and HPm x are included in calculations, the value obtained are underestimated. Therefore, these indices were calculated according to the assumptions given by Profus and Mielczarek (1981) who modified slightly the original formulae by Schüz (1952).

Starting the detailed studies on the biology of reproduction in White Stork the author had to define precisely, arrange, and unify certain concepts which in many earlier publications were used rather freely, eg. the idea of breeding success in Wojciechowski and Ogrodowczyk (1978), Górski et al. (1980), and in some papers edited by Jakubiec (1985). A scheme comprising the results of observations and symbols denoting univocally the particular phenomena have been taken from the publication by Profus (1986), except for the symbol standing for the average clutch-size (EZ), which has been drawn from Schüz (1952).

Meaning of symbols:

HPg	-	number of pairs with full clutches; according to Mrugasiewicz (1972) - HPe. Figure placed after the symbol refers to a size of full clutch
EZG	-	total number of all eggs laid in the nests with clutches considered as full ones
EZ	-	average clutch size; average number of eggs laid by one female EZ = EZG : HPg
EZm	-	average clutch size of a statistical pair with flying young EZm = EZGm : HPm, where EZGm is a total number of egg laid by all pairs raising young
SJG	-	total number of all nestlings hatched from eggs (EZG)
SE	-	fraction of hatched nestlings SE = SJG : EZG
% SE	-	hatching success, percentage of hatched nestlings % SE = (SJG : EZG) x 100 %
BE	-	breeding success, fraction of young raised from nests in relation to a number of laid eggs BE = JZG : EZG
% BE	-	breeding success expressed in per cent % BE = (JZG : EZG) x 100 %
V	-	sum of losses in broods (eggs + nestlings) V = EV + JV

% V	-	percentage of losses in broods % V = 100 % - BE = (V x 100 %) : (JZG + V)
EV	-	sum of infertile eggs, those with dead embryos, and those thrown out of nests in relation to all laid eggs EV = EZG - SJG
% EV	-	percentage of infertile eggs, those with dead embryos, and those trown out of nests in relation to all laid eggs % EV = (EV x 100 %) : (SJG +EV) = 100 % - % SE
JV	-	total number of dead and trown out young; nestlings which died during their first departure from nests, and later, were excluded JV = SJG - JZG
% JV	-	percentage of young dead and thrown out of nests in relation to the total number of hatched nestlings % V = (JV x 100 %) : SJG
JZg	-	average number of young raised by a statistical pair with clutch JZg = JZG : HPg
JZs	-	average number of hatched nestlings per statistical pair with eggs JZs = SJG : HPg

2. The beginning of egg laying and estimation of a phase of egg incubation

To determine a phase of the incubation of an egg it was put into a vessel with water of room-temperature and its positions were observed. According to the age of an embryo the egg goes to the bottom or floats in water, assuming certain characteristic positions. These positions reflect changes in the specific weight and size of the egg as well as in the shape of its air chamber, that occur during incubation (eg. M a j e w s k i 1980). To increase the accuracy of the evaluation of a phase of incubation, all eggs from a given clutch were put into water. If the embryo develops normally, the results of these experiments will allow the determination of laying dates for the first egg and for succesive ones with an exactness of 4-8 days. Two or three tests made in the later part of incubation enable to fix with good precision hatching dates for young. Knowing the hatching dates for particular nestlings, the author calculated lying dates for the successive eggs subtracting 31-32 days from the respective hatching dates. An approximate phase of egg incubation was established according to the principles as follows: 1) a newly laid egg goes quickly to the bottom of a vessel with water and lies there horizontally. The specific weight of a not incubated egg is higher than that of water and a small air chamber does not influence the position of the egg in water. After 1-6 days of incubation, the sharp pole of the egg touches the bottom of a vessel, while the blunt one is slightly raised; 2) after 1-2 weeks of incubation, the egg goes to the bottom of a vessel slowly. The blunt pole of the egg is pronouncedly raised over the bottom; 3) after about 2-3 weeks of incubation, the egg "stands" upright on the bottom of a vessel or rises straight up from water; 4) after 3-4 weeks of incubation, the egg floats in water, its longer axis being out of the vertical by 20°; 5) 1-4 days before hatching, the egg drifts in water, deflected from the vertical by 25-40°, the blunt pole of the egg protruding 5-15 mm above water. The highest diameter of the protruding part was 20-40 mm. The hatching egg assumes similar positions (P r o f u s 1986).

3. Calculation of the weight of newly laid eggs

As incubation goes on and the embryo develops, the egg weight diminishes. A decrease in egg weight with time is due to the evaporation of water through the shell. D r e n t (1975), P r i n z i n g e r et al. (1979), A r and R a h n (1980) have found that the eggs of birds lose from 15 to 20% of their initial weight in the course of incubation.

The eggs weighed during the inspection of nests were at different phases of embryonic development. Thereby, it was necessary to work out a method enabling to calculate the weight of newly laid eggs, the approximate time of incubation of a given clutch and weight of incubated eggs being known. The author made use of the data obtained by S c h i e r e r (1972) who recorded losses in the weight of Stork eggs placed in the incubator. On the basis of the above data, including in calculations only the eggs with normally developing embryos, the author has established that during the incubation the egg loses, on the average, 13.1% of its initial weight, extreme values amounting to 10.5 and 15.8%. Thereby, the weight of a newly laid egg can be calculated according to the formula:

Weight of a newly laid egg (EG; g)	=	Weight of the egg found in the nest	+	Correction including the loss in weight of the egg during incubation

During the period of embrionic development, the rate of the losses in weight of eggs changes. An analysis of the data given by S c h i e r e r (1972) has revealed that losses are highest during the first 8 days of incubation, amounting then, on the average, to 0.75% of the weight of a newly laid egg per 24 hours. Between the ninth and twenty-second day of incubation the egg loses, on the average, 0.54% of its initial weight per 24 hours. In the following days, till the hatching of nestlings, the loss in weight is practically unnoticeable and it amounts to 0.12% per 24 hours. These data were used at the calculation of corrections including losses in weight of the egg during its incubation. The particular values corresponding to the rate of losses in weight (i.e. 0.75, 0.54 or 0.12%) were multipled by the time of incubation, given in days for the particular time intervals, i.e. before 8, 9-22, or 23-31/32 day. A sum of products showed by which percent the eggs weighed in the nest were lighter than the newly laid ones. For instance, on the 14 day of incubation the egg weighed 105 g. During these 14 days the loss in weight was: (0.75% x 8 days) + (0.54% x 6 days) = 9.2% of the initial weight. This means that the actual weight of this egg is: 100% - 9.2% = 90.8% of the initial weight. Hence, the calculated weight of a newly laid is:

$$EG = (105 \text{ g} \times 100\%) : 90.8\% = 115.6 \text{ g}$$

4. Choice of a basic time unit

Generally, the period of one or two pentades has been accepted as a basic time unit to which all the collected data have been referred, according to the proposal given by B e r t h o l d (1973) on the standarization of data in European ornithology. In many ecological publications (not only on White Stork) time units were accepted rather freely, which often made direct comparisons of the results of studies impossible.

III. Results and discussion

1. Changes in numbers and ecological characteristics of the breeding population of White Stork in Upper Silesia

A considerable decline in numbers of White Stork in Poland, observed in the last years (in 1974 - about 33 900 pairs and until 1984 - a 10% decline to about 30 500 pairs, P r o f u s et al. 1989), did not take place in the population inhabiting the southern part of Silesia. Previous censuses from the years 1928-1934 (B r i n k m a n n 1930, 1933, 1934, 1935, C z u d e k 1935) revealed the lower number of Storks in Upper Silesia as compared with the years 1973-1984.

In 1928 (the year of the lowest numbers, also in many other areas in

Europe) 262 pairs were recorded there, in 1929 - 269, in 1931 - 273, in 1932 - 280, in 1933 - 298, and in 1934 (the year of great Stork numbers, also in many areas in Central Europe) - 345 pairs. In the years 1973-1979, in the same area (6915 km^2), 390-429 pairs nested, their density oscillating between 5.64 and 6.20 pairs per 100 km^2. These values are lower than the averages given for the area of Poland (1974 - 10.8 pairs per 100 km^2, 1984 - 9.78 pairs per 100 km^2; P r o f u s et al. 1989), however, they approximate the average density established for these regions of the country, which extend west of the Vistula river. The density of Stork population, calculated per 100 km^2 of feeding grounds (meadows, pastures, marshes, and leguminaceous crops), changed from 51 to 56 pairs in the years 1973-1979 (P r o - f u s 1986). Censuses, carried on in 1980-1988, has revealed that Stork numbers are rather stable in that area. This fact is also indicated by the results of censuses made in the areas of previous (from before 1975) administrative districts of Strzelce Opolskie, Gliwice, Rybnik, Wodzisław, and Racibórz, where 194 breeding pairs were found in 1974 and in 1984 (P r o f u s et al. 1989).

2. Arrivals on breeding grounds

In Southern Poland, the springtime arrivals of first Storks generally fall on the turn of the second decade of March. According to M r u g a s i e w i c z (1972), there is no correlation between arrival dates for the first individuals in Milicz region (Lower Silesia) and later dates of nest occupation. Usually, the nest is at first occupied by one Stork - often by a male. The dates of nest occupation for the south of the country are shown in fig. 1. As can be seen from this figure, 5.8% of the birds occupy nests before 20 March, 31.0% between 21 and 31 March, 43.9% between 1 and 10 April, 13.2% between 11 and 20 April, 4.1% between 21 and 30 April, and only 2.0% in May. These data concern only the first partner occupying the nest and the two partners arriving at the nest on the same day (n=342 birds, including 78 belonging to 39 pairs, which arrived at the nest on the same day). In 144 cases (out of 444 analysed ones) arrival dates for the second bird were also recorded. It used to arrive 4.5 days after the first bird (extreme value - 25 days; there were 39 pairs in which both a male and a female came on the same day). In the years 1973-1987 the average date of nest occupation for the first Stork was 3 April, and that of the arrival of its mate - 7 April (P r o f u s 1986 and new data). Z a b ł o c k a (1959) quotes slightly earlier dates of arrivals for Southern Poland (27 March - 1 April). These differences

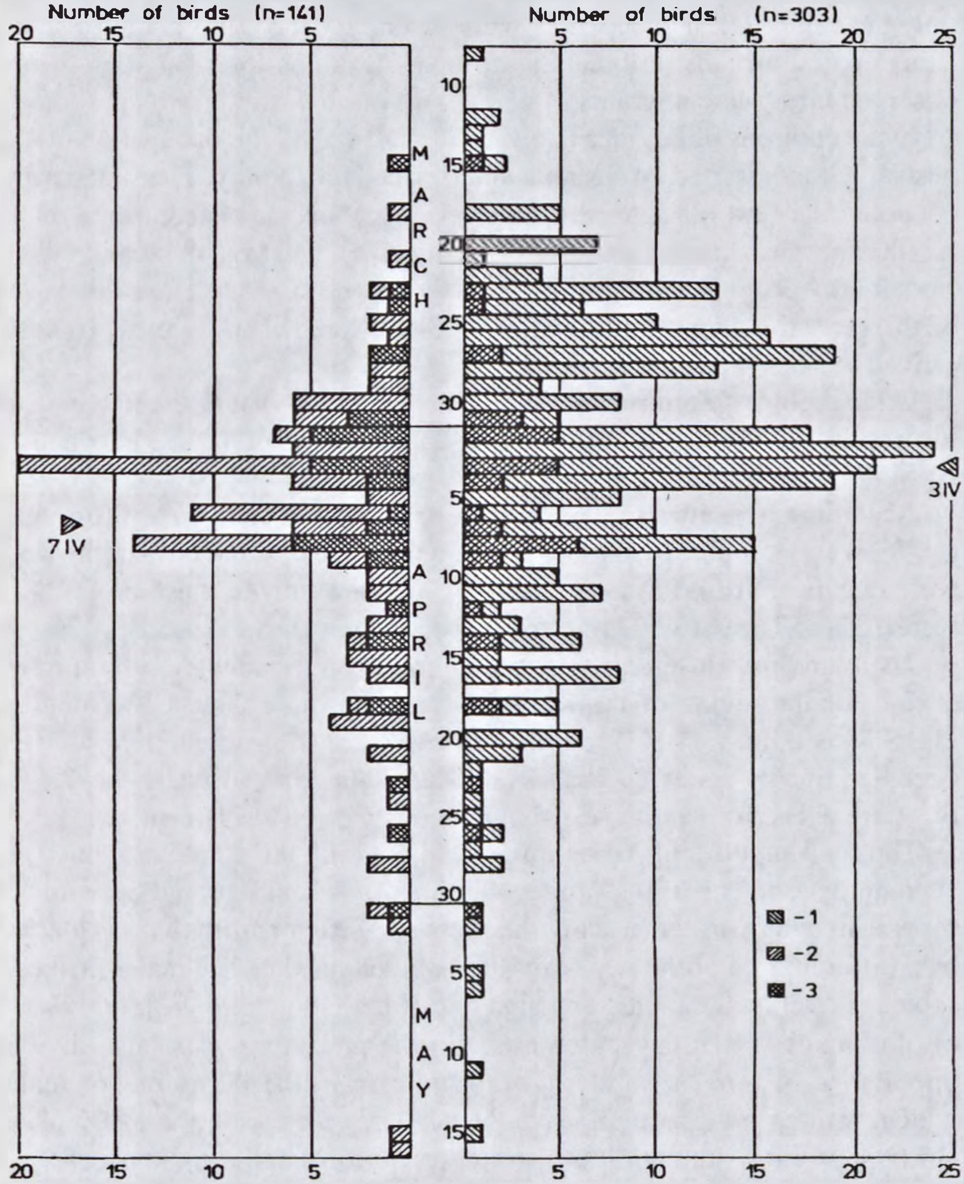

Fig.1. Dates of the occupation of nests by Storks in Upper Silesia in 1973-1987. 1 - arrival of the first Stork at the nest (x = 3 IV); 2 - arrival of the second Stork at the nest (x = 7 IV); 3 - arrival of the two partners on the same day

Ryc. 1. Terminy zajmowania gniazd przez bociany na Górnym Śląsku w latach 1973-1987. 1 - przylot pierwszego ptaka na gniazdo (średni termin przylotu 3 IV); 2 - przylot drugiego ptaka (średni termin przylotu 7 IV); 3 - przylot obu partnerów w tym samym dniu (every year variations being left of account) are possibly connected with the manner of the collection of data in the field; the author recorded and analysed only the dates of nest occupation, while Z a b ł o c k a (1959) noted also the dates of first arrivals on breeding grounds. It is possible that some of the observed birds were migrants.

In the environs of Legnica (Lower Silesia) in 1987 the occupation of 130 nests by Storks started on 5 March and finished on 22 May. The first partner occupied the nest on 5 April (on the average), and the second one on 10 April. The peak period of nest occupation by the first mate fell on 24 March-13 April when 107 Storks (82.3%) arrived at nests. The peak period of the second arriving member fell on 3-13 April when 79 birds (60.8%) arrived at nests (K u j a w a , msc).

In the region of Zamość the average date of the arrival of the first mate at the nest in 1984 was 6 April (19 March-25 April) and of the second one - 10 April (25 March-2 May) (P r o f u s et al. in print).

According to L ü h e (1906), in the former East Prussia 36% of the nests (n=75) were occupied by the two birds on the same day and 64% of the nests were occupied at first by one bird. For Southern Poland these proportions were 12% and 88% (31:221 nests), respectively.

There are also differences as to the term of nest occupation by the two sexes. For the region of the Kurische Nehrung (now Oblast Kaliningrad, U.S.S.R) S c h ü z (1943) reported 14 cases (50.0%) in which nests were occupied first by males; in 5 cases (17.9%) a female was first. In 9 cases the two partners arrived at the nest simultaneously or on the same day.

The food supplies in Africa influenced not only the number but also the average date of arrival in the breeding area. A strong correlation with the second arriving partner (usually the female) of each pair may be explained by a different role of the two sexes at the breeding site. The males arrive as soon as possible in the breeding area to claim a favourable nest; in the case of older males often the same nest as in the preceding year. The obvious importance of this early return is apparent from the behaviour of males which, waiting for a partner, leave the nest only for taking food (B a u e r, G l u t z 1966). Although it is also important for females to arrive early in the breeding area, it is also necessary for females to build up food reserves in the wintering area for the production of eggs. Obviously the percentages of successful pairs reflect conditions in the wintering area more exactly than the changes in numbers (D a l l i n g a , S c h o e n m a k e r s 1989).

Considerable deviations from the average many years' dates of Stork arrivals on breeding grounds were fairly often recorded, particularly in the years "favourable" for Storks ("Bestjahre"), characterized by early arrivals of most birds, and in "bad" years ("Störungsjahre"), characterized by very late arrivals. Then, most birds came at breeding grounds not earlier than in mid April.

The early return of most pairs on breeding grounds is the first symptom of a "good" year for Storks. Generally, "good" years are distinguished by high reproduction indices, though the final breeding effort is also determined by climatic and feeding conditions prevailing in nesting sites. The high percentage of pairs without flying young (% HPo) and low reproduction indices (JZa) are a consequence of the late arrivals of most birds from winter quarters. Then, the global production of young, as well as that calculated per statistical breeding pair is low. This indicates that conditions prevailing in wintering grounds and on passages may indirectly affect the condition of birds starting breeding as well as a clutch-size.

3. Laying of eggs and incubation period

Beginning of breeding

An examination of some nests during the period of egg laying and hatching of young enabled the author to establish that the first females start laying eggs at the beginning of the second decade of April. After the warm and green winter in 1987 and in 1988 two females started laying eggs particularly early (between 8 and 10 April). The average term of laying the first egg fell on 30 April (n=78). As much as 90% of all the females start breeding until 12 May, and further 9% - between 13 and 25 May. Mere 1% of the females lay eggs later on (fig. 2). The later is the start of breeding, the higher is the percentage of pairs without flying young. It seems that pairs starting breeding in the first decade of June are able to rise young only occasionally and under exceptionally favourable feeding conditions. In these cases dates of the departure of young from nests and those of the departure of adult birds for wintering grounds overlap and it may happen that old Storks fly away leaving their young, not flying yet, in the nest.

According to the observations of 12 nests in the province of Legnica in 1987 females began to lay eggs on 15, 17, 17,17, 17, 19, 21, 21, 28, 30 April and on 1 and 4 May (x=22 April), i.e., on the average 10 days after the arrival of the second bird from a pair (K u j a w a msc).

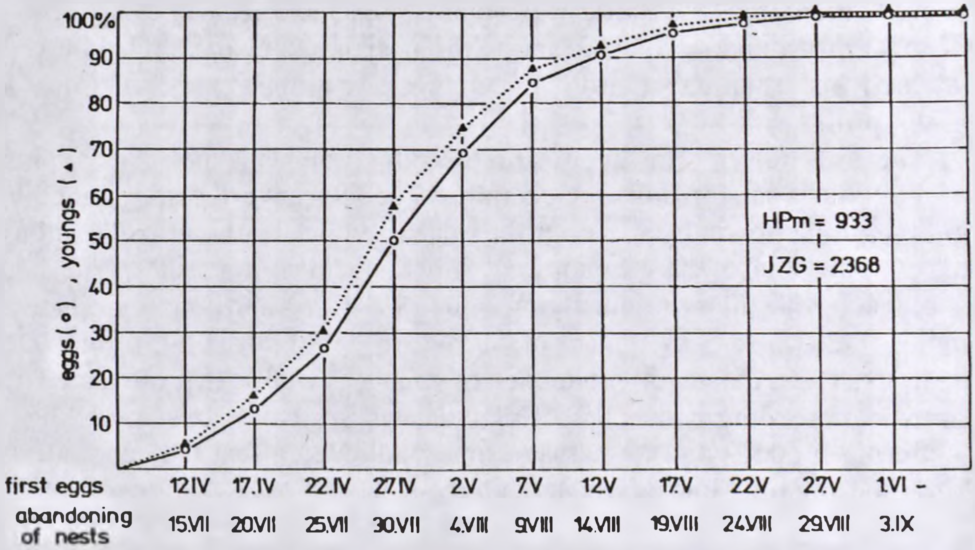

Fig. 2. Dates of egg laying and of first departures of young Storks from nests (HPm) together with percentages of the young (JZG) leaving nests in the particular pentades. For the first departures of young from nests pentades were accepted after B e r t h o l d (1973).

Ryc. 2. Terminy składania jaj i pierwszych wylotów młodych z gniazd (HPm) oraz odsetek młodych opuszczających po raz pierwszy gniazda (JZG) w poszczególnych pentadach. Pentady przyjęto zgodnie z propozycją B e r t h o l d a (1973).

Clutch-size

The number of eggs in full clutches oscillated between 2 and 6. As much as 90,7% of all the clutches consisted of 3, 4 and 5 eggs. Clutches including 4 eggs were most frequent; they constituted altogether 53.1% of all the clutches. The average clutch-size calculated for 128 pairs with full clutches was 4.06. Exceptionally Storks may lay one or seven eggs, but in the study area these clutches have not been found. Only M a z a r a k i (1979) mentioned a clutch of 7 eggs from the district of Chrzanów. The average number of eggs laid in “good” years is higher than in “bad” ones. In the"good" years distinguishable by earlier arrivals of the two partners on breeding grounds and by the earlier start of breeding, Storks laid, on the the average, 4.4 eggs (1978, 1980, 1981 and 1988; n=54), while in the “bad” years characterized by the late arrivals at nests and late start of breeding each female laid, on the average, 3.9 eggs (1973, 1979, and 1982, n=30; P r o f u s 1986 and new data).

Later clutches are mostly smaller than those laid earlier. Clutch-size, generally, diminishes from the beginning to the end of the breeding season.

The average clutch-size diminishes by 0.3 egg per decade. Pairs which start breeding before mid April lay, on the average, one egg more then pairs starting breeding on 6 May or later. Birds which start breeding earlier are most likely older than those breeding later. Ringing recoveries have shown that older Storks often arrive at nests earlier than younger ones. Moreover, Storks arriving earlier have a chance to occupy territories more abundant in food, those coming later are driven to less favourable grounds (M r u g a - s i e w i c z 1972).

Variations in clutch-size in European Storks and their causes

Many bird species nesting in Africa and Eurasia tend to lay more eggs in norhern parts of their breeding area than in southern ones (L a c k 1954, 1967, H a a r t m a n 1969, K l o m p 1970, and many others). The hitherto obtained data on clutch-size in European Storks do not support this observation (table I, fig. 3). It should be mentioned that our knowledge of clutch-size in Storks is rather poor. Besides, this species is no longer an “ideal” subject of studies on geographical variations in clutch-size because of the high rate and variety of changes influencing the whole of the White Stork population in Europe. Some factors are concerned here: a general decline in numbers, that occur more and more quickly, particulary in the last years, decrease in reproduction rate and increase in mortality among both old and young flying birds in the areas lying close to the northeastern border of the range of the species (S c h ü z, S z i j j 1975). A decline in Stork reproduction was also observed in other regions (P r o f u s , M i e l c z a r e k 1981, P r o f u s 1986). The above factors overlap and their resultant may change the age structure of population in favour of older individuals which lay more eggs than younger ones.

When geographical variations in clutch-size are studied, attention should be paid to the density of Stork populations in breeding grounds. In the most suitable areas (eg. Mazuria, Biebrza Marshes) these densities can be even 100 times as high as in less favourable regions or in those sparsely populated. The density recorded was very low, of the order of tenth parts of a pair per 100 km, or very high, amounting to 45, and locally to 73 (J a k u b i e c 1985, P r o f u s et al. 1989, M i e l c z a r e k, P r o f u s, in print) or even to 174.8 pairs per 100 km (B o r o w s k i et al. 1985).

It seems that population density affects clutch-size in White Stork, but to demonstrate this definitively, additional data for the areas of extreme densities of breeding pairs are needed.

TABLE I

Clutch size (EZ) in European White Storks. Numerals refer to the number of examined nests

Wielkość zniesień (EZ) bocianów białych w Europie. Liczby oznaczają ilość skontrolowanych gniazd (HPg)

Clutch -size (EZ) Wielkość zniesień	Estonia Estonia	Mecklenburg and Altmark Meklemburgia i Altmark	Schleswig-Holstein Szlezwig-Holsztyn	Netherlands Holandia	Białowieża Forest Puszcza Białowieska
1	—	4 (2.0)	—	—	2 (0.8)
2	4 (8.7)	7 (3.5)	3 (2.9)	5 (6.0)	31 (131)
3	10 (21.7)	40 (20.1)	5 (4.9)	20 (25.0)	64 (27.1)
4	20 (43.5)	100 (50.3)	58 (56.9)	38 (48.0)	112 (47.5)
5	10 (21.7)	42 (21.1)	27 (26.5)	13 (16.0)	26 (11.0)
6	2 (4.3)	4 (2.0)	8 (7.8)	4 (5.0)	1 (0.4)
7	—	—	1 (1.0)	—	—
Average clutch-size ± SE Średnia wielkość zniesień ± SE	3.91± 015 n = 46	3.94± 0.12 n = 199	4.34± 0.12 n = 102	3.89± 0.09 n = 80	3.56± 0.06 n = 236

(HPg). Numerals in brackets stand for percentages. SE - standard error. References: see fig. 3.

oraz ich udział procentowy (w nawiasach). SE - błąd standardowy. Wykorzystana literatura: patrz ryc. 3.

Lower Silesia Dolny Śląsk	Upper Silesia Górny Śląsk	Czecho-Slovakia Czecho-Słowacja	Bulgaria Bulgaria	Spain Hiszpania	Portugal Portugalia	Switzerland* Szwajcaria*
—	—	1 (2.6)	—	7 (3.45)	1 (2.1)	1 (1.2)
1 (5.9)	9 (7.0)	5 (13.2)	—	14 (6.90)	5 (10.4)	—
1 (5.9)	14 (11.0)	7 (18.4)	4 (28.6)	59 (29.06)	1 (2.1)	2 (2.3)
9 (52.9)	68 (53.1)	15 (39.5)	6 (42.9)	98 (48.28)	21 (43.8)	17 (20.0)
6 (35.3)	34 (26.6)	10 (26.3)	3 (21.4)	24 (11.82)	20 (41.6)	39 (45.9)
—	3 (2.3)	—	1 (7.1)	1 (0.49)	—	25 (29.4)
—	—	—	—	—	—	1 (1.2)
4.18±0.20 n = 17	4.07±0.08 n = 128	3.74±0.18 n = 38	4.07±0.25 n = 14	3.6±0.08 n = 203	4.13±0.15 n = 48	5.02±0.10 n = 85

* some Storks under semi-wild conditions (see also J e n n i et al. 1991)
część bocianów żyje w stanie półdzikim (patrz także J e n n i i in. 1991)

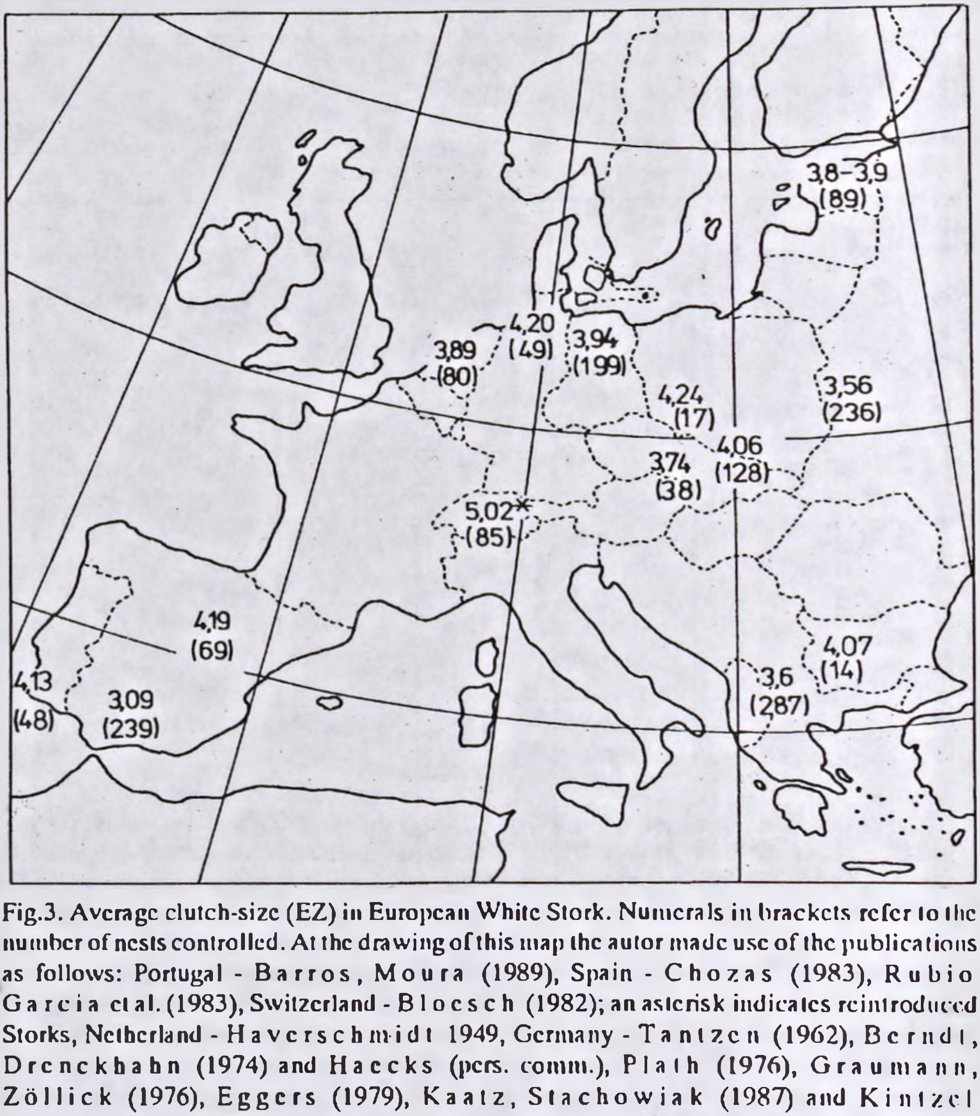

Fig.3. Average clutch-size (EZ) in European White Stork. Numerals in brackets refer to the number of nests controlled. At the drawing of this map the autor made use of the publications as follows: Portugal - Barros, Moura (1989), Spain - Chozas (1983), Rubio Garcia et al. (1983), Switzerland - Bloesch (1982); an asterisk indicates reintroduced Storks, Netherland - Haverschmidt 1949, Germany - Tantzen (1962), Berndt, Drenckhahn (1974) and Haecks (pers. comm.), Plath (1976), Graumann, Zöllick (1976), Eggers (1979), Kaatz, Stachowiak (1987) and Kintzel (1987), Czechoslovakia - Hudec, Cerny (1972), Babó (1977), Poland - Profus (1986) and this paper, Kujawa (msc), Byelorussia - Goloduško (1958), Estonia - Veromann (1962, 1980), Macedonia (Yugoslavia) - Makatsch (1950) and Jovetic (1963), Bulgaria - Michev et al. (in press).

Ryc. 3. Przeciętna wielkość zniesień (EZ) bocianów białych w Europie. Wartości w nawiasach oznaczają liczbę skontrolowanych gniazd ze zniesieniami. Korzystano z następujących prac: Portugalia - Barros, Moura (1989), Hiszpania - Chozas (1983), Rubio Garcia i in. (1983); (1989); Szwajcaria - Bloesch (1982), gwiazdka oznacza bociany reintrodukowane; Holandia - Haverschmidt (1949); Republika Federalna Niemiec - (Szlezwig-Holsztyn, Oldenburg) - Tantzen (1962), Berndt, Drenckhahn (1974), Haecks (inf. niepubl.); (Mecklenburgia i okolice Magdeburga) - Plath (1976), Graumann, Zöllick (1976), Eggers (1979), Kaatz, Stachowiak (1986); Czecho-Słowacja - Hudec, Cerny (1972); Polska (Śląsk) - Profus (1986 i nowsze dane), Kujawa (msc); Białoruś - Goloduško (1958); Estonia - Veromann (1962, 1980); Jugosławia (Macedonia) - Makatsch (1950), Jovetic (1963); Bulgaria - Michev i in. (w druku).

Data on clutch-size from different parts of Europe were collected in different years and some of them seem to be underestimated, which is indicated by methods used at their collection. If nests are not examined in the period of egg lying or/and in the first few days of incubation but later, a number of eggs found in the nest is lower than the real clutch-size. It happens that eggs dissapear from nests shortly after laying, as demonstrated by B l o e s c h (1982). It is also impossible to record all the cases of eggs thrown out of nests, displaced on the edges of nests, or destroyed during fights for nests, without entering nests. Moreover, it does not seem correct to calculate clutch-size from a number of fledglings and accidentally recorded losses in broods, eg. M r u g a s i e w i c z (1972) for the district of Milicz and M e y b o h m (in P a n z e r , R a u h e 1978) for the norhern part of Lower Saxony. Observations of the two groups of nests made by that autor revealed that in the group examined more rigorously, the losses among eggs and nestlings, accepted as actual, were higher by 5.1% than these in the group inspected only occasionally. This means that the data on clutch-size given by M r u g a s i e w i c z (1972) are possibly underestimated by about 5%, the same concerns the data on breeding losses.

The data on clutch-size published by J o v e t i c (1963) are also questionable, because that author examined Stork nests only in the latter part of incubation, and probably before the hatching of nestlings. This is indicated by the low weight of eggs in Macedonian Storks (P r o f u s 1986). On the other hand, some authors (G o l o d u š k o 1958 - for the Byelorussian part of the Białowieża Forest, R u b i o G a r c i a et al. 1983 - for Coto Doñana, Spain) did not describe methods used at the collection of material on clutch-size.

The above factors make the interpretation of geographical variations in clutch-size difficult. The same concerns the evaluation of losses in broods, breeding success and some other parameters referring to the reproduction of Storks, and this must be considered when comparisons are made.

The highest clutch-size is characteristic of Swiss Storks, living in the wild since 1965; it amounts to 5.02 eggs on the average (B l o e s c h 1982; his calculation included one clutch of 7 eggs). However, these data relate to reintroduced birds (mainly from Algeria) and to their offspring which spent a few years in aviaries. So, these Storks must have been in excellent condition for they were additionally fed and did not undertake (or only exceptionally) long and exhausting migrations for wintering grounds. Thereby, the high egg production in these Storks is for sure "artificially" increased. This finding is supported by the increased production of eggs in the kestrel

Falco tinnunculus given a supplementary food before and during egg lying (Dijkstra et al. 1982). So far, this high average clutch-size has not been recorded in "wild" Storks breeding in natural conditions. It seems that the highest recorded average clutch-size exceeds 4.4 or 4.5 eggs only exceptionally (Makatsch 1950, Berndt, Drenckhahn 1974, J.Möller and J.Haecks pers. com.)*. The high average clutch-size reported for Schleswig-Holstein (4.2 eggs per 1 pair; table I) may be explained by the favourable for Storks conditions prevailing in 1951 and 1952. The second cause of the high egg production may be the advanced age of breeding birds. In the years 1960-1966 the average age of breeding Storks in the north of West Germany was 7.2 year or only a little more, while in the years 1971-1974 it amounted to as much as 9.1-9.4 year (Meybohm, Dahms 1975). The population of Storks inhabiting these areas seems to grow old rapidly.**

A drastical increase in mortality among flying young may bring about in the following years a sharp decline in numbers or even the loss of almost entire age-groups of breeding Storks from younger age classes. In consequence of this the average age of other Storks in breeding grounds can increase, which means the aging of population. The increased participation of older pairs in breeding may result in the increased average egg production

* The yearly inspections of 3-8 Stork nests (n=66 clutches) in the village of Datyn (Wolynia - Ukraina) revealed 4.0 - 5.5 eggs per 1 pair (Škaran 1990).

**A main reason for the aging of that population is a significant and rapidly growing mortality among young birds shortly after fledging. In the years 1950-1959, 35.8% of all the known death-cases of ringed Storks were due to electrocution (when birds were perching on not secured transmition poles) or due to collisions with overhead cables. In the years 1960-1976 mortality among young Storks, induced by these factors, increased to 51.9% (Bairlein, Zink 1979). The other example is even more convincing. Out of 280 ringed young Storks which met with accidents, as much as 123 (44%) were killed in those villages in which they had been born. Further 116 birds (41%) died shortly after the beginning of autumn migrations but also within the area of Germany, i.e., still in their breeding grounds. Mortality caused by electrocution diminishes the effectiveness of natural selection because that kind of death is often accidental; both stronger and weaker individuals are equally exposed to danger of it. According to Fiedler and Wissner (1981), by 1967 the victims of electrocution or collisions with overhead cables constituted 49% (n=511) of all the known mortal cases among ringed Storks, while in the years 1971-1979 as much as 70%.

per pair. When the data by B l o e s c h (1982) were analysed, a clear relationship between the age of birds starting breeding and average clutch-size was found. Thus, the four-year old males and females laid 3.7 eggs on the average, five-year old - 4.1, six-year old - 4.9, ten- to fifteen-year old - 5.2, sixteen-year old and older - up to 5.6 eggs per pair (P r o f u s 1986, fig. 4).

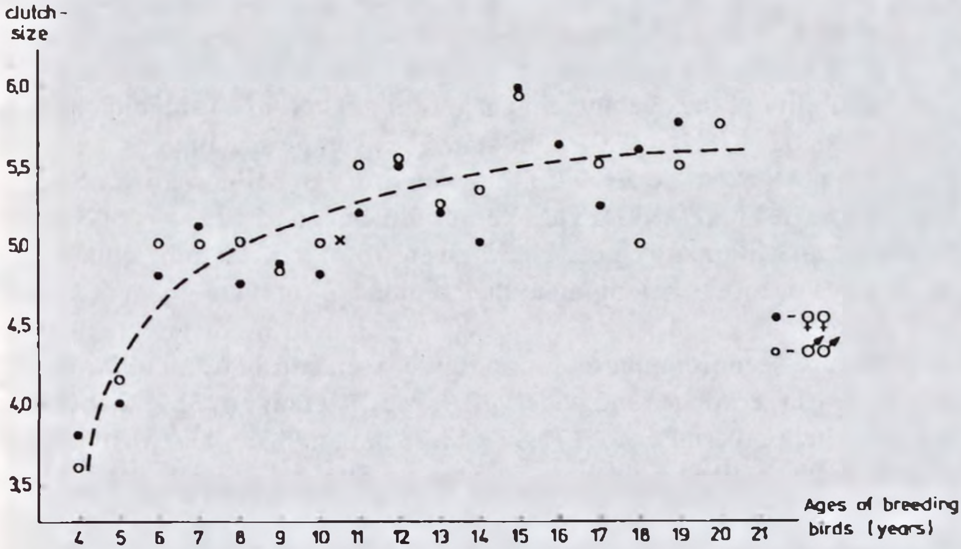

Fig. 4. Relationship (r = 0,853) between the age of breeding Storks and clutch-size (EZ) in Switzerland (on the basis of the data by B l o e s c h 1982).

Ryc. 4. Korelacja (r = 0,853) pomiędzy wiekiem ptaków lęgowych a wielkością zniesień (EZ) bocianów szwajcarskich (na podstawie danych B l o e s c h a 1982)

The average values of clutch-size for the north-eastern (Estonia) and north-western (Netherlands) areas of the range of the species are similar. However, the period of the collection of data fell on different phases of the development of these two populations. In the years 1929-1945 the population from Netherland entered a phase of decline while the Estonian population was in a phase of dynamic growth. According to P e i k e r (in V e r o m a n n 1980), who observed one nest in Estonia for 43 years, the average number of eggs laid by a female was 3.8. The average clutch-size in Estonian Storks, established on the basis of data for 86 nests, varied between 3.8 and 3.9 (fig.3).

It is noteworthy that clutches of Storks from the Białowieża Forest were relatively small. The five years' observations revealed that the extreme values of clutch-size were 3.29 and 3.75 eggs per one pair (G o l o d u š k o 1958, K r a p i v n y j 1958).

Size of eggs

Altogether 125 eggs from 35 clutches were measured. Eggs were measured with a slide calliper with the exactness of 0.1 mm. For the particular full clutches (n=21), the average dimensions of eggs were calculated in order to evaluate the range of their variability. The average arithmetical dimensions of eggs were 73.30 x 52.05 mm. The maximum values were 80.4 x 52.0 and 75.8 x 56.7 mm, and the minimum ones: 67.2 x 52.3 and 70.6 x 46.3 mm. The variability of the average dimensions of eggs from 14 full clutches (56 eggs) was 70.9 - 78.1 x 49.0 - 53.5 mm. The average size of eggs measured by M r u g a s i e w i c z (1972) in the environs of Milicz (Lower Silesia) was 73.2 x 52.3 mm (n=37). The average dimension of 125 eggs of Silesian Storks (from Milicz and Upper Silesia) were 73.25 x 52.13 mm. Dimensions of the eggs of Storks belonging to the nominative form are given in table II and figure 5.

As can be seen from this table and figure, Storks from Central Europe lay greater eggs (i.e. longer and wider; 72.95 x 52.49 mm, n=329) than Storks breeding in Southern Europe (71.84 x 51.88 mm, n=822). The smallest eggs (shortest and smallest in diameter) are laid by Storks nesting in North Africa (70.45 - 71.40 x 50.95 - 51.20).

Weight of newly laid eggs

Altogether 84 eggs from 23 clutches were weighed. These eggs were at different stages of incubation and their weight oscillated between 85 and 119g. Including corrections allowing to determine the loss in weight of the egg throughout the incubation, the author calculated the weight of newly laid eggs (see chapter II). The calculated average weight of the newly laid egg was about 115 g, the extreme values amounting to 97.7 and 138 g. The actual weight of eggs differed from that calculated in the manner described in the chapter II, by no more than 2%. The number and percentage of eggs in particular weight-classes are given in table III.

The relationship between the time of incubation, given in days (x) and the actual weight of the Stork egg, given as the percentage of the newly laid egg (y), may be expressed by the regression equation as follows:

$$y = 100 - 0.62x$$

where "x" refers to the first twenty two days of incubation.

Between the twenty third day of incubation and the hatching of a nestling, the same relationship is given by the formula:

$$y = 86.44 - 0.12x$$

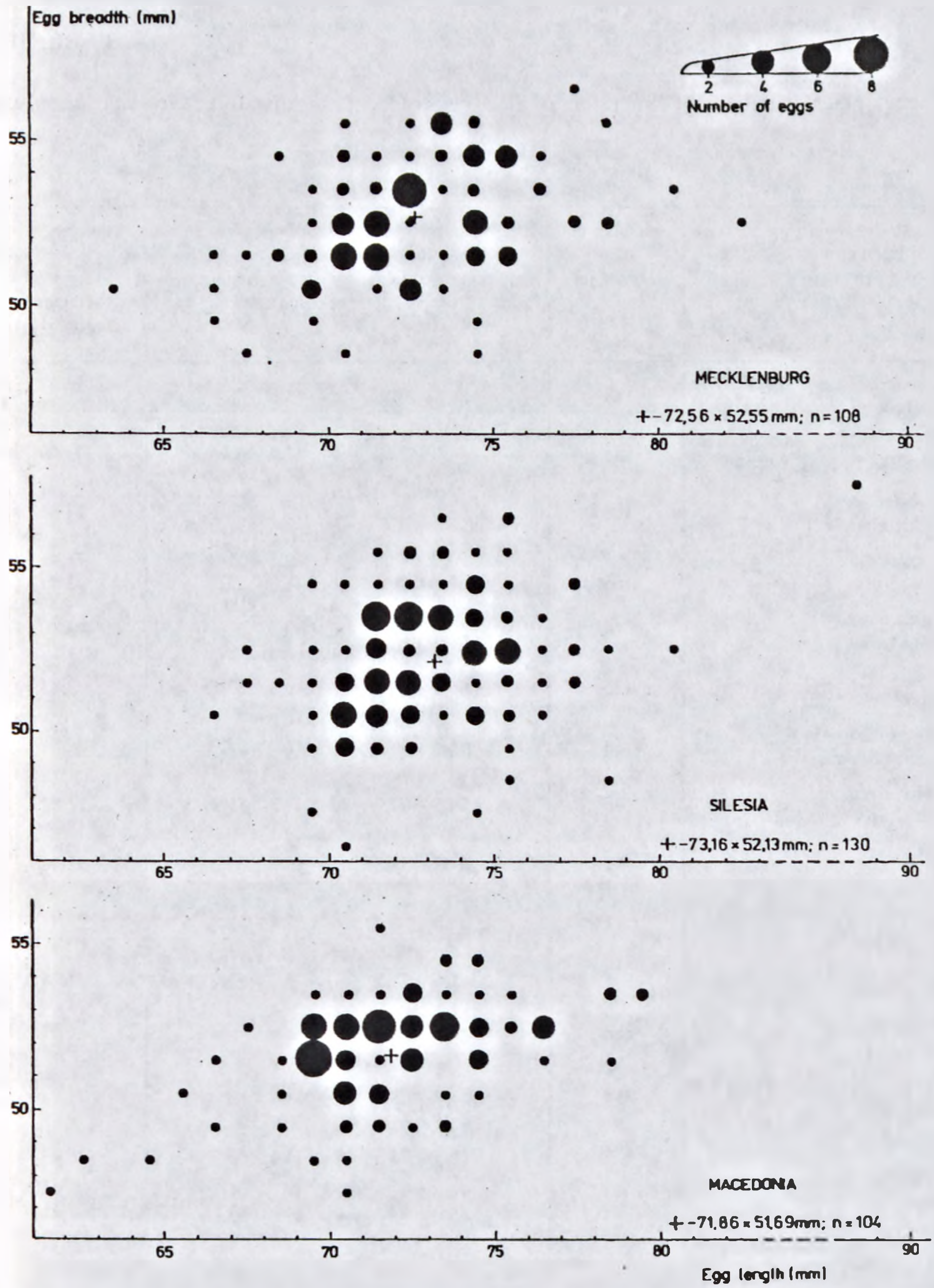

Fig. 5. Relationship between the length and width of Storks' eggs in Mecklenburg, Silesia and Macedonia. Crosses indicate mean dimensions of eggs.

Ryc. 5. Relacja pomiędzy długością i szerokością jaj bocianów białych w Mecklemburgii, Macedonii i na Śląsku. Krzyżyki oznaczają średnie arytmetyczne wartości pomiarów.

TABLE II

Geographical variability of dimensions of Stork eggs of the nominative form *Ciconia c. ciconia*.

Geograficzna zmienność wymiarów jaj bocianów formy nominatywnej *Ciconia c. ciconia*. Objaśnienie

Country or region Kraj lub region	Number of eggs Liczba jaj	Range of variability of egg size length x width (mm) Zakres zmienności wymiarów jaj; długość x szerokość (mm)	Average length of eggs (mm) Przeciętna długość jaj (mm)
Denmark Dania	145	56.5 - 97.5 x 43.8 - 58.4	
Schleswig-Holstein Szlezwig-Holsztyn	46	68.0 - 76.0 x 47.0 - 56.0	72.7
Mecklenburg Meklemburgia	108	63.0 - 82.3 x 48.2 - 56.2	72.56
Byelorussia Białoruś	? 65	70.0 - 75.8 x 49.5 - 55.0 67.2 - 79.1 x 47.0 - 55.3	73.4 72.68
Franken Frankonia	18	69.0 - 78.3 x 49.3 - 55.8	73.10
Silesia Śląsk	125	66.6 - 88.6 x 46.3 - 57.1	73.17
Czecho-Slovakia Czecho-Słowacja	53	65.6 - 78.7 x 42.7 - 55.0	72.81
Switzerland Szwajcaria	48	64.8 - 77.7 x 47.3 - 55.1	72.52
Hungary Węgry	42	64.2 - 78.8 x 46.9 - 55.3	72.44
Bulgaria Bułgaria	41	68.5 - 80.1 x 47.7 - 53.8	72.43
Macedonia Macedonia	104	61.6 - 78.5 x 47.0 - 55.0	71.86
Macedonia Macedonia	385	63.2 - 74.5 x 49.5 - 54.3	
Spain Hiszpania	718	58.2 - 88.8 x 44.6 - 62.0	71.84
Tunisia Tunezja	?	60.5 - 78.5 x 45.4 - 53.7	70.45
Marocco Maroko	24	65.0 - 75.0 x 48.0 - 53.0	71.4
Europe, Marocco, Algeria and Tunisia Europa, Maroko, Algeria i Tunezja	150	65.0 - 81.5 x 46.5 - 56.0	73.0

Abreviations: SD - Standard Deviation, SE - Standard Error, CV - Coefficient of Variation

skrótów: SD - Odchylenie standardowe, SE - błąd standardowy, CV - współczynnik zmienności

SD	SE	CV	Average width of eggs (mm) Przeciętna szerokość jaj (mm)	SD	SE	CV	Author Autor
							Skovgaard (1934)
			52.6				J. Haecks pers. comm.
3.04	0.29	4.2	52.55	1.74	0.17	3.3	Graumann, Zollick (1977) and pers. comm.
			51.0 52.25				Smogorshevskij, Lebedeva (1979), Nikiforov et al. (1989)
			52.54				Mebs after Makatsch (1974)
2.91	0.29	4.0	52.02	2.88	0.28	5.5	Mrugasiewicz (1972), Profus (this work)
			52.94				Hudec, Cerny (1972)
			51.01				Bloesch (1967, 1970, 1982)
			51.82				B. Jakab pers. comm.
			53.11				Michev et al. (in press)
3.14	0.31	4.4	51.69	1.52	0.15	3.0	Makatsch (1950, 1974 and pers. comm.)
							Jovetic (1963)
			51.91				Chozas (1983)
			50.95				Lauthe (1977)
2.39	0.49	3.4	51.2	1.40	0.29	2.7	Schierer (1972)
			51.8				Schönwetter (1967)

TABLE III

Number and percentage of newly laid eggs in particular weight classes
(n = 23 clutches)

Liczba i udział procentowy jaj w poszczególnych klasach wagowych (n = 23 zniesienia)

Calculated weight of newly laid eggs (EG) g Obliczona masa swieżo zniesionych jaj (EG) g	Number of eggs Liczba jaj	Percentage Udział procentowy
90.0 - 94.9	1	1.2
95.0 - 99.9	4	4.8
100.0 - 104.9	5	5.9
105.0 - 109.9	12	14.3
110.0 - 114.9	15	17.9
115.0 - 119.9	20	23.8
120.0 - 124.9	11	13.1
125.0 - 129.9	5	5.9
130.0 - 134.9	7	8.3
135.0 - 139.9	4	4.8
average: 115 średnio:	84	100.0

For comparison: 27 eggs of German Storks weighed shortly after the laying 111.48 g on the average, the extreme values amounting to 95.5 and 129.3 g (B a u e r, G l u t z 1966). Storks reintroduced to Switzerland laid eggs weighing on the average mere 99.8 g (86 - 122g, n=48; the mean value was calculated from data given by B l o e s c h 1960, 1967, 1982). Most of 385 eggs from Macedonia weighed by J o v e t i c (1963) were between 91 and 95 g. However, as it was mentioned in the chapter 3, his measurements included, for sure, many eggs which were at the far advanced stage of embrionic development. Thereby, the weight of newly laid eggs must have been much greater than that given by J o v e t i c (1963).

Nevertheless, the smaller size of eggs in Macedonian Storks (table II) indicate that their weight shortly after the laying should be relatively low as compared with eggs laid by Storks in Central Europe.

The eggs of Spanish Storks, also weighed at different stages of incubation, had 103.82 g, on the average (minimum - 75 g, maximum - 135 g, n=175 eggs). Among these eggs there were six with shells already pierced by nestlings, and they weighed 95.83 g, on the average, (C h o z a s 1983). The hatching eggs (diameter of the hole 5-10 mm) of Silesian Storks weighed 92.5, 100, 103, 105, 113, and 114 g (104.6 g on the average).

4. Hatching, mortality and production of young

Hatching and breeding success

Detailed data on percentages of hatched nestlings (% SE) and breeding success (% BE) were collected for 67 nests. During the incubation of eggs 7 clutches comprising altogether 27 eggs were completely destroyed. These total losses were caused by the fire of the nest placed on a chimney of a dwelling-house (1 incident), fights for nests (2 incidents), nest fallen down (3 incidents); in one case the reason for clutch destruction was unknown, though it seems possible that the eggs from that nest were taken by man.

The percentage of hatched nestlings seems to depend upon clutch-size, as shown in table IV.

As can be seen from that table, the greatest number of nestlings hatch from clutches of 2 and 3 eggs, and proportionally the least young hatch from clutches of 5 and 6 eggs. It seems that this phenomenon may be explained by the higher percentage of infertile eggs and those with dead embryos in clutches consisting of many eggs as compared with smaller ones. The probability of laying the infertile egg in a large clutch seems to be higher than in a small one. This is confirmed by the data from Switzerland for Altreu Storks kept under semi-wild conditions. Out of 25 clutches totalling 6 individually marked eggs each, only in 4 cases (16%) all the nestlings hatched. The eggs laid last of all were expected to be most frequently infertile for during the period of egg laying the eggs already laid are continuously hatched and the sexual activity of a pair decreases. However, it appeared that eggs laid as the first, fifth, and sixth were mostly infertile (28% for each group). The eggs 3 and 4 showed the highest fertility rate (84%), while the eggs 1, 5 and 6, lowest (72%). The hatching success was lowest for the eggs 5 (60%) and 6 (52%), as their fully developed embryos

TABLE IV

Percentage of hatched nestlings (% SE) for pairs with flying young (HPm) in relation to clutch-size (EZm)

Procent wyklutych piskląt (% SE) dla par z lotnymi młodymi (HPm) w zależności od wielkości zniesień (EZm)

Clutch-size Liczba jaj w zniesieniu	Number of clutches Liczba zniesień	Number of laid eggs in relation to number of hatched young Stosunek liczby zniesionych jaj do liczby wyklutych piskląt EZG : SJG	Average clutch-size in relation to average number of hatched young Stosunek średniej wielkości zniesienia do średniej liczby wyklutych piskląt EZm : JZs	Hatching success Procent wyklutych piskląt %SE
2 i 3	14	37 : 36	2.64 : 2.57	97.3
4	36	144 : 130	4.00 : 3.61	90.3
5 i 6	22	111 : 97	5.05 : 4.41	87.4
Range 2 - 6 Zakres	Σ = 72	Σ = 292 : 263	$\bar{x}$ = 4.06 : 3.65	$\bar{x}$ = 90.1

often failed to hatch. The first egg has the hatching success amounting to 64%. The eggs 2, 3, and 4 seem to be most effective. The low hatching success for the eggs 5 and 6 is likely to be caused by interruptions during their incubation (due to rising of adult birds, caring for the newly hatched nestlings, their feeding etc.) (B l o e s c h 1982). Moreover, eggs laid as fifth and sixth constitute a reserve; nestlings hatched from these eggs are smaller and lighter than those from eggs laid earlier (S c h ü z 1981).

After a lapse of about nine weeks spent in the nest, young are able to fly. Most young are raised by these pairs of Storks which lay 5 (JZm=3.24), 6 (JZm=3.00), and 4 eggs (JZm=2.58 young). On the other hand, pairs laying 2 and 3 eggs have the greatest breeding success (Table V, fig. 6).

The decrease of breeding success throughout the breeding season is a characteristic phenomenon. It is caused by the increasing percentage of losses among eggs and nestlings (% V). Breeding success in birds starting breeding before 15 April is 85%, on the average, and the losses among eggs and nestlings amount to mere 15% in total. On the other hand, Storks that start egg laying on 6 May or later raise only 50% of the young in relation to

TABLE V

Breeding success (% BE) and losses in broods (% V) for pairs with young (HPm) in relation to clutch-size (EZ)

Sukces lęgowy (% BE) i straty w lęgach (% V) dla par wyprowadzających lotne młode (HPm) w zależności od wielkości zniesień

Clutch-size (EZ) Liczba jaj w zniesieniu	2	3	4	5	6	2-6
Number of examined nests (HPm) Liczba skontrolowanych gniazd	7	12	62	33	3	117
Total number of laid eggs (EZG) Suma zniesionych jaj	14	36	248	165	18	481
Number of raised young (JZG) Liczba wyprowadzonych młodych	11	27	160	107	9	314
Brood losses (V) Suma strat w lęgach	3	9	88	58	9	167
Average number of young raised by pair with young (JZm) Średnia liczba piskląt wyprowadzonych przez parę z młodymi	1.57	2.25	2.58	3.24	3.00	2.68
Losses in broods per statistical pair with young (V:HPm) Straty w lęgach w przeliczeniu na statystyczną parę z młodymi	0.43	0.75	1.42	1.76	3.00	1.43
Global losses in broods (% V) Straty globalne wyrażone w procentach	21.4	25.0	35.5	35.2	50.0	34.7
Breeding success (% BE) Sukces lęgowy	78.6	75.0	64.5	64.8	50.0	65.3

the number of laid eggs; nesting failures constitute altogether 50% (Profus 1986).

Variations in number of raised young and their causes

Many data from the literature point to regional differences in a number of young raised by breeding pairs (Dybbro 1972, Berndt, Drenckhahn 1974, Schüz, Szijj 1975). The indices of reproduction JZm (excluding the pairs which did not raise young - HPo) and JZa (including all pairs whose brood effectivity is known - HPm + HPo) may be used to demonstrate the above variations. If the values of JZm are chosen for

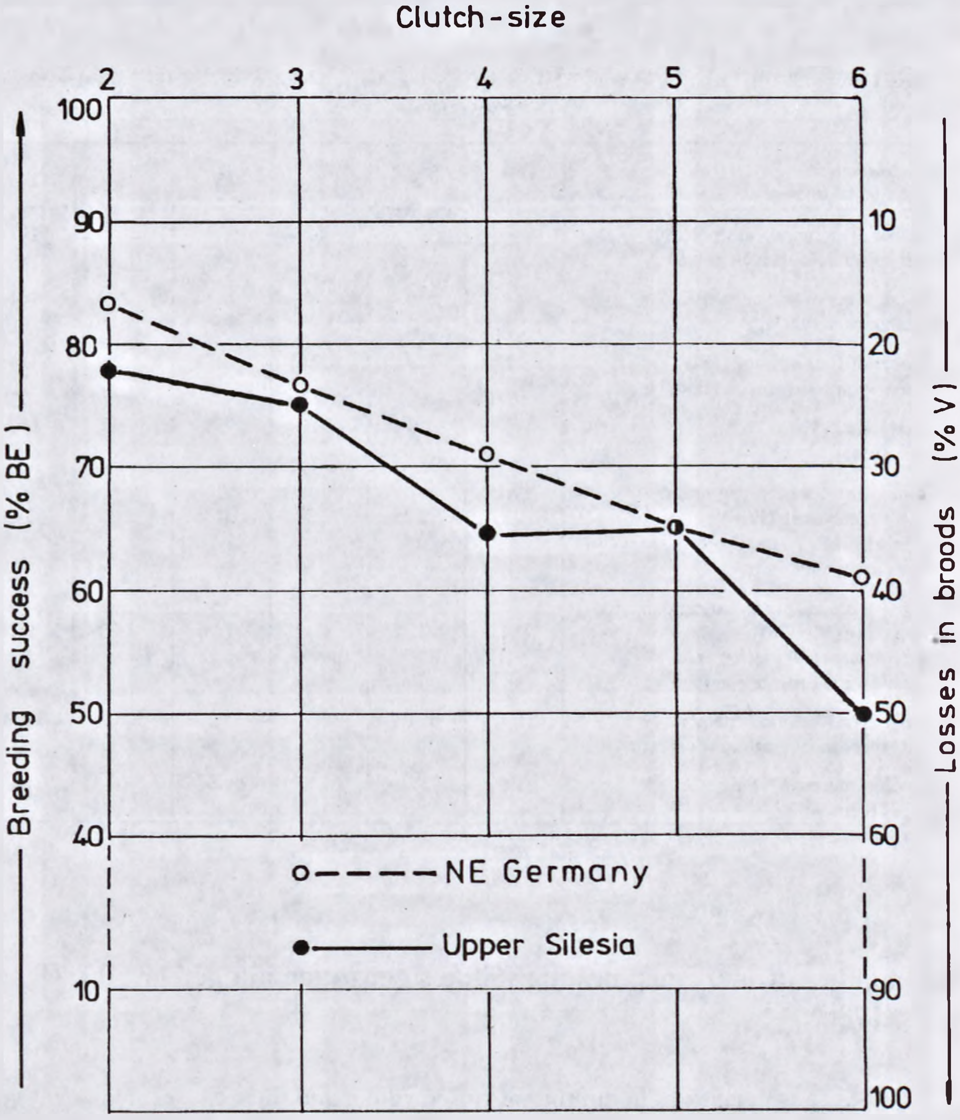

Fig. 6. Breeding success (% BE) and breeding losses (% V) in clutches of Stork pairs with young (HPm), depending on clutch-size (Germany - P l a t h 1976, K a a t z , S t a c h o - w i a k 1987; Poland - P r o f u s 1986 and recent unpubl. data).

Ryc. 6. Sukces lęgowy i straty w lęgach bocianów białych wyprowadzajacych młode (HPm) w zależności od wielkości zniesień (EZ). (Niemcy - wg danych P l a t h 1976, K a a t z , S t a c h o w i a k 1987; Polska - wg P r o f u s a 1986 i nowych informacji niepubl.)

comparisons, the importance of food resources in breeding grounds and, indirectly, of weather conditions, is accentuated. On the other hand, when the values of JZa are compared some additional factors operating during migrations an in wintering quarters (S c h ü z, S z i j j 1975) as well as interspecific interactions, are strongly marked (P r o f u s , M i e l c z a r e k 1981).

The average number of young raised by each statistical breeding pair (JZa) in Poland oscillates between 0.4 and 3.6 depending on the year, region, and certain intrapopulation factors. The low production of young is associated with the high proportion of pairs without fledglings (% HPo) in a breeding population.

The average number of young raised by each statistical breeding pair with young (JZm) in our country changes from 1.8 to 3.8 (in the areas inhabited by at least 50 pairs) (J a k u b i e c 1985, J a k u b i e c et al. 1986).

Regional differences in a number of raised young for Southern Poland (in the years 1973-1977) were rather big and amounted to 0.5-1.2 (JZa), and to 0.6-1.1 (JZm) young per pair. The highest number of raised young Storks was established for some large towns of the Upper Silesian Industrial District where in the years 1973-1977 39 pairs breeding successfully raised 114 young, this being the highest value of JZm (2.92) recorded from Southern Poland. This high value for the strongly industrialized and urbanized area seems to be surprising. But the approximate or even higher values were noted there in the years 1925-1934. So, the present results are not accidental. The above phenomenon seems associated with the scattered distribution of breeding pairs. It reduces the intraspecific competition. Thereby, fights for nests which entail considerable losses among eggs and young are less frequent. This thesis is confirmed by the fact that in the area under discussion the proportion of pairs which lost their clutches or broods is really lower (18.7%) than in the adjacent areas where the density of Storks is higher (21-26%). The same refers to the recorded nesting failures (P r o f u s, M i e l c z a r e k 1981, P r o f u s 1986). In submontane areas despite a considerable increase in Stork population the number of young per breeding pair is smallest. The main causes of that low production are, certainly, heavy losses among eggs and nestlings. These losses are much higher than in lowland areas. The losses are mostly induced by unfavourable weather conditions that affect the White Stork population directly (chiefly during the incubation of eggs and shortly after the hatching of young), or/and indirectly (influencing the distribution and numbers of its prey). In these areas spring is generally late and, in most cases, nests are occupied later than in lowlands.

Departures of young are often delayed by 1-2 weeks as compared with lowland areas. Serious losses are caused by recurrences of winter, for instance on 30 May 1966 and on 6 June 1962 many pairs left their clutches because of a heavy snow fall. In consequence of this the number of pairs without young (HPo) was high, and the index of reproduction (JZa) was exceptionally low (1962 - 1.6, 1966 1.1 young per 1 pair; values calculated on the basis of data given by S u c h a n e k (1972). The average number of nestlings raised by each statistical pair with young for submontane areas as well as for Podhale and Orawa was 2.2-2.3, and sometimes only 1.8 (P r o - f u s msc).The high precipitation and cold in 1974 also induced heavy losses in broods. In the districts of Cieszyn and Bielsko-Biała at least 35.4% of all the hatched nestlings died. In the environs of Bochnia the losses among eggs and nestlings amounted at that time to at least 47.4% in relation to the laid eggs (P r o f u s, M i e l c z a r e k 1981). Still greater nesting failures were recorded then in the districts of Krosno and Strzyżów (D o m a s z e w i c z, L e w a r t o w s k i 1985).

We observe also great variations in reproduction with time. A comparison of the data for the years 1928-1934 (B r i n k m a n n 1930, 1933, 1934, 1935; C z u d e k 1935) with those obtained in 1973-1978 (P r o f u s 1986) has shown a significant decrease in reproduction during the last half century, in the south of Poland:

a) in 1928-1932 each statistical breeding pair (HPa) raised 2.71 young on the average, while in 1974-1978 only 2.01 young (JZa; n=413 and 1199 HPa),

b) in 1928-1932 each statistical breeding pair with young raised 3.21 young on the average, whereas in 1974-1978 only 2.59 (JZm; n=349 and 933).

In 1928-1932 breeding pairs raised, with a declining frequency, 3,4,2,0,5 and 1 young, while in 1974-1978 2,3,0,4,1 and 5 young (fig. 7). An analysis of the collected material allowed the indication of the presumable causes of this decline. One reason might be a considerable growth of the density of Storks, which intensified the interspecific competition, probably mainly for food. This is indicated by frequent fights for nests and the destruction of clutches and broods, resulting in the increased proportion of pairs without fledglings (HPo). The percentage of these pairs is greater in the regions of the high density of Storks, and lower in the areas holding scattered Stork populations. This is confirmed by findings of W o j c i e c h o w s k i and O g r o d o w - c z y k (1978), as well as P r o f u s and M i e l c z a r e k (1981).

Changes in age structure of Stork populations, in favour of younger individuals, might be the second cause of that decline in reproduction. It has appeared that in younger Storks (three-five year old) that start breeding for the first time, the proportion of pairs without young (HPo) is higher and reproduction indices (JZa and JZm) are lower. Only the six-ten-year old Storks, and older, show a continuous increase in numbers of raised young and a relatively low percentage of pairs without young, which was clearly demonstrated by M e y b o h m and D a h m s (1975). These authors found also that the breeding success in younger Storks was better only in "good" years. The low JZa, recorded in the years favourable for Storks, point to the high proportion of younger birds in a breeding population.

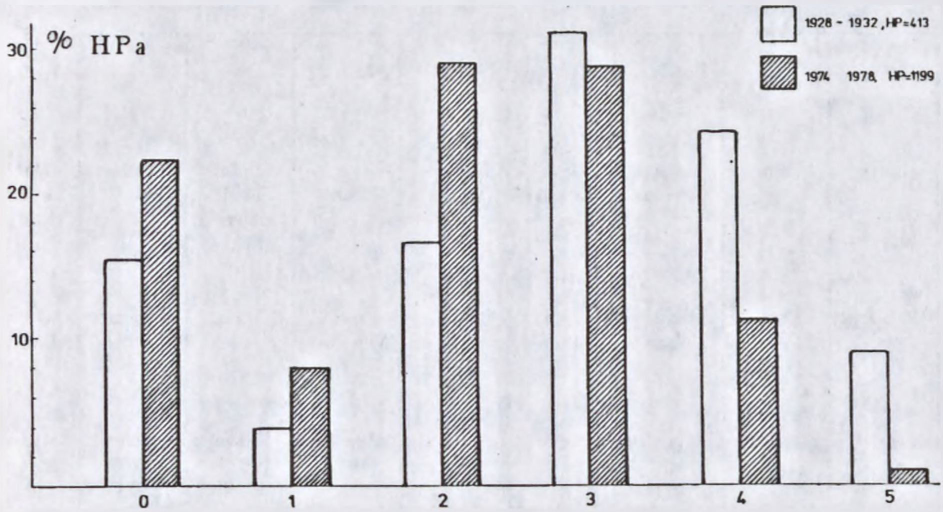

Fig. 7. Distribution of number of breeding pairs (HPa) with flying young (1-5) and without flying young (0) in Upper Silesia, in 1928-1932 and 1974-1978.

Ryc. 7. Rozkład liczebny par lęgowych (HPa) z określoną liczbą podlotów (1-5) oraz bez lotnych młodych (0) w latach 1928-1932 i 1974-1978 na Górnym Śląsku.

The average brood-size recorded for Upper Silesia in 1973-1978 (JZa=1.91 young) is almost equal to the average established for Central Europe (JZa=1.95 young, n=9088 HPa; table VI). As can be seen from tables VI and VII, the values of JZa for local populations may differ considerably from the calculated average. Moreover, it seems that for the areas situated at the north-western border of the geografical range of White Stork in Europe, the reproduction indices are lower (JZa= 1.68 young per pair; average value for Denmark, Schleswig-Holstein, Lower Saxony, Mecklenburg and district Lübz) than for the regions lying near the centre of the range of that species. This is because the fraction of pairs without young calculated for the same

TABLE VI

Percentages of pairs without flying young (%HPo) and local differences in a number of Europe, in the years 1973-1978. For %HPo, JZa

Udział par bez lotnych młodych (%HPo) i lokalne różnice w ilości młodych wyprowadzanych przez Dla %HPo, JZa i JZm podano wartości średnie,

	1	2	3	4	5	6	7	8
Index	Denmark	Schleswig-Holstein	Lower Saxonia	Franken	Wittenberg District	Lübz District (Schwerin)	Cottbus District	Ober-lausitz
Wskaźnik	Dania	Szlezwig-Holsztyn	Dolna Saksonia	Frankonia	Powiat Wittenberg	Powiat Lübz	Powiat Cottbus	Górne Łużyce
	Dybbro (1979)	U.Peterson pers. comm.	Hecke-nroth (1978)	A. Burn-hauser (msc)	Zuppke (1982)	Kintzel (1987)	Krüger (1975, 1981)	Menzel, Menzel (1980)
% HPo min.-max.	32.6 25.0-47.4	33.3 24.3-46.8	32.2 24.0-44.6	26.3 18.9-36.4	19.9 37.3-55.2	36.2 21.4-53.6	31.9 16.1-50.0	26.0 20.7-39.6
JZa min.-max.	1.80 1.26-2.08	1.68 1.17-2.04	1.81 1.29-2.10	2.15 1.93-2.54	2.28 1.66-2.91	1.55 0.97-2.43	1.86 1.17-2.59	2.04 1.45-2.35
JZm min.-max.	2.66 2.40-2.91	2.52 2.18-2.69	2.67 2.34-3.00	2.91 2.64-3.13	2.85 2.61-3.32	2.42 2.06-3.09	2.73 2.13-3.09	2.75 2.42-2.96
HPa	221	2654	2583	198	166	177	357	1179
HPm	149	1769	1750	146	133	113	243	873
HPo	72	885	833	52	33	64	114	306
JZG	397	4462	4668	425	379	274	664	2402
StD	< 1	2.6-3.2	3-4	< 1	3.45-5.25	4.2	8	3

young raised by a statistical pair (JZa) and by a statistical pair with young (JZm) in
and JZm average, minimum and maximum values are given.

statystyczną parę (JZa) i statystyczną parę z młodymi (JZm) w Europie w latach 1973-1978.
minimalne i maksymalne.

9	10	11	12	13	14	15	1-8 and 10-15	1-15
Upper Silesia	Chrzanów District	Kłopot willage	Bacs-Kiskun	Steiermark	Bohemia	Bohemia-Moravian Highland	Central Europe without Upper Silesia	Central Europe
Górny Śląsk	Powiat Chrzanów	Wieś Kłopot	Baczka Północna	Styria	Czechy zachodnie	Wyżyna Czesko-Morawska	Europa Środkowa bez Górnego Śląska	Europa Środkowa
Profus (1986)	Mazaraki (1986)	Radkiewicz (1987)	Jakab (1987)	Weissert (1977, 1979)	Beneda (1980)	Hladik (1975, 1982)		
23.4 16.5-31.2	19.9 9.7-29.6	16.3 4.1-25.0	21.1 3.6-35.1	28.6 23.9-37.1	20.8 15.2-30.8	24.9 19.9-37.5	29.9	28.5
1.91 1.65-2.25	1.78 1.44-2.12	2.59 2.05-3.48	2.09 1.26-2.93	1.85 1.47-2.08	2.23 1.98-2.39	2.16 1.55-2.56	1.86	1.87
2.50 2.36-2.69	2.22 1.50-2.43	3.09 2.17-3.60	2.64 1.95-3.04	2.59 2.34-2.73	2.82 2.78-2.89	2.88 2.81-3.03	2.65	2.62
2445	161	147	327	552	283	249	9254	11699
1874	129	123	258	394	224	187	6491	8365
571	32	24	69	158	59	62	2763	3334
4679	286	380	682	1022	631	538	17210	21889
6	4.2	40-50	2.5	1-2	1-1.5	2-3		

TABLE VII

Percentages of pairs without flying young (%Po) and local differences in a number of young raised by a statistical pair (JZa) and by a statistical pair with young (JZm) in Central Europe and Estonia. For the district of Puck and village of Lwowiec data were collected in 1973-1977, for Mecklenburg (=Hagenow, Greifswald and Rostock district) in 1973-1976, for the Strzelce Krajeńskie and voivodship of Leszno in 1974-1978 and for Estonia in 1973-1978. Average, minimum, and maximum values of %HPo, JZa and JZm were given.

Udział par bez lotnych młodych (%HPo) i lokalne różnice w ilości młodych wyprowadzonych przez statystyczną parę (JZa) i statystyczną parę z młodymi (JZm) w Europie Środkowej i Estonii. Dla powiatu Puckiego i wioski Lwowiec dane zebrano w latach 1973-1977, dla Meklemburgii (powiaty Hagenow, Greifswald i Rostock) dla lat 1973-1976, dla powiatu Strzelce Krajeńskie i województwa leszczyńskiego dla lat 1974-1978, a dla Estonii dla lat 1973-1978. Dla %HPo, JZa i JZm podano wartości średnie, minimalne i maksymalne.

	1	2	3	4	5	1-5	6
Index	Mecklenburg	District Strzelce Krajeńskie	Voivodship Leszno	District Puck	Lwowiec village	Central Europe	Estonia
Wskaźnik	Meklemburgia	Powiat Strzelce Krajeńskie	Województwo leszczyńskie	Powiat Puck	Wieś Lwowiec	Europa Środkowa	Estonia
	Graumann, Zöllick (1977), Plath (1976), Eggers, Steffens (1976)	Agapow (1979)	S. Kuźniak pers. comm.	Drzeżdżon (1980)	J. Okulewicz pers. comm.		Veromann (1980,1989)
%HPo min.-max.	42.7 37.3-55.2	17.2 8.5-27.6	27.5 12.5-37.7	22.5 15.6-34.4	27.1 14.4-39.5	29.4	27.4 19.9-37.7
JZa min.-max.	1.33 0.94-1.62	2.16 1.73-2.54	1.48 1.31-2.61	1.78 1.31-2.25	1.71 1.11-2.50	1.58	1.91 1.62-2.30
JZm min.-max.	2.32 2.03-2.59	2.61 2.39-2.77	2.04 2.10-2.98	2.30 2.00-2.67	2.35 2.17-3.57	2.24	2.64 2.34-2.87
HPa	930	545	1606	325	166	3572	3821
HPm	533	451	1157	252	121	2514	2774
HPo	397	94	449	73	45	1058	1047
JZG	1238	1179	2363	579	284	5643	7310
StD	4.8-10.4	10.1	6	11.3	> 50		3

north-western peripheries of the range is higher (% HPo=34.3 %) than that for the middle of Central Europe (% HPo=23.8 %, n=8332 HPa and 1983 HPo; tables VI and VII).

An analysis of brood-size in Storks from Upper Silesia has shown that the average number of young per nest with young (JZm) depends mainly on the broods HPm 2, 3 and 4, which constitute altogether 85 % of all the broods.

An analysis of the data collected in 15 sample areas for 6 years (table VI) and 6 other sample areas for 4-6 years has revealed that, in general, Storks from Upper Silesia raise the small number of young (JZm=2.50). The mean value for Europe is 2.65 (n=6491 HPm). In the areas abundant in food Storks can raise still higher number of young. For instance, in 1959-1968 in the former district of Milicz Stork pairs raised, on the average, 2.87 young (M r u g a s i e w i c z 1972), and in the village of Kłopot - even 3.09 young (R a d k i e w i c z 1983; table VI). In the district of Chrzanów, laying on the periphery of the dry Kraków-Częstochowa Highland, each pair with young raised mere 2.29 young in 1967-1976 (M a z a r a k i 1979). There is an interesting relationship between the density of a Stork breeding population (StD) and production of young (JZa and JZm). To demonstrate this the results of the International Census of White Stork in the eastern part of Germany in the years 1958 and 1974 have been analysed anew. The population of Storks living in the eastern part of Germany is fairly numerous and rather stable, and we have the detailed data on its reproduction (S c h i l d m a c h e r 1960, 1975). It appears from these data that the average number of young raised by Stork pairs is inversely proportional to density of breeding pairs (fig. 8). In the areas of the high Stork density (StD=10 pairs per 100 km^2) the number of raised young was by about 0.5 (JZa) or 0.4 (JZm) smaller than in the areas populated more sparsely (StD=1-3 pairs per 100km^2).

The percentage of pairs without young (% HPo) increases directly proportionally to density. The about ten-fold growth of population density seems to be the main cause of the increase in proportion of pairs without young from about 21-23% to about 30% (fig. 9). A relationship between the population density in feeding grounds (StB) and reproduction indices for Upper Silesia is discussed by P r o f u s (1986).

Departures of young Storks from nests

Young birds gain the skill of flying between the end of the first decade of July and the first few days of September with the peak intensity falling on

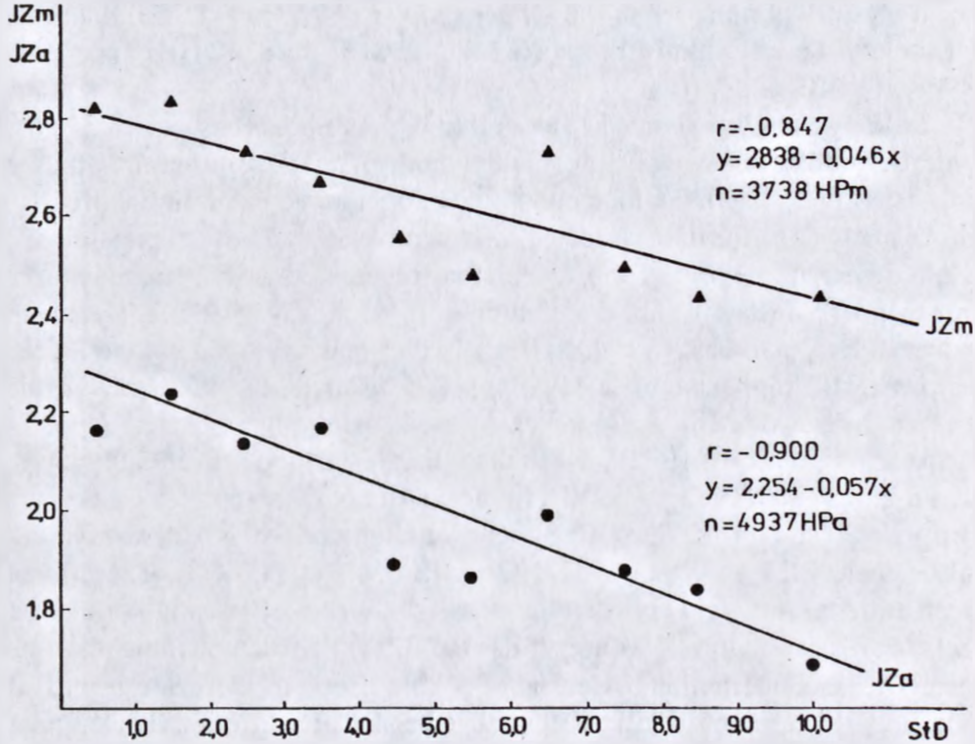

Fig. 8. Relationship between the average number of raised youngs per pair (JZa), pair with young (JZm) and density (StD) of breeding pairs in north-eastern part of Germany. On the basis of the data by S c h i l d m a c h e r (1960, 1975).

Ryc. 8. Zależność pomiędzy ilością wyprowadzonych młodych przez statystyczną parę lęgową (JZa) i parę lęgową z młodymi (JZm) a zagęszczeniem par lęgowych (StD) w północno-wschodniej części Republiki Federalnej Niemiec (dawne NRD) w latach 1958 i 1974. Na podstawie danych S c h i l d m a c h e r a (1958, 1975).

the last decade of July. The average term of the first departures of young from nests falls on 30 July (n=933 HPm). Between 25 July and 9 August young Storks from 57% of the nests fledge. During that period 58% of the young leave nests for the first time (fig. 2).

An analysis of fledging dates has revealed that the average number of raised young decreases throughout the breeding season. This is supported by the material illustrated in figure 10. As can be seen from this figure, Storks began to search for the most abundant in food habitats shortly after their return from winter quarters.

As results from observations, the young raised in nests with 5 nestlings fledge the earliest (average on 21 July), while those from nests with one nestling, the latest (average on 7 August) (P r o f u s 1986). These data seem

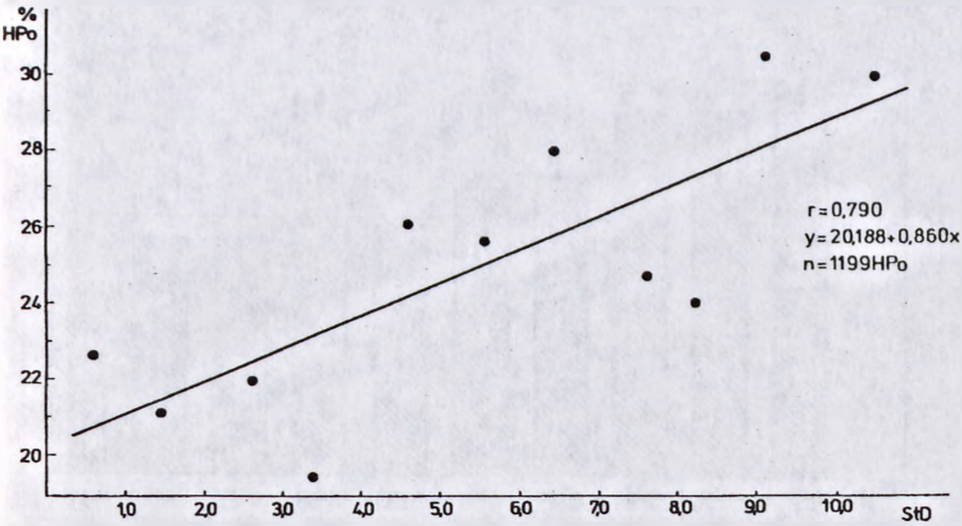

Fig. 9. Relationship between the percentage of pairs without flying young (HPo) and density of breeding pairs (StD) in 1958 and 1974 in north-eastern part of Germany. On the basis of the data by S c h i l d m a c h e r (1960, 1975).

Ryc. 9. Zależność pomiędzy procentowym udziałem par bez lotnych młodych (% HPo) a zagęszczeniem par lęgowych (StD) w północno - wschodniej części Republiki Federalnej Niemiec (dawne NRD) w latach 1958 i 1974. Na podstawie danych S c h i l d m a c h e r a (1958, 1975).

to support the conception that individuals arriving earlier, and thereby most probably older, occupy better territories. Moreover, these results provide the best argument for the dependence of brood effectivity on food resources (M r u g a s i e w i c z 1972, P r o f u s 1986).

5. Fights for nests

Each year, in the studied area in Southern Poland, 20-35% of all the pairs occupying nests fight against other Storks trying to conquer them. In the situation when the second bird arriving at the nest is of the same sex as the first one, the fight should also be expected. Fights for nests may differ very much as to their intensity. An intruder perching near the occupied nest may be quickly driven away by one of the breeding partners making "threatening gestures". This is the mildest form of the behavioural action against the invader. However, fights among Storks usually assume more drastic forms: from "pushes" in the nest during which it may come to the destruction of eggs or even nestlings, to fights in the air, that may result in heavy wounds

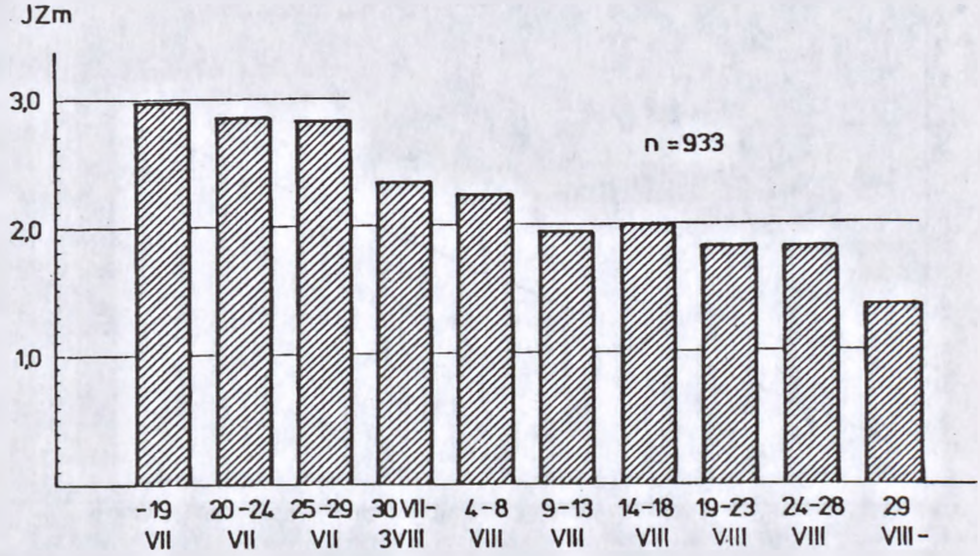

Fig. 10. Decrease in the average number of young raised by a statistical breeding pair with young (JZm) throughout the breeding season, based on fledging dates for young Storks in Upper Silesia in 1974-1978.

Ryc. 10. Spadek średniej ilości młodych wyprowadzanych przez statystyczną parę lęgową z młodymi (JZm) w miarę upływania sezonu lęgowego. Na podstawie terminów osiągania zdolności do lotu przez młode bociany na Górnym Śląsku w latach 1974-1978.

or even in a death of fighting birds. Fights for nests placed on the electric poles of a medium tension system are particulary dangerous for Storks, because fighting birds may cause a short circuit and, in consequence of this, be electrocuted.

A tendency to return to the nest of the last year breeding (not to the nest of birth !) is clearly marked in White Stork (H o r n b e r g e r 1954, H a a s 1963, S c h ü z 1981, A s s f a l g 1983). Most frequent are the fights for the nest already occupied by a pair. When the female or male, which lived in a given nest previously, arrives with delay and finds it already occupied, it comes to the fight in which the last year "owner" usually is a winner (A s s f a l g 1983). To support this thesis, an example from the area investigated by the present author is given: A male, ringed as a nestling near Pardubice in Czechoslovakia on 20 June 1962 (ring-number B 9519 Praha) occupied the nest in Kotulin-Nakło near Gliwice for at least 4 years (1978-1981). As a 19-year old bird it arrived at its nest with delay at the beginning of May. The nest was already occupied by a pair of not ringed Storks, the clutch of which consisted of 5 eggs. During the figh that ended in driving the not ringed male away, 3 eggs were destroyed. From the remaining 2 eggs 2

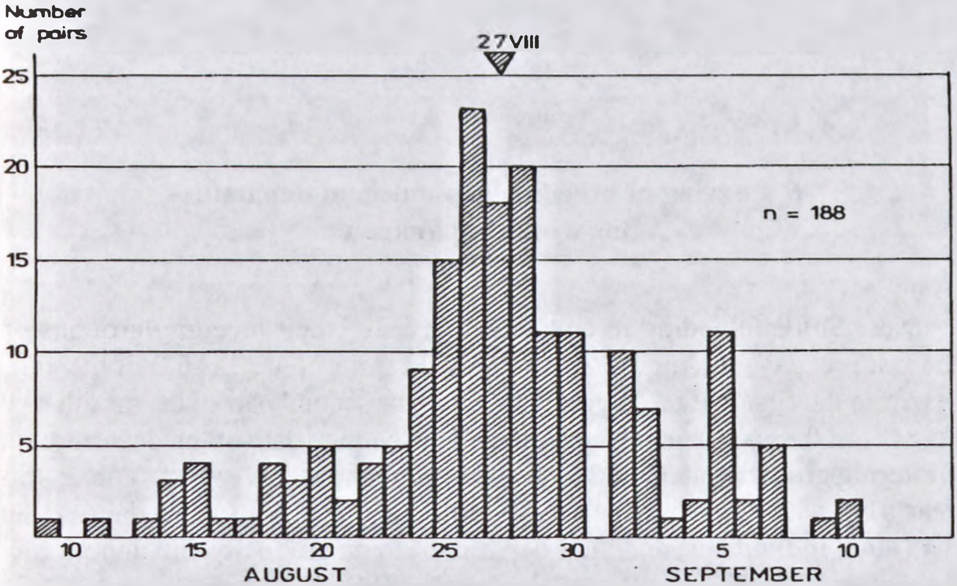

Fig. 11. Dates of the last observations of Stork pairs in nests before their departure in Upper Silesia in 1973-1987 (x=27 VIII).

Ryc. 11. Terminy odlotów (ostatnia obserwacja par na gnieździe) bocianów z obszaru Górnego Śląska wlatach 1973-1987 (x=27 VIII).

nestlings hatched and they were fed by the not ringed female and the "adoptive" male.

A s s f a l g (1983) quotes the case of a seven-year old male occupying one nest for 10 years (one year it was not recorded). During that period, it arrived three times at the already occupied nest of its own. In one case it came to a sharp night struggle for nest and female, which lasted for 2 hours. In the second case, the fight went on for 8 days and ended in the destruction of the clutch. Finally, the observed male won the nest and 4-year old female belonging to its predecessor, which laid eggs again.

It is noteworthy that intruders try to conquer the already occupied nest even when in proximity to it there are vacant ones. The attack is directed just upon the nest occupied by other Storks, that apparently "attracts" an intruder. The three-year old Storks or older which have not reach the sexual maturity yet, may be agressors, too. This may indicate that the natural tendency to posses the nest developes earlier than the full sexual maturity (S c h ü z 1981).

6. Leaving of breeding grounds and departures for wintering quarters

Most Storks breeding in Upper Silesia leave their breeding grounds on the last few days of August. As can be seen from figure 11. 6% of the pairs depart in the first half of August, 73.2%- in the second part of the month, and 20.8% - in the early part of September. The average date of the departure for wintering grounds calculated for Southern Poland is 27 August. Young, this year's birds usually leave the neighbourhood of their nests a few days earlier than adult individuals, and their departures go on gradually and unnoticeably, just as it was in the Barycz river valley (M r u g a s i e w i c z 1972). Flocks of young Storks, including more than a dozen or so individuals, were not observed. In the peak period of migrations, flocks consisted mostly of this year's Storks and older, usually total from over a dozen to some tens of individuals. Greater flocks were observed only exceptionally, eg. in the Nowy Targ Basin before their flight over the Tatra Mts., or over the neighbouring mountain ranges.

The greatest flock of migrating Storks, known from Poland, was seen in Głogówek (Opole Silesia) on 26 August 1932. On the roofs of the local castle and neighbouring dwellings houses about 600 birds spent a night. Next day, the similar in size flock of Storks (probably the same flock) flew over Bytom (B r i n k m a n n 1935).

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Streszczenie

Bocian biały jest przykładem gatunku silnie zanikającego. Tylko w latach 1974-1984 ubyło w Polsce około 3400 stanowisk lęgowych.

Materiał do niniejszej pracy zebrano na silnie uprzemysłowionym i zurbanizowanym terenie Górnego Śląska i Śląska Opolskiego w latach 1973-1988. Obszar ten (6915 km^2) zasiedlało w latach 1973-1979 od 390 do 429 par, a coroczne cenzusy na mniejszych powierzchniach monitoringowych, prowadzone tu w latach 1980-1988, też nie wykazały większych wahań liczebności. Przeciętne zagęszczenia zmieniały się corocznie w granicach 5,6 do 6,2 par na 100 km^2 i należą do niższych od przeciętnych dla całego kraju. Na lęgowiska zwykle najpierw przylatują samce (przeciętnie 3 kwietnia; wartości krańcowe 8 marzec i 15 maj, n=342). Drugi z partnerów pojawiał się na gnieździe średnio 4,5 dnia później (n=144; wartości skrajne: przylot w tym samym dniu i 25 dni później; ryc. 1). Na terminy zajmowania gniazd i liczebność ptaków powracających na lęgowiska wpływają zdecydowanie warunki troficzne na afrykańskich zimowiskach. Najwięcej par przystępuje do składania jaj w ostatniej dekadzie kwietnia a przeciętny termin złożenia pierwszego jaja przypada na 30. kwietnia. Po bezśnieżnych i łagodnych zimach (w latach 1987 i 1988) pierwsze jaja zostały zniesione już 8-10 kwietnia. Aż 90% wszystkich samic przystępuje do lęgów do 12 maja, a dalszych 9% rozpoczyna składanie jaj pomiędzy 13 a 25 maja. Zaledwie 1% samic składa jaja w terminie późniejszym (ryc. 2).

Pełne zniesienia bocianów górnośląskich składają się z 2-6 jaj (x=4,06; n=128) a 90,7% wszystkich zniesień składa się z 3, 4 i 5 jaj. Najliczniejsze są zniesienia złożone z 4 jaj (53,1% wszystkich zniesień). W innych krajach europejskich samice bocianów składają przeciętnie od 3,56 (w białoruskiej części Puszczy Białowieskiej) do 5,02 jaj (w Szwajcarii) (tabela I). Wysokie wartości stwierdzone w Szwajcarii odnoszą się do bocianów reintrodukowanych oraz ich potomstwa; ptaki te były często dodatkowo dokarmiane a część z

nich nie odbywała długich i wyczerpujących wędrówek na zimowiska.

W latach "dobrych" ptaki wcześniej przylatują na Górny Śląsk (są to prawdopodobnie osobniki starsze i lepiej odżywione), zajmują na ogół lepsze terytoria lęgowe i składają więcej jaj (4,4; n=54) niż ptaki przylatujące w latach "złych" (3,9; n=30). Przeciętna wielkość zniesienia spada w miarę upływu sezonu lęgowego o 0,3 jaja na 10 dni. Zmierzono 125 jaj, których średnie rozmiary wynosiły 73,25 x 52,13 mm (66,6-88,6 x 46,3-57,1 mm; tabela II). Z każdych 100 jaj wykluwało się się średnio 90,1 piskląt. Odsetek wyklutych piskląt jest najwyższy (97,3%) w zniesieniach złożonych z 2-3 jaj a najniższy (87,4%) w zniesieniach składających się z 5-6 jaj (tabela IV). Efektywność lęgów wynosiła 56,5% (dla wszystkich par ze zniesieniami) lub 65,3% (licząc tylko pary wyprowadzające lotne młode). Najwyższy sukces lęgowy (85%) odnotowano u par przystępujących najwcześniej do lęgów a u par opóźnionych tylko 50% daje lotne pisklęta. Sukces lęgowy jest najwyższy (76,0%) u par składających 2-3 jaja a najniższy (50,0%) u par składajacych 6 jaj. Największą produkcję młodych wykazują pary składające po 5 jaj (JZm=3,24 piskląt; tabela V).

Stwierdzono znaczne różnice w reprodukcji bocianów na tym samym obszarze Górnego Śląska w latach 1928-1932 i 1973-1990. W latach 1928-1932 pary lęgowe wyprowadzały ze zmniejszającą się częstością: 3, 4, 2, 0, 5 i 1 młode natomiast w latach 1974-1978 odpowiednio: 2, 3, 0, 4, 1 i 5 młodych (ryc. 7). Pół wieku temu każda statystyczna para lęgowa wyprowadzała po 0,6-0,7 pisklęcia więcej (tj. o 20-26% więcej) niż obecnie. Przyczyn tego zjawiska upatruje się we wzroście zagęszczenia populacji (w latach 1928-1975 liczebność na tym samym obszarze wzrosła z 367 do 774 par), w pogorszeniu się warunków troficznych na lęgowiskach i prawdopodobnie we wzroście udziału ptaków młodszych klas wiekowych w rozrodzie (młode ptaki wyprowadzają przeciętnie mniej młodych niż ptaki starsze). Regulacja liczebności i reprodukcji populacji przebiega zatem na zasadzie sprzężenia zwrotnego.

Liczne dane z literatury sygnalizują istnienie różnic regionalnych w ilości młodych wyprowadzanych przez pary lęgowe (tab. VI i VII). Średnia liczba młodych wyprowadzona przez bociany górnośląskie jest najwyższa w dużych miastach Górnośląskiego Okręgu Przemysłowego (JZm=2,92 młodego na parę). Pary lęgowe żyją na tym terenie w znacznym rozproszeniu co wpływa na osłabienie konkurencji wewnątrzgatunkowej. Odnotowano tu jedynie niewielki udział par (18,7%), które utraciły lęgi w czasie walk o gniazdo z innymi bocianami. Na terenach przyległych, o wyższym zagęszczeniu bociana, częściej dochodziło do walk o gniazdo i strat w lęgach a frakcja par bez lotnych młodych dochodziła tu do 21-26%.

Średnia wielkość lęgów notowana na Górnym Śląsku (JZa=1,91 młodego na parę; n=2445 par HPa) jest prawie równa przeciętnej dla innych badanych terenów Europy Środkowej (JZa=1,86; n=9254 par HPa) (tabela VI). Współczynnik średniej liczby potomstwa na gniazdo z młodymi (JZm=2,50 młodych na parę z młodymi; n=1874 par HPm) kształtowany jest na Górnym Śląsku głównie przez wielkości lęgów z dwoma, trzema i czterema młodymi, które stanowią razem 85% wszystkich lęgów z młodymi. Analiza danych z sześciu lat dla czternastu innych terenów próbkowych Europy Środkowej (JZm=2,65; n=6491 par HPm)(tabela VI) wskazuje, że przeciętna liczba wyprowadzanych młodych jest o 6,0% wyższa niż na Górnym Śląsku.

Osiąganie zdolności do lotu przez młode ptaki trwa od końca pierwszej dekady lipca do pierwszych dni września. Największe ich nasilenie ma miejsce w ostatniej dekadzie lipca i pierwszej dekadzie sierpnia. Od 25 lipca do 9 sierpnia gniazda opuszcza po raz pierwszy 58% wszystkich młodych (ryc. 2). Na podstawie terminów osiągania zdolności lotu stwierdzono, że średnia liczba wyprowadzanych młodych z gniazd maleje w miarę upływu sezonu lęgowego co znajduje poparcie w materiale zawartym na ryc. 10. Zebrane tu dane wskazują na wyszukiwanie najbardziej zasobnych w pokarm środowisk wkrótce po przylocie z zimowisk. Najwcześniej uzyskują zdolność do lotu młode pochodzące z gniazd, w których wychowało się po 5 piskląt, najpóźniej natomiast z gniazd z jednym młodym. Powyższe dane wydają się wspierać koncepcję o wyborze lepszych terytoriów przez osobniki wcześniej przylatujące.

Zbadano zależność pomiędzy zagęszczeniem populacji bociana (StD) we wschodnich landach Niemiec a produkcją młodych (JZa, JZm). Udowodniono, że średnia liczba wyprowadzonych młodych przez pary pozostaje w relacji odwrotnie proporcjonalnej do zagęszczenia par lęgowych. Na obszarach o wysokim zagęszczeniu (StD=10 par/100 km^2) bociany wyprowadzają średnio o około 0,5 (JZa) lub 0,4 (JZm) młodego mniej niż na terenach zasiedlanych luźniej (StD=1 do 3 par/100 km^2)(ryc. 8). Na tym samym terytorium udział frakcji bez młodych (%HPo) rośnie wprost proporcjonalnie do wzrostu zagęszczenia. Około dziesięciokrotnemu wzrostowi zagęszczenia odpowiada wzrost udziału par bez młodych z 21-23% do około 30% (ryc. 9).

Większość ptaków rozradzających się na Górnym Śląsku opuszcza swoje rewiry w ostatnich dniach sierpnia. Przeciętny wyliczony termin odlotu na zimowiska przypada na 27 sierpnia (ryc. 11) . Młode, tegoroczne ptaki opuszczają bezpośrednie sąsiedztwo gniazda zwykle kilka dni przed dorosłymi, a ich odlot odbywa się stopniowo i niepostrzeżenie.

Zakład Ochrony Przyrody i Zasobów Naturalnych PAN, ul. Lubicz 46, 31-512 Kraków