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STRUCTURE OF THE OCCURRENCE OF WATERFOWL TYPES AND MORPHO-ECOLOGICAL FORMS

The paper presents the structure of waterfowl communities. Materials come from the Mamry Lake (10,450 ha), as well as data from previous papers by the present author were utilized.

Birds do not inhabit the whole reservoir uniformly, but do it selectively — they have more or less constant places of occurrence or aggregation. Ecological association of birds of the lake was identified and there was indicated the fact that lake zones differentiate it, while individual links of the association do occupy different zones finding just in them their proper ecological niches. The boundary between reeds and the open water is the most numerously inhabited zone. Lake association has been compared with the river one, differences between them and the effect of these differences upon ecological relations in both communities and both environments has been indicated.

Contents

INTRODUCTION

The differentiation in ways of the occurrence of birds in forest environments is rather accurately understood. Numerous papers on this topic led to the formulation of known conclusions about storeyed occurrence of birds, cited even in publications of handbook character (Palmgren 1932a, Lack 1940, 1944, Kendeigh 1946, Moreau 1948, Poznanin 1949, Turček 1951, Hartley 1953, Pielowski 1961a, 1961b, Wasilewski 1961, Skoczylas 1961, Jabłoński 1967, and others).

Somewhat less numerous are papers concerning the relationship of birds with definite plant communities, the less numerous are papers dealing with changes in the occurrence of birds from the edge inside forest blocks. In spite of this, also in these cases there were approached and laid down some relationships and regularities (Palmgren 1930, 1932b, Cajander 1934, Kalela 1938, 1954, Lack and Venables 1939, Kendeigh 1946, Karpiński 1954, Pinowski 1954, Johnston and Odum 1956, Wasilewski 1961, 1967, and others).

Generally one can state that there were identified many mono- or polysynusial birds and it was found that the boundary of biotopes – edges of forest blocks, ecotones between different environments provide the most attractive sites for birds. These papers yielded also many materials about the existence or the lack of interspecific competition, about the replacement of ecological forms in individual biotopes, about the structure of forest bird communities.

On this background there strikes the scarcity of ecological papers devoted to similar problems in relation to waterfowl of fresh waters. This is striking the more that other branches of hydrobiology, and also many other groups of aquatic animals are rather well known just in the viewpoint of the structure of communities.

In Poland Dunajewski (1938, 1943) was first who was concerned with these problems (although rather in theoretical approach). (The latter paper edited during war is less known and hardly available. In spite of fact that this is a script for students, it contains many valuable and original ideas).

Relatively the greatest number of papers related with problems of the way of the occurrence of birds on water reservoirs concerns individual species. As examples there might be mentioned here some works discussing grebes (Schiermann 1927, Harrison and Hollom 1932, Hanzak 1952, Mc Cartan and Simmons 1956, Onno 1960, Wobus 1964, Gotzman 1965, Sokołowski 1967, and others), gulls (particularly black-headed gull), terns, ducks, warblers, sand-martins, and many other (Isakov, Krumina and Raspopov 1948, Szczepski 1950, Ytreberg 1956, Koskimes 1957, Józefik 1962, Bocheński 1961, 1962, 1966, Zając

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1963, Luniak 1963, Wołk 1964, Dobrowolski and Nowak 1965, Gliwicz 1967, and others).

Data concerning the way of the occurrence of birds on lakes could be found also in papers of purely faunistic character or slightly ecological. From the area of Poland such papers were provided by: Szarski 1948, 1950, Krzanowski 1950, Karczewski 1950, 1953, Bocheński 1958, Nowak 1958, 1966, Czarnecki 1962, Mrugasiewicz and Witkowski 1962, Riabinin 1962, 1963a, 1963b and other authors informing, however, about selected species (most frequently so-called rare ones) or giving information about occasional observations on small fragments of rivers, ponds or lakes.

The relation of birds with individual types of reservoirs, particularly lakes, was discussed by Palmgren (1936), Kalela (1938), Ekman (1943), Haartman (1945), Hagelund (1949), Isakov and Raspopov (1949), Hagelund and Møller (1951) (the three latter papers are rather of faunistic character), Onno (1958), Horvath (1958), Dobrowolski (1961), Rucner (1966), Creutz (1966). A separate, but close with the latter group of papers present publications dealing with the analysis of communities of waterfowl, their relations with biotope and mutual relationships (Haartman 1945, Horvath 1956, Hobbs 1957, Dobrowolski 1957, 1964, Bocheński 1960, Bień and Dobrowolski 1961, Berthold 1961, Busse and Gromadzki 1962, Lewandowski 1964, Szijj 1965a, 1965b, Havlin 1966, Beitz 1966).

Ornithological Laboratory of the Zoological Institute, University of Warszawa, from many years is engaged in just that topics, studying both terrestrial and aquatic environments and birds. It is just this laboratory where papers by Jabłoński (1964, 1967), Luniak (1963), Bień and Dobrowolski (1961), Dobrowolski (1957, 1959, 1961, 1964), Lewandowski (1964), were published. The latter one was prepared on the basis of the material collected in North Mamry Lake and presented the first attempt of the stratification of birds on a lake. In respect both to the area and problem, it provided a background for broader studies which will be presented in this paper.

The problem of the manner of bird occurrence on lakes is still not understood as are also: the contribution of birds to matter circulation in lake biocoenosis and the way of the utilization of its resources by birds. Hence it seems to me that papers dealing with the structure of waterfowl community may provide a significant contribution to the understanding of problems of reservoir productivity. This inclined me to present materials gathered during years 1958–1959 and concerning the character of the occurrence of birds on Mamry Lake. The work was done with the outstanding assistance of the Section of Lake Management, Institute of Freshwater Fishery at Giżycko

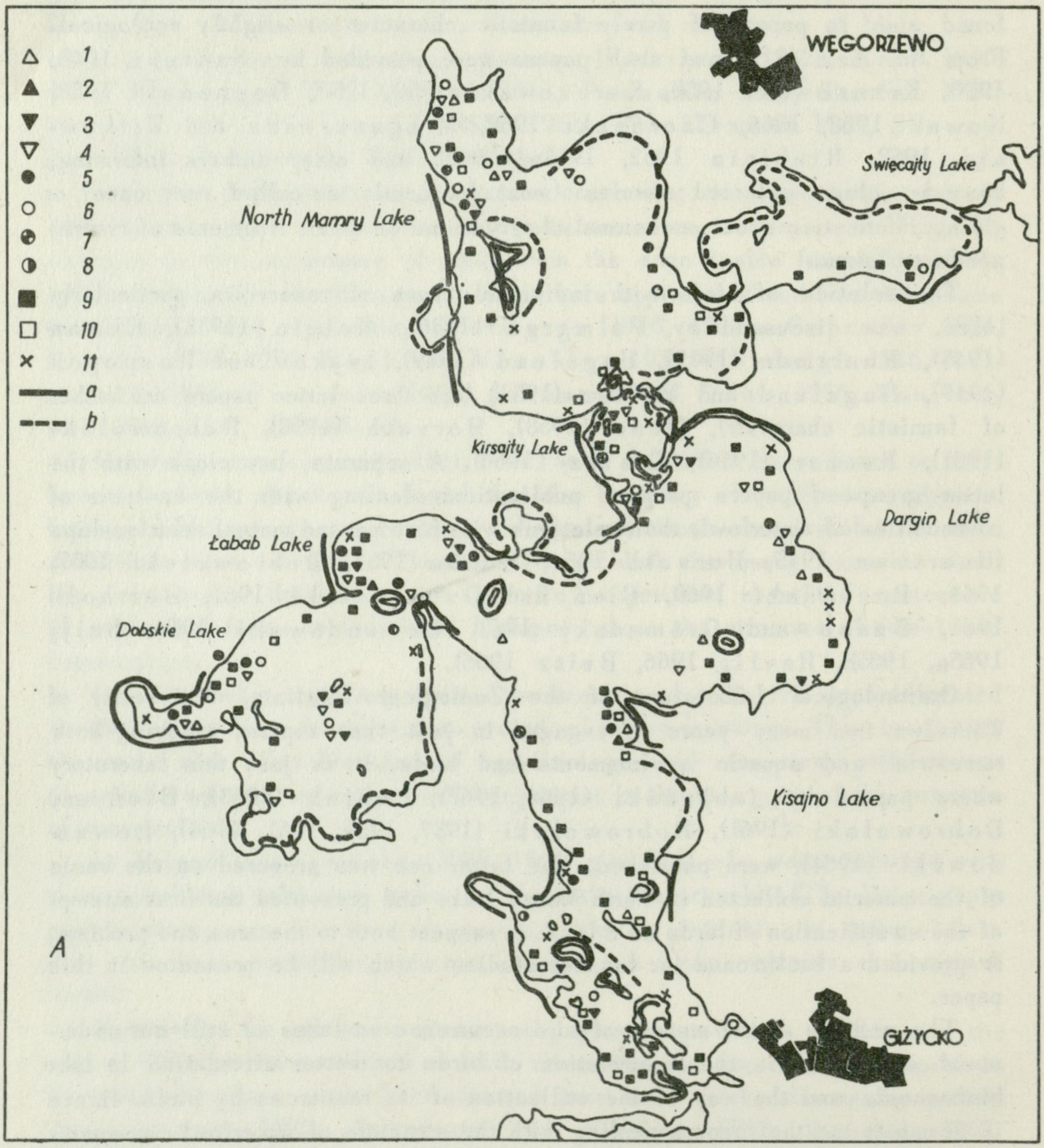
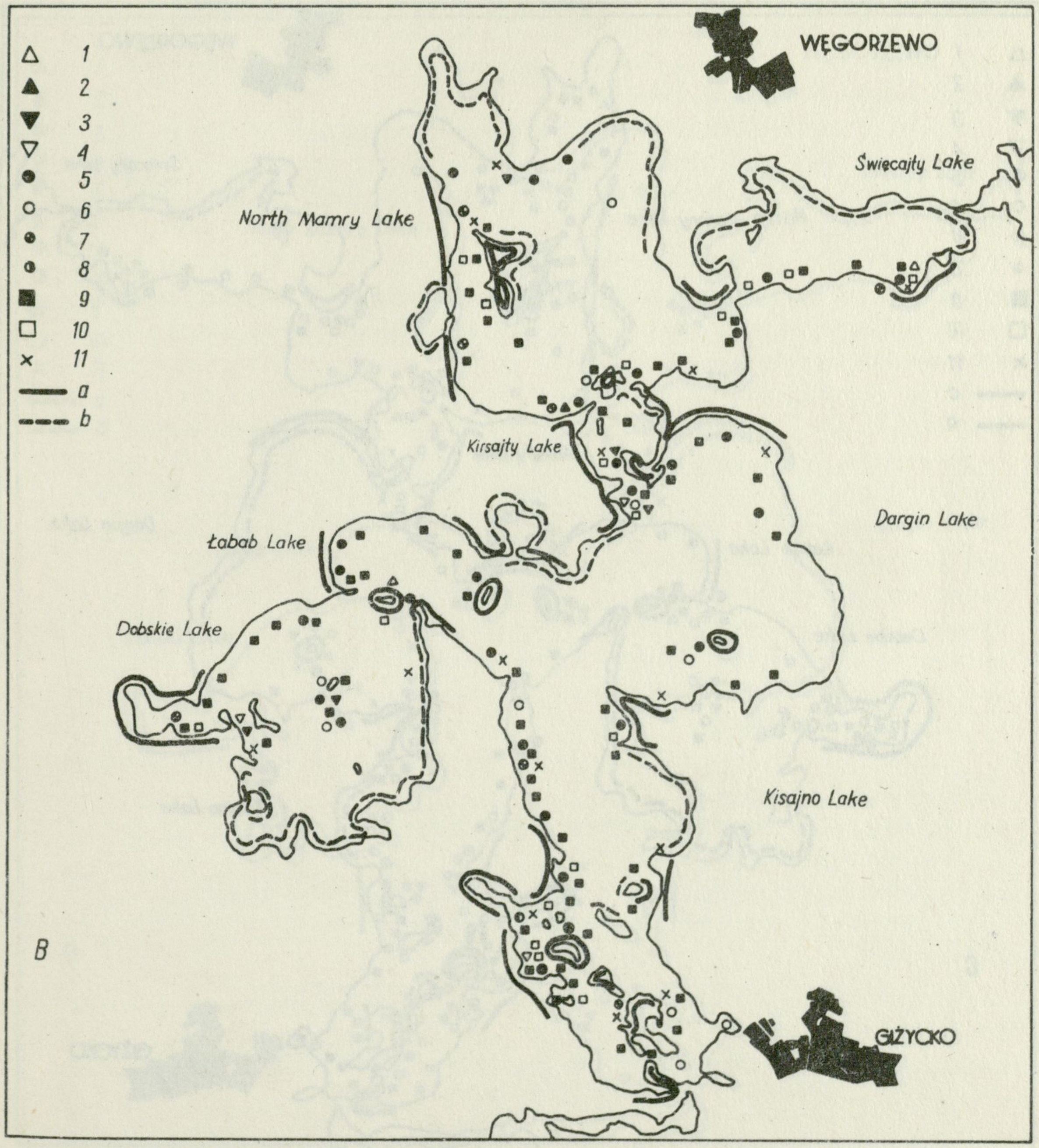


Fig. 1. Distribution of birds on Mamry Lake during different periods. There are marked by individual pairs of *Podiceps cristatus*,
A – pre-breeding season, *B* – breeding season,



aggregations of *Anas* sp., *Nyroca* sp., *Fulica atra*, *Larus ridibundus* and ranges occupied *Cygnus olor*, *Circus aeruginosus*

C – post-breeding season, *D* – autumnal season

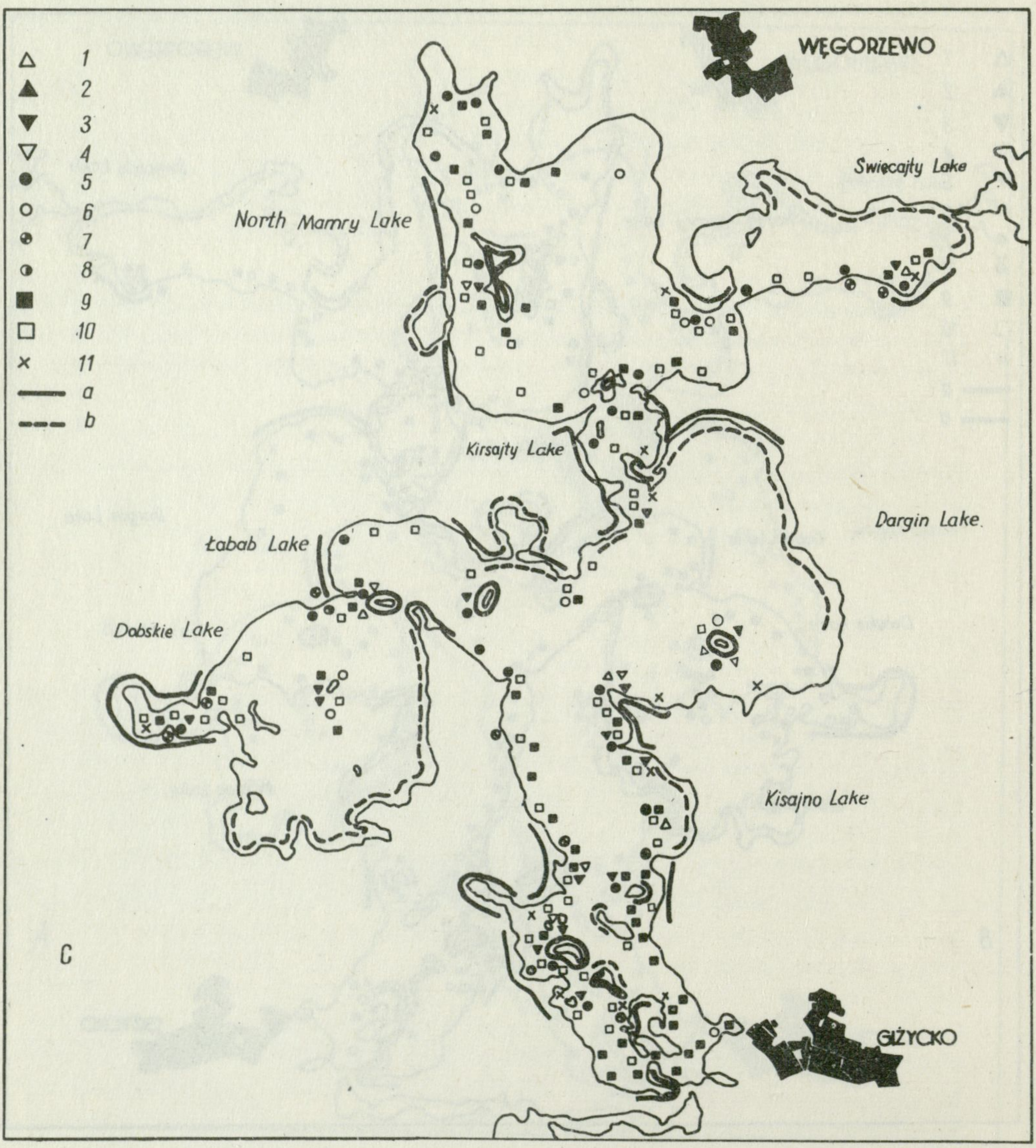
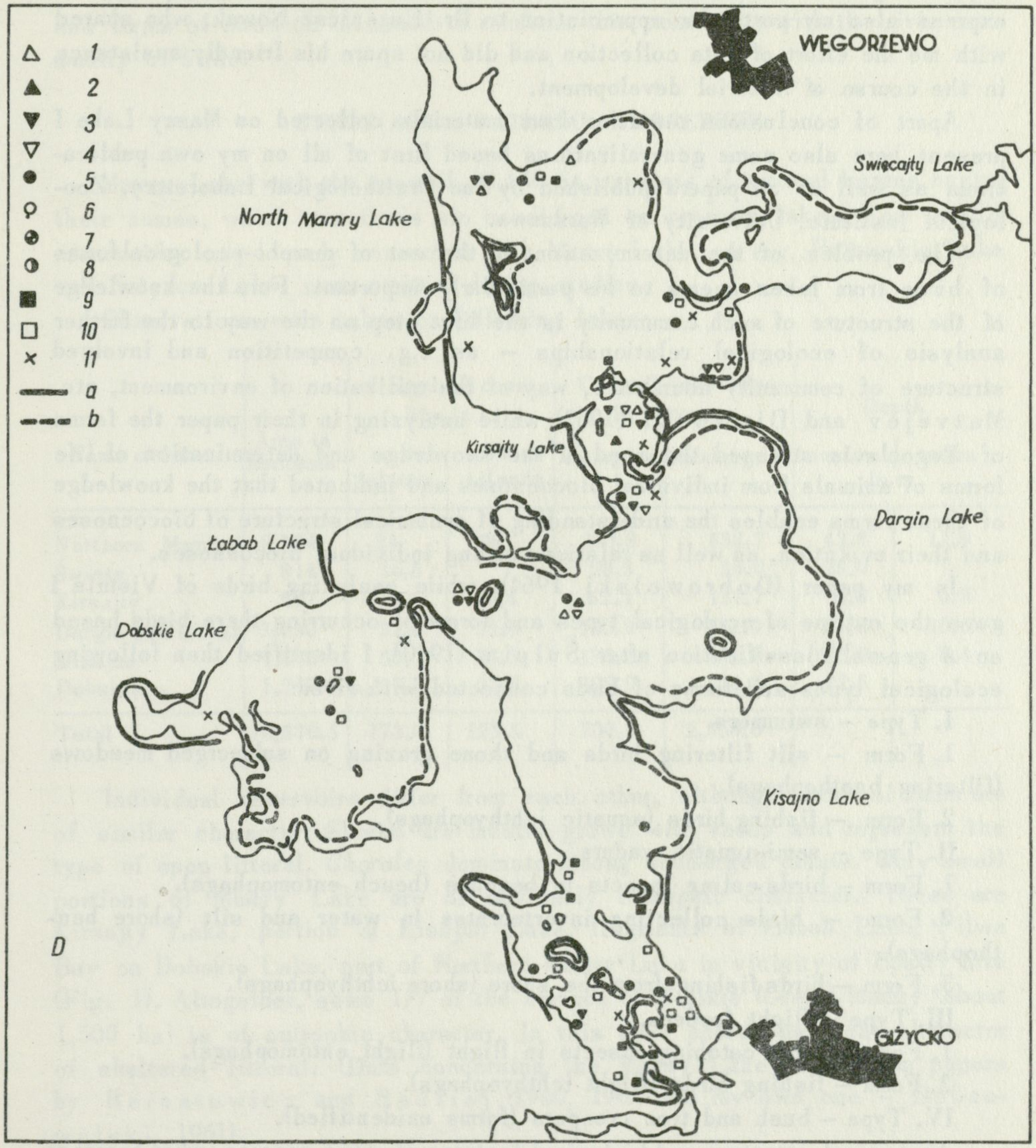


Fig. 1

a – eutrophic shore, *b* – non-observed shore, *1* – *Aythya fuligula*, *2* – *Aythya* sp., *3* – *Aythya nosus*, *8* – *Podiceps griseigena*, *9* – *Podiceps*



(continued)

ferina, 4 – Aythya nyroca, 5 – Anas platyrhynchos, 6 – Larus ridibundus, 7 – Circus aeruginicristatus, 10 – Fulica atra, 11 – Cygnus olor

and here I would like to express my appreciation to Prof. Dr. Stanisław Bernatowicz for rendering available the laboratory and floating equipment of his Section and for valuable data concerning the Mamry Lake. I would like to express also my particular appreciation to Dr. Eugeniusz Nowak, who shared with me the effort of data collection and did not spare his friendly assistance in the course of material development.

Apart of conclusions resulting from materials collected on Mamry Lake I present here also some generalizations based first of all on my own publications as well as on papers published by the Ornithological Laboratory, Zoological Institute, University of Warszawa.

The problem of the determination of the set of morpho-ecological forms of birds from lakes seems to be particularly important. For, the knowledge of the structure of such community is the first step on the way to the further analysis of ecological relationships – as e.g. competition and involved structure of community abundance, way of the utilization of environment, etc. Matvejev and Dimowski (1963) while analyzing in their paper the fauna of Yugoslavia stressed the need of the knowledge and determination of life forms of animals from individual biocoenoses and indicated that the knowledge of these forms enables the understanding of dynamical structure of biocoenoses and their evolution, as well as relations among individual biocoenoses.

In my paper (Dobrowolski 1964), while analyzing birds of Vistula I gave the outline of ecological types and forms of occurring there birds based on a general classification after Šulpin (1940). I identified then following ecological types and forms of birds connected with river:

I. Type – swimmers.

1. Form – silt filtering birds and those grazing on submerged meadows (filtering benthophags).

2. Form – fishing birds (aquatic ichthyophags).

II. Type – semi-aquatic waders.

1. Form – birds eating insects in beaches (beach entomophags).

2. Form – birds collecting invertebrates in water and silt (shore benthophags).

3. Form – birds fishing from the shore (shore ichthyophags).

III. Type – flight feeders.

1. Form – birds catching insects in flight (flight entomophags).

2. Form – fishing birds (flight ichthyophags).

IV. Type – bush and tree creepers (forms unidentified).

Anatomical structure and biological features of given species, what together defines its relation with site and adaptations to food uptake provided the background for the identification of these types and forms. Within ecological forms there may come to competitive relations, although, as a rule, there occurs here far reaching differentiation of ecological niches, way of behaviour

or kind of food, what leads to the division of environment into „zones of influences" of individual species.

The purpose of the presented work was to determine ecological types and forms of birds on lake and to confront this community with the river community of birds.

STUDY AREA, MATERIAL, PROCEDURE

Mamry Lake with the area of 10,450 ha consists of several basins having their names, which sometimes are considered as separate lakes. Few smaller reservoirs, only loosely connected with Mamry Lake, as e.g. Pniewskie Lake and Sztynort Lake, were omitted during studies.

Observations were taken on following lakes:

Name of lake	Area in hectares	Length of coast line in km		Coastal vegetation in hectares		Depth	
		with islands	without islands	emerging	submerged	maximal in m	mean
Northern Mamry	2,504	34	28	181.8	633.7	43.8	11.8
Święte	814	16.8		28.3	34.0	28.0	
Kirsajty	207	8.6	7.4	62.1	137.7	5.8	3.3
Dargin and Łabab	3,030	32.8	31.8	140.9	762.9	37.6	10.6
Kisajno	1,896	50.1	31.3	178.1	465.9	25.0	8.4
Dobskie	1,719.5	30.7	27.0	109.0	324.4	22.5	
Total	10,370.5	173.0	125.5	700.2	2,358.6		

Individual reservoirs differ from each other, although some of them are of similar character. Shores are mostly grown with reeds and represent the type of open littoral. *Charales* dominate among submerged plants. Only small portions of Mamry Lake are of obviously eutrophic character. These are Kirsajty Lake, portion of Kisajno Lake, fragments of Łabab Lake, Pilwa Bay on Dobskie Lake, part of Northern Mamry Lake in vicinity of Upałty Isle (Fig. 1). Altogether, some 1/7 of the surface of Wielkie (Great) Mamry (about 1,500 ha) is of eutrophic character. In this case shores have the character of sheltered littoral. (Data concerning the Mamry Lake come from papers by Bernatowicz and Radziej 1960, 1964 and my own one – Dobrowolski 1961).

Studies were carried out during years 1958 and 1959. During September, October, and November of 1958 and April, June, September, and October of 1959 there were done 18 routes on lake. In the course of one route on lake the distance of 8 up to 39 km was covered. Altogether, the distance of 453.5 km was covered while observations included 847.5 km of the central portion of lake and 458 km of shores.

Observations were taken from a big motor-boat moving with more or less constant speed possibly close to the reed zone and they were complemented by a check of selected portions of reeds and shallow portions of lake with the aid of a small boat with rows or outboard motor. In the course of material elaboration observations were joined and four phenological seasons were identified, namely:

pre-breeding period (April 16 and 17, 1959),
breeding period (June 2, 3, 4, 1959 and June 26, 27, 1959),
post-breeding period (September 23 and 25, 1958, September 11 and 12, 1959, October 9 and 10, 1959),
autumnal period (October 25, 26, and 27, 1958, November 26 and 27, 1958).

Observations were not entirely uniformly distributed among all reservoirs comprising Wielkie Mamry Lake. And so observations taken on Święte and Dargin lakes are less accurate, than those taken on remaining lakes, because rather small sections of these lakes were penetrated (Fig. 1). Thus data for these reservoirs are rather of only approximate character. Remaining lakes have been studied with roughly equal degree of accuracy.

Data concerning numbers of occurring birds were converted into one kilometer of route and not per 1 ha of lake area, since in connection with very diversified distribution of birds on a lake the conversion into a hectare of area gives only a mean, which fails to reflect the actual picture of bird occurrence. As it results from my previous studies carried out on Mazurian lakes (Dobrowolski 1961) there exists a relationship between the occurrence of waterfowl and the absolute number of lake area hectares occupied by vegetation. Hence it seemed to me justified to analyze the mean number of birds occurring per a kilometer of the covered distance. Ekman (1943) indicates also the relationship between character of vegetation and waterfowl.

In the course of observations birds were shot for the analysis of food contained in their stomachs.

There were killed 25 individuals of *Fulica atra*, 16 – of *Anas platyrhynchos*, 4 – of *Aythya nyroca*, 5 – *Aythya ferina*, 1 – *Aythya fuligula*, 1 – *Anas querquedula*, and 2 – *Podiceps cristatus*. Table I illustrates stomach contents.

During each trip the route made has been marked on the sketch of lake and birds observed were plotted on it with the aid of conventional signs. This enabled the analysis of places of aggregation or permanent occurrence of individual species. In order to examine at what distance from shore birds occurred there were identified following zones: shore, reeds, boundary between reeds and open water (0 m), water zone from 0 to 50 m towards the centre of lake (50 m), water zone from 50 to 100 m (100 m), and remaining water surface – central portion of lake. In spite of fact that these zones were

Number of stomachs containing definite kinds of food

Tab. I

Kind of food	*Podiceps cristatus*	*Fulica atra*	*Anas platyrhynchos*	*Anas querquedula*	*Aythya ferina*	*Aythya nyroca*	*Aythya fuligula*
Number of stomachs	2	25	16	1	5	4	1
Remnants of molluscs		9	6	1	2	2	1
Unidentified shell-fishes					1		
Dreissena polymorpha		3	1	1			1
Remnants of snails		1	2				
Vivipara vivipara		1					
Asellus aquaticus		1	2				
Gammarus sp.			2				
Chitinous remnants		6			2	3	
Sialis lutaria					1		
Trichoptera		1	2				
Zygoptera			1				
Larvae of *Chironomidae*		1			1		
Larvae of other *Diptera*		1	1				
Larvae of *Coleoptera*			1				
Imagines of *Coleoptera*	1		2				
Unidentified insect larvae			3				
Leeches			1				
Lumbricidae			1				
Rana sp.			1				
Unidentified remnants of plants	1	9	8	1	2		
Potamogeton sp.		13	1		1	2	
Chara sp.		4					
Spiralina sp.			1				
Rush						1	
Plant rhizomes			2				
Seed of aquatic plants		3	14		3	3	
Elodea canadensis			1				
Detritus			5				

estimated roughly, nevertheless they enabled the tentative analysis of the distribution of individual bird species in definite zones of lake.

Since Mamry Lake consists of more and less eutrophic parts, there were identified "oligotrophic" and "eutrophic" portions, and analyses were carried out separately for both parts in order to examine what effect has the various degree of lake eutrophy upon the distribution of birds.

During observations there were found 78 species of birds; of course this does not provide the full list of occurring here species (for comparison – Lewandowski 1964 only from Northern Mamry stated 107 species). Among those observed 60 species were more or less strictly connected with aquatic or marshy habitats and only 18 with shore environments. To species connected with freshwater environments I classified also such species which usually are considered as typically terrestrial ones and which in areas rich in freshwater use in one or another form water environments. Here belong e.g. starlings (*Sturnus vulgaris*) and swallows (*Hirundinidae*) numerously gathering in reeds for roosting. Swallows also feed willingly above water surface or reeds. *Corvus corone* also may utilize water feeding grounds to a serious extent; *Apus apus* feeds above water, *Motacilla alba* and *M. flava*, then birds of prey connected with water, then *Vanellus vanellus*, *Ciconia ciconia*, *C. nigra*, *Grus grus*, and small song birds occurring in reeds, as *Locustella luscinoides*, *Emberiza schoeniclus*, *Acrocephalus scirpaceus*, etc.

It is obvious that the applied techniques of observations does not provide material for a quantitative analysis of the occurrence of these species, similarly as it did not allow to find the maximal number of species staying on the lake. This is why only these species, the occurrence of which could be approached quantitatively and which occur on the lake as dominants or subdominants were subjected to a detailed analysis. The birds observed on Mamry Lake are presented in Table II.

DISTRIBUTION AND SEASONAL CHANGES IN WATERFOWL ASSOCIATION

Species occurring on all reservoirs, species giving a stamp to the whole community and make it similar to other ones occurring on similar Mazurian lakeland reservoirs are: *Fulica atra*, *Aythya ferina*, *A. nyroca*, *Anas platyrhynchos*, *Podiceps cristatus*, *Larus ridibundus*, *Cygnus olor*, *Phalacrocorax carbo*, *Ardea cinerea*, *Circus aeruginosus* (Tab. II).

While analyzing quantitative relationships of the complex of Wielkie Mamry Lake, excluding seasonal changes and various environment types, one can state that on all reservoirs there dominate in numbers: *Fulica atra*, *Aythya ferina*, *Anas platyrhynchos*, *Aythya nyroca*, *Larus ridibundus*. Remaining, mentioned previously species occur permanently, but as subdominants (Tab. III). *Fulica atra* fails to dominate only on the Łabab Lake. *Anas platyrhynchos* and *Aythya ferina* interchange one another on the second and third position of domination in relation to the character of reservoir, although

Tab. II

No.	Species \ Lake	Pre-breeding period							Breeding period							Post-breeding period							Autumnal period						
		Kisajno	Dargin	Łabab	Dobskie	Kirsajty	Mamry Północne	Święte	Kisajno	Dargin	Łabab	Dobskie	Kirsajty	Mamry Północne	Święte	Kisajno	Dargin	Łabab	Dobskie	Kirsajty	Mamry Północne	Święte	Kisajno	Dargin	Łabab	Dobskie	Kirsajty	Mamry Północne	Święte
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	*Anas platyrhynchos* L.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	*Aythya ferina* (L.)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3	*Fulica atra* (L.)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
4	*Larus ridibundus* L.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
5	*Podiceps cristatus* (L.)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	
6	*Aythya nyroca* (Güld.)	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x		x	x	x	x		x	x	x	x	x
7	*Cygnus olor* (Gm.)	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x
8	*Anas querquedula* L.			x	x	x				x	x	x	x	x		x	x	x	x	x	x	x	x			x	x	x	x
9	*Aythya fuligula* (L.)	x	x	x	x		x			x	x	x			x	x	x		x			x	x		x	x	x	x	x
10	*Ardea cinerea* L.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x	x						
11	*Anas strepera* L.		x	x	x		x		x	x	x	x	x	x	x	x			x		x		x				x		
12	*Bucephala clangula* (L.)	x	x		x		x				x			x		x	x	x			x		x		x	x	x	x	
13	*Phalacrocorax carbo* (L.)	x	x	x	x		x	x	x	x	x	x	x	x	x				x			x		x		x	x	x	x	
14	*Mergus merganser* (L.)		x	x	x		x		x	x	x	x		x		x	x						x		x			x	
15	*Anas crecca* L.												x			x	x	x	x			x					x	x	
16	*Mergus serrator* L.	x	x	x			x																x	x	x	x		x	
17	*Mergus* sp. L.	x	x	x	x		x		x	x	x	x		x		x	x						x	x	x	x	x	x	x
18	*Circus aeruginosus* (L.)	x	x		x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x							
19	*Hirundo rustica* L.			x					x	x	x		x	x	x	x	x	x	x		x	x							
20	*Milvus migrans* (Bodd.)	x	x		x		x		x	x		x	x	x		x													
21	*Corvus corone* L.				x		x		x	x				x		x							x						x
22	*Larus canus* L.						x														x	x	x		x	x		x	x
23	*Vanellus vanellus* (L.)						x		x	x		x		x	x	x			x										
24	*Acrocephalus arundinaceus* (L.)								x	x		x	x	x	x		x												
25	*Anas penelope* L.			x			x						x	x		x												x	
26	*Haliaëtus albicilla* (L.)		x						x				x			x	x		x				x						
27	*Podiceps ruficollis* (Pall.)									x													x				x		
28	*Sterna hirundo* L.								x		x	x		x	x														
29	*Apus apus* (L.)								x	x	x		x	x	x														
30	*Emberiza schoeniclus* L.	x			x						x				x						x								
31	*Podiceps griseigena* (Bodd.)	x			x				x			x		x															
32	*Mergus albellus* L.			x			x																			x		x	
33	*Capella gallinago* (L.)								x	x				x							x								
34	*Grus grus* (L.)													x		x	x			x	x								
35	*Ixobrychus minutus* L.												x							x	x	x							
36	*Riparia riparia* (L.)								x	x		x		x	x														
37	*Delichon urbica* (L.)								x					x			x				x								
38	*Spatula clypeata* (L.)						x									x						x							
39	*Botaurus stellaris* (L.)											x	x	x															
40	*Ciconia ciconia* (L.)											x		x		x													
41	*Alcedo atthis* L.															x	x												x
42	*Remiz pendulinus* (L.)															x	x					x							x
43	*Acrocephalus scirpaceus* (Herm.)									x		x		x															
44	*Motacilla alba* L.								x				x								x								
45	*Sturnus vulgaris* L.								x			x		x															
46	*Anas acuta* L.								x	x																			
47	*Tringa totanus* L.							x							x														
48	*Tringa* sp. L.																			x		x							
49	*Pandion haliaëtus* (L.)								x							x													
50	*Motacilla flava* (L.)									x			x																
51	*Aythya marila* (L.)																x												
52	*Oidemia nigra* (L.)																									x			
53	*Larus fuscus* L.														x														
54	*Larus minutus* Pall.																				x								
55	*Chlidonias nigra* (L.)													x															
56	*Philomachus pugnax* (L.)														x														
57	*Tringa nebularia* (Gunn.)																					x							
58	*Tringa erythropus* (Pall.)																				x								
59	*Gallinula chloropus* (L.)																			x									
60	*Ciconia nigra* (L.)									x																			
61	*Circus cyaneus* (L.)																		x										
62	*Locustella luscinoides* (Savi.)											x																	

Species connected only with shore environments: 63. *Buteo buteo* (L.), 64. *Corvus corax* L., 65. *Buteo lagopus* (Brünn.), 66. *Accipiter gentilis* (L.), 67. *Cuculus canorus* L., 68. *Parus coeruleus* L., 69. *Fringilla coelebs* (L.), 70. *Accipiter nisus* (L.), 71. *Falco tinnunculus* L., 72. *Turdus merula* L., 73. *Turdus pilaris* L., 74. *Turdus ericetorum* Turt., 75. *Phylloscopus trochilus* L., 76. *Phylloscopus collybita* Vieill., 77. *Emberiza citrinella* L., 78. *Garrulus glandarius* (L.), 79. *Coleus monedula* (L.), 80. *Corvus frugilegus* L.

A. platyrhynchos prevails as a rule. It is worthy mentioning that while comparing the community of the complex of Wielkie Mamry Lake with other communities of waterfowl occurring on other Mazurian lakes (Nowak 1958, Karczewski 1953, Lewandowski 1964, Krzanowski and Pinowski after Nowak 1966) the species classified on Mamry Lake to the group of subdominants may reveal considerable fluctuations in numbers. Besides, *Acrocephalus* sp. should be certainly classified to dominants, but due to the applied procedure they were not quantitatively approached.

Such simple picture obtained for whole community and whole lake, or even for individual reservoirs comprising Mamry Lake, is complicated when seasonal changes of community are considered. The previously stated domination of *Fulica atra* is a mean from four identified periods and results from the massy occurrence of this species during the post-breeding season, when on lake there are formed enormous flocks (Tab. IV). During pre-breeding and autumnal periods *Aythya* sp. are dominants: during the pre-breeding season – *A. nyroca*, while during the autumnal season – *A. ferina*. On the other hand the breeding period, and even the post-breeding one is characteristic with a strong decline in their abundance. During the breeding period the domination is taken by *Anas platyrhynchos*. Such a pattern is more or less uniform on all reservoirs comprising Wielkie Mamry Lake.

Certain differences in the way of bird occurrence on individual reservoirs are connected with characteristic features of the latter. As it was already mentioned Kirsajty Lake is whole strongly eutrophic, shallow and grown with soft vegetation. This distinctly determines the quantitative pattern of occurring here birds and even affects relations prevailing in bird community of Wielkie Mamry Lake as a whole. Dobskie is a lake with obvious distinctions. It seems that the reason of these distinctions provide occurring here the big colony of *Phalacrocorax carbo* and *Ardea cinerea* (on Cormorant Isle). On this lake there are, moreover, periodically occurring and disappearing colonies of *Larus ridibundus* and *Sterna hirundo*, *Chlidonias nigra* – one in vicinity of Pilwa Bay, another one close to Cormorant Isle on a small, stony isle. Both the vicinity of Cormorant Isle and the small stony isle, in spite of great lake character, are willingly visited by numerous bird species. *Fulica atra*, *Podiceps cristatus*, various species of ducks (*Anas* sp. and *Aythya* sp.) nest here and on Cormorant Isle in 1965 there were found nests of *Mergus merganser* (Pilarska and Czaja 1967). Pilwa Bay provides a region of numerous nesting sites for various duck species (*Anas* sp. and *Aythya* sp.), *Fulica atra* and *Podiceps cristatus*. Numerous breeding sites are to be found also on Kirsajty Lake and on Northern Mamry in the vicinity of Upałty Island.

The identification of more and less eutrophic portions of lake enabled the evaluation of the degree of preferences in individual bird species (Tab. IV).

The occurrence of birds on Mamry Lake

La-

Species	Kisajno			Dargin			Łabab			La-
	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total	eutro-phy
Podiceps cristatus	2.39	3.13	2.76	2.66	0.96	1.81	2.78	3.83	3.31	2.17
Fulica atra	43.16	16.67	29.92	92.18	50.97	71.57	12.85	11.00	11.97	9.97
Anas sp.	11.06	18.96	15.01	11.81	14.85	13.33	22.57	25.17	23.87	17.92
Anas platyrhynchos	9.49	14.13	11.81	9.88	14.35	12.12	22.32	17.00	19.66	10.48
Anas crecca	0.02	0.04	0.03	–	–	–	0.02	–	0.01	0.50
Anas querquedula	0.12	–	0.06	1.66	0.10	0.88	0.10	1.67	0.88	0.98
Anas strepera	0.76	0.39	0.57	–	0.40	0.20	–	6.25	3.13	1.21
Aythya sp.	9.95	7.46	8.71	57.76	11.04	34.40	19.53	12.17	15.85	9.94
Aythya ferina	8.02	4.19	6.35	21.60	3.99	12.79	1.24	1.67	1.25	0.40
Aythya nyroca	0.85	1.42	1.13	33.79	3.91	18.85	3.92	10.17	7.05	4.50
Aythya fuligula	0.27	1.03	0.65	1.96	2.52	2.24	5.81	0.33	3.07	0.33
Bucephala clangula	0.10	0.30	0.20	0.36	0.60	0.48	0.81	–	0.43	0.13
Mergus sp.	0.13	0.54	0.33	1.44	0.15	0.79	5.35	0.63	2.99	0.13
Mergus merganser	0.11	0.07	0.09	1.44	0.10	0.77	1.80	0.33	1.06	–
Mergus serrator	–	0.20	0.10	–	0.05	0.02	1.57	0.14	0.85	–
Cygnus olor	0.53	0.52	0.52	0.61	1.68	1.14	0.10	1.50	0.80	0.52
Phalacrocorax carbo	0.17	0.79	0.48	1.16	0.80	0.98	1.35	2.22	1.79	0.62
Larus ridibundus	2.59	4.72	3.65	10.12	6.71	8.41	3.13	1.75	2.44	15.82
Ardea cinerea	0.30	0.46	0.38	0.26	0.23	0.25	0.80	0.78	0.79	0.67

From the data collected for whole Wielkie Mamry Lake it results that, in general, *Anas platyrhynchos*, *Podiceps cristatus*, *Cygnus olor*, *Ardea cinerea*, and *Larus ridibundus* do not reveal preferences, and even some of these species are slightly more frequent in oligotrophic environment, as e.g. *Anas platyrhynchos* or *Cygnus olor*. It should be added that in Table IV there are evident differences in the occurrence of *Anas platyrhynchos* in eutrophic and oligotrophic environments during the autumnal season. These differences should be, however, considered as unsignificant, because just during this season numerous ducks, including a great number of *A. platyrhynchos* were due to objective reasons identified only to genus, as *Anas* sp. On the other hand the distribution of *Anas* sp. in both environments during autumnal season does not reveal differences.

after conversion into 1 current km

Tab. III

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Dobskie		Kir-sajty	North Mamry			Święte			Whole lake (Mamry)			Prevalence in environments	
oligo-trophy	total	eutro-phy (total)	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total	eutro-phic (Kirsajty Lake excluded)	oligo-tro-phic
3.03	2.60	2.81	2.31	1.19	1.75	5.67	4.42	5.04	2.97	2.76	2.86	3	3
76.02	43.00	165.63	26.90	25.05	25.97	37.83	10.02	23.92	55.50	31.62	43.56	5	1
23.61	20.76	32.64	20.10	25.38	22.74	25.00	19.25	22.13	20.16	21.20	20.68	1	5
19.84	15.16	5.60	19.69	24.48	22.08	12.00	18.96	15.48	12.78	18.13	15.45	1	5
–	0.25	0.07	–	0.02	0.01	2.00	0.21	1.10	0.37	0.05	0.21	2	3
0.39	0.69	2.27	0.01	0.38	0.20	6.67	–	3.33	1.69	0.42	1.06	4	2
1.55	1.38	0.59	0.29	0.22	0.25	3.33	0.08	1.71	0.88	1.48	1.18	3	3
16.79	13.36	181.68	49.87	26.90	38.38	9.50	5.43	7.27	48.32	13.30	30.81	5	1
7.28	3.84	133.09	1.25	12.26	6.75	3.33	5.29	4.31	24.13	5.86	15.00	2	4
5.55	5.02	38.86	3.00	7.92	5.46	1.25	–	0.63	12.31	4.83	8.57	2	4
0.95	0.64	9.43	0.62	2.38	1.50	4.50	0.04	2.27	3.27	1.21	2.24	2	4
2.13	1.13	0.04	1.01	1.98	1.49	–	–	–	0.36	0.83	0.60	1	4
2.75	1.44	–	2.41	1.48	1.94	–	0.08	0.04	1.35	0.94	1.14	3	3
0.38	0.19	–	0.11	0.47	0.29	–	–	–	0.49	0.22	0.36	3	2
2.13	1.07	–	1.68	0.27	0.97	–	–	–	0.46	0.47	0.46	2	3
1.41	0.97	1.32	0.50	0.91	0.71	2.50	0.21	1.35	0.87	1.04	0.95	2	4
0.86	0.74	0.98	1.25	0.44	0.85	5.75	0.83	3.29	1.61	0.99	1.30	4	2
6.07	10.94	7.58	9.36	10.37	9.87	0.83	6.63	3.73	7.06	0.44	6.55	3	3
0.67	0.67	0.77	0.48	0.53	0.51	0.75	1.06	0.90	0.57	0.62	0.60	2	3

Fulica atra, *Aythya ferina*, *A. nyroca*, *A. fuligula*, *Anas querquedula*, *A. crecca*, *Mergus merganser*, and *Phalacrocorax carbo* indicate a clear preference for eutrophic environments. (Similarly Szijj 1965b reports that on the Lake of Constance diving ducks (*Aythya* sp.) clearly preferred eutrophic environments). On the other hand *Anas strepera* and *Bucephala clangula* occur more frequently in oligotrophic, than eutrophic environments.

This environmental selection to a serious degree explains differences in the occurrence and quantitative composition of bird community on individual reservoirs constituting the Mamry Lake. Mentioned previously differences in relation to other lakes, which are to be found in Dobskie Lake (Tab. III) as e.g. domination of *Fulica atra* and *Aythya* sp. in oligotrophic environment,

The occurrence of birds on Wielkie

Species	Pre-breeding period *I*			Breeding period *II*		
	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total
Cygnus olor	0.77	1.19	0.98	0.75	1.59	1.17
Fulica atra	20.22	9.97	15.09	22.15	7.41	14.78
Aythya sp.	47.16	21.87	34.56	8.12	4.74	6.43
Aythya ferina	8.44	5.85	7.14	5.07	4.05	4.56
Aythya nyroca	29.69	13.72	21.71	1.86	0.21	1.03
Aythya juligula	2.20	2.09	2.14	0.68	0.12	0.40
Anas sp.	9.03	12.05	10.54	18.12	26.79	22.45
Anas platyrhynchos	5.38	6.46	5.92	15.93	25.49	20.71
Anas strepera	0.05	4.35	2.20	1.84	1.15	1.49
Anas crecca	–	–	–	0.04	–	0.02
Anas querquedula	0.18	1.18	0.68	0.31	–	0.15
Bucephala clangula	0.39	0.60	0.49	0.18	0.39	0.28
Mergus sp.	0.83	1.06	0.94	0.13	0.14	0.13
Mergus merganser	0.23	0.68	0.45	0.12	0.14	0.13
Mergus serrator	–	0.22	0.11	--	–	–
Podiceps cristatus	2.98	4.45	3.76	5.10	4.24	4.67
Phalacrocorax carbo	0.96	1.45	1.21	2.97	1.51	2.24
Larus ridibundus	17.42	9.17	13.29	4.59	6.65	5.62
Ardea cinerea	0.59	0.97	0.78	0.72	0.79	0.75

might be explained in my opinion by the presence of breeding colonies of *Phalacrocorax carbo*, *Ardea cinerea*, and *Larus ridibundus* which obviously alter the littoral of open type into an environment more attractive for *Fulica atra* and ducks (*Anas* sp. and *Aythya* sp.). Similar situation occurred also on Gołdapiwo Lake in the vicinity of *Ardea cinerea* colony (Nowak 1958). Generally, both the birds, which indicate an obvious environmental selectivity and those which do not reveal it, are distributed not uniformly on lake, latter ones revealing more uniform distribution. It seems that the uniformity of distribution is to a serious extent connected with certain features of the

Mamry Lake converted into 1 current km

Tab. IV

Post-breeding period *III*			Autumnal period *IV*			All the year		
eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total	eutro-phy	oligo-trophy	total
0.32	0.69	0.51	0.79	0.69	0.74	0.87	1.04	0.95
150.38	83.21	116.79	27.12	25.89	26.51	55.50	31.62	43.56
18.32	7.40	12.86	125.05	19.19	72.12	48.32	13.30	30.81
13.65	4.26	8.96	70.09	9.29	39.29	24.13	5.86	15.00
1.28	0.93	1.11	20.95	4.47	12.71	12.31	4.83	8.57
1.45	1.35	1.40	8.43	1.27	4.65	3.27	1.21	2.24
27.94	22.04	24.99	23.23	23.80	23.50	20.16	21.20	20.68
22.23	20.26	21.25	6.65	20.46	13.56	12.78	18.13	15.45
0.79	0.42	0.61	0.38	–	0.19	0.88	1.48	1.18
1.15	0.04	0.59	–	0.16	0.08	0.37	0.05	0.21
3.61	0.12	1.87	1.81	0.40	1.11	1.69	0.42	1.06
0.21	0.25	0.23	0.78	2.52	1.65	0.36	0.83	0.60
0.91	0.02	0.47	3.79	2.45	3.12	1.35	0.94	1.14
0.91	–	0.45	0.89	0.08	0.48	0.49	0.22	0.36
–	–	–	1.85	1.67	1.76	0.46	0.47	0.46
2.38	2.11	2.25	0.45	0.26	0.35	2.97	2.76	2.86
0.22	0.02	0.12	–	–	–	1.61	0.99	1.30
8.37	7.07	7.72	0.44	1.03	0.78	7.06	6.04	6.55
0.39	0.09	0.24	–	–	–	0.57	0.62	0.60

biology of given species. Species which occupy home ranges, are distributed more uniformly than other. *Podiceps cristatus* may provide an example. In other cases one can find the constancy of occupied territories, as e.g. in *Cygnus olor* or *Circus aeruginosus*. Lewandowski (1964) reported similar examples of this phenomenon. Attachment to definite portions of lake is revealed by the majority of species. Species forming and maintaining individual ranges occur singly, in pairs or family groups, other form greater or lesser aggregations. E.g. a pair of *Podiceps griseigena* was permanently keeping itself on Kisajno Lake in vicinity of Zimny Kąt. On one of sandy

points of this lake, rather not far from Fuledzki Róg, one could find constantly a pair of *Mergus merganser*. Above the forested part of the western shore of the same lake one could regularly watch *Haliaëtus albicilla* flying in air. *Fulica atra*, *Aythya* sp., and *Anas platyrhynchos* were concentrated or occurring in a higher than average number in shallow and as a rule strongly grown with vegetation portions, but locally also in lake portions of oligotrophic character. There were also permanent resting points of *Larus ridibundus* on Northern Mamry and Święte Lake, on stony shallows in the junction of Dargin, Kisajno, and Łabab lakes, on Dobskie Lake in the vicinity of Cormorant Isle and the colony of *L. ridibundus*, and a small resting and roosting point on Kisajno near Giżycko. Similarly cormorants (*P. carbo*) had their permanent and preferred places of resting on an isle on Kirsajty Lake, together will gulls on stony shallows in the junction of Dargin, Kisajno, and Łabab lakes and on the Łabab Lake. Places particularly preferred by bird concentrations in autumn provide all kinds of shallows in the central portion of lake, both in eutrophic and oligotrophic portions. The occurrence of such places particularly willingly occupied by birds during different periods is illustrated by Figure 1.

It seems that serious, and in certain cases even decisive effect upon the distribution of birds (besides of their biological features) has the frequency of human penetration in the given section of lake (also Lewandowski 1964 calls attention to this). For a majority of species this is a factor eliminating them from a definite section of lake, but for some on contrary this may be an attracting factor, as e.g. for *L. ridibundus* grouping close to ships or motorboats of fishermen crossing Mamry Lake.

Generally one can state that the distribution of birds on a lake is rather consistent and irrespectively to fact whether portions are eutrophic or oligotrophic birds keep themselves in definite places of the lake. With the course of time from the breeding season to autumn there is to be noted a trend towards the formation of larger flocks and occurrence of birds in enormous aggregations especially during autumn season exclusively in certain portions of lake. During this period the community is decreased by these species which migrate towards winter quarters, as *Phalacrocorax carbo*, *Ardea cinerea*, *Circus aeruginosus*, while the number of other is remarkably reduced, as that of *Podiceps cristatus*. Diving ducks (*Aythya* sp.) take an absolute domination.

The formation of coot flocks, the occurrence of constant resting and roosting places of gulls is commonly known and frequently described. The known phenomenon presents also the formation and maintaining of flocks of various duck species, what is explained by their social inclinations. Examples of this gives Szijj (1965b) who analyzed the realization of these social phenomena in relation to weather, such life activities as congregation in resting places or feeding, vegetation season, etc.

In my observations, having material coming from areas with various degree

of eutrophy I was able to examine what an effect upon the size and character of flocks has the kind of environment. I found that irrespectively to the discussed above irregularity of bird occurrence on lake there occur differences in the way of occupation of eutrophic and oligotrophic portions. In eutrophic environments groups are by far more compact – they are restricted to relatively small area. In oligotrophic environments flocks are considerably more loosened – more scattered. They extend over a larger area – they are built along a narrow belt of reeds and consist frequently of several lesser subgroups. It may be, thus, that the sheltered littoral, great volume of reed belt, enables the extension of flock not only along shore, but also "inside" – giving possibility for the full realization of flock inclinations. Open littoral does not allow for this, "extending" the flock along the shore. The situation is similar in the central portion of lake, in its eutrophic and oligotrophic portions. Only the eutrophic part of lake enables the full realization of social trends leading to the formation of large, many species including, flocks of birds.

INHABITING OF LAKE ZONES BY BIRDS

Contemporary concepts

It is obvious that different species of the presented bird community occupy different zones of the lake. The knowledge of biology of individual species makes it possible to attribute to various zones their characteristic species, and so, one can assume a priori that the reed zone will be inhabited by e.g. warblers, little bitterns, bitterns, herons, mallards, harriers; that in the zone of open water one should expect to meet grebe, cormorant or sawbills.

Nesting requirements, way of feeding and avoiding dangers, characters of anatomical structure, to a serious extent condition the zonal distribution of waterfowl. Further factor provides the interspecific competition of ecologically related species or, on contrary, the cooperation and mutual assistance during feeding.

It is just on the background of the knowledge of biological features of various species of waterfowl that Dunajewski (1938, 1943) could present schemes of the occupation of various aquatic and shore zones of reservoirs of various types. These schemes concerned breeding and feeding niches of different species. The detailed differentiation of breeding niches was presented by Bocheński (1960) on the example of avifauna occurring on fish ponds at Gołysz or Gotzman (1965) who indicated and explained reasons of nesting in different zones of reeds by different species of grebes.

Hobbs (1957) cited an interesting example of the regionalisation of feeding by coot, moorhen, and grebes indicating that on a shallow water they

feed maintaining the definite sequence owing to which one species "mobilizes" food for another. It is known that similar relationship occurs between flamingos and waders. There are, after all, observations on food robbery by ducks in relation to coot (Berthold 1961).

Studies by Beitz (1966) as well as by Krzanowski and Pinowski after (Nowak 1966), indicate that in highly eutrophic lakes in the zone of an open water there occur more abundantly than in reeds or on their ecotone: *Podiceps cristatus, Aythya nyroca, A. ferina, A. fuligula, Larus ridibundus, Sterna hirundo*. On the other hand in the zone of reeds there prevail in numbers *Anas platyrhynchos, A. querquedula, A. strepera, Fulica atra, Ardea cinerea, Cygnus olor, Circus aeruginosus*. Papers by Haartman (1945) and Horvath (1956) indicated the zonal occurrence of waterfowl and the variation in this phenomenon in various types of reservoirs. The zonal differentiation occurs also in river birds what was indicated in my paper about birds of Vistula River (Dobrowolski 1964). Finally the paper by Lewandowski (1964) done on Northern Mamry gave rather clear picture of the occurrence of individual species of birds of a lake in its various zones.

Interesting and universal discussion of these problems gave Szijj (1965a, 1965b) in his paper on the differentiation of duck community on a portion of the Lake of Constance (Ermatingen Lake). This is a shallow highly eutrophic and grown with vegetation (mainly *Charales*) reservoir, on which numerously gather various duck species. Szijj analyzed various factors affecting the way of occurrence of duck community. He claims that weather, and above all strong wind alters places of their feeding – "drifts" birds into reeds or to their vicinity (perhaps this is connected with waves). He presented also considerations analyzing the ethology of feeding in connection with differences in the way of food intake by different species and the involved depth from which food is taken. He identified six ways of food intake by ducks, namely·

1 – diving (whole bird is submerged in water),

2 – partial diving (head and front of bird's body are submerged, legs paddle on water surface),

3 – dipping in water only head and neck, while bird swims on water surface,

4 – collection of food from water surface,

5 – searching after food on land "on foot",

6 – chasing a prey (most often insects).

The majority of species obviously utilizes not one but several types of food intake, but usually one or two distinctly dominate. This is illustrated by Szijj in a table presenting the percentual frequency of the use of a definite way of food intake by given species.

In connection with different depths at which dive various bird species and with different way of food intake there occurs zonal or stratal differentiation of community. Such a zonal pattern not always, of course, might be directly observed, nevertheless it occurs always.

Species	Type of feeding					
	1	*2*	*3*	*4*	*5*	*6*
Anas crecca		12	36	16	36	
Anas querquedula		29	37	22		12
Anas penelope			20	26	54	
Anas strepera		13	71	1	15	
Spatula clypeata	3	14	46	37		
Anas platyrhynchos	1.5	42	44	7	1.5	
Dafila acuta		63	37			
Cygnus olor		40	60			
Netta rufina	34	40	13	13		
Aythya ferina	19	18	3			
Aythya fuligula	90	10				
Bucephala clangula	100					

During the resting time birds aggregate in flocks of various species in vicinity of reeds, then their gregarious instinct is revealed. The zonal pattern is subjected to changes in the course of vegetation season. During the breeding period there might be identified two groups of birds – nesting and not nesting. The nesting group feeds in reeds, close to nests, while the not nesting one – on the borderline of reeds. Relations are similar during the moulting period. During the time of autumnal migrations the zonal pattern is very well marked. *Anas crecca* and *A. querquedula* occupy reeds, while *Aythya fuligula* edge of submerged meadows. Still other relations prevail during late autumn and spring. The kind of food taken is simultaneously subjected to some seasonal changes. In general during late autumn there decreases the importance of plant food and strongly increases the consumption of animal food.

On the basis of above reviewed data from literature one can form a general opinion on the way, in which birds should be distributed in individual zones of lake. It should not be forgotten that the aggregation in definite zone may have different causes. Involved are numerous factors conditioning the distribution of spruces, such as search after suitable breeding or feeding niche, way of food intake, securing of safety (I defined this the search after safety niche). Further a significant part is played by social trends, as also the direct or undirect competition. (In the determination of feeding niche I considered stomach analyses, in the determination of security niche – the way and direction of escape of flushed birds). Mentioned elements play various role in bird's life during different periods of vegetation season, they not always are equally important, but always significant. Moreover there may come to the modification of response under the impact of environmental factors, e.g. under the impact of weather.

Thus the distribution of birds in a lake and their occupation of definite zones fails to yield a clear picture which could be noted already in the course

of superficial observations. It is only the detailed analysis of the distribution of individual birds accounting for above mentioned factors which enables the understanding of the real pattern of the zonal community of birds on lake.

Zonal occurrence of individual species

In order to carry out analysis of the zonal occurrence of birds on Wielkie Mamry Lake I calculated the percentual proportion of each species in eutrophic and oligotrophic environment for individual species and zones during each season. In certain cases I had to use collective data concerning genus only (*Anas* sp., *Aythya* sp., *Mergus* sp.), because conditions for observation, especially during autumnal period, made impossible the accurate identification of species. This is why, while analyzing diagrams presenting the distribution of particularly such species, as *Anas platyrhynchos*, *Aythya nyroca*, *A. ferina*, *Mergus merganser*, *M. serrator* one should consider data for *Anas* sp., *Aythya* sp., and *Mergus* sp.

The carried out analysis revealed that the majority of species has a similar manner of occurrence in eutrophic and oligotrophic environment. Only diving ducks (*Aythya* sp.) and *Ardea cinerea* reveal differences, the latter species by far lesser ones than diving ducks (*Aythya* sp.). Numerous species reveal also different distribution in both environments during certain periods of vegetation season. Uniform distribution in both environments reveal all species during breeding season, during the pre-breeding season differences in distribution reveal *Anas platyrhynchos*, *Mergus* sp., and *Bucephala clangula*, during the post-breeding period – only *Anas strepera*, while during autumnal season – *Anas querquedula*, *Cygnus olor*, *Fulica atra*, *Podiceps cristatus*, and *Larus ridibundus*. Moreover it appeared that as a rule the same distribution, and thus manner of occurrence, have *Aythya nyroca* and *A. ferina* during the breeding and autumnal season in eutrophic, while during the autumnal season – in oligotrophic environment. Everywhere, where there were no differences in the occurrence of birds in eutrophic and oligotrophic environments I combined data from both sites and discussed them jointly.

Fulica atra (Fig. 2). Majority of individuals is concentrated on reed boundary, only in an oligotrophic environment during autumn they aggregate at the distance of 50 m. During the post-breeding season they are distributed rather uniformly within the whole studied belt, occurring also in a rather considerable number in the central portion of lake. In the central portion of lake they may be found also during the pre-breeding period, but in a remarkably lower numbers. It is worthy mentioning that the post-breeding season is also the period of the highest concentration of coots on a lake. Reeds provide the safety niche, submerged meadows (shallow littoral) and littoral – feeding niche, food mostly vegetarian.

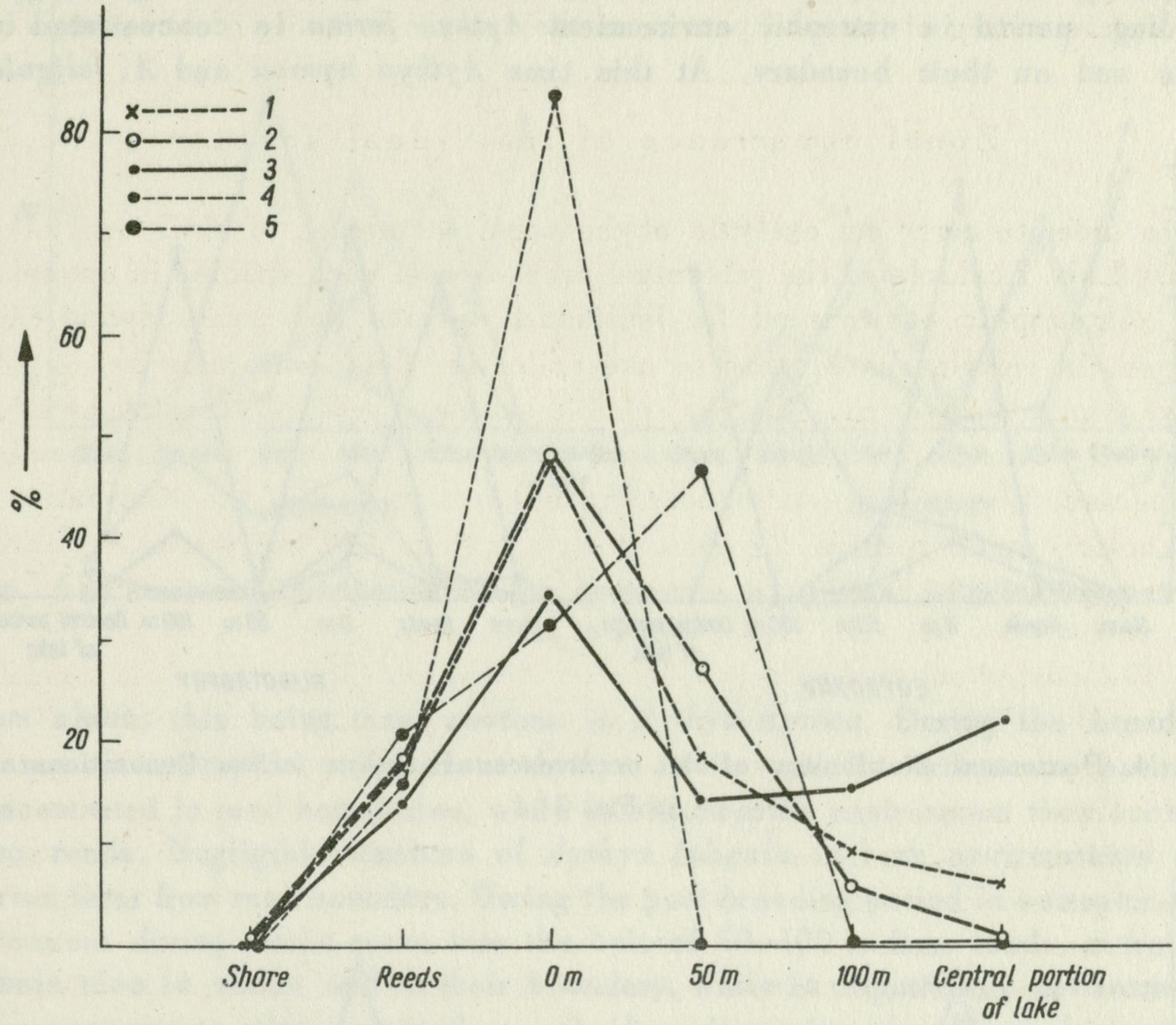


Fig. 2. Percentual distribution of the occurrence of *Fulica atra*

1 – pre-breeding season, *2* – breeding season, *3* – post-breeding season, *4* – autumnal season – eutrophy, *5* – autumnal season – oligotrophy

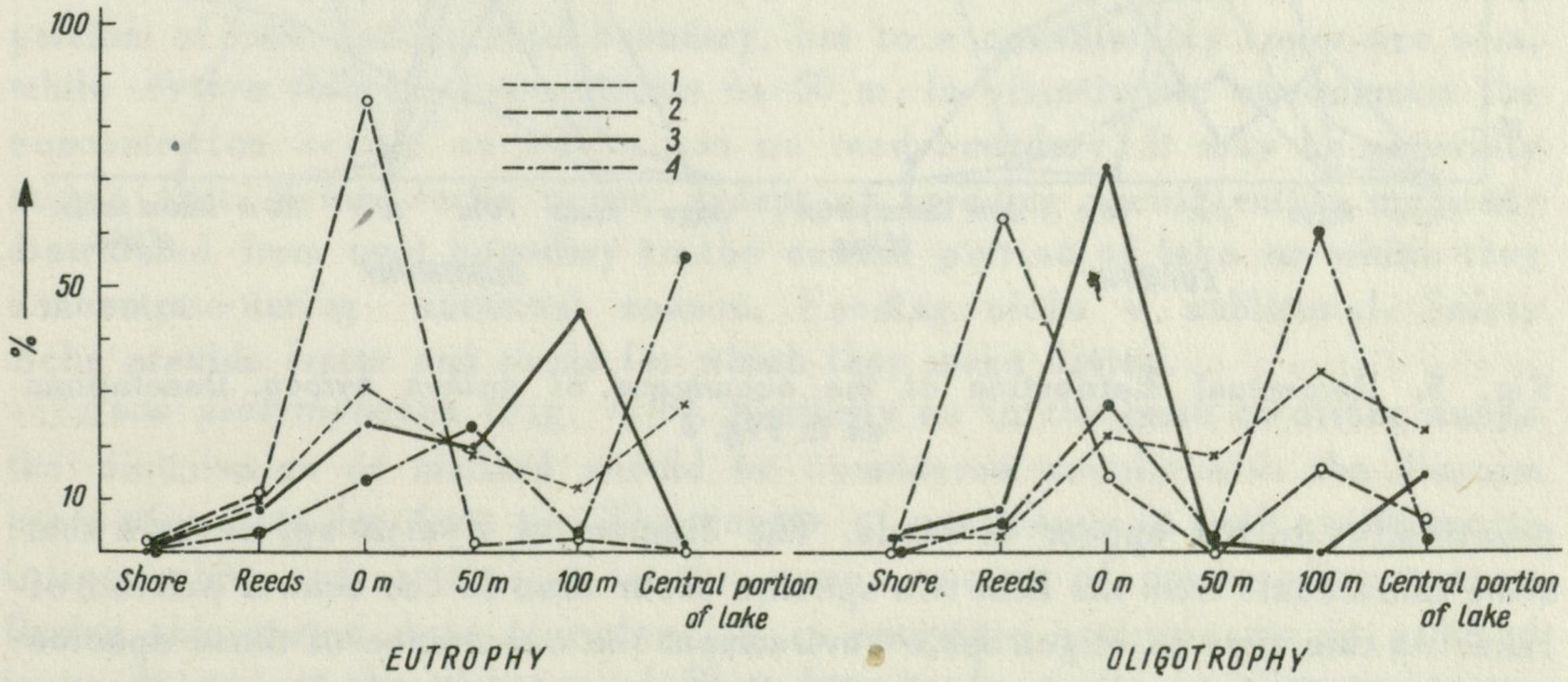


Fig. 3. Percentual distribution of the occurrence of *Aythya* sp.

1 – pre-breeding season, *2* – breeding season, *3* – post-breeding season, *4* – autumnal season

Aythya ferina, A. nyroca, A. fuligula (Figs. 3, 4, 5, 6). The diagram for *Aythya* sp. is necessary in the discussion of these species. During the pre-breeding period in eutrophic environment *Aythya ferina* is concentrated in reeds and on their boundary. At this time *Aythya nyroca* and *A. fuligula*

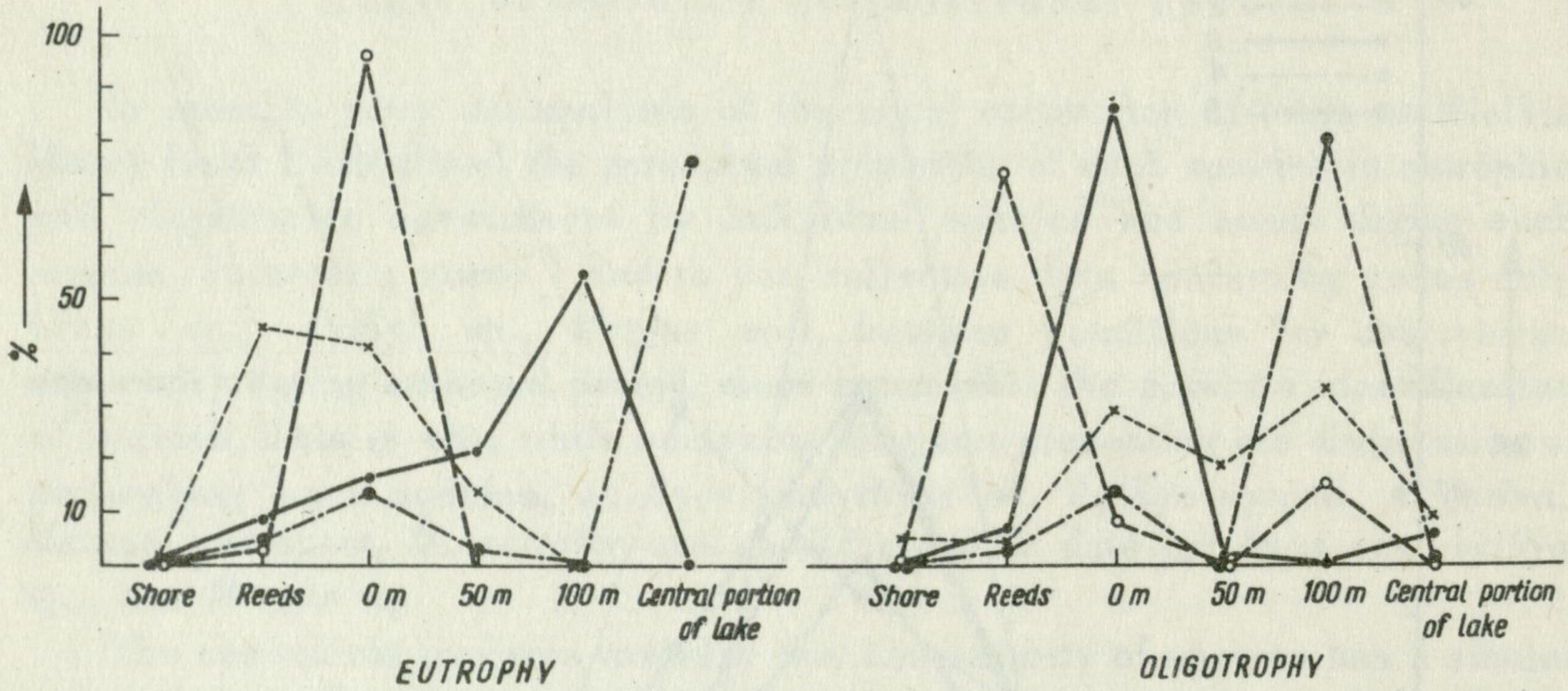


Fig. 4. Percentual distribution of the occurrence of *Aythya ferina*. Denotations as in Fig. 3

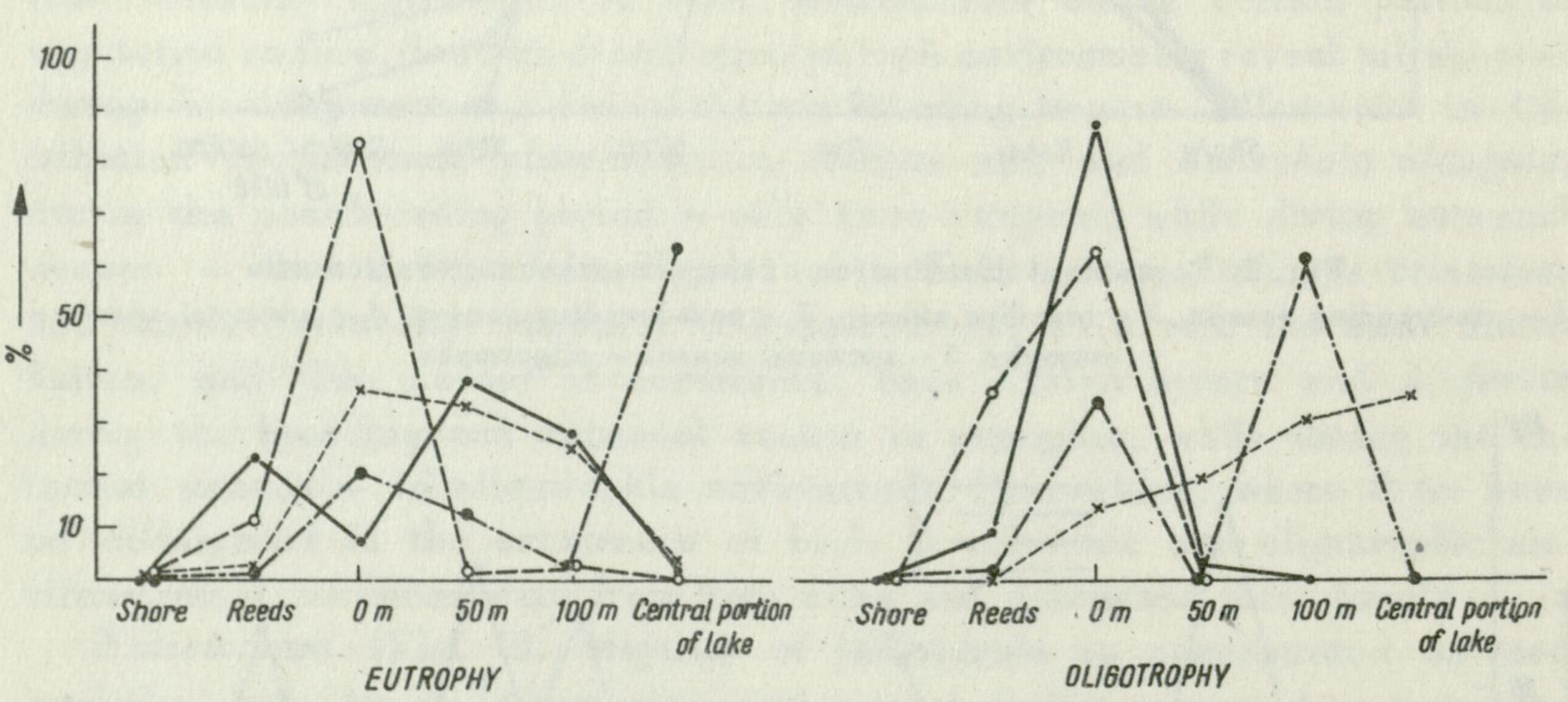


Fig. 5. Percentual distribution of the occurrence of *Aythya nyroca*. Denotations as in Fig. 3

practically do not appear in reeds. The diagram of *Aythya* sp. reveals that some individuals from the first two species occur also in the central portion of lake. At this time in oligotrophic environment the occurrence of these species is more similar to each other – the distribution among individual zones is more uniform with the trend towards the increase in numbers with increasing distance

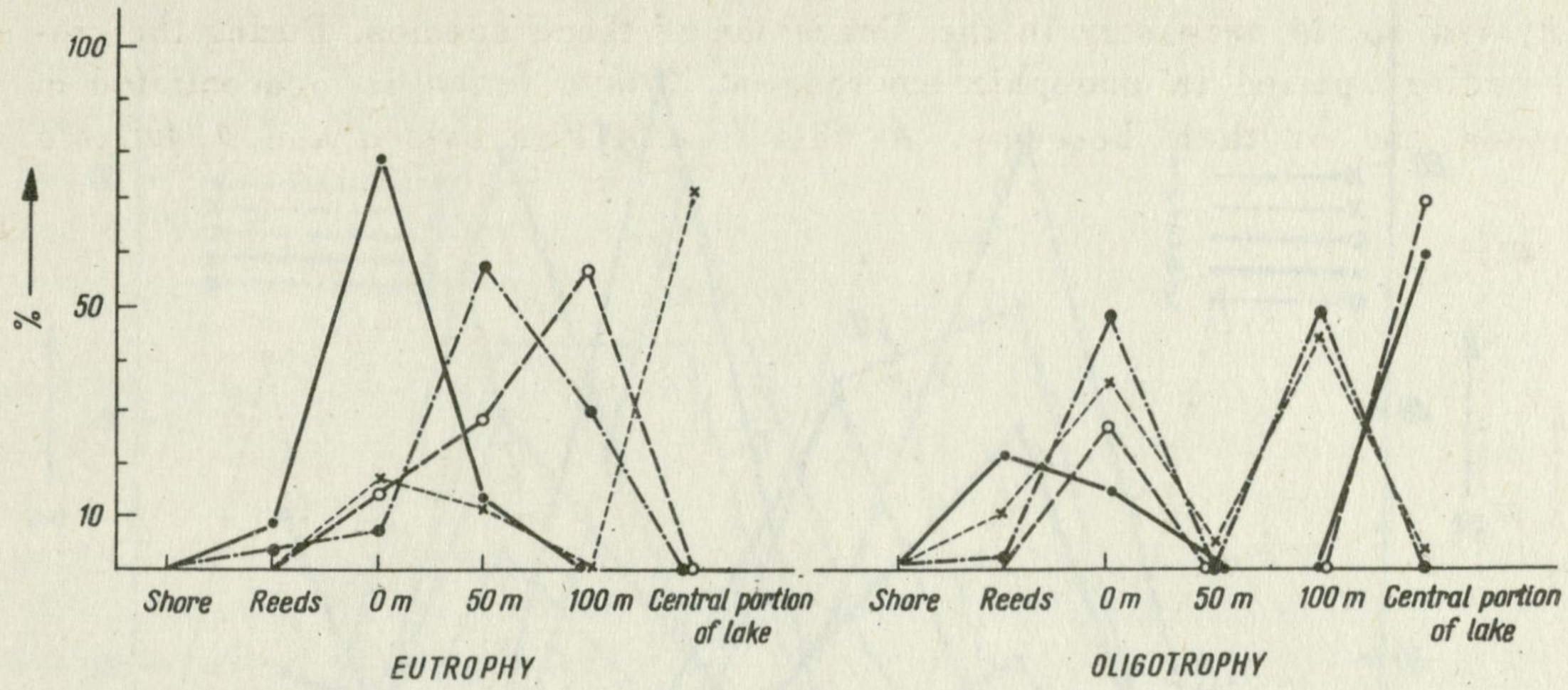


Fig. 6. Percentual distribution of the occurrence of *Aythya fuligula*. Denotations as in Fig. 3

from shore; this being most obvious in *Aythya nyroca*. During the breeding season in eutrophic environment *Aythya ferina* and *A. nyroca* are entirely concentrated in reed boundaries, while in oligotrophic environment they occupy also reeds. Negligible numbers of *Aythya fuligula* in both environments occurred farer from reed boundary. During the post-breeding period in eutrophic environment diving ducks move into the belt of 50–100 m from reeds, although remain also in reeds and on their boundary, while in oligotrophic environment they concentrate almost entirely on the boundary of reeds. (Some deviations reveals *Aythya fuligula* having two concentrations, in reeds and at 0 m, as well as in the central portion of lake). During autumnal season in eutrophic environment *Aythya ferina* and *A. nyroca* occur first of all in the central portion of lake and on reed boundary, but to a considerably lower per cent, while *Aythya fuligula* concentrates on 50 m. In oligotrophic environment the concentration occurs on 100 m and on reed boundary. It may be generally stated that diving ducks occur, except of breeding period rather uniformly distributed from reed boundary to the central portion of lake on which they concentrate during autumnal season. Feeding niche – sublittoral. Safety niche provide water and reeds for which they make diving.

Anas platyrhynchos (Fig. 7, 8). Similarly as in the case of diving ducks the distribution of mallard should be considered yointly with the diagram presenting data for *Anas* sp. The manner of occurrence in both environments (oligotrophic and eutrophic) is the same, except of pre-breeding season. During this period *Anas platyrhynchos* in eutrophic environments is grouped in reeds and at the distance of 50 m from reeds, while in oligotrophic environments – in reeds and on their boundary. During the breeding period *Anas platyrhynchos* is aggregated in reeds, during post-breeding period –

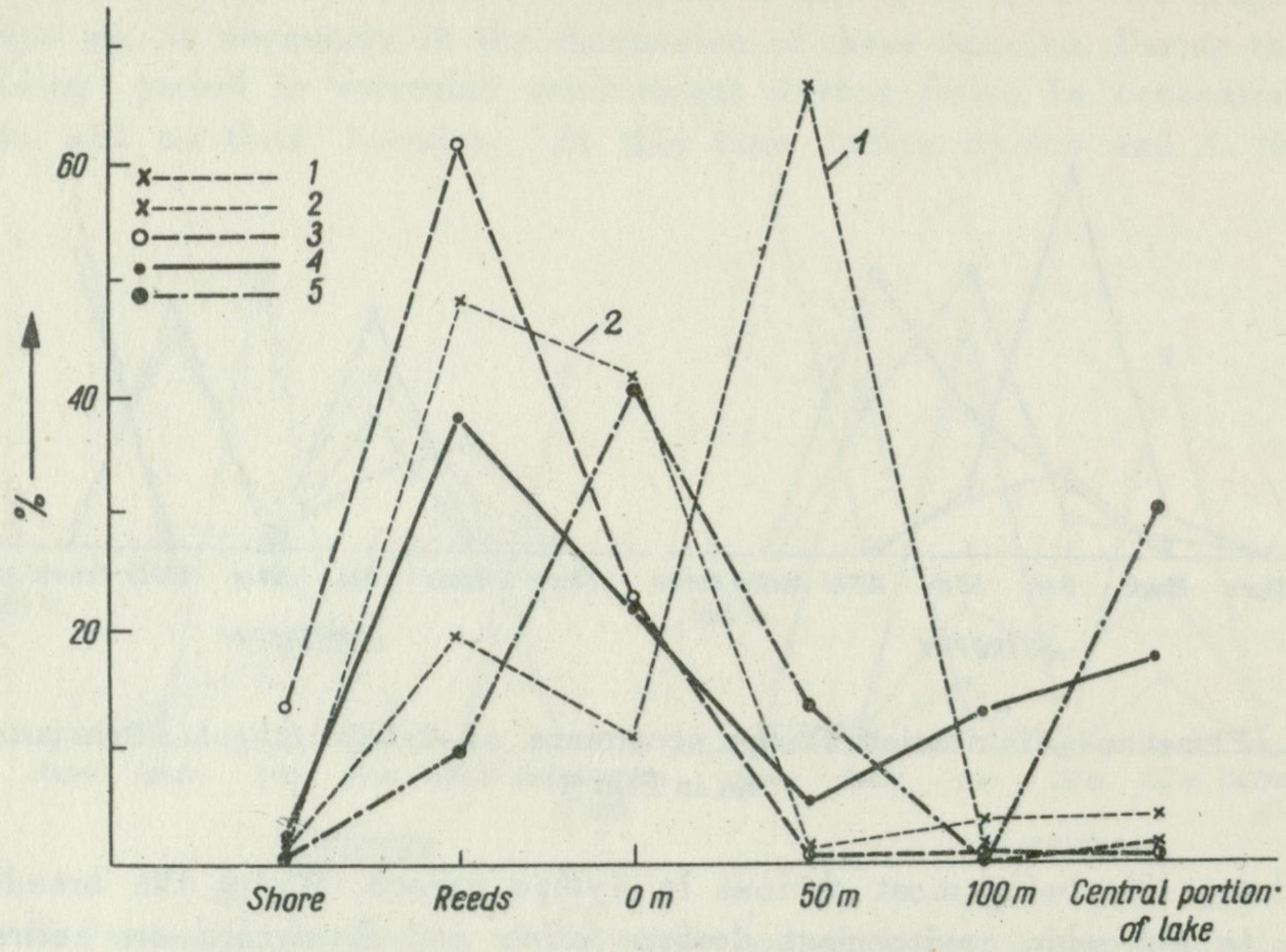


Fig. 7. Percentual distribution of the occurrence of *Anas* sp.

1 – pre-breeding season – eutrophy, *2* – pre-breeding season – oligotrophy, *3* – breeding season, *4* – post-breeding season, *5* – autumnal season

in reeds, in the central portion of lake and at the distance of 100 m from reeds, during autumnal period – on reed boundary and in the central portion of lake. It should be mentioned that in this case the value for the central portion of lake on the diagram presenting data concerning *Anas platyrhynchos* is too low and more concordant with the actual status is the diagram for *Anas* sp. Feeding niche – littoral and shore. Safety niche – reeds, air, during autumn – open water and air.

Anas strepera. Is a second after mallard puddling duck in respect to numbers and, as I had mentioned already, prefers more than *A. platyrhynchos* oligotrophic environments. The distribution of occurrence is concordant in both environments, except of the post-breeding season. Rather slight numbers of individuals were being observed. It occurs most numerously during the post-breeding season, during autumnal season not found at all in oligotrop ic environments (perhaps not identified?), while during the pre-breeding period it occurred only in oligotrophic environments (in eutrophic ones there were seen only two individuals). The manner of occurrence rather similar to that in *Anas platyrhynchos*, but concentration of birds in reeds and at 0 m is higher. Some differences are visible during the post-breeding period, when in eutrophic environments it is concentrated at 0 m, while in oligotrophic ones – in the central portion of lake (*Anas platyrhynchos* in reeds and in the

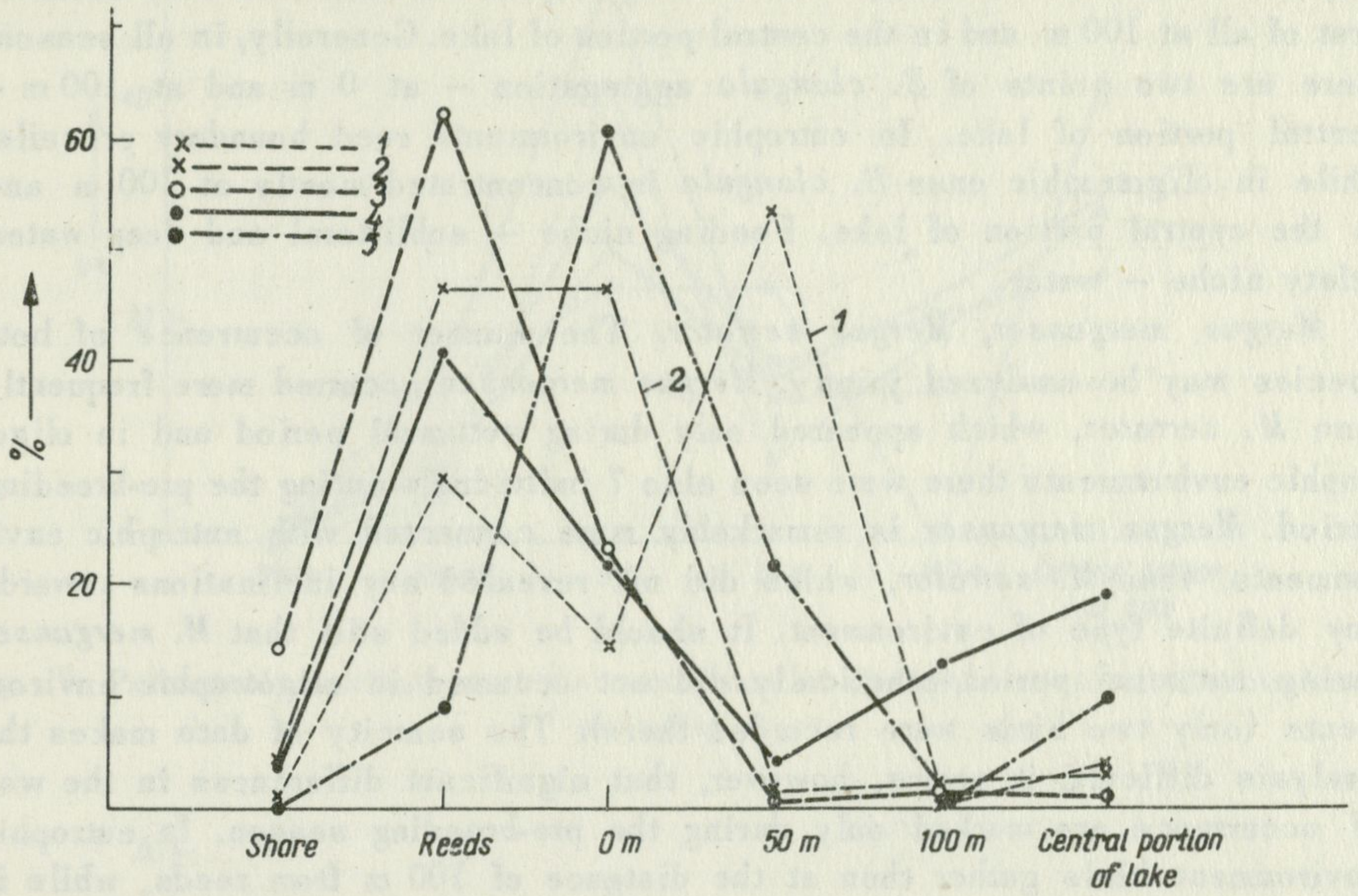


Fig. 8. Percentual distribution of the occurrence of *Anas platyrhynchos*. Denotations as in Fig. 7

central portion of lake), and during autumnal period, when it is absent everywhere, except of 0 m. Feeding and safety niches similar to *Anas platyrhynchos*.

Anas querquedula. Due to low numbers the analysis is possible only for the post-breeding and autumnal seasons. It is worthy mentioning only that during the pre-breeding season it occurred almost exclusively in oligotrophic environments (in eutrophic – only two individuals), while during the breeding season – in eutrophic environment. During the two remaining seasons it also prevails in eutrophic environments; the manner of occurrence during the post-breeding season being more or less uniform and different in autumn. Generally it may be stated that the species does not go farer from reeds than the zone of 50 m. Feeding and safety niches similar to these in *A. platyrhynchos*.

Anas crecca. It decidedly prevails in eutrophic environments, occurring slightly more numerously only during post-breeding period, when is grouped in reeds, while in eutrophic environments also in the belt of 50 m. Feeding and safety niche similar to that in *A. platyrhynchos*.

Bucephala clangula. Species dominating in oligotrophic environment and more numerously appearing only during the autumnal period. This makes the analysis of collected data difficult. Obvious differences in the occurrence in eutrophic and oligotrophic environments are marked only during the pre-breeding season, when in eutrophic environment *B. clangula* has been seen

only within the zone of 0 m, while in oligotrophic environments they occurred first of all at 100 m and in the central portion of lake. Generally, in all seasons there are two points of *B. clangula* aggregation – at 0 m and at 100 m – central portion of lake. In eutrophic environments reed boundary prevails, while in oligotrophic ones *B. clangula* is concentrated mostly at 100 m and in the central portion of lake. Feeding niche – sublittoral and deep water. Safety niche – water.

Mergus merganser, Mergus serrator. The manner of occurrence of both species may be analyzed jointly. *Mergus merganser* occurred more frequently than *M. serrator*, which appeared only during autumnal period and in oligotrophic environments there were seen also 7 individuals during the pre-breeding period. *Mergus merganser* is remarkably more connected with eutrophic environments, than *M. serrator*, which did not revealed any inclinations towards any definite type of environment. It should be added still that *M. merganser* during autumnal period practically did not occurred in oligotrophic environments (only two birds were recorded there). The scarcity of data makes the analysis difficult, it seems, however, that significant differences in the way of occurrence are marked only during the pre-breeding season. In eutrophic environment birds gather then at the distance of 100 m from reeds, while in oligotrophic environment at 0 m and in the central portion of lake. Besides, with the exception of post-breeding season, when birds were concentrated in reeds, they occurred rather on an open water. During the autumn, with the highest number of observed individuals, one can state that regions of their concentration provide – the edge of reeds and the distance of 50 m from them. Feeding niche – water and sublittoral. Safety niche – water and reeds.

Podiceps cristatus (Fig. 9). Both environments more or less equally preferred, in both it occurs roughly uniformly with certain differences during the autumn, in the season when the number of occurring birds rapidly declines. During all periods the occurrence of *P. cristatus* is similar in general outlines, concentration occurs in the zone of 0 m, while rather numerous occurrence in zones of 50 and 100 m (exception provides oligotrophy during autumnal period) and in the central portion of lake. In the central portion of lake it occurs relatively most abundantly during the post-breeding period. Feeding and safety niche – water.

Phalacrocorax carbo. The way of occurrence in general outlines the same in both environments, resembling after all the occurrence of *P. cristatus*, with an obvious preference, however, towards the occurrence in the central portion of lake, and by far less frequently at 0 m. Strictly speaking it disappears from the lake already during post-breeding period (there were met then only 5 birds). Feeding and safety niche – water.

Larus ridibundus (Fig. 10). Both environments penetrated in a similar way, except of differences during autumnal season. General trend towards

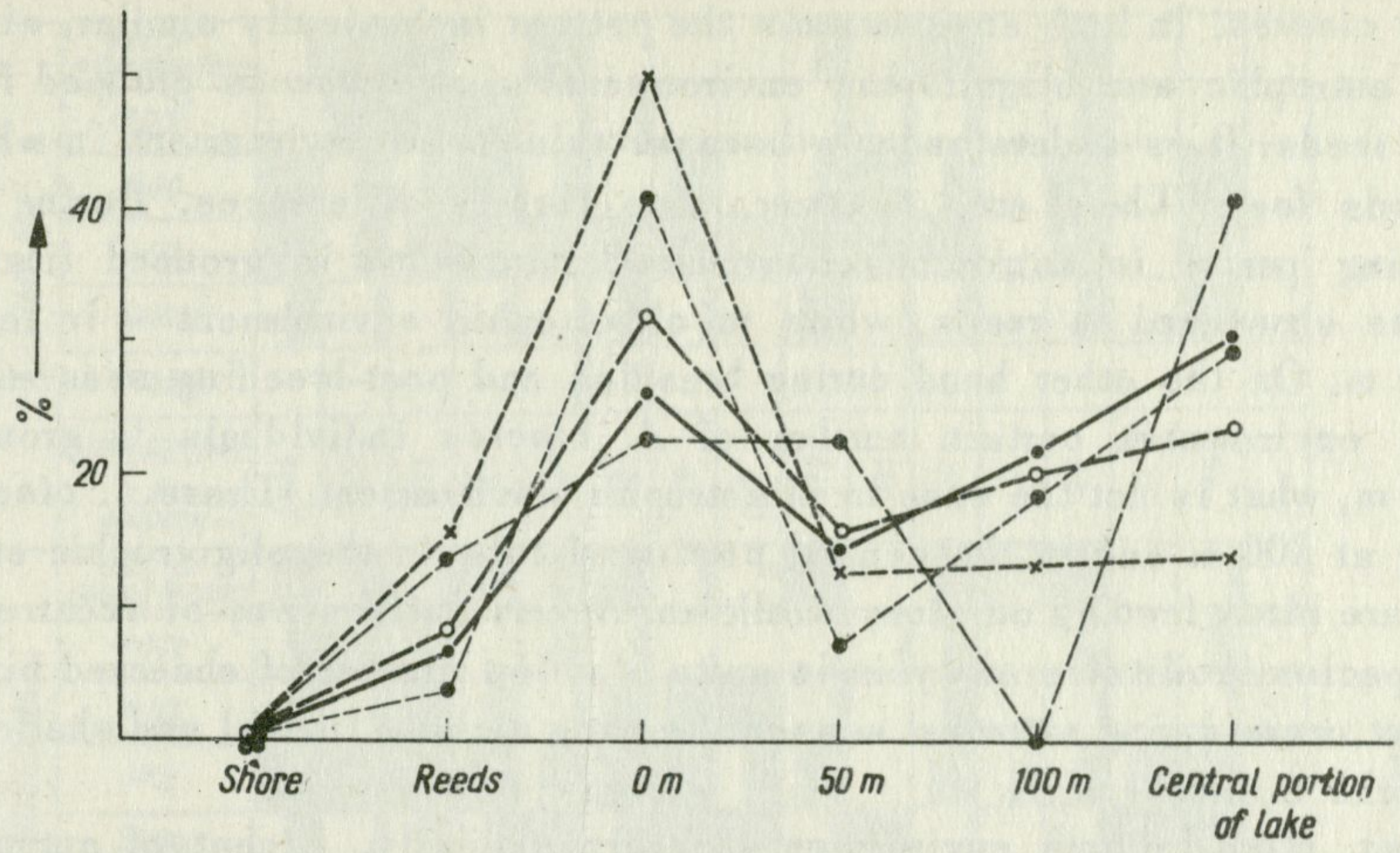


Fig. 9. Percentual distribution of the occurrence of *Podiceps cristatus*. Denotations as in Fig. 2

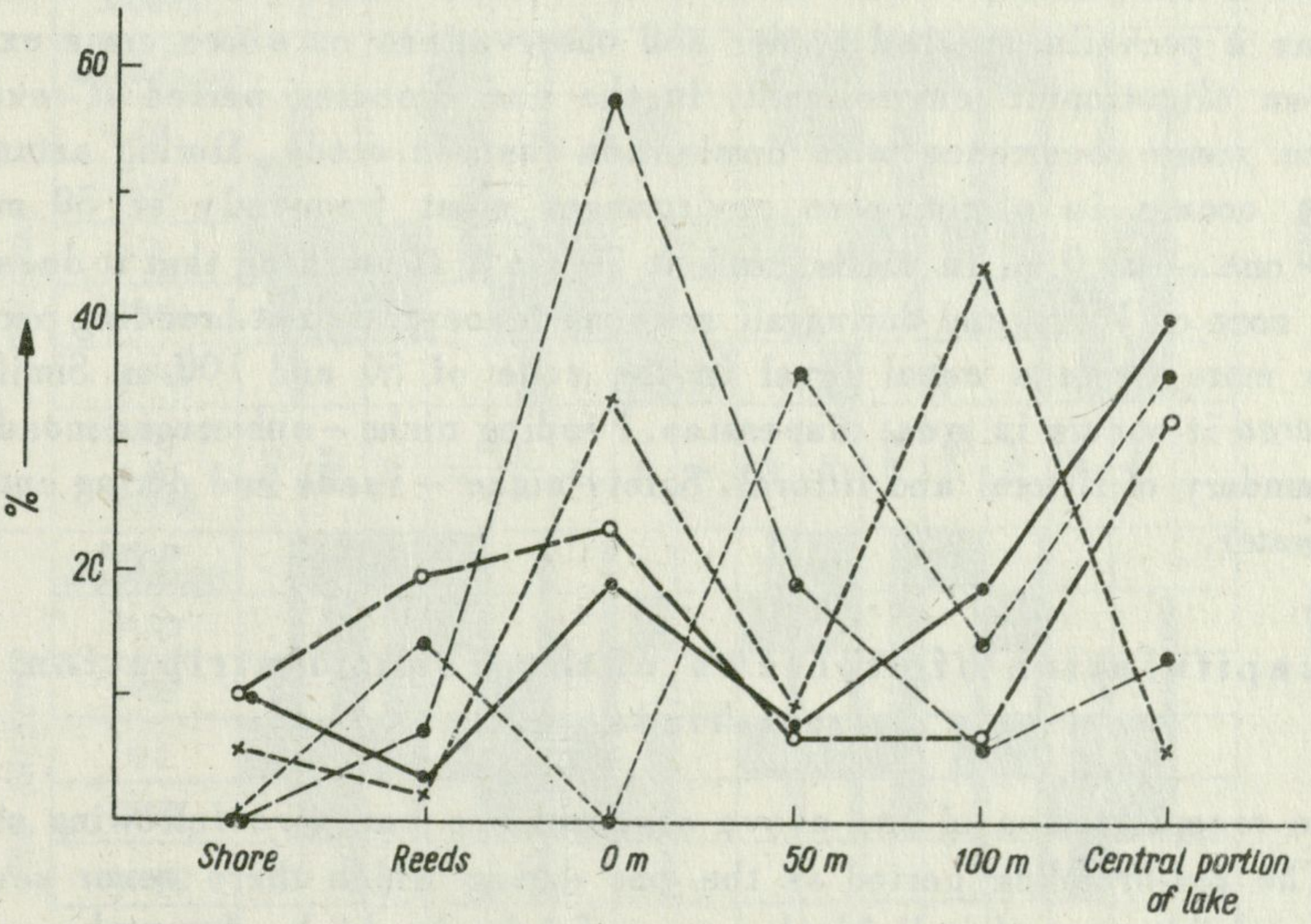


Fig. 10. Percentual distribution of the occurrence of *Larus ridibundus*. Denotations as in Fig. 2

aggregation at 0 m, in the central portion of lake or at 100 m. The distribution indicating the penetration of all sites, shore included, most uniform during breeding season, during the post-breeding season mostly preferring the central portion of lake. Feeding niche – water (upper layers), shore. Safety niche – air.

Ardea cinerea. In both environments the pattern is basically similar, since in both, eutrophic and oligotrophic environments *A. cinerea* is grouped first of all in reeds. It is understandable because this is an environment in which these birds feed. There are, however, also certain differences. During the pre-breeding period in eutrophic environment *A. cinerea* is grouped first of all on the shore and in reeds, while in oligotrophic environment – in reeds and at 0 m. On the other hand during breeding and post-breeding seasons in eutrophic environment certain number of *A. cinerea* individuals is grouped also at 0 m, what is not the case in oligotrophic environment. Those *A. cinerea* occurring at 100 m and in the central portion of lake in the oligotrophic environment are birds feeding on stony shallows. A very uniform way of occurrence of this species facilitates analysis in spite of a low number of observed birds. It does not occur during autumnal season. Feeding niche – littoral and shallows. Safety niche – air.

Cygnus olor. In both environments occurs similarly, except of autumnal season. During the pre-breeding season it occurs mostly in reeds and at 0 m, in eutrophic environment prevailing obviously in reed border, while in oligotrophic one it maintains an equal level in both these zones. During the breeding season it prevails on reed border and observations on shore come exclusively from oligotrophic environment. In the post-breeding period it reveals almost the same occurrence with domination then in reeds. During autumnal season it occurs in oligotrophic environment most frequently at 50 m, in eutrophic one – at 0 m, in reeds, and at 50 m. It is striking that it does not cross the zone of 100 m and during all seasons (except of post-breeding period) maintains more or less equal level in the zone of 50 and 100 m. Similarly as *A. cinerea* it occurs in great dispersion. Feeding niche – submerged meadows on the boundary of littoral and littoral. Safety niche – reeds and during autumn – open water.

Recapitulation of problems of the zonal distribution of birds

In the recapitulation of the above analysis one can give following statements. The pre-breeding period is the one during which there occur several types of inhabitance of individual zones of lake by birds. In reeds and on their boundary there are grouped (Fig. 11): *Anas strepera*, *A. querquedula*, *Ardea cinerea*, and *Cygnus olor*. In reeds, at 0 m, and in the belt of 50 m – *Anas platyrhynchos*, at 0 m and in slight numbers in the central portion of lake – *Fulica atra*, mainly in the central portion of lake or at 100 m, and sometimes also at 0 m – *Mergus* sp., *Bucephala clangula*, *Aythya fuligula*, *Podiceps cristatus*, *Phalacrocorax carbo*, and *Larus ridibundus*. Finally *Aythya nyroca* and *A. ferina* reveal rather uniform occurrence from reeds to the central portion of lake with certain minimum at the region of 50 m.

PERIODS	PRE-BREEDING							BREEDING							POST-BREEDING							AUTUMNAL						
SPECIES	Number of individuals	Shore	Reeds	0 m	50 m	100 m	Central portion of lake	Number of individuals	Shore	Reeds	0 m	50 m	100 m	Central portion of lake	Number of individuals	Shore	Reeds	0 m	50 m	100 m	Central portion of lake	Number of individuals	Shore	Reeds	0 m	50 m	100 m	Central portion of lake
FULICA ATRA	807							1343							16 514							2885						
AYTHYA FERINA	343							597							1601							3223						
AYTHYA NYROCA	780							90							233							1117						
AYTHYA FULIGULA	187							21							187							535						
ANAS PLATYRHYNCHOS	265							2425							3903							1489						
ANAS STREPERA	57							91							31							24						
ANAS QUERQUEDULA	16							12							139							78						
ANAS CRECCA	0							2							52							5						
BUCEPHALA CLANGULA	24							35							46							172						
MERGUS SP.	54							10							24							341						
PODICEPS CRISTATUS	199							472							404							49						
PHALACROCORAX CARBO	72							179							5							0						
LARUS RIDIBUNDUS	788							825							1074							82						
ARDEA CINEREA	40							92							36							0						
CYGNUS OLOR	55							113							78							79						

0-10% 11-20% 21-30% >31%

Fig. 11. Groupage of birds in various zones. Lines indicate that number of individuals is < 10

During the breeding period the manner of occurrence is considerably more uniform. There could be identified two main types of occurrence – one when birds are grouped in reeds and at 0 m, and another one with the peak in the central portion of lake (or at 100 m) and at 0 m. The latter type of occurrence reveal *B. clangula*, *Mergus* sp., *P. cristatus*, *P. carbo*, *A. fuligula*, and *L. ridibundus*, and thus species for which water or air provide the safety niche and water to a serious extent also the feeding niche.

The third period, post-breeding one is characterized again with the high variety of types of occurrence, but one can note certain common feature. With considerably more uniform inhabitance of all zones numerous species occur farer towards the central portion of lake, than during previous periods. Lewandowski (1964) also noticed such shift towards the central portion of lake in autumn. Generally the way of bird occurrence during this season resembles somewhat the distribution from the pre-breeding period.

In reeds and at 0 m there are grouped *A. cinerea*, *C. olor*, and *A. platyrhynchos*. In reeds, at 0 m, and in the belt of 50 m there is grouped *A. querquedula*, while in reeds and at 50 m – *A. cinerea*. At 0 and 100 m there aggregate *A. nyroca* and *A. ferina*, while in the central portion of lake and at 0 m – *B. clangula* and *A. fuligula*. Finally, in the central portion of lake, at 100 and 0 m there are concentrated *L. ridibundus*, *P. cristatus*, and *F. atra*.

During the autumnal season there is again a lower differentiation in the way of the occurrence of individual species, the majority of them obviously shifting towards the central portion of lake. And so the majority of *F. atra* is concentrated at 0 m and 50 m. *Mergus* sp. and *C. olor* aggregate at 50 m, 0 m, and in reeds. Diving ducks (*Aythya* sp.) occur at 100 m (in oligotrophic environment) or in the central portion of lake (in eutrophic environment). Puddling ducks (*Anas* sp.), *B. clangula*, *P. cristatus*, *L. ridibundus* are concentrated first of all in the central portion of lake and at 100 m, while to a lesser extent – at 50 m and 0 m. During the autumnal season the importance of reed zone is obviously lowered.

As mentioned at the beginning of this chapter the concentration of birds in definite zone should be understood as the selection of definite ecological, feeding, breeding or safety niche. In this situation the phenomenon of the most intensive concentration of birds in the border line of reeds and water (0 m) during all periods becomes understandable. Bird concentration in this zone may resemble the more numerous inhabitance of biotope boundaries in terrestrial environments. On a lake, in this zone there occur both birds feeding in littoral, on shallow submerged meadows, and in sublittoral, as well as those which seek shelter in reeds or escape danger diving. The fact should be stressed that this is the region in which numerous birds search after food utilizing less available to other animals food resources of lake such as soft vegetation (*F. atra* and *C. olor*, to a lesser extent puddling (*Anas* sp.) and diving (*Aythya* sp.) ducks) and sublittoral animals [e.g. *Dreissena polymorpha*,

Sialis lutaria consumed by *F. atra* and diving ducks (*Aythya* sp.)]. This indicates rather many-sided utilization of lake resources by the community of waterfowl.

THE STRUCTURE OF LAKE WATERFOWL ASSOCIATION

The collected data enable the statement that birds inhabit lake not uniformly, but selectively. This concerns not only the preference of certain portions of lake, but also its zones. This is connected with characteristic features of morphology and biology of individual species, way of feeding and avoiding danger, and thus with their morphoecological type.

In my paper on birds of Vistula (Dobrowolski 1964) I presented an attempt of the identification of ecological types and forms of birds occurring there. This classification was presented in the introduction. Another specific composition occurring on lake, other sites, different possibilities of feeding, and often also different food forms in river and in lake provide basis for the comparison of both communities and eventual verification of the general classification.

Swimmer type included two forms: filtering benthophags and aquatic ichthyophags. Taking into consideration species occurring on lake it seems purposeful to identify a new form, namely aquatic phytophags, including birds feeding first of all on soft vegetation. This form did not occur on river due to an almost complete lack of this type of feeding grounds. Moreover, certain species classified on river to the form of filtering benthophags, on lake should be parallely reckoned among phytophags, since their food on lake is by far more diversified and contains as a rule some quantities of soft vegetation. So it seems that within the first type there ought to be identified three types – filtering benthophags, aquatic phytophags, among which there should be classified first of all *F. atra*, *C. olor* and some puddling (*Anas* sp.) and diving (*Aythya* sp.) ducks, and aquatic ichthyophags.

In the second type – semi-aquatic waders I do not see any reason for the identification of new forms – here belong beach entomophags, shore benthophags, and shore ichthyophags.

In the third type – birds catching prey in flight I identified previously two forms: flight entomophags and flight ichthyophags. It seems that this type should by supplemented by still one form – namely shore predatory birds. This would include those birds of prey, which permanently stay on shores of water reservoirs and for which fishes are not the main food, as e.g. *Circus* sp. or *Milvus* sp.

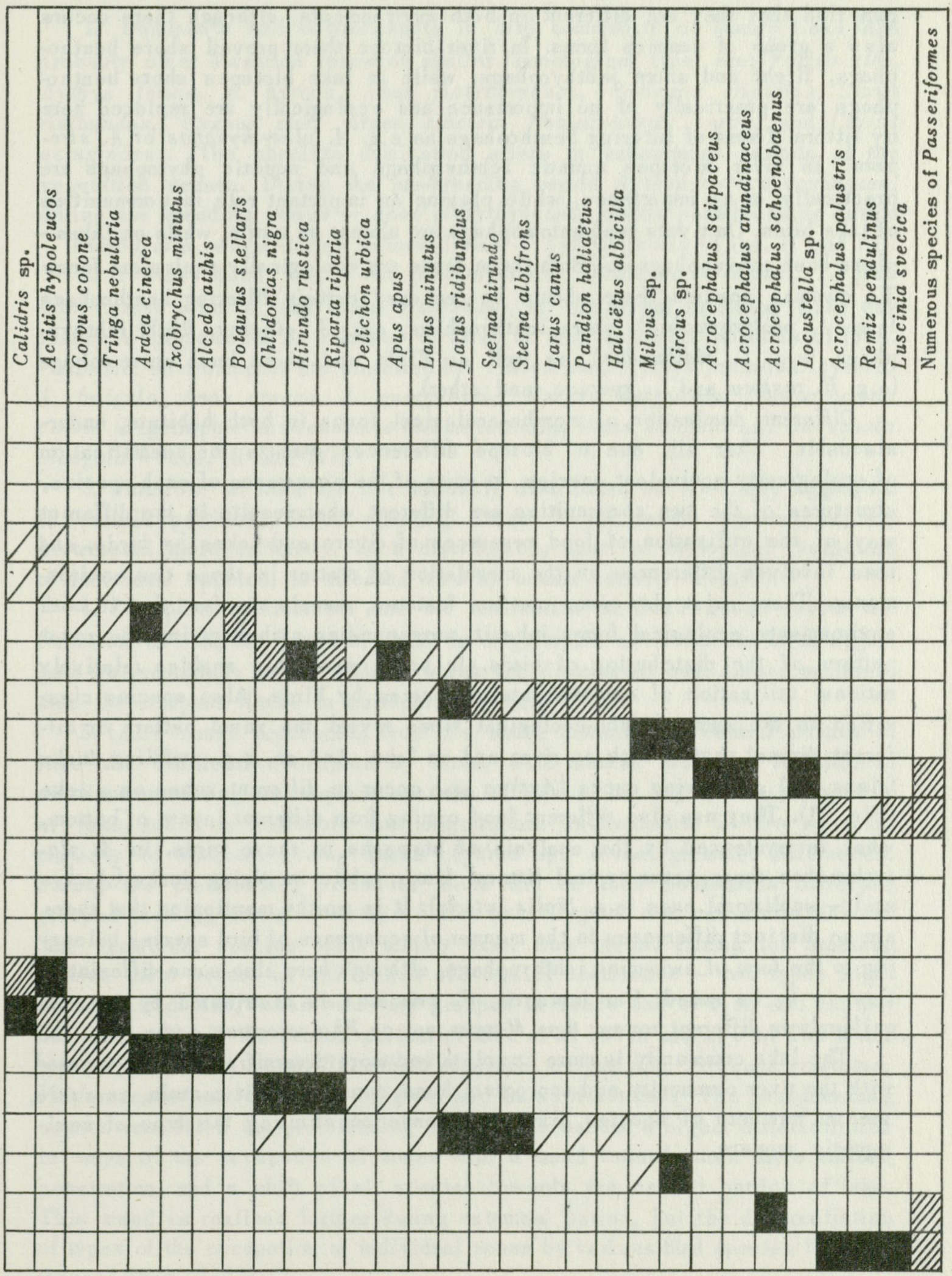
Finally the fourth type – bush and tree creepers, in which I have not identified any forms, might be roughly divided into two – reed entomophags and shore bush entomophags. It is an obvious matter that in this case the division is not sufficient and for sure the more careful examination of this type would provide basis for the identification of still other forms.

Comparison of types and morpho-ecological

Environment	Types	Forms	*Cygnus olor*	*Fulica atra*	*Gallinula chloropus*	*Anas platyrhynchos*	*Anas strepera*	*Aythya ferina*	*Aythya nyroca*	*Anas querquedula*	*Anas crecca*	*Aythya fuligula*	*Bucephala clangula*	*Podiceps cristatus*	*Mergus* sp.	*Motacilla flava*	*Motacilla alba*	*Charadrius* sp.	*Tringa* sp.
Lake	Swimmers	aquatic phytophags	■	■	/	▨	▨	/	/	/	/								
		filtering benthophags				■	■	■	■	▨	▨	▨	▨						
		aquatic ichthyophags										/	▨	■	■				
	Semiaquatic wading birds	beach entomophags														▨	/	/	/
		shore benthophags																/	/
		shore ichthyophags																	
	Flight feeders	flight entomophags																	
		flight ichthyophags																	
		shore predators																	
	Bush-tree creepers	reed entomophags																	
		shore bush entomophags																	
River	Swimmers	aquatic phytophags		/	■	/	/												
		filtering benthophags				■	/	▨	▨	▨	▨	▨	▨						
		aquatic ichthyophags										/	▨	/	▨				
	Semiaquatic wading birds	beach entomophags														■	■	■	■
		shore benthophags															■	■	■
		shore ichthyophags																	
	Flight feeders	flight entomophags																	
		flight ichthyophags																	
		shore predators																	
	Bush-tree creepers	reed entomophags																	
		shore bush entomophags																	

Black colour – dominant forms, lines – subdominant forms, single – accessory forms.

forms of birds of lake and river Tab. V



While comparing dominant forms in river and lake biotopes (Tab. V) one can find that they are different in both environments, although there occurs also a group of common forms. In river biotope there prevail shore benthophags, flight and shore ichthyophags, while in lake biotopes shore benthophags are practically of no importance and ecologically are replaced here by littoral forms of filtering benthophags as e.g. *A. platyrhynchos* or *A. strepera*. In river biotopes aquatic ichthyophags and aquatic phytophags are practically of no importance, while playing an important role in communities of lake birds. On rivers reed entomophags are absent as a rule, while on lakes – shore bush entomophags do. Both these forms are ecologically equivalent forms. To common species there should be reckoned certain filtering benthophags (e.g. *A. platyrhynchos*), shore ichthyophags, e.g. *A. cinerea*, flight ichthyophags (e.g. *L. ridibundus*), as well as flight and shore bush entomophags (e.g. *H. rustica* and *L. svecica*, and other).

Different domination of morpho-ecological forms in both habitats, understandable, after all, due to biotope differences permits the identification of ecologically equivalent species. In spite of the occurrence of such species, structures of the two communities are different what results in the different way of the utilization of food resources of rivers and lakes by birds, and thus involves differences in the circulation of matter in those two environments. There exist also some common features, namely the fact that in both environments ecological forms inhabit corresponding niches giving the zonal pattern of the distribution of birds. In both cases this enables relatively rational utilization of environmental resources by birds. Also species classified to the same morpho-ecological forms reveal the zonal pattern or different diurnal rhythm both on river and on lake. And so, e.g. puddling ducks (*Anas* sp.) and diving ducks (*Aythya* sp.) occur in different zones on a lake (Fig. 11). They use also different food coming from different layers of bottom, what is evidenced by the analysis of stomachs of these birds. In *A. platyrhynchos* there occur typical littoral forms, while in diving ducks (*Aythya* sp.) – sublittoral ones (e.g. *Sialis lutaria*). It is worthy mentioning that there are no distinct differences in the manner of occurrence of bird species belonging to the form of swimming ichthyophags, although here also some differentiation is to be noted. For instance, *P. cristatus* is distributed by far more uniformly in different zones, than *Mergus* sp. or *Phalacrocorax carbo*.

The lake community is more complete and more diversified, when compared with the river community and ecological forms constituting it contain, as a rule, greater numbers of species, except of forms constituting the type of semi-aquatic waders.

RESULTS AND CONCLUSIONS

1. Dominants and subdominants in bird community of Mamry Lake (and probably other Mazurian lakes of similar limnological type) are: *Fulica atra*, *Aythya ferina*, *A. nyroca*, *Anas platyrhynchos*, *Podiceps cristatus*, *Larus ridibundus*, *Cygnus olor*, *Ardea cinerea*, *Phalacrocorax carbo*, and *Circus aeruginosus*. The absolute domination alters in subsequent periods of the vegetation season. During the pre-breeding period *Aythya nyroca* dominates, during the breeding period – *Anas platyrhynchos*, during post-breeding period – *Fulica atra*, while during autumnal one – *Aythya ferina* (Tabs. II and III).

2. It was found that *Anas platyrhynchos*, *Podiceps cristatus*, *Cygnus olor*, *Ardea cinerea*, and *Larus ridibundus* do not reveal in Mamry Lake any particular preferences in relation to more or less eutrophic portions of lake. Futrophic environments are preferred by: *Fulica atra*, *Aythya ferina*, *A. nyroca*, *A. fuligula*, *Anas crecca*, *A. querquedula*, *Mergus merganser*, *Phalacrocorax carbo*. Oligotrophic environments are preferred by *Anas strepera* and *Bucephala clangula* (Tabs. III and IV).

3. Waterfowl of lake are not uniformly distributed on it – they aggregate in certain portions. Those species, which do not reveal preferences, are distributed more uniformly. Such distribution, apart of biological characters of individual species, is affected also by human activity (Fig. 1).

4. Eutrophic environment and the realization of flock trends favour the formation of compact flocks of birds. In oligotrophic environments birds aggregate in remarkably looser flocks, which are distributed over larger sections, than the compact flocks in eutrophic portions.

5. Lake zones proceeding from the shore towards the central portion of lake are differently occupied by birds, with marked also the variation in distribution during subsequent seasons of year. The way of the occupation of lake zones in eutrophic and oligotrophic environments is the same for majority of species. Diving ducks (*Aythya* sp.) reveal greatest differences. During the pre-breeding period in reeds and on their boundaries there are grouped puddling ducks (*Anas* sp.) *Fulica atra*, *Cygnus olor*, and *Ardea cinerea*. The remaining species occur mainly farer from reeds. During the breeding season there occurs an unification of ways of occurrence – two types might be identified: one, when birds are grouped in reeds and at 0 m, and another one with peaks in the central portion of lake or at 100 m and at 0 m. The latter type of occurrence reveal *Bucephala clangula*, *Mergus* sp., *Podiceps cristatus*, *Phalacrocorax carbo*, *Aythya fuligula*, and *Larus ridibundus*. The post-breeding season resembles the pre-breeding one – there occurs a higher differentiation in ways of the occupation of zones with a trend towards their more uniform penetration and a shift of all species towards the central portion of lake. This trend is realized further during autumnal period, but the differentiation of types of the occupation of individual zones by various bird species is again reduced (Fig. 2–11).

The occupation of various zones might be understood as the selection of definite ecological niches – breeding, feeding, or safety one. The boundary of reeds and open water (0 m) is most numerously occupied by birds (both by species and individuals).

6. Owing to new data the classification of types and morpho-ecological forms of waterfowl was extended, when compared with that given on the base of the community of river birds.

I. type – swimming birds
  1. form – filtering benthophags
  2. form – aquatic phytophags
  3. form – aquatic ichthyophags
II. type – semi-aquatic wadding birds
  1. form – beach entomophags
  2. form – shore benthophags
  3. form – shore ichtyophags
III. type – birds feeding in flight
  1. form – flight entomophags
  2. form – flight ichthyophags
  3. form – shore predators
IV. type – birds creeping on shrubs and trees (provisional division)
  1. form – birds of reeds
  2. form – birds of shore shrubs

Communities of birds of lakes and rivers were compared (Tab. V) and it was found that the first one is based first of all on the morpho-ecological type of swimming birds, in all three forms, while the river community – on the type of semi-aquatic waders and on the form of flight ichthyophags. The community of lake birds is more complete, than the community of river, and various forms and species utilize different zones of a lake. Different environmental conditions of river and lake provide the reason of the formation of different communities (within each of them one can find ecologically equivalent species). In both cases, however, the structure of community ensures the rational utilization of environment resources.

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STRUKTURA WYSTĘPOWANIA TYPÓW I FORM MORFO-EKOLOGICZNYCH PTAKÓW WODNYCH

Streszczenie

Celem pracy było poznanie i przedstawienie struktury zespołu ptaków wodnych zasiedlających jezioro oraz porównanie tego zespołu z zespołem ptaków rzecznych.

Materiał pochodzi z jeziora Mamry (10 450 ha) składającego się z kilku basenów, z których zbadano jezioro Mamry Północne, Święte, Kirsajty, Dargin, Łabab, Kisajno i Dobskie (razem 10 370 ha). Obserwacje prowadzone w latach 1958 i 1959 wyróżniają cztery okresy: przedlęgowy (połowa kwietnia), lęgowy (czerwiec), polęgowy (wrzesień do 10 października), jesienny (koniec października, listopad). Dokonano 18 objazdów przebywając łącznie 453,3 km i obserwując 847,5 km plosa i 458 km brzegów. Wyróżniono odcinki eutroficzne i oligotroficzne, przeprowadzając porównanie występowania na nich ptaków. Dane ilościowe przeliczono na 1 km bieżący, a nie na hektar. Dokonano też analizy pokarmu 25 łysek (*Fulica atra*), 16 krzyżówek (*Anas platyrhynchos*), 4 podgorzałek (*Aythya nyroca*), 5 głowienek (*Aythya ferina*), 1 czernicy (*Aythya fuli-*

gula), 1 cyranki (*Anas querquedula*) i 2 perkozów dwuczubych (*Podiceps cristatus*) (Tab. I). Podczas przejazdów zaznaczono trasę i nanoszono na nią spotkane ptaki. Wyróżniono też strefy jeziora licząc od brzegu: brzeg, szuwary, granice szuwarów i wody (0 m), pas 50 m, pas 50–100 m (100 m) i ploso.

W czasie przeprowadzonych badań stwierdzono 78 gatunków ptaków, analizując szczegółowiej jedynie formy dominujące i takie, których obserwacje zapewniły możność przeprowadzenia analizy w oparciu o dane ilościowe.

Podczas rozważań i przy wyciąganiu wniosków oparto się także na poprzednich pracach własnych i pracach, które zostały wykonane w Pracowni Ornitologicznej Instytutu Zoologicznego Uniwersytetu Warszawskiego.

1. Dominantami i subdominantami zespołu ptaków jeziora Mamry (a prawdopodobnie i innych jezior mazurskich podobnego typu limnologicznego) są: *Fulica atra*, *Aythya ferina*, *Aythya nyroca*, *Anas platyrhynchos*, *Podiceps cristatus*, *Larus ridibundus*, *Cygnus olor*, *Ardea cinerea*, *Phalacrocorax carbo* i *Circus aeruginosus*. Bezwzględna dominacja zmienia się w poszczególnych okresach sezonu wegetacyjnego. W okresie przedlęgowym dominuje *Aythya nyroca*, w lęgowym – *Anas platyrhynchos*, w polęgowym – *Fulica atra*, i w jesiennym *Aythya ferina* (Tab. II i III).

2. Stwierdzono, że na Mamrach nie wykazują szczególnej wybiórczości w stosunku do silniej lub mniej zeutrofizowanych odcinków jeziora: *Anas platyrhynchos*, *Podiceps cristatus*, *Cygnus olor*, *Ardea cinerea*, *Larus ridibundus*. Środowiska eutroficzne preferują: *Fulica atra*, *Aythya ferina*, *Aythya nyroca*, *Aythya fuligula*, *Anas crecca*, *Anas querquedula*, *Mergus merganser*, *Phalacrocorax carbo*. Środowiska oligotroficzne preferują *Anas strepera* i *Bucephala clangula* (Tab. III i IV).

3. Ptaki wodne jeziora rozmieszczone są na nim nierównomiernie – tworzą skupiska w niektórych jego częściach. Gatunki nie wykazujące wybiórczości rozmieszczone są bardziej równomiernie. Na rozmieszczenie takie, poza cechami biologicznymi poszczególnych gatunków, ma też wpływ działalność człowieka (Fig. 1–4).

4. Środowisko eutroficzne i realizowanie się tendencji stadnych sprzyjają tworzeniu się zwartych stad ptaków. W środowiskach oligotroficznych ptaki zbierają się w znacznie luźniejsze stada, które rozmieszczają się na większych odcinkach niż zwarte stada w partiach eutroficznych.

5. Strefy jeziora licząc od brzegu w kierunku plosa są różnie zasiedlane przez ptaki, przy czym występuje tu też zmienność rozkładu w poszczególnych okresach roku. Sposób zasiedlania stref jeziora w środowiskach eutroficznych i oligotroficznych jest dla większości gatunków taki sam. Największe różnice wykazują grążyce (*Aythya* sp.). W okresie przedlęgowym w szuwarach, i na granicy trzcin grupują się kaczki właściwe (*Anas* sp.), łyska (*Fulica atra*), łabędź (*Cygnus olor*), czapla (*Ardea cinerea*). Pozostałe gatunki występują głównie dalej od szuwarów. W okresie lęgowym następuje ujednolicenie sposobów występowania – wyróżnić można dwa typy: jeden gdy ptaki grupują się w szuwarach i na 0 m, i drugi ze szczytami na plosie lub 100 m i na 0 m. Ten drugi typ występowania wykazują gągoł (*Bucephala clangula*), tracze (*Mergus* sp.), perkoz dwuczuby (*Podiceps cristatus*), kormoran (*Phalacrocorax carbo*), czernica (*Aythya fuligula*) i mewa śmieszka (*Larus ridibundus*). Okres polęgowy przypomina przedlęgowy – występuje większe zróżnicowanie sposobów zajmowania stref z tendencją do bardziej równomiernego ich opanowywania i przesuwania się wszystkich gatunków w kierunku plosa. Ta tendencja realizuje się dalej w okresie jesiennym, przy czym ponownie zmniejsza się zróżnicowanie typów zasiedlania poszczególnych stref przez różne gatunki ptaków (Fig. 5–14).

Zajmowanie różnych stref można rozumieć jako wybór określonych nisz ekologicznych – lęgowej, pokarmowej lub bezpieczeństwa. Najliczniej obsadzona przez ptaki (zarówno gatunki jak i osobniki) jest granica szuwarów i wolnej wody (0 m).

6. Dzięki nowym materiałom rozszerzono klasyfikację typów i form morfo-ekologicznych ptaków wodnych w stosunku do podanej na podstawie zespołu ptaków rzecznych.

I. typ – ptaki pływające
  1. forma – benotofagi cedzące
  2. forma – fitofagi wodne
  3. forma – ichtiofagi wodne
II. typ – ptaki brodzące półwodne
  1. forma – entomofagi plażowe
  2. forma – bentofagi brzegowe
  3. forma – ichtiofagi brzegowe
III. typ – ptaki polujące w locie
  1. forma – entomofagi powietrzne
  2. forma – ichtiofagi powietrzne
  3. forma – drapieżniki brzegowe
IV. typ – ptaki łażące zaroślowo-drzewne
  1. forma – ptaki szuwarów
  2. forma – ptaki zarośli nadbrzeżnych

Porównano zespół ptaków jeziornych i rzecznych (Tab. V) stwierdzając, że ten pierwszy opiera się przede wszystkim na typie morfo-ekologicznym ptaków pływających, wszystkich trzech formach, a zespół rzeczny na typie brodzących półwodnych i na formie ichtiofagów powietrznych. Zespół ptaków jeziora jest pełniejszy niż zespół rzeczny, a różne formy i gatunki wykorzystują różne strefy jeziora. Różne warunki środowiskowe rzeki i jeziora są przyczyną tworzenia się różnych zespołów (przy czym w ich obrębie można znaleźć gatunki zastępujące się ekologicznie). W obu przypadkach jednak struktura zespołu zapewnia racjonalne wykorzystanie zasobów środowiska.

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