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The Mute Swan *Cygnus olor* (GMELIN 1789) on Lake Łuknajno (North-eastern Poland)

[with 3 text-figs.]

Łabędź niemy *Cygnus olor* (GMELIN, 1789) na jeziorze Łuknajno (północno-wschodnia Polska)*

Abstract. The population of Mute Swans on Lake Łuknajno consists of breeding birds (on the average c. 20 pairs), flocks of non-breeding, moulting birds, which numbered as many as 1756 specimens in 1968, and spring and autumnal migrants (c. 1000 birds in the autumn). The number of breeding birds was found to be on the increase, which manifested itself by their colonial nesting on the island. A fall in the size of non-breeding flocks observed in the last few years is connected with a change in the habits of the Swans, which have begun showing a preference for the littoral shallows of the Baltic.

I. INTRODUCTION

Not many ornithological reserves enjoy such renown as does Lake Łuknajno (Łukniany). This is so owing to its largest wild population of the Mute Swan on the European continent (SOKOŁOWSKI, 1960; HILPRECHT, 1970). Numerically strong populations of the Mute Swan are of particular importance now, for in most Central European countries flocks of these birds have been derived from introduced couples (SZIJJ, 1963; BAUER and GLUTZ z. BLOTZHEIM, 1968; HILPRECHT, 1970; SCHERNER, 1980).

In spite of the international importance attached to Lake Łuknajno as a refuge of Swans (HEINROTH, 1922, 1928; v. SANDEN, 1939; TISCHLER, 1941; SOKOŁOWSKI, 1958, 1960; BERGLUND et al., 1963; BAUER and GLUTZ v. BLOTZHEIM, 1968; HILPRECHT, 1970; MATHIASSON, 1973a), there is, as yet, no adequate estimation of the numbers of breeding pairs, the size of moulting flocks and the numbers of migrants stopping on the lake.

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* Praca wykonana w ramach Problemu MR.II.3

The results of investigations of the Swans on Lake Łuknajno published up to 1939 have been surveyed by TISCHLER (1941). They are fragmentary and the data quoted cause doubts. Even such a full estimation of the number of breeding pairs and the size of non-breeding flocks cited by TISCHLER (o.c.) as that made by him and v. SANDEN in 1932, was not furnished with the counts of led fledgelings in the autumn. Neither do the counts of the total number given by STEINFATT explain the structure of the population, i.e. the numbers of pairs and led fledgelings. The same is also true of the observations reported by HEINROTH, GROSS or FABER (TISCHLER, 1941). The postwar publications lack estimates of the size of non-breeding flocks and the number of led fledgelings as well as reliable figures concerning the breeding pairs. SOKOŁOWSKI (1951, 1958, 1960, 1972) gives relatively most information, whereas PANFIL (1966, 1971) writes nothing on the total number of pairs or chicks. Some data concerning the numbers of birds are published by PUCHALSKI (1956), LEŃKOWA (1958), FERENS (1963) and TOMIAŁOJĆ (1972, after KOPTON).

A critical survey of the above-mentioned data and the collection of new and, as far as possible, full data for the last years were the objective of the present work.

II. STUDY AREA AND METHOD

Lake Łuknajno is situated north-west of Lake Śniardwy, with which it communicates by a short canal, in the Suwałki Province (53°48.9'N; 21°37.6'E). As regards physical geography, it belongs to the region of the Masurian Lakeland and within its limits to the District of the Masurian Great Lakes. Since 1947 it has been a nature reserve. The origin of Lake Łuknajno was due to a superficial deglaciation in a depression left behind by dead ice (KONDRACKI, 1972). As a result, the northern, western and southern shores of the lake are flat and border upon low bogs. In the east, where the ground is higher, a narrow tract of cultivated fields separates the lake from an old pinewood of the Łuknajno Forest-range.

The water and floral conditions of the reserve have been presented by POLAKOWSKI et al. (1973), whereas OLSZEWSKI and PASCHALSKI (1959) have characterized the limnological situation. In the light of these studies and a Report of the Institute of Inland Fisheries, Lake Łuknajno is now a typical eutrophic lake, 680 hectares in area, with its shore line poorly diversified, mean depth of 0.60 m and shoreline length of 10.2 km (15 m shore per 1 hectare lake area). The shallow bottom is covered by a thick layer of gyttja, on which underwater meadows of stoneworts spread, occupying 77.4% of the lake area, up to an isobath of 1.5 m. It is to them that the lake owes its great transparency and, owing to intense assimilation, its chemical stratification together with high amount of dissolved oxygen (OLSZEWSKI and PASCHALSKI, 1959).

Four associations of underwater meadows, distinguished by POLAKOWSKI et al. (1973), *Charetum aculeolatae, Charetum contrariae, Charetum tomentosae* and *Charetum asperae,* are the most important so far of Swans' living conditions are concerned. Because of the shallowness of the lake the underwater meadows are accessible for foraging Swans over an area of 527 hectares. So abundant food resources attract huge numbers of Swans to this lake. However, the association *Scirpo-Phragmitetum,* a continuous strip of which, 50—100 m across, surrounds the lake and which overgrows the island, awakens the feeling of safety in birds and creates breeding conditions for them (Fig. 1).

The large area of the lake and its shallowness, which makes the food get-at-table even in the middle part of the lake, enable the Swans to keep at a suitable distance from other specimens of the same species.

The Swans' nesting grounds are the areas with emerging water plants (*Scirpo-Phragmitetum*) on the periphery of the lake and on the island. It is just this island that has been the greatest attraction of Lake Łuknajno, the colonial nesting of Swans being noted on it for years (HEINROTH, 1922; TISCHLER. 1941; SOKOŁOWSKI, 1958, 1960; BAUER and GLUTZ v. BLOTZHEIM, 1968). It is situated off the western shore of the lake, at a distance of 800 m. It extends north-south, its measurements being 73 $\times$ 36 m and 250 m in circumference. The island, the substratum of which is hard and stony, is the remainder of a flooded hill of a frontal moraine.

The significance of Lake Łuknajno is not restricted exclusively to the presence of large flocks of Mute Swans on it. At the same time it is a nesting ground of the Red-crested Pochard and Bearded Tit and a feeding area of the White-tailed Eagle, Osprey, Golden Eagle and Lesser-spotted Eagle.

The data on the Swans from 1945 to 1976 have been obtained from the documentation concerning the Lake Łuknajno Reserve, collected by the Provincial Inspector of Nature Conservancy and comprising the counts got by the reserve attendants H. BEUTLER and W. OLSZEWIK, reports of the Mikołajki and Mrągowo Forest Inspectorates and those of the ornithologists J. SOKOŁOWSKI, Z. KARCZEWSKI and W. BAGIŃSKI. Moreover, by courtesy of Messrs F. ULCZYCKI and R. CZERWIŃSKI we had access to their results of counting.

The present authors carried out a field study from 1954 to 1979. It was casual in nature till 1976 and its aim was to grasp changes in the size of flocks and reproduction in particular years. In 1977 the Swans of Lake Łuknajno were counted every two weeks, starting from their spring arrival at the beginning of April until the lake froze over in January 1978. The counts were performed using PZO 20—40$\times$64 field-

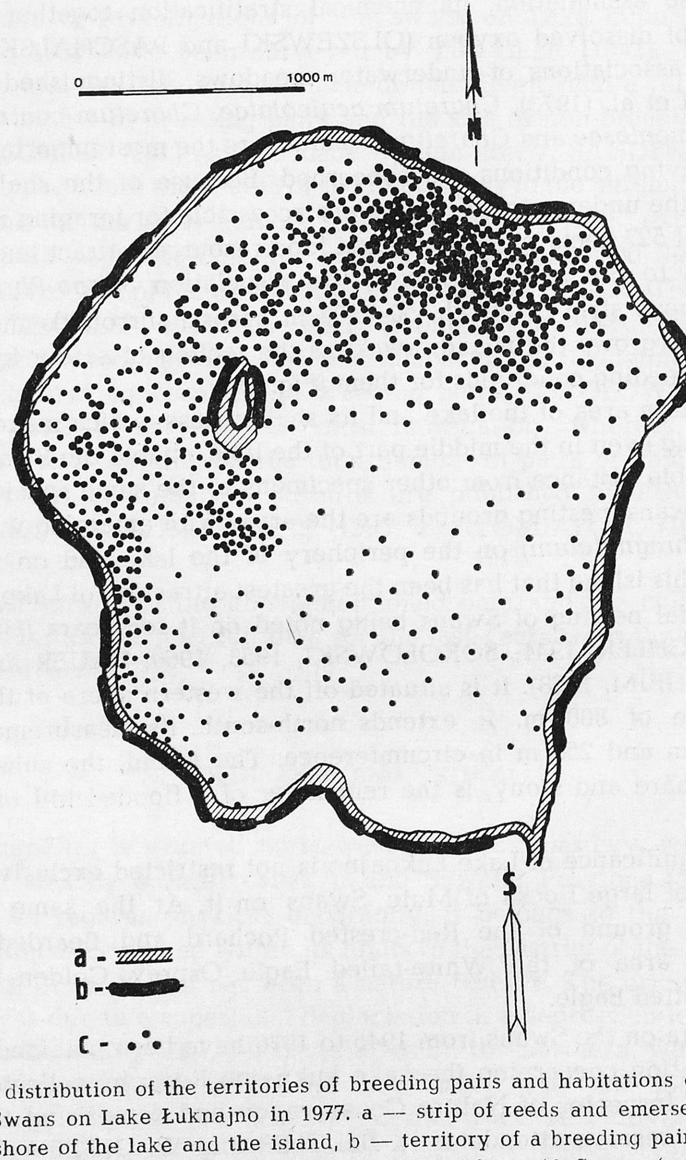

Fig. 1. The distribution of the territories of breeding pairs and habitations of non-breeding Mute Swans on Lake Łuknajno in 1977. a — strip of reeds and emersed vegetation along the shore of the lake and the island, b — territory of a breeding pair (determined by the cartographic method), c — habitations of at least 10 Swans (result obtained by adding non-breeding Swans found in particular places during 21 days of observation)

-glasses from three vantage points: the water-tower situated on the western shore of the lake and two specially constructed coigns of vantage in the tracts of reeds in the east and south. The cartographic method of counting was used and thus the size of the territories of particular breeding pairs, the spots of concentrations of non-breeding birds and the size of the reproduction of the pairs were established. The observation of the lake took 21 whole days altogether. After a year's break a control count was made in 1979. In order to obtain a full picture analogous counts were taken up in 1977 on Lake Pogubie Wielkie, c.25 km SSE of Łuknajno.

III. THE OCCURRENCE OF THE MUTE SWAN ON THE LAKE

The accessibility and abundance of food and safe conditions have attracted large flocks of Mute Swans to the lake since long ago. Some of them find convenient breeding sites here, whereas others use it as a safe place to survive the period of moulting, when they lose their flight power and, finally, migrating Swans stop here to regenerate their strength when they are on spring or autumn migrations.

A. Breeding population

Large concentrations of Swans on the lake cause that some chance observers overestimate the number of breeding pairs. A number of authors repeat false information about the nesting of 250 pairs here (CURRY-LINDAHL in BERGLUND et al., 1963; BAUER and GLUTZ v. BLOTZHEIM, 1968; HILPRECHT, 1970). However, for a space of 70 years various authors have generally been recording the nesting of about 20 pairs. These data are given in Tables I and II. A study carried out in 1977 showed that there were 22 pairs breeding on the lake (Table III). Their distribution reveals a certain preference for the northern and western shores (Fig. 1). Their territories are small, in size resembling those occupied by halfwild Swans on the River Alster (PETERS, 1931, after HILPRECHT, 1970).

The percentage relation of the breeding population to the whole population of Lake Łuknajno decreased from 23.1% in 1932 to 4.3% in 1979 (Table II, Fig. 2a).

Increases in the number of breeding pairs were found only in three periods: 1928—1932, 1954—1956 and 1963—1968. No doubt, they were dependent on such intrapopulation conditions as the increase in the number of Swans after the introduction of their conservancy in 1921, the quantitative explosion of the Baltic population in the fifties and the excessive density of the biotopes in the midsixties. A characteristic feature of these periods was the exceptional nesting of a group of breeding pairs in the colonial fashion on the island, for as many a 56 pairs nested in an area of 0.4 hectare in 1955 (SOKOŁOWSKI, 1960), which brought about such a concentration of birds that the average area of the territory of one pair was 71.4 sq.m and the average length of the shore falling to one nest 4.4 m. PUCHALSKI (1956) recorded that situation in his film and photographs.

The large number of pairs which happen on the island is a temporary phenomenon and it is difficult to decide what later causes a long-lasting

Table I

Counts of Mute Swans flocks and nests on Lake Łuknajno in 1905—1979

Time of observation		Results of counting of Swans and their nests										Authors and observers	Remarks
		in the spring (up to 31 May)				in the summer (1 June — 10 Sept.)		in the autumn and in the winter (from 11 Sept.)					
			of which:						of which:				
				nests									
year	date	to-tal	pairs	total	on the island	total	of which non-breeding	total	non-breeding	pairs with chicks	chicks		
1905			25									Questionaire	according to TISCHLER (1941)
1922	24.05.		>6		6							HEINROTH (1922)	
1928			>30		30							GROSS (1929)	
1929			20										
1932			30—40		15	260	160—200					v. SANDEN, TISCHLER (1941)	
1936										110	260	Questionaire	
1937	29.07.						320					O. STEINFATT	
1937	29.08.						340					A. FABER	
1937	15.10.							60—80				A. FABER	
1945			10									H. BEUTLER	
1946			20									H. BEUTLER	
1948			20		2							H. BEUTLER, PUCHALSKI (1956)	
1950						250						SOKOŁOWSKI (1951)	
1951			15—20		1	~200						PUCHALSKI (1956)	
1954	3—12.06.			52	>26					28	130	H. BEUTLER	

cd. tab. I

Time of observation		Results of counting of Swans and their nests											
		in the spring (up to 31 May)				in the summer (1 June — 10 Sept.)		in the autumn and in the winter (from 11 Sept.)				Authors and observers	Remarks
			of which:						of which:				
				nests									
year	date	total	pairs	total	on the island	total	of which non-breeding	total	non-breeding	pairs with chicks	chicks		
1954	July		64	64								H. BEUTLER	
1954	November							1000				R. KLAROWSKI	
1955	26.04.	1000										R. KLAROWSKI	
1955	16—30.05.	760		76	56	>760						H. BEUTLER, PUCHALSKI (1956)	making of a film
1955	August										200	R. KLAROWSKI	
1956	May				17							H. BEUTLER	
1956	12—13.06.		73		17	1000	450					Z. KARCZEWSKI, SOKOŁOWSKI (1958, 1960); J. PANFIL	
1956						750						J. PANFIL; LEŃKOWA (1958)	
1956	October							1100	800		300	H. BEUTLER	
1957	July					1300						R. KLAROWSKI	
1957	August					1500						J. PANFIL	
1959	February	200										W. OLSZEWIK	The Swans wintered
1959	1.04.	500										W. OLSZEWIK	Cormorants

cd. tab. I

Time of observation		Results of counting of Swans and their nests										Authors and observers	Remarks
		in the spring (up to 31 May)				in the summer (1 June — 10 Sept.)		in the autumn and in the winter (from 11 Sept.)					
			of which:						of which:				
				nests									
year	date	total	pairs	total	on the island	total	of which non-breeding	total	non-breeding	pairs with chicks	chicks		
1959	10.06.					1200	908					W. OLSZEWIK, J. PANFIL, J. SOKOŁOWSKI	60 nests of Cormorants
1962	2.06.		20			948	908			20		J. KOPTON (TOMIAŁOJĆ, 1972)	
1963	July					1400	1100				300	W. OLSZEWIK	
1964	13.04.— —12.05.		>36		36	900						J. PANFIL (1966)	measuring of eggs
1968	August					>1756	1756					Z. KARCZEWSKI, EMPEL	
1969			>6		6	600						J. PANFIL (1971)	
1971	9.07.					500						R. KLAROWSKI	
1972	22.04.	105										R. KLAROWSKI	
1972	20.05.	420				>420					30	W. OLSZEWIK	
1972	12.08.					400						R. KLAROWSKI	
1972	20.09.						320					R. KLAROWSKI	
1973	6.05.	450				>450						W. BAGIŃSKI	
1973/4	winter							50				R. KLAROWSKI	the swans wintered
1974	24.03.	386										W. BAGIŃSKI	
1974	May	498										R. MACKOWICZ	

Time of observation		Results of counting of Swans and their nests										Authors and observers	Remarks
		in the spring (up to 31 May)				in the summer (1 June — 10 Sept.)		in the autumn and in the winter (from 11 Sept.)					
			of which:						of which:				
				nests									
year	date	total	pairs	to-tal	on the island	total	of which non-breeding	total	non-breeding	pairs with chicks	chicks		
1974	29.05.	500										R. KLAROWSKI	
1974	13.07.					1100						R. MACKOWICZ	
1974	12.08.		10			700				10		R. KLAROWSKI	
1974	10.09.		50			900				50		W. OLSZEWIK	
1974	19.10.							>400				W. BAGIŃSKI, Z. LEWAR-TOWSKI	fog
1974	14.12.							1050				W. BAGIŃSKI, F. ULCZYCKI	19/20 of the lake covered by ice
1975	6.10.		13		1			1026	970	13	30	R. KLAROWSKI, R. MACKOWICZ	
1975	12.10.							1159				W. BAGIŃSKI, G. DERDOWSKI, F. ULCZYCKI	
1975	17.10.							1230				F. ULCZYCKI	
1976	19.05.	340	20		1							R. KLAROWSKI, R. MACKOWICZ, Z. SZKIRUĆ	584 nests of Black-headed Gulls
1976	5.09.					686						F. ULCZYCKI	
1976	10.10.							290				F. ULCZYCKI	

cd. tab. I

Time of observation		Results of counting of Swans and their nests										Authors and observers	Remarks
		in the spring (up to 31 May)				in the summer (1 June — 10 Sept.)		in the autumn and in the winter (from 11 Sept.)					
			of which:						of which:				
				nests									
year	date	total	pairs	total	on the island	total	of which non-breeding	total	non-breeding	pairs with chicks	chicks		
1976	24.10.							340				F. ULCZYCKI	
1977	24.04.	218	22		2							K. SŁAWIŃSKA	
1977	31.08.					958	914					K. SŁAWIŃSKA	
1977	21.11.							800		3	10	K. SŁAWIŃSKA	
1979	2.05.	6	2									R. MACKOWICZ	
1979	19.05.	48										R. CZERWIŃSKI	
1979	20.06.					230						R. CZERWIŃSKI	
1979	3.10.		5					550		5		R. CZERWIŃSKI	

Table II

Changes in the number of breeding pairs, chicks, moulting specimens and migrants of Mute Swan on Lake Łuknajno in 1932—1979 (on the basis of the data from Table I)

Year	Number of breeding pairs	Summer population		Number of nests on the island	Number of chicks	Size of migrating flocks		Breeding population as the percentage of whole summer population	Pairs nesting on the island as the percentage of breeding population	Average number of chicks per pair	Number of chicks as the percentage of summer population
		Total	of which non-breeders			Spring	Autumn				
1932	30	260	200	15	—	—	—	23,1	50,0	—	—
1951	20	240	200	1	—	—	—	16,7	5,0	—	—
1954	64	—	—	30	130	—	1000	—	46,9	2,0	26,3
1955	76	>760	—	56	200	1000	—	20,0	73,7	2,6	30,0
1956	73	1000	450	17	300	—	1100	14,6	23,3	4,1	—
1959	—	1200	—	—	—	500	—	—	—	—	—
1962	20	948	908	—	—	—	—	4,2	—	—	21,4
1963	—	1400	1100	—	300	—	—	—	—	—	—
1964	>36	900	—	36	—	—	—	8,0	?	—	—
1968	—	—	1756	—	—	—	—	—	—	—	—
1969	>6	600	—	6	—	—	—	2,0	?	—	7,1
1972	—	>420	320	—	30	105	—	—	—	—	—
1974	10	1100	—	—	—	386	1050	1,8	—	—	—
1975	13	—	—	1	30	—	1230	—	7,7	2,3	—
1976	20	686	—	1	—	340	340	5,8	5,0	—	1,0
1977	22	958	914	2	10	218	800	4,6	9,1	0,5	—
1979	5	230	—	—	—	48	550	4,3	—	—	18,51
	$\bar{X}$ = 30,4	764,4	731,0	15,4	142,9	371,0	867,1	8,28	38,68	2,70	—

Table III

Distribution of the territories of breeding pairs of Mute Swan along the shore of Lake Łuknajno in 1977

Shore	Length, in m	percentage of whole shoreline	Number of pairs	Length of shore occupied by territories	Mean length of territory of 1 pair	Percentage of shore occupied for swans territories	Length of territories	
							Minimum	Maximum
eastern	3120	30,59	3	1580	526,7	50,64	400	770
northern	2250	22,06	4	1330	332,5	59,11	280	390
western	2630	25,78	8	2260	282,5	85,93	160	410
southern	2200	21,57	5	1940	388,0	88,18	240	610
Whole shore line	10200	100,00	20	7110	355,5	70,97	100	770
Island	250	—	2	200	100	80,00		

collapse of the population. When the density of nests is great, some broods are destroyed during territorial fights between particular pairs (HEINROTH, 1922; PUCHALSKI, 1956; DOST, after HILPRECHT, 1970). However, an abrupt drop in the number of broods seems to be due, above all, to disturbances caused by man at the time of incubation. There is an example quoted from this island in ornithological literature, namely, HEINROTH (1928) gives the statement of a fisherman from Łuknajno that boating round the island makes frightened chicks cross the boundaries of so small territories of pairs neighbouring upon each other. Defending their territories, the adult birds „clear" them of intruders and thus 60 chicks perished during one tour round the island. Next, work on PUCHALSKI's film about Swans resulted in a decrease in the population of the island from 56 nests in 1955 to 17 nests in the following year. Such a great number of nests as in 1955 has never been observed later. In the last period of increase in the size of the population of Swans on Lake Łuknajno in 1963—1968 there were 36 nests on the island (PANFIL, 1966). Frequent visits of people to the island for studying the development of the population in those years may again have caused a reduction in the number of breeding pairs. In 1969 there were still 6 pairs (PANFIL, 1971), now 1 to 2 pairs can be found nestings on the island. Deserted by breeding pairs, the island is still a place of rest of non-breeding Swans. E.g. on 19 May 1976 48 Swans and so one-seventh of the total population of the lake at that time, were standing on the eastern shore of island. In consequence, the south-eastern shore is covered by a thick layer of their excreta.

This reduction of the population of Swans on the island in 1956

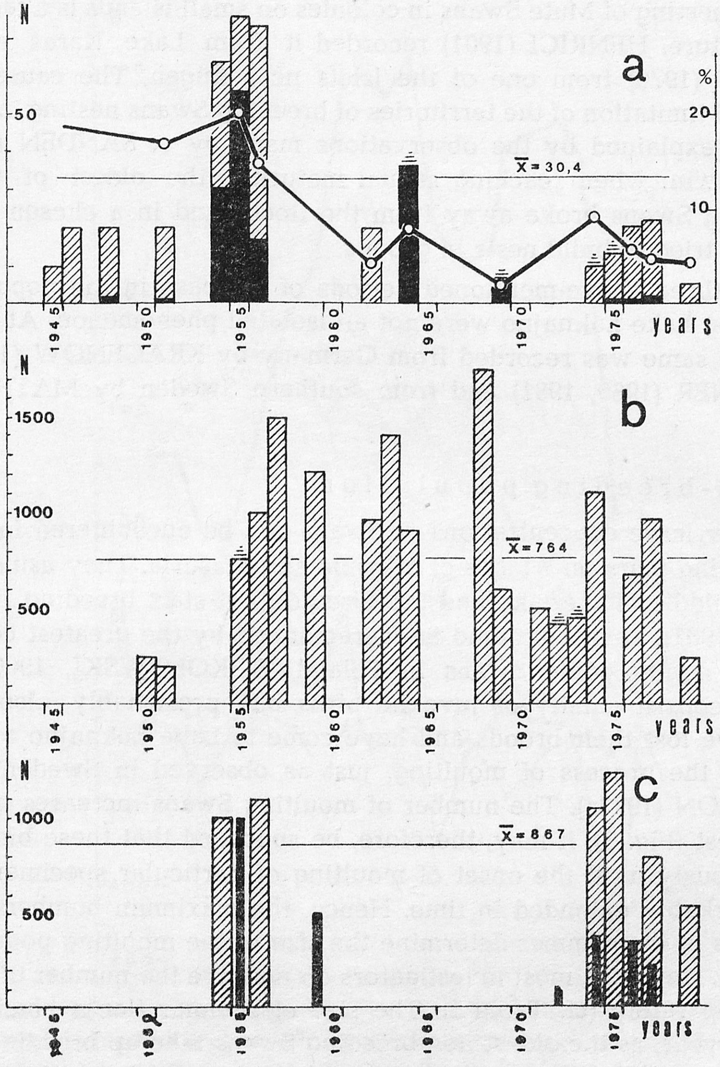

Fig. 2. Numbers of breeding pairs (a), moulting specimens of non-breeding flocks (b) and migrants (c) of Mute Swans on Lake Łuknajno in 1945—1979. Designations in part a: black columns — numbers of nests found on the island; solid line — breeding population as percentage of the whole summer population of Swans on the lake: Designations in part c: black columns — number of spring migrants; hatched column — number of autumn migrants

attracted cormorants which in 1958 built several and in 1959 60 nests there (SOKOŁOWSKI, in litt.). Black-headed Gulls nest permanently on the island, but the number of pairs has been increasing rapidly since the breeding Swans left, and thus, e.g. there were 500 pairs in 1956 and 584 in 1976. Therefore, here we are concerned with the filling of an abandoned ecological niche.

The nesting of Mute Swans in colonies on small islands is a fact known to literature. HENRICI (1901) recorded it from Lake Karaś and HILPRECHT (1970) from one of the islets near Rügen, The causes of the marginal limitation of the territories of breeding Swans nesting in colonies may be explained by the observations made by v. SANDEN (1938) on Lake Oświn: when reaching sexual maturity, the oldest of the non-breeding Swans broke away from the flocks and in a chosen place on the lake tried to build nests in groups.

The three above-mentioned periods of increase in the population of Swans on Lake Łuknajno were not an isolated phenomenon. At a similar time the same was recorded from Germany by KRÄGENOW (1979), and SCHERNER (1980, 1981) and from southern Sweden by MATHIASSON (1973a).

B. Non-breeding population

Fairly large concentrations of Swans can be encountered in addition to breeding pairs on 7 lakes of Warmia and Masuria. They usually occur in the middle of the lake and the birds do not start breeding (MACKOWICZ, 1981). Lake Łuknajno is characterized by the greatest concentration of non-breeding Swans in Poland (SOKOŁOWSKI, 1960). These groups consist chiefly of juvenile birds but, presumably, also of pairs that have lost their broods and have come to Lake Łuknajno to go here through the process of moulting, just as observed in Sweden by MATHIASSON (1973a). The number of moulting Swans increases from June to August (Fig. 3), it may, therefore, be supposed that these birds arrive continuously until the onset of moulting of particular specimens, which is remarkably extended in time. Hence, the maximum numbers of birds in flocks in the summer determine the size of the moulting population of the lake. However, most investigators do not give the number of breeding birds separately (cf. Table I). The size of summer flocks changes from year to year, as the oldest non-breeding Swans take up breeding and the last year's chicks, driven away from their native lakes, arrive. And so the number of moulting Swans is dependent on the situation prevailing in the whole Baltic population of the Mute Swan (MATHIASSON, 1973b). As early as 1950 the non-breeding flock on Lake Łuknajno numbered 200 birds (Table I). Seven years later it was seven times as large, coming to 1500 specimens, and in 1968 to 1756 non-breeding Swans. That was the record number, never again observed on this lake. Fluctuations in the number of birds in the seventies were rather considerable, there being still 1100 non-breeding Swans in 1974 and 958 in 1977; after the breakdown of the population in the winter of 1978/1979 in the summer of 1979 the smallest number of moulting Swans, i.e. 230 specimens, was noted.

The size of non-breeding flocks is conditioned, among other things, by the amount of food. On Lake Łuknajno the *Charetum* associations

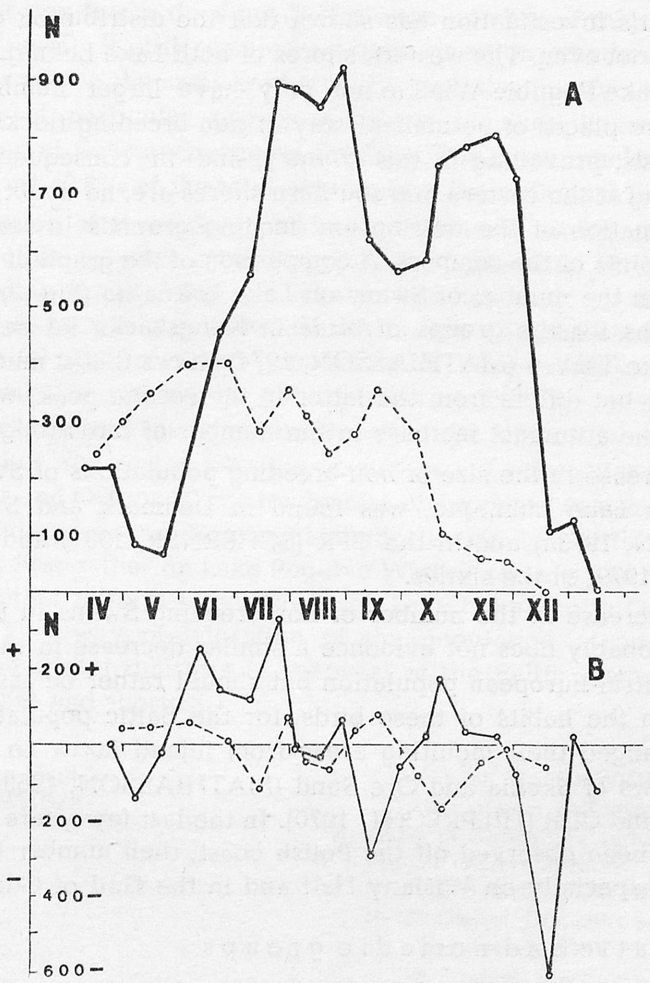

Fig. 3. Changes in the numbers of Mute Swans on Lake Łuknajno (solid line) and on Lake Pogubie Wielkie (dashed line) in 1977. A — counts on particular days of observation; B — increase and decrease in the size of flocks on particular days of observation

cover 572 hectares. They are one of the main sources of food of Swans (SOKOŁOWSKI, 1958). The mean number of birds in flocks — according to Table II — comes to 907.3 Swans, of which 764 adults. This means that on the average 14.45 specimens fall to 10 hectares of area with a depth up to 1.5 m (cf. MACKOWICZ, 1981) or 17.22 specimens to 10 hectares (in this same depth) of the meadows of the *Charetum* associations. These calculations indicate that the food mass of the underwater meadows of Lake Łuknajno is nearly by half larger than the amounts occurring in other lakes. The excessive density of the population on Lake Łuknajno is also the greatest of all the lakes in Poland — 30.93 Swans per 10 hectares of area from the shore to a depth of 1 m (MACKOWICZ, 1981). A whole year's investigation has shown that the distribution of Swans on the lake is not even. The western shores of both Lake Łuknajno (cf. Fig. 1) and, e.g. Lake Pogubie Wielkie not only have larger numbers of pairs but also are places of permanent stay of non-breeding flocks. North-westerly winds, prevailing in this country, and in consequence stronger lake waving at the eastern and southern shores are, no doubt, responsible for the situation of the nesting and feeding grounds in relation to the cardinal points of the compass. A comparison of the graph of intra-annual variation in the number of Swans on Lake Łuknajno (Fig. 3) with analogous graphs for the groups of birds in Kungsbacka Fd near Göteborg and on Lake Tåkern (MATHIASSON, 1974) shows that it much resembles the former but differs from the latter in the second peak, which corresponds to the autumnal increase in the number of birds (migrants).

An increase in the size of non-breeding populations of Swans, similar to that on Lake Łuknajno, was found in Denmark and Sweden (MATHIASSON, 1973a) and in the GFR (SCHERNER, 1981) and GDR (KRÄGENOW, 1979) in the sixties.

The decrease in the number of non-breeding Swans in the seventies (Fig. 2) probably does not evidence a similar decrease in the size of the whole Central-European population but should rather be associated with changes in the habits of these birds, for the Baltic population of Mute Swans changed their moulting areas from inland lakes to the littoral sea-shallows of Skania and Ore Sund (MATHIASSON, 1963a,b, 1973a,b), Denmark and GDR (HILPRECHT, 1970). In the last few years Mute Swans have also been observed off the Polish coast, their number being on the increase, especially on Wiślany Haff and in the Gulf of Gdańsk.

C. Migratic and nomadic groups

Lake Łuknajno lies on the route of spring and autumn migrations of Mute Swan populations from the South- and partly North-Baltic subareas to the subarea occupying the west of the Baltic (the islands of Denmark and southern Sweden) (SCHMIDT et al., 1979). The size of Lake Łuknajno, the abundance of food and the sight of large flocks of Swans attract the passing birds. There are no detailed data concerning this phenomenon from the period preceding World War II. In the postwar period counts of autumnal flocks were started in 1954 and those of spring migrants on 1 April 1959. The number of 500 Swans found at that time became the cause of an incorrect estimate of breeding pairs. Particularly well known are the numbers of birds of migrating flocks in the seventies (Tables I and II, Fig. 2c). In spite of an increase in the Swan population, especially in the North-Baltic area (IVANAUSKAS, 1957, 1960; JYGI et al., 1976), the size of flocks migrating in autumn did not undergo any significant changes in a 20-year period (1000 birds in 1954 and 1050 in 1974).

The spring passage lasts shorter (Fig. 3) and is less intensive. The size of the spring flocks does not balance the number of migrants in the autumn (Table II). It still remains an open question whether only part of the Swans return the same way from their winter quarters or whether a short stay of particular groups of migrants makes it impossible to notice the fact of their exchange on the lake. The mean number of spring migrants forms 42,8% of the total obtained for the autumnal flocks.

The situation of three Swan lakes — Łuknajno, Oświn and Pogubie Wielkie — close to each other suggests the possibility of the passage of non-breeding flocks from one lake to another and so their living a nomadic life on various water bodies in one and the same breeding season. Parallel studies of the populations of Lake Łuknajno and Lake Pogubie Wielkie were carried out in this respect. Fig. 3b shows time differences of the decreases and increases in the size of Swan flocks on these two lakes and so the possible occurrence of micromigration. Only in September and October these tendencies are opposed to each other and do not exclude passages. This would indicate that before the departure the migrants first gather on Lake Pogubie Wielkie (as early as September) and join together to form larger flocks on Lake Łuknajno in October and November. This way of migration of the population of north-eastern Poland to the winter quarters in the west of the Baltic seems to be the most consistent and shortest.

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STRESZCZENIE

Jezioro Łuknajno (Łukniany) jest znanym miejscem przebywania dużych stad łabędzi niemych. Zróżnicowane oceny wielkości stad i liczebności par lęgowych, podawane przez różnych autorów, wymagały dokładniejszego prześledzenia zmian sezonowych w populacji łabędzi Łuknajna. W tym celu zestawiono dostępne wyniki liczeń dokonywanych przez strażników rezerwatu, leśników i ornitologów, zawarte w dokumentacji Wojewódzkiego Konserwatora Przyrody w Olsztynie oraz w literaturze (tab. I). Zmiany liczebności łabędzi w cyklu rocznym badano w roku 1977, od chwili stopienia lodu wiosną do ponownego zamarznięcia w zimie. Liczenia przeprowadzano z ambon obserwacyjnych za pomocą lunety w odstępach dwutygodniowych. Wynikiem tych badań jest wyodrębnienie 4 ugrupowań łabędzi niemych na jeziorze: par lęgowych, nielęgowych stad pierzących się, migrantów wiosennych i migrantów jesiennych. Dzięki kartografowaniu ustalono występowanie 22 par lęgowych, zasięgi ich terytoriów i miejsca przebywania ptaków pierzących się (ryc. 1). Pary lęgowe preferują zachodni i południowy brzeg, zaś ptaki nielęgowe i migrujące północny i zachodni. Wybór tych brzegów nie jest uzależniony od występowania szerszych pasów trzcin lub obfitszych żerowisk, lecz unikaniem przez łabędzie miejsc o większym falowaniu. Dzięki płytkości ($\bar{x}$ = 0,6 m) dno jeziora Łuknajno jest dostępne dla łabędzi w 92% swej powierzchni (627 ha). Łąki podwodne 4 zespołów ramienic porastają 84% powierzchni jeziora. Ze względu na głębokość, dla żerowania łabędzi jest dostępne 527 ha łąk (77%), co odpowiada średnio liczbie 17,22 łabędzi/10 ha łąk podwodnych.

W okresie 80 lat liczeń wyróżniono 3 okresy liczniejszego gnieżdżenia się łabędzi na jeziorze: w latach 1928—1932, 1954—1956 i 1963—1968 (ryc. 2a i 2b). Wzrost liczby par łączył się z kolonijnym gnieżdżeniem się na małej wyspie (40 arów) pewnej liczby łabędzi, które miały tu najmniejsze terytoria lęgowe w skali światowej (np. w roku 1955 terytorium gniazdowe na wyspie wynosiło średnio 71 m^2). Efemeryczność występowania dużej koncentracji gniazd na wyspie zależy nie tylko od liczebności dojrzewających płciowo nielęgowych łabędzi, ale również od częstotliwości zakłóceń cyklu gniazdowego na wyspie przez człowieka.

Średnia liczebność par lęgowych na jeziorze Łuknajno wynosi 33,5 (tab. II, ryc. 2a), a nielęgowych pierzących się stad łabędzi 763 ptaki (tab. II, ryc. 2b). Stada nielęgowe koncentrują się na jeziorze od czerwca do sierpnia, a we wrześniu rozpoczynają odlot.

Przelot migrantów jesiennych trwa od października do listopada. Odlot ostatnich łabędzi następuje w grudniu (w roku 1978 w styczniu) (ryc. 3). Wielkość stad migrujących trudno jest bez znakowania ustalić ze względu na możliwość przebywania jeszcze na jeziorze pierzących się łabędzi i par lęgowych. Stado migrantów jesiennych może jednak dochodzić do 1300 ptaków. W roku 1977 stwierdzono tylko 240 łabędzi migrujących przy łącznej liczbie 800 przebywających wtedy na jeziorze ptaków. Średnia liczba populacji jesiennej wynosi 867 łabędzi (tab. II, ryc. 2c). Znacznie trudniej ocenić liczebność migrantów wiosennych ze względu na przebywanie na jeziorze już par lęgowych i pojawianie się pierwszych łabędzi nielęgowych. Migrantów wiosennych jest mniej niż jesiennych — w roku 1977 było 150 łabędzi przelotnych w stadzie wynoszącym 218 ptaków (ryc. 2c, ryc. 3).

Od połowy lat 70. obserwuje się spadek liczebności łabędzi na jez. Łuknajno, związany niewątpliwie ze wzrastaniem liczebności stad pierzących się łabędzi na południowym wybrzeżu Bałtyku.

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