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Pokarm naturalny narybku karpia (*Cyprinus carpio* L.)

The natural food of carp fry (*Cyprinus carpio* L.)

A b s t r a c t — The composition of the natural food of the larvae and fry of carp in the spawning-grounds and nursery ponds of three pond complexes was investigated. The nursery ponds were treated with superphosphate and farmyard manure and sown with a mixture of cereal-papilonaceous plants.

It was found that *Crustacea* prevailed in the food, among them *Cladocera* followed by *Copepoda* and *Chironomidae*. On the third day after hatching the first food components of the fry were *Crustacea* and *Rotatoria* in one of the spawning-grounds, small *Chironomidae* larvae in the second, and *Rotatoria*, *Crustacea*, and *Protozoa* in the third.

An increase in the intensity of feeding of the fry was noted during the day, a decrease being observed during the night hours. The presence or absence of food components in the guts as compared with their appearance in the environment suggested a positive or negative food selectivity of the fry. The food components which constituted the main content of the alimentary canals were well utilized by the fry.

The quality and quantity of food are the main factors deciding the survival and growth of the larvae of carp. The absence or unsatisfactory amounts of nutrients suitable for a given stage of development in the period of transition from endogenous to mixed nutrition (the stage of final resorption of the vitelline sac with the simultaneous beginning of assimilation of food from the environment) may result in the death of fish, particularly if great numbers of parasites and predators appear in the ponds (H o r o s z e w i c z 1974).

In spite of the great number of investigations in this field, the problem of food and nutrition of carp fry has aroused renewed interest, in consequence of new breeding methods which eliminate the spawning-grounds and nursery ponds (tank breeding).

The purpose of this study was to investigate the composition of the natural food of carp fry reared in the ponds of three complexes in the

Experimental Station of the Polish Academy of Sciences at Gołysz, and to examine the kinds of food most often utilized by young larvae of the carp at this stage of feeding. Also in tank breeding the natural food is still an irreplaceable constituent in feeding these larvae in the first ten days.

It should be mentioned that the present investigations revert to the previously published works on the growth rate of fry and its morphological changes, since they were carried out on the same material (Matlak 1966).

Material and method

Materials were collected for the investigation in 1955 according to the instructions of Professor K. Starmach as to the dates of collecting samples, sampling frequency in one day and in the whole period of the investigation, the number of fry caught in the spawning-grounds and nursery ponds, the investigation of the environment (plankton, components of places covered with vegetation), the implements used in catching, conservation of the fry, and many others.

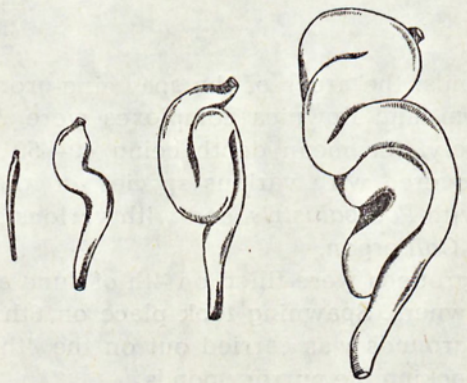
The description of the ponds, with the exception of the Iłownica complex which was at that time excluded from the elaboration in consequence of a flood, was given in the first part of the work (Matlak 1966). Since the ponds at Iłownica were to have been considered together with the ponds of the Pod Borem and Pod Janikiem complexes their character was similar. These ponds were also described in the works of other authors who continued investigations in them a year before and a year after the present study (Klimczyk 1957, Bombówna et al. 1962, Krzeczkowska-Wołoszyn 1967).

987 alimentary canals of fry were investigated (Table I), 10—15 specimens of fry caught at a given date and hour being examined from each pond. The catches were carried out at 4 a.m., 10 a.m., 4 p.m., and 10 p.m. In some cases all the fry caught at a given time were examined, i.e. 30—40 specimens 4 times (the nursery pond Pod Borem, 2nd July). On account of four catches in 24 hrs and the distance between the ponds of separate complexes, the catch of the fry took two days each time. The date given in the tables refers to the fry from the pond complexes Pod Borem and Pod Janikiem in the first place and in the second the ponds of the Iłownica complex. Four catches of the fry in 24 hrs at various times of the day and in the ponds of complexes lying at a distance from each other, and sometimes under changeable weather conditions, illustrate the difficulties which accompanied the collections of the materials.

Tabela I. Średnie długości w mm: przewodów pokarmowych (a); longitudo corporis (b); oraz ilość przebadanych przewodów pokarmowych narybku karpia (c)

Table I. Mean lengths in mm: of alimentary canals (a); longitudo corporis (b); and number of examined alimentary canals of carp fry (c)

Kompleksy stawów Complexes of ponds / Data odłowu narybku Date of fry removal		Pod Borem			Pod Janikiem			Iłownica			Razem przewodów pokarmowych Total of alimentary canals
		a	b	c	a	b	c	a	b	c	
11.VI wylęg hatch											
13.VI -14.VI		3.0	-	-	3.0	-	-	3.0	-	-	-
14.VI -15.VI		3.0	6.5	36	3.0	6.9	15	3.0	6.9	40	91
16.VI -17.VI		3.0	7.0	55	3.5	7.1	16	3.5	7.2	30	101
19.VI -20.VI	1955	5.0	9.5	43	4.5	7.3	25	5.0	9.2	60	128
22.VI -23.VI		5.1	11.1	38	5.0	10.5	87	6.0	11.6	58	183
27.VI -28.VI		18.0	17.4	61	13.1	13.6	60	19.5	18.0	40	161
29.VI - --		21.0	18.2	36	19.0	17.4	60	-	-	-	96
2.VII- 3.VII		30.0	23.6	147	23.0	19.6	45	29.0	22.4	35	227
Razem przewodów pokarmowych: Total of alimentary canals:				416			308			263	987



Ryc. 1. Zmiany kształtu i długości (od lewej ku prawej: 3,0 mm, 5,4 mm, 16,9 mm, 27,3 mm, wartości średnie) przewodów pokarmowych badanego karpia

Fig. 1. Changes in the shape and length (from left to right: 3.0 mm, 5.4 mm, 16.9 mm, 27.3 mm, mean values) of the alimentary canals of the investigated carp

The entire contents of the intestines were analysed in parts, initial, middle, and final, and an attempt was made to identify all the food constituents under a Mst 130 PZO type stereoscopic microscope and then a Zeiss microscope. Fig. 1 presents the development stages of the investigated intestines, while Table I gives the data on the length of alimentary canals, longitudo corporis of the investigated fry, and the number of alimentary canals examined from separate ponds and from various times of fry catches.

In general, the gut content was well preserved. In the intestines with a large amount of constituents, the *Chironomidae* larvae preserved a body colour similar to the natural one. The constituents were found at various degrees of digestion, easy or difficult to identify. In almost all intestines large quantities of animal or plant detritus and mud particles or sand grains were observed, occupying about one fourth to a half or even more than a half of the field of vision under the microscope.

In elaborating the materials the following problems were considered: the composition of the food of fry within the first three weeks of its growth in the spawning-grounds and nursery ponds, the percentage composition of nutritive components within the main groups, the changes in the numbers of *Cladocera* and *Copepoda* in the food of the fry from three complexes of ponds investigated, the share of the *Chironomidae* larvae in the food of the fry, and the feeding at various times of the day.

Characteristics of the experimental ponds

Spawning-grounds: the areas of the spawning-grounds of the Pod Borem, Pod Janikiem, and Iłownica complexes were 252 m², 227 m², and 200 m² respectively, the mean depth being 40—50 cm. The spawning--grounds were covered with various species of the genus *Carex*, to a lesser degree with *Poa palustris*, and with various species of the genera *Equisetum* and *Calliergon*.

The spawning-grounds were filled on 4th of June and on the next day stocked with spawners. Spawning took place on 6th of June. The catch in the spawning-grounds was carried out on the 4th day after hatching with the aim of stocking the nursery ponds.

The nursery ponds had an area of 2 ha in the Pod Borem and Iłownica complexes and of 1 ha in the Pod Janikiem one, the mean depth being 50—70 cm. In the Pod Borem complex superphosphate was applied twice (at the end of May and at the end of the III decade of June) at the total rate of 100 kg, farmyard manure being spread on the bottom before the pond was filled. In the nursery ponds of the Pod Janikiem and Iłownica complexes a cereal-papilonaceous mixture was sown (wheat and rye 30 kg each, winter vetch 45 kg, crimson clover 15 kg), fertilization with lime nitrogen (250 kg), superphosphate (220 kg) and potassium fertilizer (200 kg) having been applied before sowing. The mixtures were not mown.

In the Pod Borem nursery ponds the following species of plants were noted: *Glyceria aquatica* (L.) W a h l b., *Heleocharis acicularis* R. B r o w n., *Polygonum amphibium* L., *Oenanthe aquatica* (L.) P o i r., *Carex* sp. and fairly numerous *Iris pseudoacorus* L. near the dam. On 14th

July the nursery ponds were stocked with the carp hatch numbering 80 000/ha. The fry remained 26 days in the ponds and on 10th July a catch was carried out in order to stock the second nursery ponds.

Characteristics of plankton samples and samples from places covered with plants in the nursery ponds

The results of plankton analyses are presented in Table II. The components found both in the plankton and in the intestines of the fry being given a plus mark (+) and those observed only in the plankton a zero (0). The plankton samples were elaborated by Mrs Krystyna Kyselowa, M. Sci., who also helped in the identification of some plankton specimens from the intestines.

A total number of 48 species were found in the samples of the plankton. In the gut contents species not noted in the samples of plankton were found, however. Similar cases are also known from other studies on the feeding of fish (Megyeri 1969). Merla (1959) suggests that in the nutrition investigations the problem of the simultaneous examination of the „supply and demand" of the natural food in ponds is very important.

Invertebrates in the places covered with vegetation in the ponds

Cladocera, Copepoda, Chironomidae, and *Culicidae* were classified as species occurring in great numbers in the samples of the macrofauna and in gut contents. *Ostracoda* were encountered very frequently in the samples and less frequently in the guts. *Oligochaeta* were rare in the samples and in the food of the fry (digested specimens but also fresh ones, among them chiefly of the genus *Stylaria*), *Chaoborus* were still more rare, while *Hydracarina* and *Araneina* were very rare, *Lymneida* and *Odonata* were very numerous in the macrofauna samples, the former not being encountered in the gut contents and the latter very rarely. The *Trichoptera* and *Sididae* larvae, fairly frequent in the samples of the macrofauna, were not noted among the components of the food of fry.

In recapitulating, it should be stressed that the different degree of quantitative and qualitative utilization of particular components by the carp fry may be explained by its selectivity.

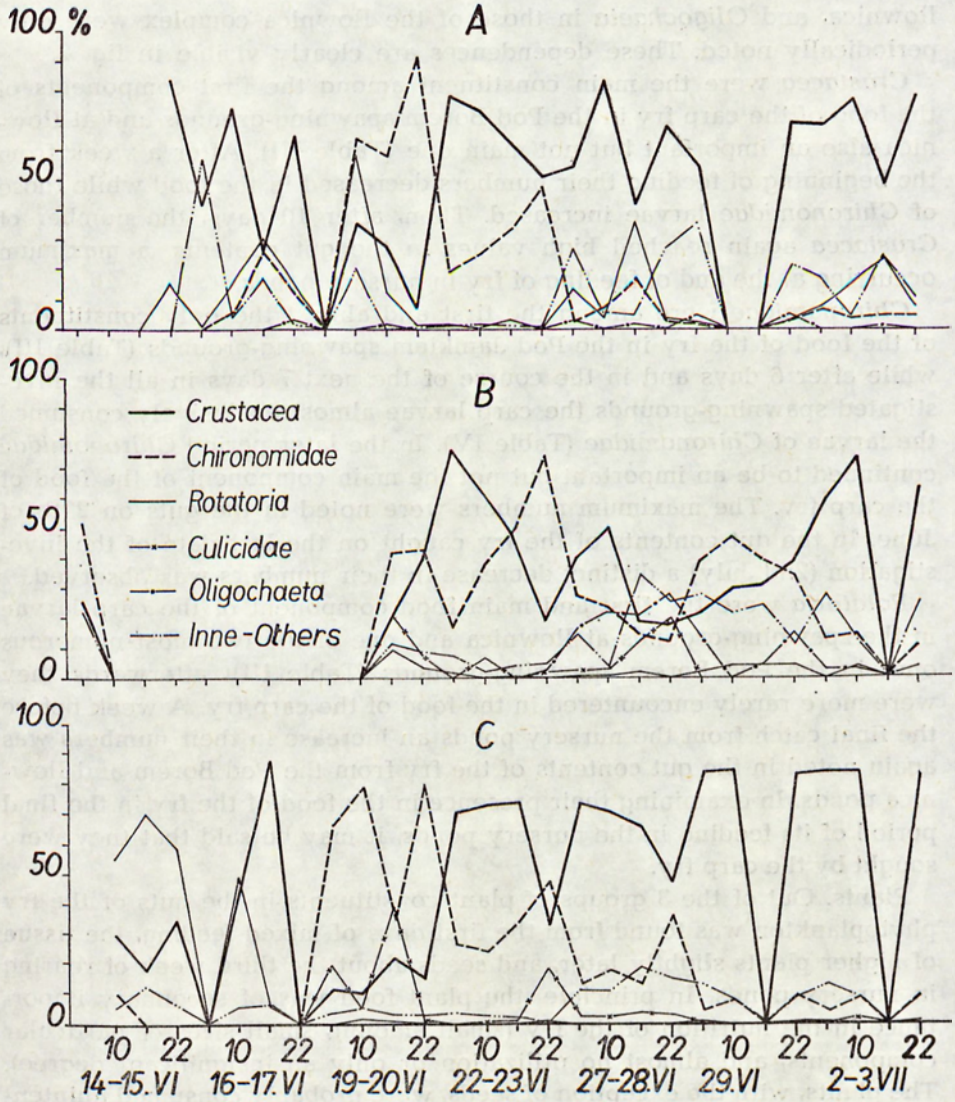
Tabela II. Składniki planktonu stawów Pod Borem i Pod Janikiem, stwierdzone w próbach wody i w treści jelit narybku (+), oraz stwierdzone tylko w próbach wody (o) w 1955 r.

Table II. Plankton components of the ponds Pod Borem and Pod Janikiem found in the samples of water and in the gut content of fry (+) and only in the samples of water (o) in 1955

Takson - Taxon	Daty poboru prób Date of sampling				Takson - Taxon	Daty poboru prób Date of sampling			
	20.VI	22.VI	27.VI	2.VII		20.VI	22.VI	27.VI	2.VII
Difflugia sp.			o	o	Anabaena circinalis Rabenhorst				o
Vorticella sp.		o	o	o	Trachelomonas volvocina Ehr.	o			
Asplanchna brightwelli Gosse	•	+			- hispida (Perty) Stein		o		
Asplanchna sp.			o	o	Dinobryon bavaricum Imhof			o	o
Brachionus angularis Gosse		+	+	+	- cylindricum Imhof		o		
Conochilus sp.		o			- divergens Imhof			o	o
- unicorius Rousselet			o	o	Synura uvella Ehr.		o		
Euchlanis dilatata Ehrb.	o				Cymbella sp.	+			
Filinia longiseta Ehrb.		o	o	o	Melosira granulata (Ehr.) Ralfs	+			
Keratella cochlearis Gosse	+	+	+	+	Pinnularia sp.	+			
- quadrata O.F. Müller	+	+	+	+	Synedra sp.	+	+		
Lecane luna O.F. Müller	+				Eudorina elegans (L.) Ehr.		o	o	o
Polyarthra euryptera Wierzejski			o	o	Pandorina morum Bory		+	+	+
- vulgaris Carlin		o	o	o	Volvox sp.	o	o	o	o
Synchaeta sp.		o	o	o	Scenedesmus falcatus Chod.	o			
Trichocerca cylindrica Imhof	+		+	+	- quadricauda (Turp.) Bréb.	+			
Nematoda		+			Scenedesmus sp.			+	+
Bosmina longirostris Müller	+	+	+	+	Tetraedron sp.			+	+
Ceriodaphnia quadrangula O.F. Müller		+		+	Spirogyra **sp.**	+			
Daphnia longispina O.F. Müller	+	+	+	+	Cosmarium sp.	+		+	+
Diaphanosoma brachyurum Lièven			+	+					
Scapholeberis mucronata O.F. Müller			+						
Ostracoda	+								
Cyclopidae	+	+	+	+					
Nauplii	+	+	+	+					
Diaptomidae		+	+	+					
Chironomidae	+		+	+					

General characteristics of the feeding of carp fry

In the guts of the fry (spawning-grounds, nursery ponds) two groups of animal components prevailed, *Crustacea* and *Chironomidae* (fig. 2), other animals and plants not attaining such numbers or frequency. *Cru-*



Ryc. 2. Charakterystyka odżywiania się karpia podczas trzech pierwszych tygodni jego wzrostu w tarliskach i w przesadkach. Stawy: Pod Borem (A), Pod Janikiem (B), w Iłownicy (C)

Fig. 2. Characteristics of the feeding of carp in the first three weeks of its growth in the spawning-grounds and nursery ponds: Pod Borem (A), Pod Janikiem (B), and at Iłownica (C) ponds

stacea and the larvae of *Chironomidae* constituted the groups of complementary components and were almost always found in the gut contents of the fry from the beginning of feeding in the spawning-grounds to the last catch in the nursery ponds, while, e.g. *Rotatoria* in one pond of the Iłownica complex, *Culicidae* in the ponds of the Pod Janikiem and at Iłownica, and *Oligochaeta* in those of the Iłownica complex were only periodically noted. These dependences are clearly visible in fig. 2.

Crustacea were the main constituent among the first components of the food of the carp fry in the Pod Borem spawning-grounds and at Iłownica also an important but not main one (Table III). After a week from the beginning of feeding their numbers decreased in the food while those of *Chironomidae* larvae increased. Then, after 10 days, the number of *Crustacea* again reached high values in the gut contents, a maximum occurring at the end of feeding of fry in nursery ponds.

Chironomidae were among the first and almost the only constituents of the food of the fry in the Pod Janikiem spawning-grounds (Table III), while after 6 days and in the course of the next 7 days in all the investigated spawning-grounds the carp larvae almost exclusively consumed the larvae of *Chironomidae* (Table IV). In the later period *Chironomidae* continued to be an important but not the main component of the food of the carp fry. The maximum numbers were noted in the guts on 29th of June. In the gut contents of the fry caught on the last date of the investigation (2nd July) a distinct decrease in their numbers was observed.

Rotatoria were the first and main food component of the carp larvae in the spawning-grounds at Iłownica and one of the two most numerous ones in the Pod Borem spawning-grounds (Table III); afterwards they were more rarely encountered in the food of the carp fry. A week before the final catch from the nursery ponds an increase in their numbers was again noted in the gut contents of the fry from the Pod Borem and Iłownica ponds. In examining their presence in the food of the fry in the final period of its feeding in the nursery ponds, it may be said that they were sought by the carp fry.

Plants. Out of the 3 groups of plant constituents in the guts of the fry phytoplankton was found from the first days of mixed feeding, the tissue of higher plants slightly later, and seeds about the third week of rearing in nursery ponds. In principle, the plant food was of secondary importance in the nutrition of the fry (small amount, small sizes of particular components, and almost no utilization or only an insignificant degree). The plants, with the exception of seeds, were probably consumed unintentionally, in seeking and eating invertebrate animals.

Varia also had no significance in the nutrition of the 3-week-old carp fry, because of too small numbers of particular constituents consumed within various groups. Exceptions were *Oligochaeta*, *Chaoborus*, and the smallest *Culicidae*, slightly more numerous in the gut contents. *Culicidae*

Tabela III. Pierwszy pokarm narybku karpia odłowionego ze stawów: A - Pod Borem; B - Pod Janikiem; C - w Iłownicy

Table III. First food of carp fry removed from ponds: A - Pod Borem; B - Pod Janikiem; C - at Iłownica

Nr kolejny przewodu pokarmowego / No of successive alimentary canal — Staw / Pond	Arcella sp.			Rotatoria			Bosmina sp.			Cerio-daphnia sp.			Daphnia sp.			Cladocera inne / other			Copepoda			Ostracoda			Chironomidae			Culicidae			Jaja / Eggs			Bacillariophyceae			Algae varia			Niezidentyfikowana reszta / Unidentified remnant		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1				1	3						8					1									1						2					1			+	+	
2				4	5											1														3								+	+	
3					2		5				1														5								3					+		
4					5		5												1						1													+	+	+
5																									2																	
6					4		1						1																				4			1	1		+	+
7					3																				1											1			+		
8				1	14								2			4						1			1											1					
9		1			6		5		1																												+		+		
10							4		1							1									2						2							+		+		
11					2		3			2	7														1						1	1						+				
12					8		2				3		1						1									1										+		+		
13					10						2		1												1													+	+	+		
14		1		1	6		7			1	6					1																								+		
15					1		1		2		1								1						1									1				+	+	+		
																																								+		+		

Tabela IV. Pokarm narybku karpia po tygodniu od rozpoczęcia żerowania

Table IV. Food of carp fry a week after beginning of grazing

Nr kolejny przewodu pokarmowego / No of successive alimentary canal — Staw / Pond	Rotatoria			Nematoda			Alona sp.			Bosmina sp.			Chydorus sp.			Daphnia sp.			Scapholeberis sp.			Copepoda			Chironomidae			Culicidae			Hydracarina			Jaja / Eggs			Bacillariophyceae			Algae varia			Niezidentyfikowana reszta / Unidentified remnant		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1			1										1	1											9	4	14							1						1					+
2										5													2	2	7	5	13			1											+			+
3																		3							3	1	10		5												+			+
4																						1		2	5		14	3	5															+
5										1			1			1						1	6		7	3	7			1											+			+
6										1			1			4						1			13	1	12		3															+
7							2															1			9	1	5		5					1					1			+			+
8	7					1								1							1	1			6	2	10							1					1	1		+			+
9													1									1			14	10	7																	+
10		1	1				1			3				3		1									6	8	16									1			1					+
11	3									4				2				1				5			8	1	7			1		1		3			1						+
12	2															4						4			7	1	6		1	1													+
13	3	17											1									2			10	11	10		1	1				10					1					
14	8	1											1									5			4	2	9			2		1		2								+		
15		2								2			1									1			6		10		5					3								+	+	

and *Chaoborus* were consumed by the carp from the first week of feeding, and *Oligochaeta* in quantities of any account no earlier than from the third week. The 3 above-mentioned components of the Varia group were well utilized by the fry. *Nematoda*, fairly frequent and numerous in the guts, were not digested at all and thus had no nutritive value for the fry. The other constituents of Varia were less frequent and occurred in still smaller numbers.

The first food of the carp

The first traces of food were found in the intestines of the fry on the third day after hatching. The food was noted in the first part of the gut, immediately behind the oesophagus. On the 3rd and 4th days after hatching, besides the food consumed in the spawning-grounds, decreasing quantities of the vitellus were observed. The remains of the vitellus sac were very sporadically found still on the 5th day after hatching.

Not all of the analysed guts were filled with food but some of them contained large quantities. With the exception of the above-mentioned period of mixed feeding (3—5 days) no larvae were noted with an entirely empty intestine. In principle, the first and basic food of the carp hatch was composed of similar constituents but with different dominants in separate spawning-grounds. In the Pod Borem spawning-grounds *Cladocera* dominated, *Rotatoria* being in the next place with regard to numbers; in the Pod Janikiem spawning-grounds almost the only constituent were the very small larvae of *Chironomidae* and in the spawning-grounds at Iłownica the dominants were *Rotatoria* followed by *Cladocera*. In all the investigated intestines, besides the main components, small quantities of other constituents were found. Table III contains the results of the analyses of carp food from the first day of feeding. For the sake of comparison the data obtained from the 10 p.m. analyses are listed, while the data from the other times of sampling are quoted as illustrating the process of feeding of the fry in the first 24 hours.

The Pod Borem spawning-grounds. The larvae of carp were caught at 4 a.m., 4 p.m., and 10 p.m., 4 a.m.: out of six guts examined two were empty, the others containing 3—15 specimens of *Bosmina longirostris*, unidentified plant detritus, bristles, and sand grains. In one gut 15 specimens of *Bosmina* were noted.

Twelve hours later (4 p.m.) in the guts of 15 larvae no traces of food from the environment were found besides the remains of vitelline sac, while at 10 p.m. only 3 out of 15 guts examined did not contain any food.

The presence of detritus of various types was remarkable, indicating an "unclean" way of feeding of the carp fry.

The Pod Janikiem spawning-grounds. The data from 10 p.m. analyses are listed. In $^1/_3$ of the larvae of carp caught food composed of *Chironomidae* larvae was found (1—5 specimens in one gut) and, moreover, single specimens of *Copepoda, Cladocera, Culicidae, Bacillariophyceae,* eggs, bristles of gnats, and unidentified remnants. The size of the *Chironomidae* larvae consumed was 0.5—1.5 mm; among them some specimens had just been consumed, others were partly digested, and of some only the heads remained.

The spawning-grounds at Iłownica. The carp larvae were caught at 10 a.m. and at 4 and 10 p.m. Table III contains the results of analyses from the 10 p.m. catch.

At 10 a.m. in the guts of 5 carp larvae no food except the remains of vitellus was observed; in the remaining 10 guts 1—2 larvae of rotifers *(Keratella cochlearis* or *K. quadrata,* more rarely *Lecane luna)* and single specimens of *Bosmina longirostris, Ceriodaphnia* sp., *Copepoda, Chironomidae,* eggs, and unidentified remnants were noted. At 4 p.m. two out of ten intestines were empty and in the remainder the number of *Rotatoria* was greater than in the former catch, *Keratella cochlearis* ocurring fairly frequently. In one gut 17 rotifers were found and also *Bosmina, Ceriodaphnia,* eggs, and unidentified remnants. At 10 p.m. in one gut of the examined carp no food was noted and in the others *Rotatoria* and *Ceriodaphnia,* more rarely other species of *Cladocera.* For the first time *Rhizopoda (Arcella)* were found in the food, also eggs and unidentified remnants.

Characteristics of the carp food after the first week of feeding

At this time the total mean length of the carp was 10 mm and the mean length of alimentary canals 4.5—5.0 mm. The intestines had the shape of a straight tube (fig. 1) with a distinctly widened oesophagus part. The walls of the intestines were thin and transparent, hence the macroscopic evaluation of their content was simple. The sectors of the gut filled with *Crustacea* were lighter, "pinkish", with black dots (eyes of crustaceans), while those filled with the larvae of *Chironomidae* or species of the Varia group were grey or black.

In the gut contents greater quantities of food were found which, after removing the gut walls, preserved a cylindrical shape of compact consistency. Sometimes the guts examined were poorly filled but no intestines were empty. The inner walls of some guts were coated with digested remnants, slime, or sand grains.

In Table IV the results of food analyses of the fry are listed, considering one catch time within 24 hours from each pond.

In the food of the carp fry from all ponds and all catch times the *Chironomidae* larvae prevailed. The greatest numbers of them were noted in the food of fry from the Iłownica and Pod Borem complexes. Smaller numbers of these larvae in the food of fry from the Pod Borem ponds were compensated by *Crustacea*, and in the Pod Janikiem ponds by *Culicidae*. In the investigated period the length of the *Chironomidae* larvae consumed was 1—3 mm, and that of *Culicidae* 1—2.5 mm. In one alimentary canal of the fry up to 20 specimens of *Chironomidae* were found, the larvae prevailing. Besides *Chironomidae* small numbers of *Crustacea*, *Oligochaeta*, nauplius, *Chaoborus*, *Hydracarina*, *Nematoda*, sand, and fine detritus were encountered.

The degree of digestion of individual components was also variable. Besides freshly consumed, unaffected specimens, crushed and lacerated ones were noted, forming a kind of pulp composed of various fragments of bodies of consumed animals and plants (furca of *Copepoda*, legs of *Crustacea*, mastaxes of *Rotatoria*, uncinate *Oligochaeta* bristles, antennae, legs of *Crustacea* and of other animals, eggs, great numbers of *Bacillariophyceae*, mud, sand, detritus, and many others).

To recapitulate, in the second week of feeding great numbers of *Chironomidae* larvae were noted in the alimentary canals of the carp while from the 9th day the number of *Copepoda* increased.

Detailed analysis of the composition of the carp food

Within the first 3 weeks of feeding of the carp in the spawning-grounds and nursery ponds, the chief components of the food were *Crustacea*, most numerous and most frequent in the gut contents (63.0%, 98.4%). These were followed by *Chironomidae* (11.1%, 88.7%), *Rotatoria* (10.4%, 72.6%), plants (10.5%), Varia (3.51%), and an unidentified remnant (1.4%).

In the group of consumed *Cladocera* the following were identified: *Cladocera* (42.9%), *Copepoda* (19.8%), and *Ostracoda* (0.17%). Instead of a detailed description of the individual groups of food constituents the data are given in Tables V and VI and in figs 3 and 4.

The daily rhythm of feeding of the carp

In the course of analysing the alimentary canals of the fry differences were observed in the degree of their filling. This suggested a variability in the intensity of feeding of the fry throughout the day. Besides aliment-

Tabela V. Częstość występowania składników zwierzęcych (A) i roślinnych (B) w przewodach pokarmowych karpia wyrażona w procentach prób (przewodów pokarmowych), które dany takson zawierały

Table V. Frequency of occurrence of animal (A) and vegetal (B) components in the alimentary canals of carp, expressed in percentage of samples containing a given taxon

A		B	
Takson - Taxon	%	Takson - Taxon	%
Arcella sp. (Rhizopoda)	22.59	Phacus sp. div.	16.13
Asplanchna brightwelli Gosse	0.98	Peridinium sp.	0.64
Brachionus calyciflorus Pallas	19.36	Cymbella sp.	-
Keratella cochlearis Gosse	43.54	Fragilaria sp. div.	-
- quadrata O.F. Müller	33.87	Gomphonema sp.	-
Lecane luna O.F. Müller	41.93	Melosira sp.	-
- lunaris Ehrb.		Pinnularia sp. div.	25.81
Platyias patulus O.F. Müller	20.96	Pandorina morum (Müll.) Bory	12.90
Trichocerca cylindrica Imhof	1.13	Crucigenia tetrapedia (Kirchn.) West	0.81
Rotatoria n. det.	19.35	Pediastrum sp. div.	19.36
Nematoda	30.64	Scenedesmus acuminatus (Lagerh.) Chod.	22.58
Oligochaeta	43.54	- bijuga (Turp.) Lagerh.	14.52
Alona quadrangularis O.F. Müller	41.93	- ecornis (Ralfs) Chod.	25.80
- rectangula G.O. Sars		- obliquus (Turp.) Kütz.	12.90
Bosmina longirostris O.F. Müller	64.51	- platydiscus (G.M. Smith) Chod.	17.74
Ceriodaphnia quadrangula O.F. Müller	62.90	- quadricauda (Turp.) Bréb.	0.16
- reticulata Jurine		Tetraëdron sp.	0.32
Chydorus sphaericus O.F. Müller	75.80	Tetrallanthos Lagerheimii Teiling	0.16
Daphnia longispina O.F. Müller	66.12	Closterium sp. div.	32.26
Daphnia sp.	0.48	Cosmarium sp. div.	41.94
Eurycercus lamellatus O.F. Müller	0.64	Euastrum oblongum (Grev.) Ralfs	0.64
Macrothrix laticornis Jurine	0.32	Spirogyra sp. div.	12.90
Scapholeberis mucronata O.F. Müller	25.80	Staurastrum sp. div.	0.32
Simocephalus vetulus O.F. Müller	20.96	Oedogonium sp.	-
Cladocera (juv.)	0.64	Nasiona - Seeds	19.36
Cladocera ephipia	19.36		
Cladocera inne (głównie Diaphanosoma brachyurum Lièven) other (mostly	66.12		
Ostracoda	37.10		
Cyclopidae	90.32		
Diaptomidae	0.81		
Ephemeroptera	0.32		
Corixidae	19.36		
Lepidoptera	11.29		
Coleoptera	16.13		
Chironomidae (larvae)	88.70		
Chironomidae (pupae)	38.70		
Chaoborus	29.03		
Culicidae	38.70		
Heleidae	0.64		
Hydracarina	1.29		
Araneina	0.48		
Bryozoa	12.90		
Nieoznaczone - Not determined	83.87		

ary canals well filled in the whole length, there were guts or sectors of them poorly filled or with small gaps.

In order to investigate the problem in detail, an indicator organism was appointed, the criterion being the unaffected appearance of the body of the component from the first sector of the alimentary canal. Considering the differences in the digestion of separate food components, the *Chironomidae* larvae were chosen, since, in general, *Crustacea* were more changed in the above-mentioned sector of the alimentary canal. Four times of fry catches in 24 hours and all freshly consumed *Chironomidae* larvae of the first sector being considered, it was found that the fry were feeding throughout 12 hrs of the day and less intensely in the remaining 12 hrs. An increase in the intensity of feeding occurred between 4 a.m. and 4 p.m. while between 4 p.m. and 4 a.m. of the next day a decrease in intensity was observed. Within the period of an increase and the period of a decrease in the intensity of feeding certain differences were

Tabela VI. Udział larw Chironomidae w pokarmie narybku ze stawów:
A - Pod Borem; B - Pod Janikiem; C - w Iłownicy

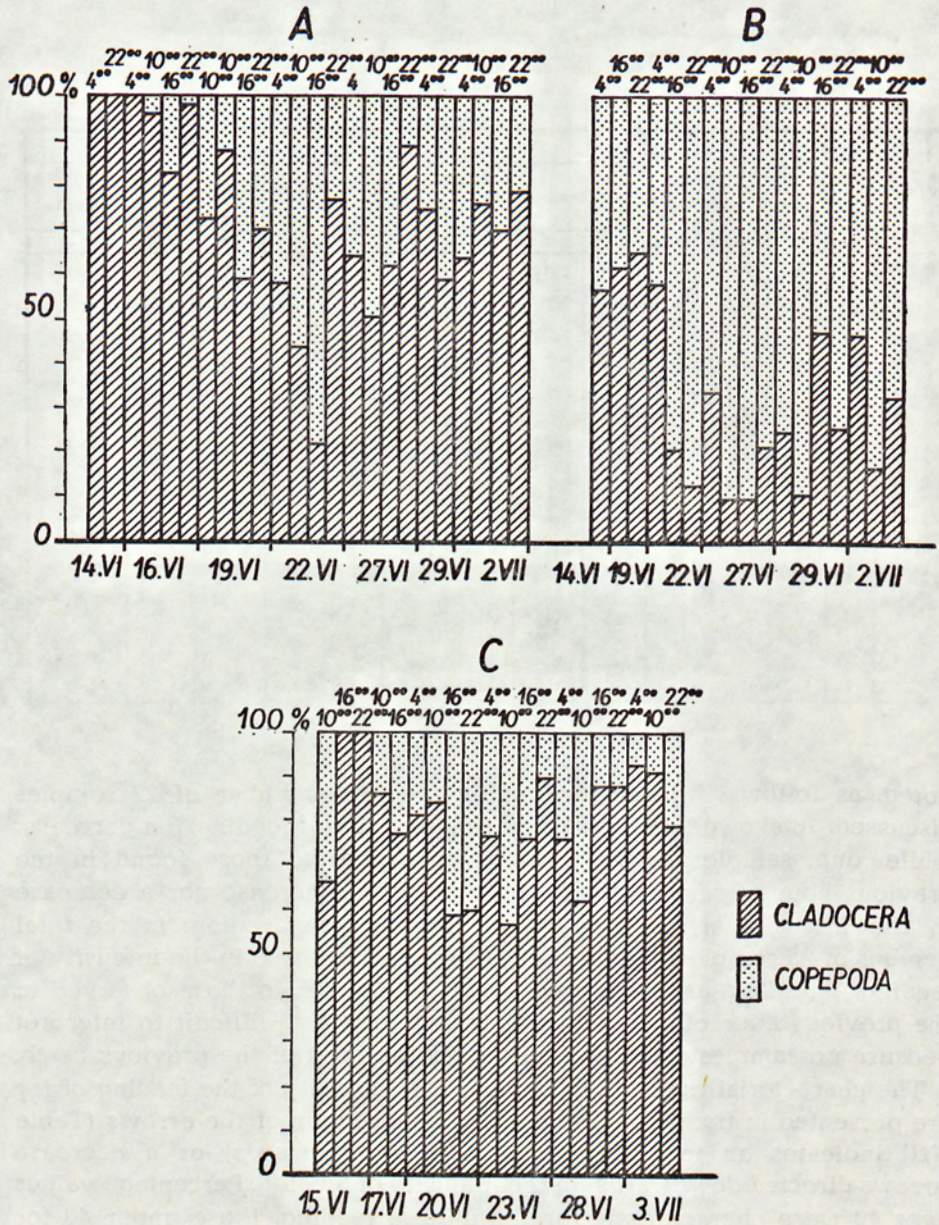
Table VI. Share of Chironomidae larvae in food of fry from ponds:
A - Pod Borem; B - Pod Janikiem; C - at Iłownica

1955 Data i godziny odłowu narybku Date and hours of fry removal		Ogółem ryb w próbie Total number of fish in sample			Larw Chironomidae-of Chironomidae larvae								
					Ogółem - Total			Świeżo pobranych Recently taken			% przewodów pokarmowych ze świeżymi larwami % of alimentary canals with fresh larvae		
		A	B	C	A	B	C	A	B	C	A	B	C
14-15.VI	4	6	15	-		14						53.3	
	10	-	-	15			2						
	16	15	-	10									
	22	15	-	15									
16-17.VI	4	15	16	-		7							
	10	17	-	15	4								
	16	8	-	15	6								
	22	15	-	-	9								
19-20.VI	4	-	-	15	-		124			16			33.3
	10	13	-	15	85		148	0	-	33			66.7
	16	15	15	15	115	51	79	14	23	8	46.7	66.7	53.3
	22	15	10	15	272	54	215	1	5	24	6.6	30.0	33.3
22-23.VI	4	15	15	15	67	50	99	6	12	11	46.7	40.0	20.0
	10	15	30	15	142	87	99	37	62	7	66.7	53.3	40.0
	16	4	31	15	27	62	130	5	36	13	75.0	61.3	40.0
	22	4	11	13	42	93	97	2		13	25.0		69.2
27-28.VI	4	15	15	10	43	69	54	18	14	15	53.3	60.0	50.0
	10	15	15	10	77	107	71	18	15	11	66.7	66.7	40.0
	16	16	15	10	214	79	56	56	35	19	75.0	80.0	60.0
	22	15	15	10	29	31	102	5	12	9	20.0	60.0	20.0
29.VI	4	20	15	-	32	303	-	8	23	-	45.0	46.7	
	10	-	15	-	-	383	-	-	31	-		33.3	
	16	-	15	-	-	673	-	-	52	-		46.7	
	22	16	15	-	55	480	-	9	46	-	43.7	73.3	
2- 3.VII	4	36	15	15	304	94	145	23	13	8	27.8	40.0	20.0
	10	39	15	10	255	272	100	49	71	35	48.7	93.3	70.0
	16	31	-	-	629	-	-	34	-	-	48.4		
	22	41	15	10	422	158	147	91	18	24	73.2	40.0	50.0

noted, as follows: intense feeding: in the total number of 22 samples discussed, 18 showed an increase in the intensity of feeding, 3 a decrease, while one sample showed values analogical to those found in the previous hour of sampling, showing neither an increase nor a decrease in the intensity of feeding (fig. 5). Less intense feeding: in the total number of 25 semples discussed, 11 showed a decrease in the intensity of feeding, 7 an increase, 3 showed values analogical to those observed in the previous hour of catching, and 3 samples were difficult to interpret because no samples were available from the hour of the previous catch.

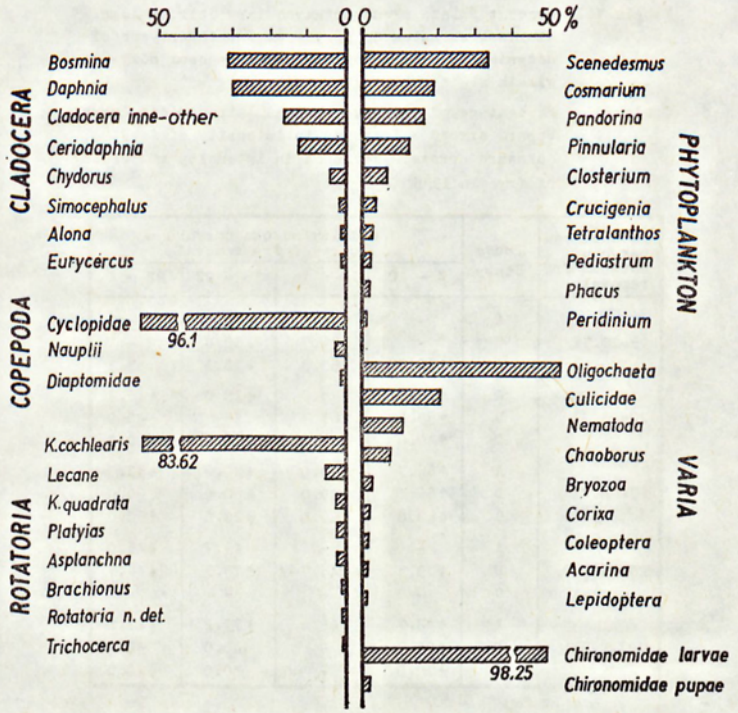
The characteristics of the changes in the intensity of the feeding of fry are presented in fig. 5 and Table VII. The direction of the arrows (Table VII) indicates an increase (arrows directed upwards) or a decrease (arrows directed downwards) in the intensity of feeding. Percentage values over 40 were characteristic for the intense feeding, those under 40 for the less intense feeding.

Moreover, the feeding of the fry, in the night hours suggested a secondary importance of the carp's sense of sight in seeking food. This was also observed by K l u s t (1935). It is worthy of note that the carp fry consumed the *Chironomidae* larvae during the day, i.e. from the early morning to late afternoon. In the evening and at night the number



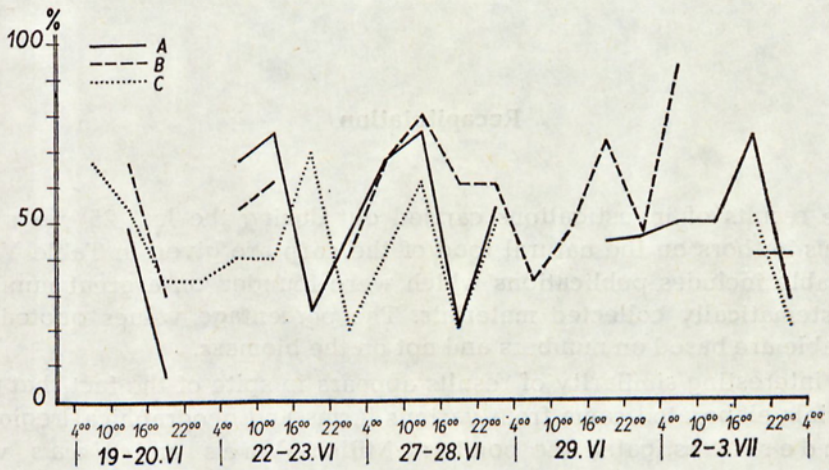
Ryc. 3. Udział *Cladocera* i *Copepoda* w pokarmie karpia ze stawów: A — Pod Borem, B — Pod Janikiem, C — w Iłownicy

Fig. 3. The share of *Cladocera* and *Copepoda* in the food of carp from the ponds: A — Pod Borem, B — Pod Janikiem, C — at Iłownica



Ryc. 4. Skład procentowy ważniejszych komponentów pokarmowych narybku karpia w obrębie poszczególnych grup

Fig. 4. The percentage share of important food components of the carp fry within separate groups



Ryc. 5. Zmiany intensywności odżywiania się narybku karpi w ciągu doby. Stawy: A — Pod Borem, B — Pod Janikiem, C — w Iłownicy

Fig. 5. Changes in the intensity of feeding of the carp fry during the day. Ponds: A — Pod Borem, B — Pod Janikiem, C — at Iłownica

Tabela VII. Procent świeżo skonsumowanych larw Chironomidae. Kierunek strzałek do góry - wzrost intensywności odżywiania, na dół - spadek intensywności odżywiania się narybku w 1955 r.

Table VII. Percentage of freshly consumed Chironomidae larvae. Upward arrows - increase in intensity of feeding, downward arrows - decrease in intensity of feeding of fry in 1955

Data odłowu narybku Date of fry removal	Ponds Stawy	Godziny odłowu narybku Hours of fry removal			
		4 - 10	10 - 16	16 - 22	22 - 4
19-20.VI	A	-	↑48.7	↓ 6.6	-
	B	-	↑66.7	↓30.0	-
	C	↑66.7	↓53.3	↓33.3	33.3
22-23.VI	A	↑66.7	↑75.0	↓25.0	↑46.7
	B	↑53.3	↑61.3	-	40.0
	C	↑40.0	40.0	↑69.2	↓20.0
27-28.VI	A	↑66.7	↑75.0	↓20.0	↑53.3
	B	↑66.7	↑80.0	↓60.0	60.0
	C	↑40.0	↑60.0	↓20.0	↑50.0
29.VI	A	-	-	43.7	↓45.0
	B	↓33.3	↑46.7	↑73.3	↓46.7
	C	-	-	-	-
2-3.VII	A	↑48.7	48.4	↑73.2	↓27.8
	B	↑93.3	-	40.0	40.0
	C	↑70.0	-	50.0	↓20.0

of *Chironomidae* larvae consumed was markedly smaller. Similar observations on the rhythm of feeding of *Vimba vimba* were made by Nabereznyj et al. (1973).

Recapitulation

The results of investigations carried out during the last 25 years by various authors on the natural food of the carp are given in Table VIII. The table includes publications which were founded on a great number of systematically collected materials. The percentage values quoted in this table are based on numbers and not on the biomass.

An interesting similarity of results appears in spite of the fact that the materials elaborated came from various farms and geographical regions. Wunder investigated the ponds at Milicz, Vaas and Vaas van Oven those in Indonesia (Java), Hajduk in the region of Wrocław, Saadi in various farms in the German Federal Republic, Skaziński the ponds of the Gołysz I complex, Trzoch-Szalkiewicz and Ciborowska the ponds of Żabieniec, and J. Matlak and O. Ma-

tlak the ponds of the Pod Borem, Pod Janikiem, and Iłownica complexes.

The data listed in Table VIII clearly show that throughout the first 3 weeks of life (the stage of spawning-grounds and nursery ponds) the carp fed on crustaceans, among *Crustacea* the most frequently consumed group being *Cladocera* but not *Copepoda*. Besides the authors listed in Table VIII, the dominance of *Copepoda* in the pond of the fry was also found by Bishai et al. (1973) and by the present authors in the ponds of the Pod Janikiem complex (fig. 3). Although in the ponds discussed in the present paper the total number of *Crustacea* consumed by the fry was smaller, they still prevailed among their food constituents, Merla (1959) also noted much greater quantities of crustaceans than of bottom food.

The value of *Bosmina* in the nutrition of fry is controversial in consequence of a poor degree of its utilization. However, according to the data of Grygierek (1973), in warm years, in the ponds investigated by this author, the production of fry was the greater the larger was the percentage share of *Bosmina*, and not of *Daphnia*, in the total number of crustaceans. Saadi (1965) claimed that *Bosmina* was not willingly consumed by the fry, but this opinion could be connected with the small numbers of the genus in the ponds investigated by this author. Wunder (1949), and Skaziński (1966) quoted it among the frequent food components of the fry, though among those less frequent than *Daphnia*. Trzoch-Szalkiewicz shares our opinion on the poor utilization of *Bosmina* (personal communication).

A proper answer with regard to the utilization and value of *Bosmina* and other components of the food of fry may be obtained on the basis of a laboratory investigation. Investigations of this kind were undertaken by many authors (Prus 1970, Proskurina 1973).

From similar reasons as those described above, the value and utilization of *Chydorus* is also dubious. From the very first days in the spawning-grounds *Chydorus* was found in the food very frequently and on a level with *Rotatoria* (Wunder 1949, Hajduk 1963, Skaziński 1966, Trzoch-Szalkiewicz 1970, 1972, Ciborowska 1970, 1972). Only Saadi (1965) classified it among the components not very willingly consumed.

The present authors agree in the evaluation of the species of the genera *Daphnia*, *Ceriodaphnia*, and *Diaphanosoma*, most frequently encountered in the food of the fry, the second and third of them being consumed by the carp hatch from the first moment of mixed feeding and greater numbers of *Daphnia* slightly later. Among *Cladocera* which were well utilized but consumed in numbers much smaller than the above-mentioned genera, were *Eurycercus*, *Simocephalus*, and *Macrothrix*. *Macrothrix* was mentioned in great numbers only by Vaas and Vaas van Oven (1959).

Tabela VIII. Skład procentowy głównych komponentów pokarmu karpia w przesadkach I, według różnych autorów

Obecność komponentów w jelitach, bez określenia ilości (+)

Table VIII. Percentage share of main components of carp food in nursery ponds I, according to different authors

Presence of components in gut, without given quantity (+)

Komponenty Components / Autor Author	Wunder	Vaas et al.	Hajduk	Saadi	Skaziński	Trzoch-Szalkiewicz				Ciborowska	Ciborowska	Matlak J. Matlak O.
Rok opublikowania lub zebrania materiałów Year of publication or of material collection	1949	1959	1963	1965	1966	1966	1967	1968	1970	1970	1972	1955
Liczba ryb Number of fish	101	260	180	1571	124	120	558	882	515	160	121	987
Crustacea ogółem total	dominujący dominant		71.91	87.3	82.2	83.42	80.92	78.66	79.98	72.24	65.73	63.04
Cladocera + Ostracoda			39.43	38.2	46.89	37.79	50.35	59.10	49.99	48.78	46.70	43.17
Copepoda			32.48	49.1	35.39	43.86	30.57	19.56	29.98	23.46	19.10	19.86
Chironomidae	subdominujący subdominant		11.69	11.0	14.0	14.87	10.05	16.95	14.26	9.04	7.79	11.07
Rotatoria	+	+	5.14	1.4	+	0.51	8.01	0.12	2.75	16.32	0.001	10.44
Oligochaeta	+	+	-	3.8	-	-	-	-	-	-	-	1.62
Rośliny - Plants	+	+	-	-	-	-	0.28	2.80	1.78	+	24.79	10.48
Varia	+	+	8.03	0.1	+	1.20	0.72	1.47	1.23	2.40	1.62	3.69

On the contrary, *Copepoda* are estimated as explicitly useful, all authors (Table VIII) classifying them among the best components of the food of carp fry. Among *Copepoda, Cyclopidae* and the nauplius stage were consumed more frequently, but *Diaptomus* sporadically, this being shown in Table V and also by the data of Wunder (1949) and Hajduk (1963). It should be noted that the nauplius did not appear so often as a component of the food of fry as was claimed by Saadi (1965), Skaziński (1966), Trzoch-Szalkiewicz (1970), and Ciborowska (1972).

Ostracoda, the third food component of the *Crustacea* group, were mentioned frequently only by Vaas and Vaas van Oven (1959).

Chironomidae were a very important component of the diet of the fry and sometimes dominated over the crustaceans with regard to biomass (Hajduk 1963, Trzoch-Szalkiewicz 1970). According to the present observations, *Crustacea* and *Chironomidae*, in a degree complementing each other, were the two main sources of nourishment of the fry throughout the first 3 weeks of growth in the nursery ponds.

Considering the poor growth of the fry fed with *Chironomidae* larvae only, some authors suggest their lower nutritive value (Hajduk 1963, Vaas et al. 1959, Saadi 1965). In the present investigation the importance of the smallest *Chironomidae* larvae was stressed since they were among the first components of the food of the young carp hatch. It was also observed by Vaas et al. (1959) and Grygierek (unpublished

materials). As they grew, the carp consumed ever larger specimens of *Chironomidae* (0.5—14 mm). *Chironomidae* were digested slower than *Crustacea* but in the third part of the alimentary canals they were usually found in the form of remnants with the heads well preserved. It should be mentioned that in the third part of the alimentary canals of the fry, among the digested remnants of *Chironomidae*, very large numbers of diatoms were found, which had most probably constituted the food of the *Chironomidae* larvae and also of *Cladocera* and, after they had been digested, reached that part of the intestines of the fry (Kajak et al. 1968, Semenova 1974). The species of diatom frequently encountered in the third part of the intestines of the fry are listed in Table V.

It may be supposed that the percentage of phytophile *Chironomidae* consumed by the fry might be fairly great, considering their numbers in the plant-covered zone of ponds (Matlak 1963) and also the results obtained by Aleksevnina (1972), who estimated their quantity in the food of fry as 33%.

Rotatoria: many authors attribute importance to this group only during 7—10 days after the hatch (Wunder 1949, Vaas et al. 1959, Hajduk 1963, Skaziński 1966). As the present data show, the fry consumed *Rotatoria* also in the later period, when many other food components were available. This was also noted by Ciborowska (1970). In consequence of their small body size, *Rotatoria* are particularly useful in tank breeding during the first days (the beginning of mixed feeding).

Plants: almost all authors (Table VIII) mention the presence of plant components in the food of fry and explicitly classify them as secondary ones in the stage of feeding the fry in spawning-grounds and nursery ponds (small numbers and sizes, particularly of the phytoplankton, little or almost no utilization).

Varia: some species of the Varia group could be more important for the fry if they were consumed in greater numbers, e.g. *Oligochaeta* mentioned only by some authors (Table VIII), *Chaoborus*, the smallest specimens of *Culicidae* or *Ephemeroptera*.

The majority of authors mention the presence of plant and animal detritus, mineral particles, and others determined as ballast by Wunder (1949). *Bryozoa* were found by a few authors (Hajduk 1963, Megyeri 1969).

In estimating the quantities of food consumed by the fry it was observed that in the first day they were small, then they increased as the length (the development of the loop) and lumen of the alimentary canal grew. The greatest quantities of nutritive components were contained in the guts of fry caught in nursery pounds at the end of the observation period. However, it should be noted that in some alimentary canals of the youngest carp very large amounts of food were encountered in relation to their length or volume. In computing the mean numbers of

the specimens of components per 1 alimentary canal, without detritus and other remnants which were difficult to evaluate quantatively, it was found that in the initial period they ammounted to 2—3 specimens per 1 gut (the length of the gut being 3 mm), after 10 days to 16—30 specimens (the length of the gut being 5—6 mm), and after the next 10 days, i.e. at the end of the investigation, 100—250 specimens per 1 gut with a mean length of 23—30 mm.

Considering the degree of digestion of food components on the basis of the macroscopic evaluation of differences in the appearance of components in particular sectors of the intestine, it was found that *Oligochaeta* were digested most rapidly, being noted in the alimentary canal in the form of remnants of various size or of bristles scattered in the whole contents. Crustaceans, with the exception of *Bosmina* and *Chydorus*, were also well utilized. Crustaceans were encountered in the form of crushed or lacerated remnants, similarly as small specimens of *Culicidae* or *Chaoborus*, whose presence in the food was indicated by bunches of setae. Ermeeva (1967) stressed the role of pharyngeal teeth in the feeding of fry from the very earliest stages of its development.

Rotifers were fairly rapidly digested *(Asplanchna, Conochilus, Brachionus)* but some of them maintained their original appearance longer *(Keratella cochlearis, K. quadrata, Platyias). Nematoda, Heleidae*, eggs of invertebrates, and phytoplankton were found almost or entirely unaffected in the final sector of the gut. Damaged cells of *Closterium* and *Pediastrum* were occasionally found, though very rarely, but most frequently filaments of algae of various length were encountered (chiefly *Spirogyra).*

Chironomidae were digested more slowly than crustaceans but equally well. Sometimes digested remnants of *Chironomidae* coated the walls of the guts of the fry.

In nursery ponds the preparation of a base of natural food should aim in the initial period at a strong development of the smallest forms of zooplankton, without predatory forms (some *Copepoda* species), this being also important in the tank breeding of carp. In a slightly later period of carp fry feeding in nursery ponds, the development of larger species of the zooplankton would be advisable. At this stage of feeding of the carp their concentration should amount to 1000—1500 specimens/I (Panov at al. 1973). The consumption of food should be accompanied by the maximum development of the most important food groups (Merla 1959).

In nursery ponds such conditions may be ensured through suitable fertilization (Bombówna et al., 1962, Klimczyk 1959, Krzeczkowska-Wołoszyn 1967) as well as by chemical treatment (Tamas et al. 1974) and by keeping the spawning-grounds and nursery ponds in proper culture.

STRESZCZENIE

Zbadano zawartość 987 przewodów pokarmowych narybku karpia, pozyskanego z odłowów w tarliskach i przesadkach I, trzech kompleksów stawowych Zakładu Doświadczalnego Polskiej Akademii Nauk w Gołyszu. Odłowy wykonywano czterokrotnie w ciągu doby, w godzinach 4, 10, 16, 22, w odstępie czasu co dwa, trzy do pięciu dni, w ciągu trzech pierwszych tygodni życia narybku. Analizy pokarmu rozpoczęto, gdy jelita miały kształt prostych rurek i długość 3 mm, zakończono, gdy były uformowane w kilka pętli i osiągnęły średnią długość 30 mm.

Odżywianie się narybku w badanych stawach miało charakter endogenny w ciągu pierwszych 2—3 dób, mieszany do 5 doby, a następnie egzogenny.

Stwierdzono, że pokarm narybku karpia był bardzo różnorodny, złożyło się bowiem nań więcej niż 100 komponentów zwierzęcych i roślinnych. Jednak tylko nieliczne z nich odegrały w nim zasadniczą rolę. W miarę wzrostu narybku zwiększał się skład jakościowy i ilościowy jego pokarmu.

Na pokarm narybku w okresie trzech pierwszych tygodni jego życia złożyły się: *Crustacea* 63,0%, *Chironomidae* 11,0%, *Rotatoria* 10,4%, rośliny 10,5%, Varia 3,5% i nieoznaczone 1,4%. Ciągłość występowania zanotowano w wypadku *Crustacea* i *Chironomidae*, inne składniki charakteryzowała okresowość występowania.

Crustacea i *Chironomidae* cechowała dość wyraźna rozbieżność pod względem ilości (63,0%, 11,0%), ale duże podobieństwo pod względem częstości występowania w przewodach pokarmowych (98,4%, 88,7%).

Dane dotyczące częstości występowania poszczególnych składników w pokarmie narybku nie są wystarczające dla interpretacji ich roli w odżywianiu się narybku i powinny być uzupełnione analizą ciężarów tych składników.

Wśród *Crustacea* dominowały *Cladocera* (43,0%) przed *Copepoda* (19,9%). W obrębie *Cladocera* najliczniejszymi gatunkami były: *Bosmina longirostris* (32,9%), *Daphnia longispina* (30,3%), *Diaphanosoma brachyurum* (16,5%), *Ceriodaphnia* z gatunkami *quandrangula* i *reticulata* (12,7%), *Chydorus sphaericus* (3,9%).

W obrębie *Copepoda* — *Cyclopidae* (96,1%), postembrionalne stadium rozwojowe *Copepoda*, nauplius (2,7%) oraz *Diaptomus* (1,1%).

W obrębie *Chironomidae* — larwy (98,2%), przed poczwarkami (1,7%). Na pierwszy i główny pokarm karpia w 3 dniu po wylęgu złożyły się, w jednym z tarlisk *Crustacea* i *Rotatoria*, w drugim małe larwy *Chironomidae*, w trzecim *Rotatoria*, *Crustacea* i *Protozoa*. Prócz nich małe ilości innych składników zwierzęcych i roślinnych, a ze składników mineralnych — piasek i cząstki mułu.

Nie wszystkie gatunki z wymienionych w próbach planktonu i z miejsc stawów pokrytych roślinnością były znajdowane w pokarmie narybku, jak również w treści jelit znajdowano gatunki, nie zauważone w wymienionych próbach. Okoliczność ta mogła być świadectwem selektywności pokarmowej narybku.

Większość komponentów pokarmowych była dobrze trawiona. Bez śladów trawienia znajdowane były w końcowym odcinku przewodów pokarmowych — *Nematoda*, *Heleidae*, jaja i fitoplankton.

Niemal w każdym przewodzie pokarmowym notowano większe lub mniejsze ilości detrytusu roślinnego i zwierzęcego, a w trzecim odcinku, także duże ilości *Bacillariophyceae*. Wchodziły one najprawdopodobniej w skład przewodów pokarmowych larw *Chironomidae* i *Cladocera* i w wyniku ich strawienia przedostały się do wspomnianego odcinka przewodów pokarmowych narybku.

Nie stwierdzono pustych przewodów pokarmowych, z wyjątkiem okresu odżywiania mieszanego, ale zanotowano różnice w stopniu wypełnienia jelit, pozwalające stwierdzić zmiany intensywności odżywiania się narybku w ciągu doby.

Odżywianie się narybku było bardziej intensywne począwszy od wczesnych go-

dzin rannych, w ciągu dnia do późnych popołudniowych oraz mniej intensywne w godzinach nocnych.

Zwiększanie się ilości składników pokarmowych przypadających na jeden przewód pokarmowy następowało wraz ze wzrostem długości (rozwój pętli) i pojemności jelita.

Skład pokarmu narybku ze stawów kompleksu Pod Janikiem charakteryzowała największa rozmaitość gatunków, co mogło być odzwierciedleniem ich mniejszej żyzności.

Z danych zawartych w pierwszej części opracowania (Matlak 1966) oraz z niniejszych wynika, że baza pokarmowa narybku badanych stawów oraz jej wykorzystanie przez narybek nie były dostateczne skoro osiągnął on pod koniec przesadek I mały ciężar (0,5 g) oraz niewielką długość ciała (23—33 mm, średnie wartości dla długości całkowitej). Słabe przyrosty narybku były wynikiem nadmiernej obsady.

Uwzględniając przedstawione wyniki i dane innych autorów stwierdzono, że na główny pokarm narybku karpia złożyły się, niezależnie od warunków środowiska czy geograficznych: *Crustacea*, wśród nich *Cladocera* i *Copepoda* oraz larwy *Chironomidae*. *Rotatoria* i *Protozoa* z uwagi na małe rozmiary ciała mogą odegrać ważną rolę, szczególnie w okresie odżywiania się mieszanego i pierwszych dni egzogennego. Z Varia mogłyby mieć znaczenie jedynie komponenty zjadane przez narybek w ilościach większych (*Oligochaeta, Chaoborinae,* najmniejsze osobniki *Culicidae*). Rośliny stanowią wprawdzie stałe składniki pokarmu narybku, lecz tak pod względem ilości, jak i wykorzystania drugorzędny na tym etapie odżywiania się narybku.

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