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Department of Systematic Zoology, Faculty of Science, Charles University, Prague

NOTE ON THE GROWTH OF THE COMMON CARP, CYPRINUS CARPIO, IN OPEN WATERS IN CZECHOSLOVAKIA

Abdel Moneim KHALID

Received November 4, 1985

Abstract. The growth of 105 specimens of the common carp, *Cyprinus carpio*, caught by anglers from 1980 up to 1984 in 21 different localities has been studied using the scale structure. Some specimens reached a considerable age and size, being in the twelfth age class. Regardless of the limited material it seems that the carp artificially planted into open waters in Czechoslovakia has a good growth rate.

INTRODUCTION

The common carp, *Cyprinus carpio* Linnaeus, 1758, is the most popular pond fish species in Czechoslovakia, highly valued also by anglers, who plant it into open waters for angling purposes. E. g., in 1968 in the Czech Socialist Republic the number of angled carps reached 477,954 specimens weighing 767,998 kg, avg. weight 1.60 kg. In 1970 according the angler's statistics 553,228 specimens were angled, weighing 933,758 kg, avg. weight 1.72 kg (Kavalec 1972). Among all fishes angled in 1968 the carp represented 19 % in number and 47 % in weight. In 1970, this relationship was 22 % and 47 %. Both examples document the enormous importance of the carp for Czechoslovak anglers. In 1982 angler's clubs planted 2,400,000 carps in the second and third year of life, avg. weight 0.55 kg, altogether 1,331,268 kg; yield was 918,650 specimens, avg. weight 1.61 kg, altogether 1,481,917 kg. From the planted specimens 38 % were caught; the "returned weight" was 111 %. The square area of all the so called open waters is estimated as 26,000 ha, the stocking rate is 92 specimens per ha^{-1}, the yield 35 specimens, the weight 51 kg . ha^{-1}. In special artificial breeding ponds of the Czech Angler's Union (the total square area 2,700 ha) during the above mentioned period 5,425,000 carp yearlings and 2,444,000 carps in the second and third year of life were produced for planting purposes (7,869,000 specimens in total).

Growth rate in ponds is well known among fish breeders and can be determined by comparing differences in the weight of planted carp and those remaining after the total outfishing of artificial pond by the draining of the pond; on the contrary, we have a striking lack of information concerning the life and growth history of the carp released repeatedly into open waters every year. Therefore I suppose that every information to this problem could be useful.

MATERIAL AND METHODS

All scales were studied in dry condition using various magnification of the projection apparatuts "Lesegerät Zeiss, VEB, Jena, DDR". The annuli were counted along the diagonal radius of the scale. For the back calculation of lengths attained in single

Table 1. Back calculated body lengths of the common carp in selected localities

Locality	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}	l_{12}
Ponds													
Pond — Levínské Petrovice (Litoměřice)	13	53	132	189	205								
Věřovice (Nový Jičín)	13	53	123	162	185	191							
Jan (Jevany)	5	62	190	286	425								
Pond at Záblatí (Skalice nad Lužnicí)	10	71	161	245	332	394							
Tobolka (Jankov)	5	115	185	296	429	490	575	620	650	665	715		
Máchovo jezero	1	75	209	370	415	470	536	570	585	600	620	648	665
Rivers													
Vltava (Prague)	18	64	161	252	343	402	450						
Berounka at Karlštejn	5	65	166	245	280	330	356	395	435				
Riverine lakes													
Klíčava	13	97	185	290	413	470	513	550	579	606	675		
Dalešice	1	56	121	213	245	340	382	431	479	510	560		
Orlík	1	80	217	338	408	468	515	575	607	611			
Hracholusky	1	110	298	382	465	542	570	600	620	638	662	675	

years of life the method of Rosa Lee was used following in detail the papers by Oliva 1955, Novák, Johal, Oliva 1983. The graphically determined intercept for the body length of the carp at the begining of the scale formation was 11 mm

Scale material was sampled during angling by many persons on following localities (the number of specimens in brackets):

1. artificial ponds: the pond situated in the fields near Levínské Petrovice, district Litoměřice (13), the pond in Veřovice, district Nový Jičín (13), the pond near Záblatí, near Skalice nad Lužnicí (10), pond Podzámecký at Průhonice u Prahy (2), pond Marvánek in the drainage of the river Sázava (1), pond Pilský near Kutná Hora (2), pond Turyňský near Kamenné Žehrovice, central Bohemia (1), pond Máchovo jezero (1).
2. rivers: the Vltava in Praguue (18), the Berounka near Karlštejn and Mokropsy (5), the Ohře (1), the Sázava near Havlíčkův Brod (1).
3. riverine lakes: Orlík (1), Dalešice (1), Klíčava (13).
4. backwaters: Fořtovka near Čelákovice, the river Labe (1).

RESULTS

Not all results were summarized in Table 1, due to the fact that from the most localities only 1—4 specimens were available so that no reliable comparison is possible. Exception was made in big single specimens the so called trophy carps. From fractional data the variability in the growth in different ponds is evident; unfortunately, no precise hydrobiological and planting data are available. This variability is certainly caused by the different productivity level and density of fish. The results from rivers and riverine lakes, regardless of the limited material seem to show a good growth rate at the high age. When compared with the growth rate of acclimatized carp in India (Johal, Novák, Oliva 1983) the carp in Central Europe keeps the good growth tempo also at a higher age.

Acknowledgements

The author is indebted to Messrs. Adamec, Kubečka, Pásek, Poupě and Sviták for the scale material offered to study. Valuable advice in the final stages of the work was given by Dr. J. Závěta. Finally, Dr O. Oliva read the typescript critically and helped in various ways during laboratory work.

LITERATURE

Anonymus, 1984: Činnost mezi III. a IV. sjezdem ČRS, 1978—1982. Český rybářský svaz, Praha, 80 pp.

Johal, M. S., J. Novák, O. Oliva, 1984: Notes on the growth of common carp (Cyprinus carpio) in Northern India and in Central Europe. *Věst. čs. Společ. zool.*, 48: 24—38.

Kavalec, J., 1972: Hospodaření na tekoucích vodách. SZN Praha, 78 pp.

Oliva, O., 1955: Příspěvek k biologii a rychlosti růstu kapra (Cyprimus carpio L.) v Polabí. *Acta Univ. Carol. Biologica*, 1: 225—273.

Author's address: RNDr Abdel Moneim Khalid, postgraduate scholar, Agricultural Research Corporation in Sudan, now: Department of Systematic Zoology, Fac. Sci., Charles University, Viničná 7, 128 44 Praha 2, Czechoslovakia.

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Department of Parasitology and Hydrobiology, Charles University, Prague

FILTERING STRUCTURES OF CLADOCERA AND THEIR ECOLOGICAL SIGNIFICANCE. II. RELATION BETWEEN THE CONCENTRATION OF THE SESTON AND THE SIZE OF FILTERING COMBS IN SOME SPECIES OF THE GENERA DAPHNIA AND CERIODAPHNIA

Vladimír KOŘÍNEK, Blanka KŘEPELOVÁ-MACHÁČKOVÁ, Jiří MACHÁČEK

Received December 10, 1985

Abstract. Parameters of filtering combs of the third and the fourth thoracic limbs were studied in the cladoceran species *Daphnia pulicaria*, *D. galeata*, *Ceriodaphnia affinis* and *C. quadrangula* with some attention to the species *D. pulex*, *C. megops*, *C. pulchella* and *C. dubia* s. l. Populations from different habitats were compared. Those living in a reservoir and a lake with a low seston concentration had larger filtration areas within the same size group of animals than those from carp ponds with a high seston content. In the genus *Daphnia*, the length of setae and their number were responsible for the difference in the size of filtering combs within the same species. In the genus *Ceriodaphnia*, the intersetal distance and setal length influenced the difference between combs of two species studied. The corresponding difference in the density of setules was found only in the species *Daphnia pulicaria*. The differences in the size of filtering combs were not only habitat-specific, they were subjected to seasonal changes within one population as well. The increase in the seston concentration was followed by a decrease in the mean size of filtering combs in pond-dwelling populations of *Daphnia pulicaria*. We regard the ability to change the filtering structures according to changes in environmental conditions as a part of the life strategy established in the evolution of the species, when it has to live in different levels of food concentration.

INTRODUCTION

Regarding the remarkable range of fluctuations in the amount of seston in freshwaters (Lampert, 1971, Fott et al., 1974, Hrbáček et al., 1979), adaptive changes of structures responsible for the concentration of food particles seem to be a logical step in the feeding strategy among cladoceran populations. The first unambiguous data were published by Behning (1912). He found seasonal variations in the number of setae in filtering combs of thoracic limbs in species of the genus *Daphnia* and suggested that the changes in temperature and alternation of exephippial and parthenogenetic generations were responsible. The different dependence of the projected area of setal combs on the body length in two species, *Daphnia magna* Straus and *D. rosea* Sars, was demonstrated by Egloff and Palmer (1971). Kořínek and Macháček (1980) presented data on other quantitative parameters of setal combs of the species *Daphnia pulicaria* Forbes. Some of their data indicated a possible influence of environmental factors on both the area of the filtering screen and the density of setules. Such findings stimulated new experimental and field studies (Koza and Kořínek, 1985) and could be tentatively connected with the hypothesis about different life strategies of populations living

Table 1. List of species and habitats sampled. If not otherwise mentioned, all localities are from Czechoslovakia.

Species	locality	date	chlorophyll *a* mg.m^{-3}	area ha	max. depth m	collector
Daphnia pulicaria	1. West Blue Lake	22. 6. 1971.	0.6—2.1	160	31	V. Kořínek
	Manitoba, Canada	27. 6. 1971.				idem
	2. Hubenov Reservoir	23. 6. 1976.	1.7	92.5	31.5	O. Albertová
	3. Jezárko Pond	12. 8. 1968.	130.0	4	1.2	V. Kořínek
		20. 5. 1968.	1.0			idem
	4. Radov Pond	26. 8. 1979.	27.0	44	1.9	B. Křepelová
D. pulex	5. Roadside pond Saskatchewan, Canada	16. 7. 1971.				V. Kořínek
	6. Ditch, Khubsugul Lake, Mongolia	10. 7. 1974.				V. Halgoš
	7. Ditch, Lednice	26. 4. 1969.				V. Kořínek
D. galeata	8. Želivka Reservoir	13. 7. 1976	5.0	1,430	46	V. Houk
	9. Starý Pond	25. 5 1979.	135.0	28	3	V Kořínek
	10 Smyslov Pond	22. 4. 1968.	20—40	21.5	2.8	idem
Ceriodaphnia pulchella	11. Forest pond near Blatná	11. 9. 1970.				idem
C. quadrangula	12. Želivka Reservoir	21. 9. 1977.	10.0			V. Houk
	13. Slapy Reservoir	24. 1. 1963.				M. Straškraba
	14. Sphagnum pond, Wipsowo, Poland	21. 8. 1958.				K. Patalas
C. affinis	15. Jezárko Pond	7. 8. 1968.	130.0			V Kořínek
	16. Smyslov Pond	22. 9. 1968.	100—200			idem
C. megops	17. Small pond near Blatná	7. 9. 1968				idem
C. dubia s.l.	18. White Nile at Khartoum, Sudan	4. 2. 1969.				B. Fott

Table 2. Mean body length of specimens studied, confidence limits at 95 % conf. level in parantheses. *Daphnia pulicaria* (DP), *Daphnia galeata* (DG), *Ceriodaphnia quadrangula* (CQ), *Ceriodaphnia affinis* (CA).

Species	locality	size groups in mm					
		1.		2.		3.	
DP	W. Blue Lake	1.01	(0 04)	1.76	(0.04)	2.34	(0.05)
	Hubenov	0.98	(0.03)	1.72	(0.06)	2.31	(0.07)
	Jezárko, Aug.	*1.00*	*(0.04)*	*1.75*	*(0.04)*	*2.15*	*(0.07)*
DG	Starý	0.59	(0.02)	1.01	(0.01)	1.68	(0.03)
	Želivka	0.60	(0.02)	1.00	(0.01)	1.45	(0.03)
CQ	Želivka	0.43	(0 02)	0.57	(0.03)	0.76	(0.02)
CA	Jezárko	—		0 69	(0.05)	0.93	(0.03)

in conditions of high seston concentration and those from lakes with long histories of low seston content (Hrbáčková, 1971, Hrbáček, 1977, and Neill, 1981).

To exploit this trend of reasoning, we selected two hypotheses for testing in the present study: (1) populations of the same species living in two habitats with different food concentration without any overlap differ in the parameters of filtering combs of thoracic limbs, and (2), change in the seston concentration provokes adequate change in the parameters of filtering combs within one population. Our results were already referred to in an abstract (Kořínek et al., 1981).

MATERIAL AND METHODS

Two species of the genus *Daphnia*, *Daphnia pulicaria* Forbes and *D. galeata* Sars and two species of the genus *Ceriodaphnia*, *C. affinis* Lillj. and *C. quadrangula* (O. F. Müller), were examined from habitats with different seston concentration Populations were compared; one from a lake and/or a drinking-water reservoir with low seston concentrations, and the other from a carp pond in a period of high seston concentration. To see the possible overlap of different species from various habitats, partial information was gathered from populations living in habitats from which data on morphology and chlorophyll concentration were not available: *D. pulex* Leydig, *C. pulchella* Sars, *C. megops* Sars, and *C. dubia* Richard s. l. Basic information on habitats sampled for the study is listed in Table 1. Further information on carp ponds in Central Europe is in Kořínek et al. (in print); on West Blue Lake in Canada, Ward and Robinson (1974); and on Hubenov Reservoir, Hrbáček et al., (1979).

Methods used for the evaluation of parameters of setal combs on the third and fourth thoracic limbs were described in our previous paper (Kořínek and Macháček, 1980). Five parameters were measured on dissected specimens preserved in 4 % formalin: (1) mean size of the projected area of setal combs, (2) mean number of setae per comb, (3) mean length of setae, (4) mean intersetal distance, and (5) mean density of setules counted per 0.1 mm of setal length. For the measurements, only the central portion of combs was selected. As most of the parameters are body-size dependent, 20 specimens from each of the size groups per population were examined except for two size groups in C. affinis (Tab. 2). Detached limbs or combs were observed under a supported cover slip. The projected area of setal combs was drawn using Visopan projecting microscope and its size was measured with a polar planimeter. The intersetal distance was measured proximally and distally of the setal constriction in the genus *Daphnia* and distally in the genus *Ceriodaphnia*. The density of setules was counted on microphotographs with 1,250× magnification using Peraval microscope with Interphaco equipment, a combination of phase contrast and interference effect.

The material for the study of seasonal changes was collected during regular sampling program on carp ponds of the State fishery near the town Blatná, Jezárko Pond being selected due to the high amplitude of oscillations in the seston concentration. Pond zooplankton was dominated by Daphnia pulicaria, and was sampled once a week from spring to autumn and in longer intervals during the winter. Detailed information on environmental conditions is available in Fott et al. (1974). The amount of seston was measured by three methods: (1) as chlorophyll *a* content, (2) energy content by bichromate method, and (3) as the biomass of bacteria. The first two sets of data ware kindly supplied by Dr. J. Fott and the last one by Dr. J. Fuksa. Twenty specimens were selected for dissection from each sample, their mean length being 2.2 mm (standard deviation = 0.02). For comparison, only the setal comb of the third thoracic limb was used. The projected area of the comb was measured in all selected specimens and remaining parameters were measured in half of them. Setal diameter was measured proximally of setal constriction.

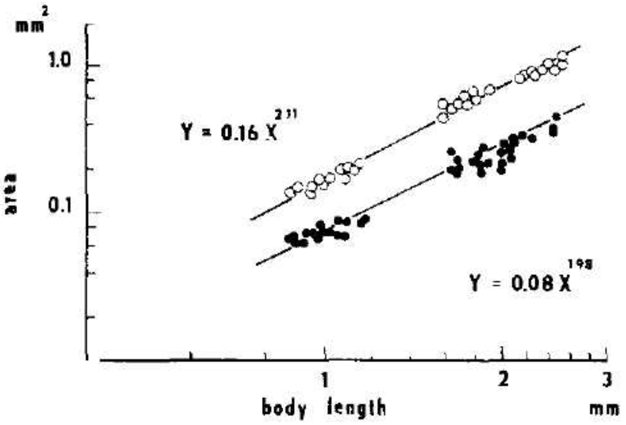

Fig. 1. **Relation** between body length and projected area of setal combs of the 3rd and 4th thoracic limbs of *Daphnia pulicaria*. West Blue Lake (circles), Jezárko Pond (dots).

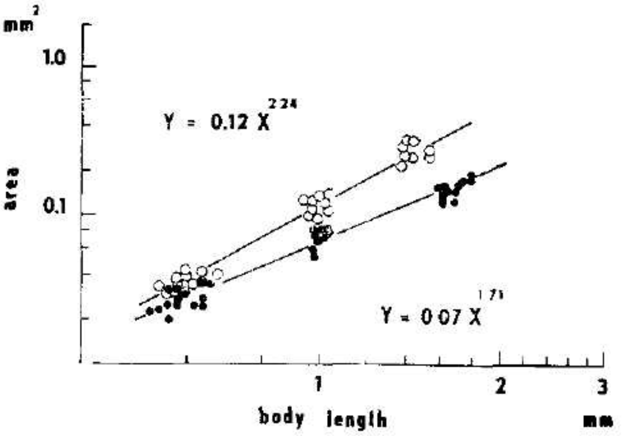

Fig. 2. **Relation** between body length and projected area of setal combs of the 3rd and 4th thoracic limbs of *Daphnia galeata*. Želivka Reservoir (circles), Starý Pond (dots).

RESULTS

1. Difference between habitats

Comparison of populations was focused on the mean size of the filtering area; other parameters were measured to find their individual share in the change of the area. Regression analysis of the dependence of the log transformed data of the area on body length is shown in Figs. 1—3. The difference in the slope of the regression lines was not statistically significante in populations of *D. pulicaria* living in low and high concentrations of chlorophyll. However, for any value of body length, the area of setal combs was always significantly larger in the environment with low seston concentration than that from high seston concentration (Fig. 1). This was not the case in *D. galeata* (Fig. 2). The difference in the size of the area was less in small individuals

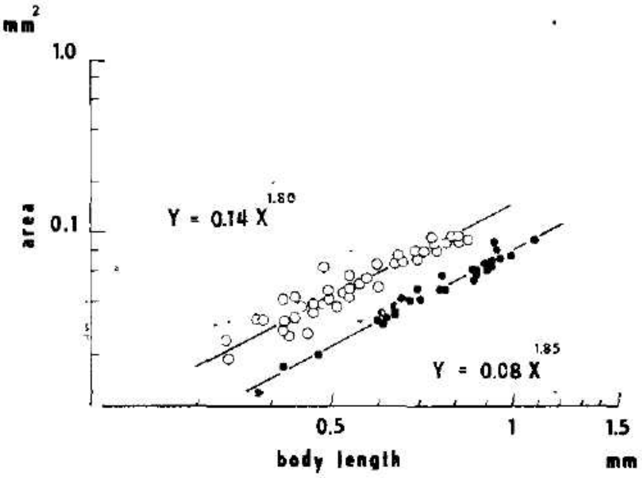

Fig. 3. Relation between body length and projected area of setal combs of the 3rd and 4th thoracic limbs in two populations of the genus *Ceriodaphnia*. *C. quadrangula*, Želivka Reservoir (circles), *C. affinis*, Jezárko Pond (dots).

Table 3. Mean total projected area in mm² of four setal combs, limb 3 and 4. Explanation see Tab. 2.

species	locality	size groups					
		1		2		3	
DP	W. Blue Lake	0.16	(0.01)	0.58	(0.03)	0.93	(0.04)
	Hubenov	0.16	(0.01)	0.58	(0.04)	0.94	(0.05)
	Jezárko, Aug.	0.07	(0.01)	0.24	(0.01)	0.33	(0.03)
DG	Starý	0.03	(0.002)	0.07	(0.004)	0.16	(0.01)
	Želivka	0.04	(0.002)	0.12	(0.007)	0.26	(0.02)
CQ	Želivka	0.03	(0.003)	0.05	(0.005)	0.09	(0.004)
CA	Jezárko		—	0.04	(0.005)	0.07	(0.005)

Table 4. Mean number of setae, 3rd thoracic limb. Explanations see Table 2.

Species	locality	size groups 1.		2.		3.	
DP	W. Blue Lake	81	(2)	82	(2)	78	(1)
	Hubenov	88	(2)	93	(3)	81	(1)
	Jezárko, Aug.	66	(2)	69	(2)	69	(2)
DG	Starý	52	(1)	53	(1)	52	(1)
	Želivka	55	(1)	60	(1)	59	(2)
CQ	Želivka	38	(1)	39	(2)	41	(1)
CA	Jezárko	—		46	(1)	48	(1)

and greater in those with large body sizes. No pair populations of the same species from different habitats, one seston poor and the other seston rich, were available for the study of the genus *Ceriodaphnia*. Therefore, we compared two species, *C. affinis* from a carp pond and a reservoir-dwelling population of the species *C. quadrangula*. The compared habitats of both species differed in the seston concentration by one order of magnitude (Tab. 1). Trends similar to those in the species *D. pulicaria* were observed (Fig. 3, Tab. 3). Regression lines have nearly identical slopes (b = 1.80 and 1.85), while the population from Želivka Reservoir has significantly larger filtering area in all size groups than the population of *C. affinis* from Jezárko Pond.

Results of the measurements of all parameters studied on the third thoracic limb in species of both the genera are listed in Tab. 4 to 6. Corresponding information is available for the fourth limb, but was not included as no difference in interrelationship of values was found. Only the absolute values of means are different.

As to the contribution of individual parameters of setal combs to differences in their projected areas, species of the genus *Ceriodaphnia* differ from those of the genus *Daphnia*. While *C. affinis* has higher numbers of setae in combs than *C. quadrangula*, the difference in their length and density (intersetal distance) are responsible for the larger area of combs of the latter species from Želivka Reservoir. Within *Daphnia pulicaria* and *D. galeata* populations, the difference in the area is due both to different numbers of setae and their different lengths. Intersetal distance does not seem to be significantly influenced by different concentrations of food (Tab. 4 to 6).

Table 5. Mean length of setae in µm, 3rd thoracic limb. Explanations see Table 2.

Species	locality	size groups 1.		2.		3.	
DP	W. Blue Lake	163	(6)	326	(9)	401	(9)
	Hubenov	151	(8)	325	(12)	406	(11)
	Jezárko, Aug.	110	(4)	192	(7)	239	(14)
DG	Starý	66	(2)	114	(7)	158	(5)
	Želivka	80	(2)	140	(3)	229	(7)
CQ	Želivka	89	(4)	116	(6)	151	(4)
CA	Jezárko	—		95	(6)	129	(5)

Table 6. *Mean intersetal distance in* μm, 3rd thoracic limb. Explanations see Table 2.

Species	locality	proximal			distal		
		size groups					
		1.	2.	3.	1.	2.	3.
DP	W. Blue Lake	1.3(0.1)	3.3(0.2)	4.2(0.2)	2.1(0.2)	4.8(0.2)	6.0(0.2)
	Hubenov	1.4(0.1)	2.5(0.2)	4.1(0.2)	2.1(0.1)	3.8(0.2)	5.6(0.2)
	Jezárko. Aug.	1.5(0.1)	2.6(0.1)	3.2(0.2)	2.4(0.1)	4.2(0.2)	4.7(0.2)
DG	Starý	1.5(0.1)	1.8(0.1)	3.1(0.2)	1.9(0.1)	3.0(0.3)	4.6(0.3)
	Želivka	1.4(0.1)	1.9(0.1)	3.2(0.3)	1.9(0.1)	3.0(0.2)	4.5(0.4)
CQ	Želivka	—	—	—	3.0(0.3)	3.6(0.3)	3.9(0.2)
CA	Jezárko	—	—	—	—	2.3(0.2)	3.3(0.2)

The density of setules was measured within selected populations for which the long-term history of the level of food concentration was known (Tab. 7). The only significant difference was detected between populations of *Daphnia pulicaria* from West Blue Lake and Hubenov Reservoir in one group and the pond dwelling population in the other group. No such trend was observed in paired populations of *Daphnia galeata* and in the species of the genus *Ceriodaphnia*.

To see the possible range of differences within individual species and among species, data from other localities were gathered for the species already studied and additional ones, such as *Daphnia pulex, Ceriodaphnia pulchella, C. megops* and *C. dubia* s. l.

Table 8 shows the dependence of the projected area of combs on the body size. It is similar in all cases studied; the value of the exponent *b* being close to 2.0. The difference between species and populations of the same species from different habitats concerns the position of regression lines expressed as coefficient *a* (Fig. 4). The range of *Daphnia pulicaria* is the largest among all populations studied.

2. Seasonal variation of the size of setal comb related to the seasonal changes in seston concentration.

Jezárko Pond in 1968 (Fig. 5, 6) was remarkable in the abrupt change in the seston concentration. The population of *Daphnia pulicaria* started to grow

Table 7. Mean density of setules, 3rd throracic limb. Explanations see Table 2.

Species	locality	size mm	setules per 0.1 mm of setal length	temperature °C
DP	W. Blue Lake	2.4	80 (5)	10—18
	Hubenov	2.3	98 (8)	10—15
	Jezárko, Aug.	2.5	117 (7)	10—20
	Jezárko, May	2.3	131 (10)	10—20
DG	Smyslov	1.5	145 (7)	10—20
	Želivka	1.5	156 (10)	6—22
CQ	Želivka	0.8	120 (12)	10—20
CA	Smyslov	0.8	137 (10)	10—15

in January, and, after a short period of exponential growth in March, reached the highest density level of about 10^2 individuals per litre at the begining of April (Fig. 5). Simultaneously, a rapid depression in the phytoplankton biomass occurred, presumably due to the grazing of daphnids (Fig. 6). The steady state established between the processes responsible for population density of *Daphnia pulicaria* and the phytoplankton biomass lasted until mid June, when more two-year old carp were introduced into the pond. Their predation depressed the population to a new level of about 60 individuals per litre. The lower grazing activity of the reduced population of *Daphnia* was not able to check the growth of phytoplankton whose concentration increased considerably during the next two months.

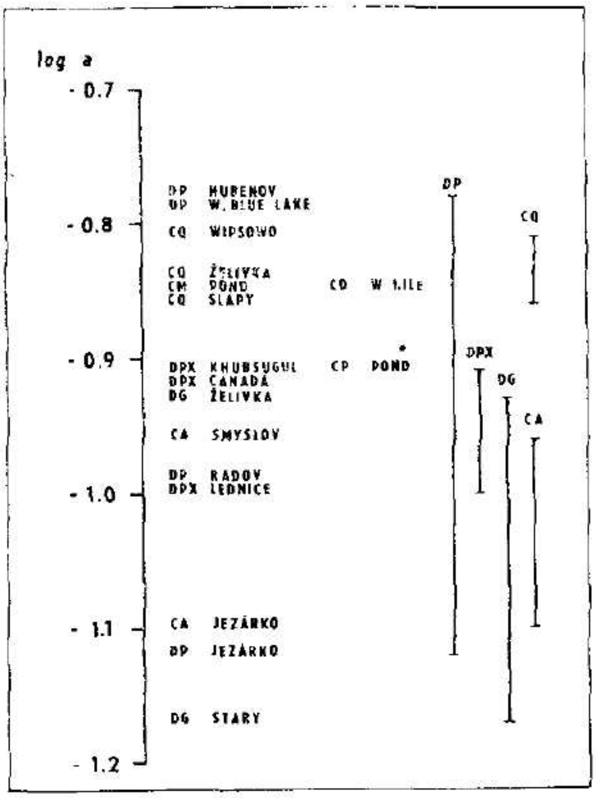

Fig. 4. Comparison of all populations studied, ranked according to the log-transformed value of the coefficient *a* of standard linear regression equation (log y = log a + b log x). The range of log *a* values for individual species on the right. *Daphnia pulicaria* (DP), *D. pulex* (DPX), *D. galeata* (DG), *Ceriodaphnia affinis* (CA), *C. quadrangula* (CQ), *C. pulchella* (CP), *C. megops* (CM). *C. dubia* s. l. (CD).

With the exception of one sampling date in February, the trend in the mean size of the projected area of setal combs changed inversely in contrast to that of food concentration (Fig. 7). During the spring depression of the phytoplankton, the area increased by one half, from 0.20 to 0.28 mm^2 in the

Table 8. Relation between the combined projected areas of all four setal combs of the 3rd and 4th thoracic limbs (y) and body length (x). Standard linear regression equation: $\log y = \log a + b \cdot \log x$, r = *correlation coefficient*, n = *number of specimens measured*. *Daphnia pulicaria* (DP), *D. pulex* (DPx), *D. galeata* (DG), *Ceriodaphnia affinis* (CA), *C. quadrangula* (CQ), *C. pulchella* (CP), *C. megops* (CM), *C. dubia* s. l. (CD).

Species	locality	standard linear regression	r	n
DP	W. Blue Lake	$\log y = -0.79 + 2.11 \log x$	0.99	60
	Hubenov	$\log y = -0.78 + 2.13 \log x$	0.99	60
	Jezárko, Aug.	$\log y = -1.12 + 1.98 \log x$	0.97	60
	Radov	$\log y = -1.00 + 2.08 \log x$	0.99	60
DPx	Saskatchewan	$\log y = -0.92 + 1.99 \log x$	0.99	60
	Khubsugul	$\log y = -0.91 + 2.12 \log x$	0.91	60
	Lednice	$\log y = -1.00 + 1.90 \log x$	0.95	60
DG	Starý	$\log y = -1.17 + 1.71 \log x$	0.97	60
	Želivka	$\log y = -0.93 + 2.24 \log x$	0.98	60
CM	Small pond	$\log y = -0.85 + 1.98 \log x$	0.99	60
CP	Forest pond	$\log y = -0.91 + 1.93 \log x$	0.99	60
CQ	Želivka	$\log y = -0.84 + 1.80 \log x$	0.92	60
	Slapy	$\log y = -0.86 + 2.05 \log x$	0.99	60
	Wipsowo	$\log y = -0.81 + 2.01 \log x$	0.98	60
CA	Jezárko, Aug.	$\log y = -1.10 + 1.74 \log x$	0.99	59
	Smyslov	$\log y = -0.96 + 1.78 \log x$	0.95	60
CD	White Nile	$\log y = -0.85 + 1.95 \log x$	0.98	60

size class of 2.2 mm of body length. When the phytoplankton switched to the exponential growth in mid June, the *Daphnia* population reacted immediately, decreasing the mean size of the projected area on the third thoracic limb to one half within the next three weeks and to one third of the maximal size during the following two months. The share of individual parameters of the comb in the reduction of its area is not uniform. The change is implemented again mainly by the shortening of setae and partly by the decrease in their number (Figs. 7, 8). The evaluation of changes in the intersetal distance is hampered by high variability, due probably to the uneven pressure of cover slips (Fig. 8).

DISCUSSION AND CONCLUSIONS

Hrbáček (1977) dealt with considerable detail in the different life strategies of cladoceran populations living in oligo- and eutrophic conditions and during the last ten years many authors demonstrated the effect of the amount of food on various aspects of cladoceran biology. The effect on the length of the postembryonic development is now evident (Hrbáčková, 1971, Hrbáčková and Hrbáček, 1978, 1979, Neill, 1982) as well as changes in enzyme activity (Hebert, 1973) and the rate of metabolism expressed as oxygen consumption (Dr. L. Havel, personal communication, 1986). The adaptability of the filtering screen is considered as a further member of the set of abilities established in the evolution of the species.

However, the assumption that the filtering apparatus of Cladocera is a stable structure within one species is inherent not only in morphological studies, starting with Cannon (1933) to Egloff and Palmer (1971), Crittenden (1981), Geller and Müller (1981), and Brendelberger and

Geller (1986), but is also accepted in the strategy and the design of nearly all experiments dealing with the filtration of Cladocera (for references see Downing and Rigler, 1984). Cladoceran populations respond, however, continuously to the changing environment and the size of the filtering area is only one of their adaptive abilities. The rapid reaction to the changing concentration of food may be executed within weeks at temperature above 20° C. The adaptation differentiates populations of the same species living in different habitats with different levels of seston concentration. The possible overlap in the size of combs between species or even genera (see pond-dwelling *Daphnia galeata* and lake-dwelling *Ceriodaphnia quadrangula* populations), is a warning against simple treatment of differencies as interspecific ones (Egloff and Palmer, 1971, Crittenden, 1981, Brendelberger and Geller, 1986).

The original habitat of the species *Daphnia pulicaria* in Central Europe is in high mountain lakes, all without fish stock and with negligible predation pressure on its population and low seston content as well (Dr. J. Hrbáček, personal communication, 1980). The influence of low water temperature and/or the depth of larger lakes with fish on the growth and reproduction of *Daphnia* is another parameter of such habitats (Hrbáčková-Esslová, 1966). The

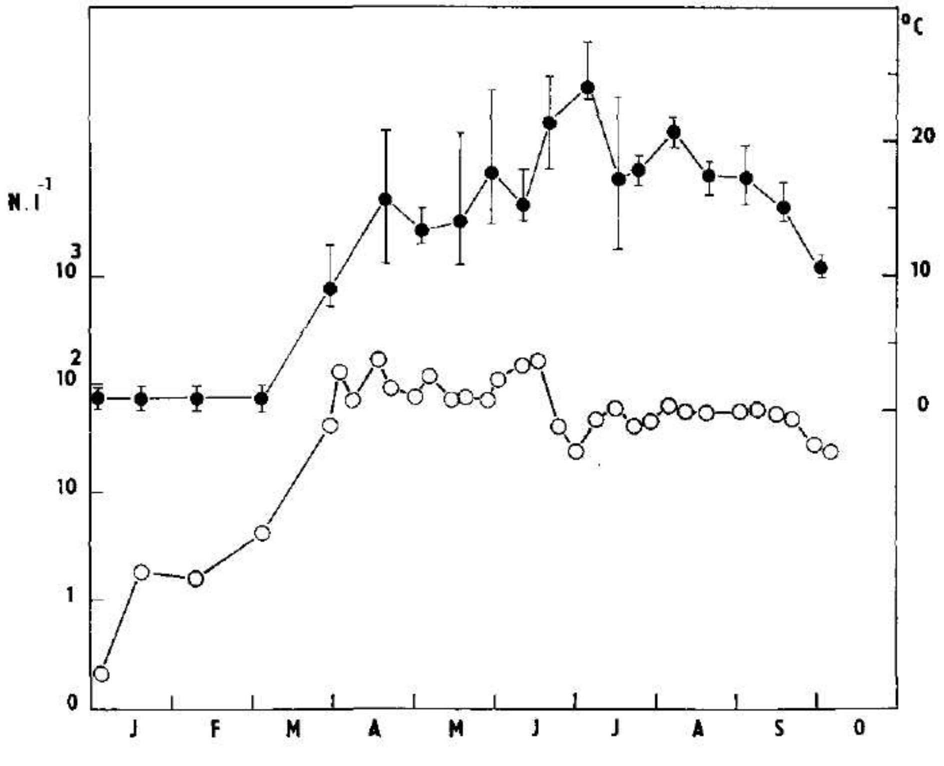

Fig. 5. Changes of population density of *Daphnia pulicaria* in Jezárko Pond, 1968 (circles); changes in the temperature of water with the range of minimal and maximal values in the water column (dots).

occurrence of the speices in lowland carp ponds with managed and mostly low fish stock is a secondary event, as the ponds were built mostly from the 13th to 16th century. Such populations seem to have three courses open on how to react to changing food concentration:

1. Immediate adaptation as it is observed in classical experiments when the feeding rate is directly proportional to the food concentration up to a certain level, over which it is limited by "handling time" (Rigler, 1961). The adaptation is only behavioral and does not imply any change in the morphology of filtering structures.
2. The short-term morphological adaptation, as it was observed during the seasonal changes of seston in the present study. The structural change within filtering comb affects the length of setae and their number. The density of setules seems to be unaffected.
3. Long-term morphological adaptation of populations living in a lake with constantly low seston concentration. In such a case, the adaptation affects parameters of setae and probably the density of setules as well Genetic selection may be involved, too.

As to the mechanism of the structural change within combs, there are two possible courses for explanation. Either several clones with different parameters of setal combs coexist within one population, which is analogous to the findings of Hebert (1978) and Hebert and Crease (1980), or the

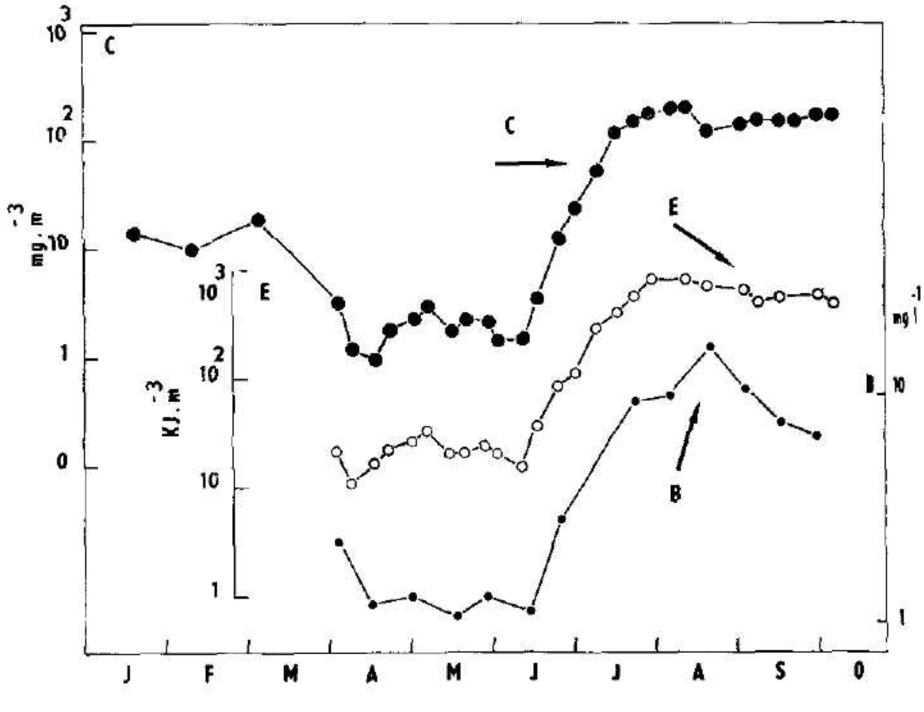

Fig. 6. Seasonal changes of seston content in Jezárko Pond, 1968. Chlorophyll a content (C), energy content (E), bacterial biomass (B).

change proceeds gradually during the molting of an individual. The first hypothesis explains the observed morphological change by the selective replacement of one predominating clone with another. As the variability of individual parameters of combs is not distinctly larger in the period of the change than in the previous one and the change is rapid (see Figs. 7 and 8), we are inclined to accept the molting as the main responsible process. Such explanation is further supported by experiments with the closely related species *Daphnia pulex*, in which the corresponding changes within setal combs were produced in one clone (Koza and Kořínek, 1985). In the Jezárko Pond population of *Daphnia pulicaria*, the replacement of clones can at most contribute in the second half of the period of ten weeks within which the area was decreasing in size.

The problem of different densities of setules within one species is less clear. The difference between populations, while statistically significant, is not too impressive. The screen is, in both the lake and pond populations, more than sufficiently dense to clear even bacterial cells from the water. Previously

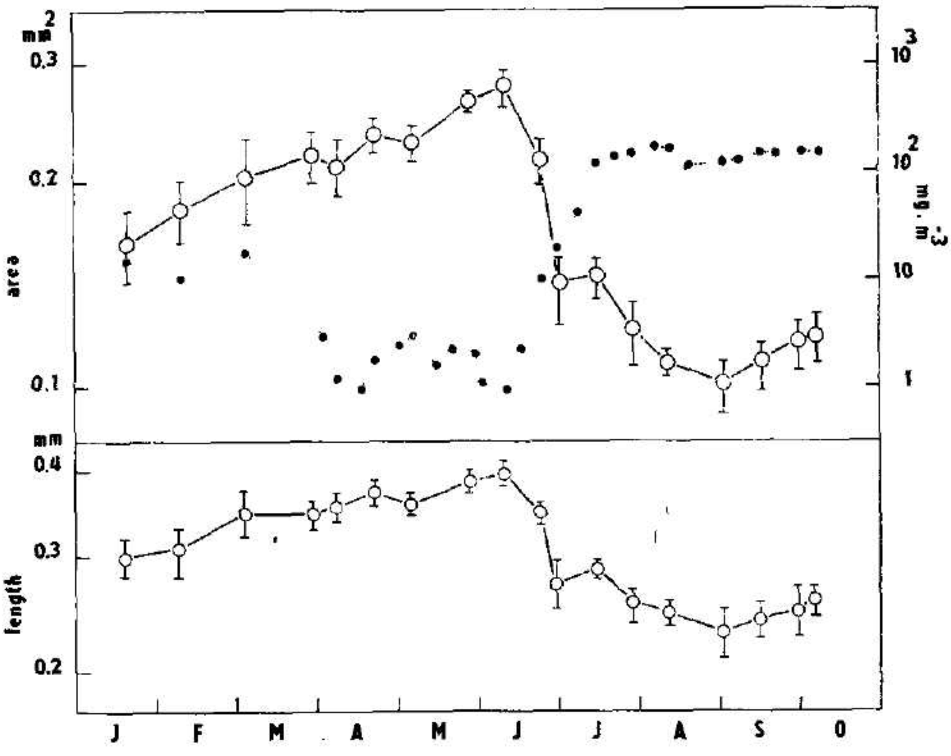

Fig. 7. Seasonal changes in the projected area and length of setae of the comb, 3rd thoracic limb of *Daphnia pulicaria*, size group 2.2 mm, Jezárko Pond, 1968 related to the seasonal changes in chlorophyll. Log-transformed data. Top: projected area of the comb (circles), chlorophyll *a* content in pond water (dotted line). Vertical lines indicate 95% conf. limits of the mean.

published information (Crittenden, 1981, Geller and Müller, 1981, Brendelberger and Geller, 1986) does not consider the possibility of changes within one species and we haven't enough data for a sound interpretation. Here of course genetic selection is very likely.

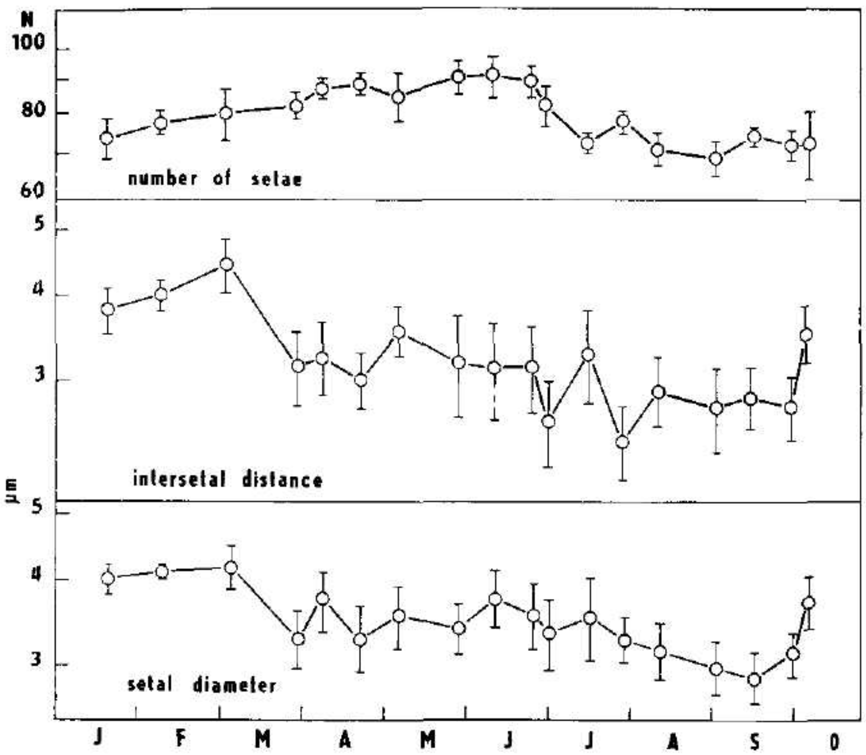

Fig. 8. Seasonal changes in the number of setae, intersetal distance and setal diameter of the comb, 3rd thoracic limb of *Daphnia pulicaria*, size group 2.2 mm, Jezárko Pond 1968. Middle and bottom panel with log-transformed data. Vertical lines indicate the 95% conf. limits of the mean.

The data on the environmental control of filtering areas in species other than *Daphnia pulicaria* suggest a similar mechanism of reaction but further study is needed.

Acknowledgements

We are grateful to our colleagues Drs. B. Desortová, J. Fott, J. Fuksa and V. Houk who kindly made available their data on seston from ponds and reservoirs, as well as to Prof. F. Ward and Dr. N. Snow of the University of Manitoba in Canada for data from West Blue Lake and the opportunity to work at the University field station. We are indebted to Mr. A. Turnowski for his excellent assistance in the sampling programme of zooplankton at the same station. Several colleagues from our department helped with field sampling on carp ponds. We wish to thank Dr. J. Hrbáček for comments and critical reading which substantially improved the manuscript. Drs. J. Křepela and M. Straškraba kindly helped with computer treatment of the data.

REFERENCES

Behning, A., 1912: Studien über die vergleichende Morphologie, sowie über die temporale und Lokalvariation der Phyllopodenextremitäten. *Internat. Revue ges. Hydrobiol., Biol. Suppl.*, 4: 1—70.

Brendelberger, H., Geller, W., 1986: Variability of filter structures in eight Daphnia species: mesh sizes and filtering areas. *J. Plankton Res.*, (in print).

Cannon, H. G., 1933: On the feeding mechanism of Branchiopoda. *Phil. Trans. Roy.* Soc., B, 222: 267—352.

Crittenden, R. N., 1981: Morphological characteristics and dimensions of the filter structures from three species of Daphnia (Cladocera). *Crustaceana*, 41: 233—248.

Downing, J. A., Rigler, F. H., 1984: A manual on methods for the assessment of secondary productivity in fresh waters. IBP handbook, 17, 2nd edition, 501 pp., Oxford.

Egloff, A. D., Palmer, S. D., 1971: Size relations of the filtering area of two Daphnia species. *Limnol. Oceanogr.*, 16: 900—905.

Fott, J., Kořínek, V., Pražáková, M., Vondruš, B., Forejt, K., 1974: Seasonal development of phytoplankton in fish ponds. *Internat. Revue ges. Hydrobiol.*, 59: 629—641.

Geller, W., Müller, H., 1981: The filtration apparatus of Cladocera: filter mesh-sizes and their implications on food selectivity. *Oecologia*, 49: 316—321.

Hebert, P. D. N., 1973: Phenotypic variability of lactate dehydrogenase in Daphnia magna. *J. Exp. Zool.*, 186: 33—38.

Hebert, P. D. N., 1978: The population biology of Daphnia (Crustacea, Daphnidae). *Biol. Rev.*, 53: 387—426.

Hebert, P. D. N., Crease, T. J., 1980: Clonal coexistence in Daphnia pulex (Leydig): another plankton paradox. *Science*, 207: 1363—1365.

Hrbáček, J., 1977: Competition and predation in relation to species composition of freshwater zooplankton, mainly Cladocera. In: J. Cairns, Aquatic microbial communities, Garland Publ., 305—353.

Hrbáček, J., Desortová, B., Popovský, J., 1979: Influence of the fishstock on the phosphorus-chlorophyll ratio. *Verh. Internat. Verein. Limnol.*, 20: 1624—1628.

Hrbáčková, M., 1971: The size distribution of neonates and growth of Daphnia hyalina Leydig (Crustacea, Cladocera) from lake Maggiore under laboratory conditions. *Mem. Ist. Ital. Idrobiol.*, 27: 357—367.

Hrbáčková-Esslová, M., 1966: The difference in the growth and reproduction at 8°C and 20°C of Daphnia pulicaria Forbes (Crustacea, Cladocera) populations inhabiting midland ponds and high Tatra lakes. *Věst. čs. Společ. zool.*, 30: 30—38.

Hrbáčková, M., Hrbáček, J., 1978: The growth rate of Daphnia pulex and Daphnia pulicaria (Crustacea, Cladocera) at different food levels. *Věst. čs. Společ. zool.*, 42: 115—127.

Hrbáčková, M., Hrbáček, J., 1979: Rate of the postembryonic development in several populations of the group of the species Daphnia hyalina leydig at various concentrations of food. *Věst. čs. Společ. zool.*, 43: 253—259.

Kořínek, V., Fott, J., Fuksa, J., Lellák, J., Pražáková, M., 1986: Carp ponds of Central and Eastern Europe. In: R. G. Michael (ed.), Ecosystems of the world. 29. Managed aquatic ecosystems, 120—185. Elsevier, Amsterdam.

Kořínek, V., Křepelová, B., Macháček, J., 1981: Filtering structures in Cladocera and their ecolocal significance. II. Species of the genera Daphnia and Ceriodaphnia (Abstract). *Verh. Internat. Verein. Limnol.*, 21: 1567.

Kořínek, V., Macháček, J., 1980: Filtering structures of Cladocera and their ecological significance. I. Daphnia pulicaria. *Věst. čs. Společ. zool.*, 44: 213—218.

Koza, V., Kořínek, V., 1985: Adaptability of the filtration screen in Daphnia: another answer to the selective pressure of the environment. *Arch. Hydrobiol. Beih. Ergebn. Limnol.* 21: 193—198.

Lampert, W., 1978: Climatic conditions and planktonic interactions as factors controlling the regular succession of spring algal bloom and extremely clear water in Lake Constance. *Verh. Internat. Verein. Limnol.*, 20: 969—974.

Neill, W. E., 1981: Developmental responses of juvenile Daphnia rosea to experimental alternation of temperature and natural seston concentration. *Can. J. Fish Aquat. Sci.*, 38: 1357—1362.

Rigler, F. H., 1961: The relation between concentration of food and feeding rate of Daphnia magna Straus. *Can. J. Zool.*, 39: 857—868.

Ward, F. J., Robinson, G. G. C., 1974: A review of research on the limnology of West Blue Lake, Manitoba. *J. Fish. Res. Board Can.*, 31: 977—1005.

Authors' address: Katedra parasitologie a hydrobiologie, Karlova Universita,
Viničná 7, Praha 2, 128 44 Czechoslovakia.

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Department of Evolutionary Biology, Czechoslovak Academy of Sciences, Praha, and Department of Paleontology, Faculty of Natural Sciences, Charles University, Praha

REVIEW OF THE TERTIARY WATERFOWL (AVES: ANSERIDAE) OF ASIA

Jiří MLÍKOVSKÝ and Petr ŠVEC

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Abstract. The types of 10 waterfowl species described from the Tertiary of Asia were restudied. The following systematic changes are proposed: *Anas oligocaena* becomes *Dendrochen oligocaena*, *Cygnus pristinus* is synonym of *Cygnus olor*, *Anser liskunae* becomes *Olor liskunae*, *Heterochen vicinus* becomes *Anser vicinus* (species status uncertain), *Anas soporata* becomes *Dendrocygna soporata*. Two species were excluded from Anseridae: *Cygnopterus lambrechti* is synonym of *Agnopterus turgaiensis* (Phoenicopteridae), and *Limicorallus saiensis* becomes *Phalacrocorax saiensis* (Phalacrocoracidae).

In addition, *Sinanas diatomas* from the Miocene of China, the type of which we could not examine, was found to be a meaningless name until redescription.

INTRODUCTION

More than 160 nominal fossil species of the waterfowl (order Anseriformes Brisson 1760, family Anseridae Vigors 1825) have been described so far (see Mlíkovský 1983 for their review), and they begin slowly to build a good factual basis for the reconstruction of the waterfowl phylogeny. However, but a small fraction of those nominal species represent species which have really occurred in nature and which may be used in the respective phylogenetic reconstruction. The uncertainty which nominal species represents a real one and which does not makes it necessary to write and to publish papers which are considered destructive, not constructive, by many paleontologists, i. e. papers which contain only revisions of formerly described species and no, or nearly no, descriptions of new material. However, there are only these papers which make the so-called fossil evidence really valuable to science in general and to evolutionary biology and systematics in particular.

In the present paper we continue the modern revision of fossil waterfowl species started independently by Olson (1977a, b, Olson and Feduccia 1980), Van Tets and Rich (1980), Mlíkovský (1982a, b, 1983), and Cheneval (1983). We selected for this purpose the waterfowl species described from the Cenozoic of Asia, in view of the fact that the Cenozoic Asia still belongs to the least known areas in which the waterfowl evolution occurred.

Only 11 fossil waterfowl (or supposedly waterfowl) species were described from the Cenozoic of Asia so far, all of them from the Tertiary. They include 4 species from the Oligocene of Kazakhstan (*Anas oligocaena* Tugarinov 1940, *Cygnavus formosus* Kuročkin 1968, *Cygnopterus lambrechti* Kuročkin 1968, and *Limicorallus saiensis* Kuročkin 1968), one species from the Miocene of

China (*Sinanas diatomas* Yeh 1980), and 6 species from the Pliocene of Mongolia (*Cygnus pristinus* Kuročkin 1971, *Anser devjatkini* Kuročkin 1971, *Anser liskunae* Kuročkin 1976, *Heterochen vicinus* Kuročkin 1976, *Anas soporata* Kuročkin 1976, and *Aythya spatiosa* Kuročkin 1976). We were able to see and to revise the types of all of them but *Sinanas diatomas* Yeh 1980.

In addition, 8 waterfowl species and subspecies were described from Oligocene to late Pleistocene deposits of Azerbaidzhan and Gruzia in the Causasus region including *Guguschia nailiae* Aslanova and Burčak-Abramovič 1968, *Anser eldaricus* Burčak-Abramovič and Gadžiev 1978, *Anser udabnensis* Burčak-Abramovič 1957,*Anas apscheronica* Burčak-Abramovič 1958, *Anser azerbaidshanicus* Serebrovskij 1940, *Cygnus olor bergmanni* Serebrovskij 1941, *Anas platyrhynchos palaeoboschas* Serebrovskij 1941, and *Aythya marila asphaltica* Serebrovskij 1941. Although this region is included in Asia by contemporary geographers, Caucasus lays at the border between Europe and Asia and it seems appropriate to treat Caucasian fossils separately from proper Asiatic forms.

In the following we present our critical revision of the waterfowl species described from the Asia proper. The species are arranged according to their systematic position they acquired after our revision. The classification follows Delacour (1954, 1956, 1959) and Woolfenden (1961).

We are deeply indebted to Dr. Evgenij N. Kuročkin (Institute of Paleontology Academy of Sciences of the USSR, Moscow; PIN AN SSSR) for his kind permission to examine the fossil specimens under his care and to use his comparative collection of Recent birds. We are also very grateful to Aleksandr A. Karkhu (PIN AN SSSR Moscow) for providing valuable assistance during our visits in Moscow in August 1982 (Jiří Mlíkovský, Petr Švec) and March/April 1983 (Petr Švec). For comparisons we used especially the rich osteological collection of the waterfowl in the PIN AN SSSR in Moscow, which contains representatives of nearly all Recent waterfowl genera. In addition, Jiří Mlíkovský profited during the preparation of this paper from his studies of both Recent and fossil waterfowl skeletons in the collections of the Institute of Zoology, Martin Luther University, Halle (Saale), GDR (R. Piechocki), Museum of Zoology, Humboldt University, Berlin, GDR (K. Fischer, G. Mauersberger, B. Stephan), Institute of Zoology, Academy of Sciences of the USSR, Leningrad, USSR (L. V. Firsova, V. M. Loskot, S. V. Vinter), Anthropos Institute Moravian Museum, Brno, Czechoslovakia (J. Jelínek, L. Seitl), and Natural History Museum, Budapest, Hungary (D. Jánossy). He appreciates the help of all of the named persons.

Anatomical terminology used in this paper follows Baumel et al. (1979).

RESULTS AND DISCUSSION

Family: Anseridae Vigors, 1825
Subfamily: incertae sedis
Genus: *Sinanas* Yeh, 1980

Sinanas diatomas Yeh, 1980

Sinanas diatomas **Yeh, 1980: 116, pl. 1**

Holotype: incomplete skeleton, location unknown (**? Shandong Museum**), probably without number.

Age: middle Miocene, Shanwan series

Locality: China, Shandong Province, Linqu

Discussion: We were not able to study the holotype of *Sinanas diatomas*, but we include a brief discussion of it in our review of the Tertiary waterfowl of Asia for it is complete. Yeh (1980: 124) restricted his diagnosis and description of this species to an assurance that *Sinanas diatomas* is similar to the genus *Anas* Linné, 1758, but differs from it "by its stoutness appearing in bones of limbs". However, robustness of limb bones is typical especially for Cairinini and partly for Aythyini among the waterfowl (Woolfenden 1961; pers. obs.), i. e. for tribes with which Yeh (1980) compared his *Sinanas diatomas* not at all. Other characters listed by Yeh (1980) are of no importance for the identification of *Sinanas diatomas*. For example, he writes "Tarsometatarsus short, only 40 mm in length". Only in central Europe, 13 waterfowl species are living today which have equally short, or even shorter tarsometatarsi (cf. data in Woelfle 1967).

Hence, only the figure saves *Sinanas diatomas* from being nomen nudum. In any case, however, it is a meaningless name until its holotype is located and restudied.

Subfamily: Anserinae Vigors, 1825
Tribus: Dendrocygnini Reichenbach, 1852
Genus: *Dendrochen* Miller, 1944

Dendrochen oligocaena (Tugarinov, 1940), combinatio nova

Anas oligocaena Tugarinov, 1940b: 314, Fig. 1

Lectotype: distal end of right humerus, PIN 210—745 (here selected; see below). Paralectotypes: distal end of right ulna, PIN 210—746; fragmentary right radius, PIN 210—744; proximal end of left carpometacarpus, PIN 210—747.

Age: late Oligocene, Lake Aral beds

Locality: western Kazakhstan, Agispe

Discussion: Because it cannot be sure that Tugarinov's (1940b) syntypes of *Anas oligocaena* belong all to the same species, or even individual, we select here the distal end of right humerus, PIN 210—745, which is most diagnostic among the syntypes, as the lectotype of *Anas oligocaena* Tugarinov, 1940.

The lectotype humerus fragment differs markedly from the same element of Anatini in having the width of the space between condylus dorsalis and insertio ligamenti collaterale ventrale in relation to this insertio's width narrower. Because this character is exclusive for Dendrocygnini among the Anseriformes (cf. Woolfenden 1961), we transfer "*Anas*" *oligocaena* from Anatini to the latter tribe. This conclusion is supported also by the morphology of the paralectotype carpometacarpus which differs from Anatini and agrees with Dendrocygnini in having: (1) lower portion of the external rim of trochlea carpalis slightly notched, and (2) fovea origini m. extensoris confined to the tip of the processus extensorius.

Three genera are commonly recognized within Dendrocygnini: *Dendrocygna* Swainson, 1837, *Dendrochen* Miller, 1944, and more recently also *Thalassornis* Eyton, 1838 (cf. Kear 1967, Johnsgard 1967, Raikow 1971, Brush 1976). We compared "*Anas*" *oligocaena* with two Recent representatives of the genus *Dendrocygna*, viz. *D. javanica* (Horsfield, 1821) and *D. bicolor* (Vieillot, 1816), from which it differs in having the fossa m. brachialis broader and the internal ridge bordering it consequently narrower. In both these characters "*Anas*" *oligocaena* agrees with the fossil dendrocygnine genus *Dendrochen* (see Miller 1944 for its description). No skeleton of *Thalassor-*

nis leuconotus Eyton, 1838, the only living member of the last known genus of Dendrocygnini, was available for comparison, but because *Thalassornis* differs from *Dendrochen* in many respect (J. Cheneval, in litt.), it seems highly improbable that *"Anas" oligocaena* can be included in *Thalassornis*. In addition, because *"Anas" blanchardi* Milne-Edwards, 1863, *"Anas" natator* Milne-Edwards, 1867, and *"Anas" consobrina* Milne-Edwards, 1867, all from the Aquitanian of France, are closely related species which belong in Dendrocygnini (Cheneval 1983, Mlíkovský 1983), we compared *"Anas" oligocaena* with these species, too (materials from the Museum of Zoology, Humboldt University, Berlin, GDR), although their generic status within Dendrocygnini remains uncertain (Mlíkovský unpubl.). They differ clearly from *"Anas" oligocaena* in having the space between the condylus dorsalis and the insertio ligamenti collaterale ventrale in relation to this insertio's width broader.

Hence, it is evident from these comparisons that *Anas oligocaena* should be best transferred in the genus *Dendrochen*, which was known only from the early Miocene of South Dakota so far (Miller 1944). That also the three waterfowl species from the French Aquitanian belong in *Dendrochen* as suggested by Cheneval (1983) is improbable (Mlíkovský, unpubl.).

Genus: *Dendrocygna* Swainson, 1837

Dendrocygna soporata (Kuročkin, 1976), combinatio nova

Anas soporata Kuročkin, 1976: 61, Fig. 8

Holotype: proximal end of right coracoid, PIN 2614—95

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Šargain-Gobi

Discussion: The proximal end of coracoid on which *Anas soporata* has been based differs according to our observations on the same element of several Recent representatives of this genus from *Anas* Linné, 1758 in having: (1) notch in the facies articularis clavicularis nearly absent, (2) medial margin of this facies sharp and extended over the canalis triosseus, (3) medial margin of the head deeply undercut by sulcus m. supracoracoidei, and (4) ventromedial margin of this sulcus sharp. Such a character complex is quite typical for Dendrocygnini (see also Woolfenden 1961), indicating thus that *"Anas" soporata* should be transferred in that tribe.

Within Dendrocygnini, we were unfortunately not able to compare the coracoid fragment under discussion with the same element of *Dendrochen* (where it is unknown so far) and *Thalassornis*, but until this comparison will be possible we suggest that *"Anas" soporata* should be best placed in the genus *Dendrocygna* (sensu lato). The tentative exclusion of *Dendrochen* is based on its stratigraphic occurrence (Oligocene through early Miocene; Mlíkovský 1983), and that of *Thalassornis* on its biogeographic occurrence (Recently only in the Afrotropical region; Brown et al. 1982).

Tribus: Anserini Brisson, 1760

Genus: *Cygnavus* Lambrecht, 1931

Cygnavus formosus Kuročkin, 1968

Cygnavus formosus Kuročkin, 1968: 95, Fig. 2

Holotype: distal end of right tibiotarsus, PIN 2432—36

Age: early Oligocene, Aksyirskian Formation

Locality: eastern Kazakhstan, Žongiz-Šoki

Discussion: Our reexamination of the holotype tibiotarsus fragment confirmed wholly the description given by **Kuročkin** (1968: 94—96). An additional difference between *Cygnavus* on the one hand and *Cygnus* Bechstein, 1803 and *Olor* Wagler, 1832 on the other one can be noted, namely that incisura intercondylaris is markedly narrower in *Cygnavus*. Hence, we argee with **Kuročkin's** (1968) opinion that *Cygnavus formosus* is a primitive anserid closely resembling Recent swans *(Cygnus* and *Olor)* in its morphology, and that it is quite probably congeneric with *Cygnavus senckenbergi* Lambrecht, 1931, the only previously known representative of the genus *Cygnavus*.

Genus: Olor Wagler, 1832

Note: We include here substantiation of the separation of the genera *Olor* Wagler, 1832 and *Cygnus* Bechstein, 1803, because they are repeatedly lumped in the common genus *Cygnus* by some recent authors (e. g., **von Boetticher** 1952, **Delacour** 1954, **Johnsgard** 1978, 1979, **Kolbe** 1984). However, all of these authors based their classification on external characters only, and although they were certainly aware of some other differences between *Olor* and *Cygnus*, they ignored them simply in this case. On the other hand, authors studying internal morphology of swans (e. g., **Berndt** 1938, **Howard** 1946, **Wetmore** 1951, **Woolfenden** 1961), their behavior (**Johnsgard** 1960, **Petzold** 1964), and external morphology of downy cygnets (**Nelson** 1976) found significant differences between *Olor* and *Cygnus* and suggested then usually that *Olor* should be established as a valid unit. We consider the latter approach correct (cf. also **Mlíkovský** 1983) and follow it, hence, throughout the present paper.

Olor liskunae (Kuročkin, 1976), combinatio nova

Anser liskunae Kuročkin, 1976: 59, Fig. 6

Holotype: distal end of left humerus, PIN 2614—105

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Dzabchan

Discussion: According to our comparison of *Anser liskunae* with the Recent representatives of the genera *Anser* Brisson, 1760, *Branta* Scopoli, 1769, *Cygnus* Bechstein, 1803, and *Olor* Wagler, 1832, its holotype humerus fragment shows clear differences from the humeri of both *Anser* and *Branta* as follows: (1) fossa olecrani not divided from the shaft by a conspicuous rim, (2) fossa olecrani more shallow and wide, (3) foramina pneumatica in the fossa olecrani present, and (4) the whole extremitas distalis more robust in shape. In all of these characters *Anser liskunae* agrees with Recent swans *(Cygnus* and *Olor)*. However, in having the distance between the insertio ligamenti collaterale ventrale and condylus dorsalis small, it differs from *Cygnus* and agrees with *Olor*.

Within the genus *Olor*, *Olor liskunae* seems to be smaller than *Olor bewickii* (Yarrell, 1830), the hitherto smallest known representative of the genus: width of the distal end of humerus is 28.2 mm (holotype; not 27.2 mm as printed in **Kuročkin** 1976: 59) and 26.6 mm (referred specimen), respectively, in *Olor liskunae*, while it is 28.8—36.6 mm in 31 adult males and females of the Recent *Olor bewickii* (Bacher 1967). We suggest, thus, that "*Anser*" *liskunae* represents a small, distinct *Olor* species, *Olor liskunae* (Kuročkin 1976).

Genus *Cygnus* Bechstein, 1803

Cygnus olor (Gmelin, 1789)

Cygnus pristinus Kuročkin, 1971: 60, Fig. 2 = *Anas* (= *Cygnus*) *olor* Gmelin, 1789, syn. nov.

Holotype (of *Cygnus pristinus*): distal fragment of left radius, PIN 2614—25

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Chung-Kure

Discussion: Kuročkin (1971) considered his *Cygnus pristinus* to represent an intermediate form between *Cygnus* Bechstein, 1803 and *Olor* Wagler, 1832, which he holded for congeneric (cf. our above comments on this problem). Although the distal part of radius on which *Cygnus pristinus* is based is not a very diagnostic element in the watefowl (and in birds in general), the radii of *Cygnus* differ from those of *Olor* in having: (1) the dorsal margin of extremitas distalis very narrow and rather sharp (this margin is more rounded in *Olor*), and (2) the most distal point of the dorsal margin building a blunt tip (this tip is more pointed in *Olor*). *Cygnus pristinus* agrees with *Cygnus* (sensu stricto) in both these characters, indicating thus that it is a true member of this genus (sensu stricto) and not a link between *Cygnus* and *Olor* as suggested by Kuročkin (1971).

Within the genus *Cygnus*, Kuročkin (1971) calls only one difference between *Cygnus pristinus* and *Cygnus olor*, namely the presence of a broad sulcus on the margo dorsalis extremitatis distalis radii in *Cygnus pristinus*. This structure is, however, well known in some specimens of *Cygnus olor*, too (Bacher 1967, Mlíkovský pers. obs.), and is therefore evidently assignable to individual variability. There are also no biometrical differences between *Cygnus pristinus* and *Cygnus olor*: dorsoventral width of the extremitas distalis radii measures 16.5 mm in *Cygnus pristinus* (holotype; pers. obs.) and 14.2—17.6 mm in 50 adult males and females of the Recent *Cygnus olor* (Bacher 1967). Hence, we propose to synonymize *Cygnus pristinus* Kuročkin, 1971 with the Recent *Cygnus olor* (Gmelin, 1789), which is the only known Recent or fossil representative of the genus *Cygnus* sensu stricto in Palearctic (cf. Vaurie 1965, Hilprecht 1970, Ogilvie 1972, Johnsgard 1978, Kolbe 1984), which still locally occurs in Mongolia (Vaurie 1964, Piechocki 1968, Piechocki et al. 1981), and which is a common breeder in the nearby Kazakhstan (Dolgušin 1960, Krivonosov 1981).

Genus: *Anser* Brisson, 1760

Anser devjatkini Kuročkin, 1971

Anser devjatkini Kuročkin, 1971: 64, Fig. 3

Holotype: distal end of left tibiotarsus, PIN 2614—28

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Chirgiz-Nur-2

Discussion: The results of our reexamination of the holotype tibiotarsus fragment are in full agreement with Kuročkin's (1971) original description.

Anser vicinus (Kuročkin, 1976), combinatio nova

Heterochen vicinus Kuročkin, 1976: 60, Fig. 7

Holotype: proximal part of right tarsometatarsus, PIN 2614—110

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Chirgiz-Nur-2

Discussion: The holotype tarsometatarsus fragment of *Heterochen vicinus* differs from the same element of *Heterochen pratensis* Short, 1970, the type species of the genus *Heterochen* Short, 1970 and its only formerly known representative, in having: (1) fossa infracotylaris dorsalis deep, and (2) crista medialis hypotarsi with a small, but distinct, distad oriented tip (see Short 1970 for the description of *Heterochen pratensis*). In its robustness and a relatively very short hypotarsus, *Heterochen vicinus* most closely resembles the Recent *Anser fabalis* (Latham, 1787), sensu lato, while it differs from other Anserini just by this combination of characters.

We are, hence, convinced that "*Heterochen*" *vicinus* is actually a goose from the *Anser fabalis* complex. We are, however, not able to decide at present with any certainty the exact taxonomic relation between *Anser vicinus* and *Anser fabalis* for the following reasons: First, the systematics of the Recent *Anser fabalis* complex is far from understood (cf., e. g., Alferaki 1904, 1907, Buturlin 1907, 1908, 1934, Peters 1931, Grote 1934, Dement'ev 1936, Tugarinov 1941: 144—150, Hachler 1944a, b, Johansen 1945, Coombes 1947a, b, 1951, Delacour 1951, 1954, Vaurie 1965, Bauer and Glutz von Blotzheim 1968, C. S. Roselaar in Cramp and Simmons 1977, Johnsgard 1979, Van Impe 1980, 1981). Second, we compared *Anser vicinus* with only two specimens of *Anser fabalis* from the Kuročkin's collection in Moscow, and we found two differences between these two tarsometatarsi and the holotype tarsometatarsus of *Anser vicinus*, namely greater robustness and larger foramina vascularia proximalia in *Anser vicinus*. However, both these differences could be well assigned to individual or other intraspecific variability, when larger series of *Anser fabalis* could be compared. Third, there are still serious conceptual difficulties in recognizing fossil species (e. g., Tintant 1980, Mlíkovský et al. 1985). Fourth, it is possible that *Anser vicinus* is actually a valid species, but then it may be synonymous with *Anser devjatkini* Kuročkin, 1971 which was described from the same horizon and the same locality as *Anser vicinus*, and whose systematic position within the genus *Anser* remains uncertain, but which could not be compared with *Anser vicinus* due to the lack of knowledge of comparable elements representing these two species.

Hence, until a complete revision of waterfowl materials from the middle Pliocene of Mongolia is made, and until taxonomic problems with the Recent *Anser fabalis* are satisfactorily solved and its osteological peculiarities studied, we preliminarily leave *Anser vicinus* (Kuročkin, 1976) as a valid species in the *Anser fabalis* complex of the genus *Anser* Brisson, 1760.

Subfamily: Anatinae Vigors, 1825
Tribus: Aythyini Delacour and Mayr, 1945
Genus: *Aythya* Boie, 1822

Aythya spatiosa Kuročkin, 1976

Aythya spatiosa Kuročkin, 1976: 62, Fig. 9

Holotype: distal end of right femur, PIN 2614—81

Age: middle Pliocene, Chirgiz-Nur Formation

Locality: western Mongolia, Čono-Chariach

Discussion: Although a deep fossa poplitea on which Kuročkin (1976) based his tribal determination of the species under discussion is characteristic not only for Aythyini, but also for, e. g., Dendrocygnini or Somateriini (pers. obs.), we agree that *Aythya spatiosa* is a member of Aythyini because of the lateral position of its trochlea fibularis. We are, however, not quite sure about the position of *Aythya spatiosa* within Aythyini, but because it more closely resembles *Aythya* Boie, 1822 than *Netta* Kaup, 1829 in its general shape, we have no reason to doubt Kuročkin's (1976) original allocation of *Aythya spatiosa* in the genus *Aythya.*

We are also presently not able to discuss with a sufficient insight the validity and position of this species within the genus *Aythya.* Hence, until a detailed osteological revision of the genus *Aythya*, or even better of the whole tribus Aythyini, is made, we suggest to leave *Aythya spatiosa* as a valid species in this genus.

Species non-Anseriformes

"*Agnopterus*" *turgaiensis* Tugarinov, 1940

Cygnopterus lambrechti Kuročkin, 1968: 93, Fig. 1 = *Agnopterus turgaiensis* Tugarinov, 1940b, syn. nov.

Holotype (of *Cygnopterus lambrechti):* distal end of left humerus, PIN 1399—123

Age: middle Oligocene, Indricotherium beds

Locality: central Kazakhstan, Kur-Saj

Discussion: The genus *Cygnopterus* in which Kuročkin (1968) placed his new species under discussion was originally erected by Lambrecht (1931: 1) for *Sula affinis* Van Beneden, 1883 from the Rupelian (middle Oligocene) of Flanders, Belge. In the same paper Lambrecht (1931) suggested that *Cygnopterus* has anseriform affinities. Mlíkovský (1983) revised Lambrecht's (1931) redescription of this species and excluded it from Anseriformes leaving it preliminarily in Aves incertae sedis. A similar fate has *Cygnopterus lambrechti.* Its holotype humerus fragment lays in many characters well out of the range of morphological variability of the Anseriformes (cf. Woolfenden 1961; pers. obs.) and is decidedly not anseriform. It differs from Anseriformes and agrees with Phoenicopteridae (pers. obs. on the genus *Phoenicopterus* Linné, 1758) in having: (1) impressio m. brachialis located in the length axis of the shaft, (2) turberculum supracondylare ventrale absent, (3) cranial surface of the distal end immediately proximally to the condylus ventralis conspicuously deepened, (4) condylus ventralis oval in shape, and (5) epicondylus dorsalis located more proximally.

The only representative of the Phoenicopteridae known so far from the Paleogene of Asia is *Agnopterus turgaiensis* Tugarinov, 1940 which was described from the same horizon as *Cygnopterus lambrechti* and from a locality which is only about 10 km distant from the Kur-Saj gorge, the type locality of *Cygnopterus lambrechti* (A. A. Karkhu, pers. comm.). *Agnopterus turgaiensis* was described on the basis of a distal part of tibiotarsus, so that it is not directly comparable with *Cygnopterus lambrechti.* However, as judged from the proportions of Recent flamingos (pers. obs.), both *Cygnopterus lambrechti* and *Agnopterus turgaiensis* were birds of approximately the same size. Because we consider the co-occurrence of two similar-sized flamingo species rather improbable, we tentatively synonymize here *Cygnopterus lambrechti* Kuročkin, 1968 with *Agnopterus turgaiensis* Tugarinov, 1940.

A problem poses the generic name of this species. *Agnopterus* was based upon *Agnopterus laurillardi* Milne-Edwards, 1868 from the late Eocene of France, which was recently found to be non-phoenicopterid by Olson and Feduccia (1980). They concluded at the same time that *Agnopterus turgaiensis* represents a true flamingo species, a point of view with which we agree. Hence, *Agnopterus turgaiensis* cannot be included in the genus *Agnopterus*, and it should be either included in another flamingo genus known so far, or placed in a new, own genus. Currently, at least 6 fossil and Recent flamingo genera are recognized, including *Juncitarsus* Olson and Feduccia, 1980, *Leakeyornis* Rich and Walker, 1983, *Palaelodus* Milne-Edwards, 1863 (incl. *Megapaloelodus* Miller, 1944), *Phoeniconotius* Miller, 1963, *Ocyplanus* DeVis, 1906, *Xenorhynchopsis* DeVis, 1906, and *Phoenicopterus* Linné, 1758. We were not able to study the problem of the systematic position of "*Agnopterus*" *turgaiensis* within Phoenicopteridae (sensu lato) in any detail, and we leave, thus, the problem of its generic allocation open.

Phalacrocorax saiensis (Kuročkin, 1968), combinatio nova

Limicorallus saiensis Kuročkin, 1968: 99, Fig. 4

Holotype: distal end of left humerus, PIN 1442—262

Age: middle Oligocene, Indricotherium beds

Locality: central Kazakhstan, Myn-Saj

Discussion: This species was originally described by Kuročkin (1968) as a member of Rallidae, but Cracraft (1973: 39) suggested after examining Kuročkin's original figure of its holotype the re-allocation of *Limicorallus saiensis* in Anseridae. The figure of the holotype published in Kuročkin (1968: 100, Fig. 4) is, indeed, very suggestive of Anseridae, but our re-examination of the actual holotype revealed that the figure is not very accurate and that *Limicorallus saiensis* belongs neither in Rallidae nor in Anseridae.

In its general shape, the holotype humerus fragment agrees closely with the same element of small representatives of the family Phalacrocoracidae (cf. Ono 1980). Particularly it differs from Anseridae and agrees with Phalacrocoracidae in having: (1) tuberculum supracondylare ventrale oval, proximally pointed and ventrally inclined, (2) fossa m. brachialis very long and relatively narrow, and (3) a distinct fossa located proximally to the condylus ventralis and condylus dorsalis present.

All true cormorants (Phalacrocoracidae) are usually united in one genus only, *Phalacrocorax* Brisson, 1760 (e. g., Peters 1931; cf. also Brodkorb 1963). We agree with this opinion, and synonymize here consequently the genus *Limicorallus* Kuročkin, 1968 (type species: *L. saiensis* Kuročkin, 1968) with *Phalacrocorax* Brisson, 1760. *Actiornis* Lydekker, 1891, another genus listed by Brodkorb (1963) in Phalacrocoracidae is actually no cormorant, although its relationships remain unclear (Harrison and Walker 1976, Olson 1981), and *Pliocarbo* Tugarinov, 1940a, the last cormorant genus recognized by Brodkorb (1963) is known only from a tarsometatarsus and needs reexamination before it can be used in future systematic work.

Within the genus *Phalacrocorax*, *Phalacrocorax saiensis* seems to represent a valid species. Among other Oligocene and early Miocene cormorant species, *P. marinavis* Shufeldt, 1915 from the early Miocene of Oregon, *P. littoralis*

Milne-Edwards, 1863 from the Aquitanian of France (see also Paris 1912) and West Germany (Lambrecht 1933), and *P. subvolans* Brodkorb, 1956 from the early Miocene of Oregon are all much larger than *Phalacrocorax saiensis*, and also *P. miocaenus* Milne-Edwards, 1867 from the Aquitanian of France and Czechoslovakia (Švec, unpubl.), which was recently transferred in its own genus *Nectornis* by Cheneval (1984), and *P. anatolicus* Mourer-Chauviré, 1978 from the early or middle Miocene of Turkey, although smaller than the previously listed cormorant species, are still sufficiently larger than *Phalacrocorax saiensis* to leave no doubt on its species identity: width of the distal end of humerus is 11.0 mm in *Phalacrocorax miocaenus* (Milne-Edwards, 1867), while it is only 8.6 mm in *Phalacrocorax saiensis* (Kuročkin, 1968). *Phalacrocorax anatolicus* is said to be somewhat larger than *Phalacrocorax miocaenus* (Mourer-Chauviré 1978).

We are presently not able to discuss, or even to solve, the question of the relationships of *Phalacrocorax saiensis* within the genus *Phalacrocorax*. If one would divide the genus *Phalacrocorax* in two or more smaller genera as suggested for the Recent cormorants by, e. g., Wolters (1975—1982) and Van Tets (1976), and for fossil ones by Lambrecht (1933) (but see Wetmore 1935 and Brodkorb 1963 for his critics), it would perhaps be advisable to retain a separate genus, *Limicorallus* Kuročkin, 1968, for *Phalacrocorax saiensis*.

SUMMARY

Eleven waterfowl species from the Tertiary of Asia were revised, based on personal re-examination of type materials (10 species), or on the re-examination of the original description and figure (1 species). The following results were achieved:

(1) The taxonomic status of *Cygnavus formosus* Kuročkin, 1968, *Anser devjatkini* Kuročkin, 1971, and *Aythya spatiosa* Kuročkin, 1976 was confirmed, although with some restrictions for the latter two species.

(2) *Cygnopterus lambrechti* Kuročkin, 1968 was excluded from Anseriformes and synonymized with *Agnopterus turgaiensis* Tugarinov, 1940 from Phoenicopteridae.

(3) *Limicorallus saiensis* Kuročkin, 1968 was excluded from Anseriformes and included in the genus *Phalacrocorax* (Phalacrocoracidae) as a valid species *Phalacrocorax saiensis* (Kuročkin, 1968), combinatio nova.

(4) *Anas oligocaena* Tugarinov, 1940 was transferred from *Anas* in *Dendrochen* (Dendrocygnini), where it represents a valid species *Dendrochen oligocaena* (Tugarinov, 1940), combinatio nova.

(5) *Cygnus pristinus* Kuročkin, 1971 was synonymized with the Recent *Cygnus olor* (Gmelin, 1789).

(6) *Anser liskunae* Kuročkin, 1976 was transferred from *Anser* in *Olor* (Anserini), where it represents a valid species, *Olor liskunae* (Kuročkin, 1976), combinatio nova.

(7) *Heterochen vicinus* Kuročkin, 1976 was transferred from *Heterochen* in *Anser* (Anserini), where it belongs in the *Anser fabalis* complex. Whether or not it is a valid species cannot be decided until the systematics of this species complex is elaborated.

(8) *Anas soporata* Kuročkin, 1976 was transferred from *Anas* in *Dendrocygna* (Dendrocygnini), where it represents a valid species *Dendrocygna soporata* (Kuročkin, 1976), combinatio nova.

(9) *Sinanas diatomas* Yeh, 1980 was found to be a meaningless name until a re-description.

REFERENCES

Alferaki, S. N., 1904: Gusi Rossii (The geese of Russia). Moskva: Kušnerev, 189 pp + 24 pls.

Alferaki, S. N., 1907: A few words in reply to Mr. E. W. Oates' paper on the species of bean-geese. *J. Bombay nat. Hist. Soc.*, 17: 598—602.

Aslanova, S. M., N. I. Burčak-Abramovič, 1968: A fossil swan from the Maykopian series of Azerbaydzhan. *Acta zool. cracov.*, 13: 325—338.

Bacher, A., 1967: Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Mitteleuropa vorkommender Schwäne und Gänse. Diss., Ludwig-Maximilian-Universität München, 109 pp.

Bauer, K. M., U. N. Glutz von Blotzheim, 1968: Handbuch der Vögel Mitteleuropas. Vol. II. Anseriformes 1. Frankfurt (Main): Akademische Verlagsgesellschaft.

Baumel, J. J., A. S. King, A. M. Lucas, J. E. Breazile, H. E. Evans, eds., 1979: Nomina anatomica avium. London: Academic Press, 637 pp.

Bechstein, J. M.: 1803: Ornithologisches Taschenbuch von und für Deutschland. Vol. II. Leipzig.

Berndt, R., 1938: Intrasternale Trachealschlingen bei Vögeln. *Morphol. Jb.*, 82: 27—118.

Boetticher, H. von, 1952: Gänse- und Entenvögel aus aller Welt. Leipzig: Geest & Portig, 95 pp.

Boie, F., 1822: Tagebuch, gehalten auf einer Reise durch Norwegen im Jahre 1816. Schleswig: Taubstummen-Institut.

Brisson, M. J., 1760: Ornitologia. Vol. VI. Paris: Bauche, 543 + xlvii + 146 + xxiii pp.

Brodkorb, P., 1956: Two new birds from the Miocene of Florida. *Condor*, 58: 367—370.

Brodkorb, P., 1963: Catalogue of fossil birds: Part 1 (Archaeopterygiformes through Ardeiformes). *Bull. Florida State Mus., Biol. Sci.*, 7: 179—293.

Brown, L. H., E. K. Urban, K. Newman, 1982: The birds of Africa. Vol. I. London: Academic Press, 536 pp.

Brush, A. H., 1976: Watefowl feather proteins: analysis of use in taxonomic studies. *J. Zool.*, 179: 467—498.

Burčak-Abramovič, N. I., 1957: Iskopaemyj gus' v gipparionovoj faune Udabno (A fossil goose in the Hipparion fauna of Udabno). *Dokl. AN Azerb. SSR*, 13: 655—659.

Burčak-Abramovič, N. I., 1958: Tretičnye pticy SSSR (Tertiary birds of the USSR). *Uč. Zap. Azerb. gos. Univ. (Otd. biol.)*, 1: 81—88.

Burčak-Abramovič, N. I., D. V. Gadžiev, 1978: Anser eldaricus sp. nova from Upper Sarmatian Hipparion fauna of Eldar. *Acta zool. cracov.*, 23: 67—78.

Buturlin, S. A., 1907: On bean geese. *J. Bombay nat. Hist. Soc.*, 17: 603—607.

Buturlin, S. A., 1908: Bean-geese of Asia. *J. Bombay nat. Hist. Soc.*, 18: 555—561.

Buturlin, S. A., 1934: A vetési ludfajták szemléje (Übersicht der Saatgansrassen). *Aquila*, 38—41: 219—226.

Cheneval, J., 1983: Les Anatidae (Aves, Anseriformes) du gisement aquitanien de Saint-Gérand-le-Puy (Allier, France). In: E. Buffeteaut, J. M. Mazin, E. Salmon, eds., Actes du symposium paléontologique Georges Cuvier: 85—98. Montbéliard.

Cheneval, J., 1984: Les oiseaux aquatiques (Gaviiformes a Ansériformes) du gisement aquitanien de Saint-Gérand-le-Puy (Allier, France): révision systématique. *Palaeovertebrata*, 14: 33—115.

Coombes, R. A. H., 1947a: On the races of the bean goose in the Netherlands. *Limosa*, 20: 229—230.

Coombes, R. A. H., 1947b: On the original description of the bean goose. *Ibis*, 89: 272—275.

Coombes, R. A. H., 1951: Two races of bean goose in western Europe. In: S. Hörstadius, ed., Proceedings of the Xth International ornithological congress: 185—188. Uppsala: Almqvist and Wiksells.

Cracraft, J., 1973: Systematics and evolution of the Gruiformes (class Aves). 3. Phylogeny of the suborder Grues. *Bull. amer. Mus. nat. Hist.*, 151: 1—127.

Cramp, S., K. E. L. Simmons, eds., 1977: The birds of western Palaearctic. Vol. 1. Ostrich to ducks. Oxford: Oxford University Press, 722 pp.

Delacour, J., 1951: Taxonomic notes on the bean geese, Anser fabalis Lath. *Ardea*, 39: 135—142.

Delacour, J., 1954: The waterfowl of the world. Vol. I. London: Country Life, 284 pp.

Delacour, J., 1956: The waterfowl of the world. Vol. II. London: Country Life, 232 pp.

Delacour, J., 1959: The waterfowl of the world. Vol. III. London: Country Life, 270 pp.

Delacour, J., E. Mayr, 1945: The family Anatidae. *Wilson Bull.*, 57: 3—55.

Dement'ev, G. P., 1936: Essai de revision des formes de l'Oie des Moissons. *Alauda*, 8: 169—193.

DeVis, C. W., 1906: A contribution to the knowledge of the extinct avifauna of Australia. *Ann. Queensland Mus.*, 6: 3—25.

Dolgušin, I. G., ed., 1960: Pticy Kazachstana (The birds of Kazakhstan). Vol. I. Alma-Ata: AN Kazach. SSR.

Eyton, T. C., 1838: A monograph of the Anatidae or duck tribe. London: Longman, Orme, Brown, Green, Longman & Eddowes, 183 pp.

Gmelin, J. F., 1789: Systema naturae. Vol. II. Leipzig. p. 501—1032.

Grote, H., 1934: A vetési ludfajták ismertetö jegyei (Die Kennzeichen der Saatgansrassen. *Aquila*, 38—41: 211—218.

Hachler, E., 1944a: Über die Farbvarietäten einiger Saatgansformen (Anser fabalis Lath.). *Verh. naturforsch. Ver. Brünn*, 75: 157—171.

Hachler, E., 1944b: Geografické rasy husy polní (Anser fabalis Lath.). a jejich variety (Geographic races of the bean goose (Anser fabalis Lath.) and their varieties). *Čs. Ornithol.*, 11: 17—21.

Harrison, C. J. O., C. A. Walker, 1976: Birds of the British Upper Eocene. *Zool. J. Linn. Soc.*, 59: 323—351.

Hilprecht, A., 1970: Höckerschwan, Singschwan, Zwergschwan. 2nd rev. ed., Wittenberg Lutherstadt: A. Ziemsen, 184 pp.

Horsfield, T., 1821: Systematic arrangement and description of birds from the island of Java. *Trans. Linn. Soc. London*, 13: 133 ff.

Howard, H., 1946: A review of the Pleistocene birds of Fossil Lake, Oregon. *Carnegie Inst. Publ.*, 551: 141—195.

Johansen, H., 1945: Om racor af Saedgaes (On the races of the bean goose). Dansk ornithol. *Foren. Tidsskr.*, 39: 106—127.

Johnsgard, P., 1960: Comparative behaviour of the Anatidae and its evolutionary implications. *Wildfowl Trust annu. Rep.*, 11: 31—45.

Johnsgard, P., 1967: Observations on the behaviour and relationships of the white-backed duck and the stifftailed ducks. *Wildfowl Trust annu. Rep.*, 18: 98—107.

Johnsgard, P., 1978: Ducks, geese and swans of the world. Lincoln: University of Nebraska Press, 409 pp.

Johnsgard, P., 1979: Order Anseriformes. In: E. Mayr, G. W. Cottrell, eds., Check-list of birds of the world. Vol. I: 425—506. Cambridge: Museum of Comparative Zoology.

Kaup, J. J., 1829: Skizirte Entwicklungsgeschichte und natürliches System der europäischen Thierwelt. Vol. I. Darmstadt: Leske.

Kear, J., 1967: Notes on the eggs and downy young of Thalassornis leuconotus. *Ostrich*, 38: 227—229.

Kolbe, H., 1984: Die Entenvögel der Welt. 3rd rev. ed., Radebeul: Neumann, 382 pp.

Krivonosov, G. A., 1981: Skoľko lebedej-šipunov v SSSR? (How many mute swans are there in the USSR?). *Ochota ochot. Chozjajstvo*, 1981 (7): 18—19.

Kuročkin, E. N., 1968: Novye oligocenovye pticy Kazachstana (New Oligocene birds of Kazakhstan). *Paleontol. Ž.*, 1968 (1): 92—101.

Kuročkin, E. N., 1971: K avifaune pliocena Mongolii (On the Pliocene avifauna of Mongolia). In: B. A. Trofimov, ed., Fauna mezozoja i kajnozoja Zapadnoj Mongolii (The fauna of the Mesozoic and Cenozoic of western Mongolia): 58—67 Moskva: Nauka.

Kuročkin, E. N., 1976: Novye dannye o pticach pliocena zapadnoj Mongolii (New data on the Pliocene birds of western Mongolia). In: Paleontologija i biostratigrafia Mongolii (Palentology and biostratigraphy of Mongolia): 51—67. Moskva: Nauka.

Lambrecht, K., 1931: Cygnopterus and Cygnavus, zwei fossile Schwäne aus dem Tertiär Europas. *Bull. Mus. roy. Hist. nat. Belgique*, 7 (31): 1—6.

Lambrecht, K., 1933: *Handbuch der Palaeornithologie*. Berlin: Gebr. Borntraeger, 1024 pp.

Latham, J., 1787: Supplement to the general synopsis of birds. London.

Linné, K. von, 1758: Systema naturae. 10th ed., Stockholm: Salvius, 824 pp.

Lydekker, R., 1891: Catalogue of the fossil birds in the British Museum (Natural History). London: British Museum (Natural History), 368 pp.

Miler, A. H., 1944: An avifauna from the Lower Miocene of South Dakota. *Univ. California Publ., Bull. Dept. geol. Sci.*, 27: 85—100.

Miller, A. H., 1963: The fossil flamingos of Australia. *Condor*, 65: 289—299.

Milne-Edwards, A., 1863: Mémoire sur la distribution géologique des Oiseaux fossiles et description de quelques espèces nouvelles. *Ann. Sci. nat. Paris*, 20: 132—176.

Milne-Edwards, A., 1867—1868: Recherches anatomiques et paléontologiques pour servir à l'histoire des Oiseaux fossiles de la France. Vol. I. Paris: Masson & Fils, 475 pp. + 96 pls.

Mlíkovský, J., 1982a: Taxonomische Identität der Anas submajor Jánossy, 1979 (Aves: Anseriformes) aus dem Oberpliozän Ungarns. *Věst. čs. Společ. zool.*, 46: 199—202.

Mlíkovský, J., 1982b: Zur systematischen Stellung von Bucephala angustipes Jánossy, 1965 und Somateria gravipes Harrison, 1979 (Aves: Anseriformes) aus dem Pleistozän Europas. *Z. geol. Wiss.*, 10: 1463—1475.

Mlíkovský, J., 1983: Fosilní doklady evoluce vrubozobých (Aves: Anseriformes) [Fossil evidence for the waterfowl evolution (Aves: Anseriformes)]. Diss., Czechoslovak Academy of Sciences Praha, 320 pp.

Mlíkovský, J., L. Bělka, K. Zemek, 1985: Morphogenesis and the problem of morphospecies. In: J. Mlíkovský, V. J. A. Novák, eds., Evolution and morphogenesis: 201—211. Praha: Academia.

Mourer-Chauviré, C., 1978: Le bassin lacustre miocène de Bes-Konak (Anatolie-Turquie): *géologie et introduction à la paléontologie des vertebrates II/5.* Oiseaux. *Geobios*, 11: 52—54.

Nelson, C. H., 1976: A key to downy cygnets with analysis of plumage characters. *Wilson Bull.*, 88: 4—15.

Ogilvie, M. A., 1972: Distribution, numbers and migration. In: P. Scott, ed., The swans: 29—55. London: Joseph.

Olson, S. L., 1977a: The identity of the fossil ducks described from Australia by C. W. DeVis. *Emu*, 77: 127—131.

Olson, S. L., 1977b: Notes on subfossil Anatidae from New Zealand, including a new species of pink-headed duck (Malacorhynchus). *Emu*, 77: 132—135.

Olson, S. L., 1981: The generic allocation of Ibis pagana Milne-Edwards, with a review of fossil ibises (Aves: Threskiornithidae). *J. Vert. Paleontol.*, 1: 165—170.

Olson, S. L., A. Feduccia, 1980: Presbyornis and the origin of the Anseriformes (Aves: Charadriomorphae). *Smithson. Contrib. Zool.*, 323: 1—24.

Ono, K., 1980: Comparative osteology of three species of Japanese cormorants of the genus Phalacrocorax (Aves: Pelecaniformes). *Bull. natl. Sci. Mus.* (C), 6: 129—151.

Paris, P., 1912: Oiseaux fossiles de France. *Rev. Franc. Ornithol.*, 4: 283—298.

Peters, J. L., 1931: Check-list of birds of the world. Vol. I. Cambridge: Harvard University Press, 345 pp.

Petzold, H.-G., 1964: Vergleichend-ethologische Beobachtungen an Schwänen. *Beitr. Vogelk.*, 10: 1—126.

Piechocki, R., 1968: Beiträge zur Avifauna der Mongolei. Teil I. Non-Passeriformes. *Mitt. zool. Mus. Berlin*, 44: 149—292.

Piechocki, R., M. Stubbe, K. Uhlenhaut, D. Sumjaa, 1981: Beiträge zur Avifauna der Mongolei. Teil III. Non-Passeriformes. *Ann. Ornithol.*, 5: 71—128.

Raikow, R. J., 1971: The osteology and taxonomic position of the white-backed duck, Thalassornis leuconotus. *Wilson Bull.*, 83: 270—277.

Reichenbach, H. G. L., 1852: Das natürliche System der Vögel. Dresden: Expedition der vollständigen Naturgeschichte; und Berlin: Hofmeister, VIII +xxxi + 36 pp.

Rich, P. V., C. A. Walker, 1983: A new genus of Miocene flamingo from East Africa. *Ostrich*, 54: 95—104.

Scopoli, J. A., 1769: Annus I. historico-naturalis. Leipzig: C. G. Hilscher, 168 pp.

Serebrovskij, P. V., 1940: Novye nachodki ptic iz binagadinskich otloženij (New finds of birds from Binagada deposits). *Dokl. AN SSSR*, 27: 766—768.

Serebrovskij, P. V., 1941: Ostatki plejstocenovych ptic iz binagadinskich otloženij (Remains of Pleistocene birds from Binagada deposits). *Dokl. AN SSSR*, 33: 473—475.

Short, L. L., 1970: A new anseriform genus and species from the Nebraska Pliocene. *Auk*, 87: 537—543.

Shufeldt, R. W., 1915: Fossil birds in the Marsh collection of Yale University. *Trans. Connecticut Acad. Arts Sci.*, 19: 1—110.

Swainson, W., 1837: On the natural history and classification of birds. Vol. II. London.

Tintant, H., 1980: Problématique de l'espèce en paléozoologie. In: C. Bocquet, J. Génermont, M. Lamotte, eds., Les problèmes de l'espèce dans le règne animal. Vol. III: 321—372. Paris: Société Zoologique de France.

Tugarinov, A. Ja., 1940a: Novye nachodki pliocenovoj ornitofauny Odessy (New finds of the Pliocene ornithofauna of Odessa). *Dokl. AN SSSR*, 26: 311—313.

Tugarinov, A. Ja., 1940b: Novye dannye dlja tretičnoj ornitofauny SSSR (New data on the Tertiary ornithofauna of the USSR). *Dokl. AN SSSR*, 26: 314—316.

Tugarinov, A. Ja., 1941: Plastičnatokljuvye (The waterfowl). In: Fauna SSSR. Pticy (Fauna of the USSR. Birds). Vol. I (4): 1—383. Moskva: AN SSSR.

Van Beneden, P. J., 1883: Sur quelques formes nouvelles des terrains tertiaires du pays. *Bull. Acad. roy. Sci. nat. Belgique*, (3) 6: 132—134.

Van Impe, J., 1980: Ecologie et ethologie des Oies des Moissons, Anser fabalis fabalis et Anser fabalis rossicus. *Gerfaut*, 70: 499—558.

Van Impe, J., 1981: Sur la cladogenese et l'évolution d'Anser fabalis fabalis et d'Anser fabalis rossicus. *Gerfaut*, 71: 163—174.

Van Tets, G. F., 1976: Australasia and the origin of shags and cormorants, Phalacrocoracidae. In: H. J. Frith, J. H. Calaby, eds., Proceedings of the 16th international ornithological congress: 121—124. Canberra: Australian Academy of Sciences.

Van Tets, G. F., P. V. Rich, 1980: A review of the DeVis fossil pigeons of Australia. *Mem. Queensland Mus.*, 20: 89—94 (includes a revision of Nyroca effodiata DeVis 1906).

Vaurie, C., 1964: A survey of the birds of Mongolia. *Bull. amer. Mus. nat. Hist.*, 127: 103—143.

Vaurie, C., 1965: The birds of the Palearctic fauna. Non-Passeriformes. London: Witherby, 763 pp.

Vieillot, L. J. P., 1816: Nouveau dictionaire d'histoire naturelle. Vol. V. Paris: Déterville.

Vigors, N. A., 1825: Observation on the natural affinities that connect the orders and families of birds. *Trans. Linn. Soc. London*, 14: 395—517.

Wagler, J. G., 1832: Neue Vögel. *Isis*, 1832: 1221 ff.

Wetmore, A., 1935: On the genera Oligocorax and Miocorax. *Auk*, 52: 75—76

Woelfle, E., 1967: Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skelettes in Mitteleuropa vorkommender Enten, Halbgänse und Säger. Diss., Ludwig-Maximilian-Universität München, 203 pp.

Wolters, H. E., 1975—1982: Die Vogelarten der Erde. Berlin: Paul Parey, 748 pp.

Woolfenden, G. E., 1961: Postcranial osteology of the waterfowl. *Bull. Florida State Mus., Biol. Sci.*, 6: 1—129.

Yarrell, W., 1830: On a new species of wild swan, taken in England and hitherto confounded with the hooper. *Trans. Linn. Soc. London*, 16: 445—454.

Yeh, H., 1980: Fossil birds from Linqu, Shandong. Vert. palasiat, 18: 116—125 (in Chinese, with English summary).

Authors' addresses: Jiři Mlíkovský, Department of Evolutionary Biology, Czechoslovak Academy of Sciences, Na Folimance 5, CS 120 00 Praha 2, Czechoslovakia.

Petr Švec, Institute of Entomology, Czechoslovak Academy of Sciences, Branišovská 31, CS 370 05 České Budějovice, Czechoslovakia.

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Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice

REVIEW OF CAPILLARIID NEMATODES (CAPILLARIINAE) PARASITIC IN AMPHIBIANS AND REPTILES. PART 3. GENUS PARACAPILLARIA

František MORAVEC

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Abstract. Studies on type and other materials of nematodes of the subfamily Capillariinae parasitic in cold-blooded vertebrates made it possible to review all species of the genus *Paracapillaria* Mendonça, 1963 from reptiles. A new subgenus, *Ophidiocapillaria* subgen. n., is proposed to accomodate all the *Paracapillaria* members parasitizing snakes; this is characterized by the conspicuously large nuclei of stichocytes with nucleoli containing several distinct corpuscles. The names *Trichosoma mingazzinii* Rizzo, 1902, *Capillaria heterodontis* Harwood, 1932, *C. xochimilcensis* Caballero et Cerecero, 1943, *C. colubra* Pence, 1970 and *C. ptyasi* Wang, 1982 are newly synonymized with *Paracapillaria sonsinoi* (Parona, 1897) and *Capillaria amarali* Freitas et Lent, 1934 with *Paracapillaria cesarpintoi* (Freitas et Lent, 1934). A new species, *Paracapillaria congolensis* sp. n., is described from the penis of the African snake *Grayia ornata* (fam. Colubridae) from Zaire. Three species, *Trichosoma modiglianii* Parona, 1897, *Capillaria murinae* Travassos, 1914 and *C. cesarpintoi* Freitas et Lent, 1934 are transferred to *Paracapillaria*. All species studied by the present author are redescribed and illustrated and the taxonomy, range of hosts and geographical distribution of *Paracapillaria* members are discussed. A key to the species of *Paracapillaria* parasitic in reptiles is also provided.

This paper is another continuation of the author's earlier work (Moravec, 1986a, b) presenting the results of a revision of capillariid nematodes from amphibians and reptiles. It reviews the species of *Paracapillaria* parasitizing reptiles (snakes).

Genus *Paracapillaria* Mendonça, 1963

Diagnosis: Stichosome consisting of single row of stichocytes; lateral caudal alae in male absent; membraneous bursa present, supported by two lateral digital projections (rays), bent along margin of bursa to dorsal side; dorsal caudal projection absent; one pair of large sessile adanal or postanal papillae present; spicule without rough transverse grooves on surface, spicular sheath nonspiny; vulvar appendage absent; parasites of digestive tract of fishes and reptiles.

Type species: *P. piscicola* (Travassos, Artigas et Pereira, 1928)

All *Paracapillaria* species from reptiles are members of the subgenus *Ophidiocapillaria* subgen. n.

Key to subgenera of *Paracapillaria*

1 Nuclei of stichocytes medium sized, their nucleoli without distinct corpuscles; parasites of fishes . . . . *Paracapillaria*
— Nuclei of stichocytes conspicuously large, their nucleoli containing several distinct corpuscles; parasites of snakes . . . *Ophidiocapillaria* subgen. n.

Subgenus *Ophidiocapillaria* subgen. n.

Diagnosis: *Paracapillaria.* Nuclei of stichocytes conspicuously **large**, their nucleoli containing several distinct corpuscles; parasites of snakes.
Type species: *P. (O.) sonsinoi* (Parona, 1897)

Key to species of ***Paracapillaria*** from reptiles

1 Maximum length of spicule 0.8 mm 2
— Spicule longer than 0.9 mm 5
2 Spicule conspicuously short, its length 0.055 mm. Body length of male 11—13 mm, that of female 21—23 mm. Parasitic in snakes of family Colubridae in Madagascar . . . . *P. madagascariensis*
— Spicule much longer, 0.40—0.81 mm. Body length of male 5—10 mm, that of female 7—13 mm. Parasitic in snakes in southern and south-eastern Asia or in South America 3
3 Length ratio of anterior oesophageal part of body to posterior part of body in female approximately 1 : 3. Size of eggs 0.040—0.057 × 0.022—0.024 mm. Length of spicule 0.40—0.57 mm. Parasitic in snakes of family Colubridae in South America (Brazil) . . . . *P. cesarpintoi*
— Length ratio of anterior oesophageal part of body to posterior part of body in female approximately 1 : 1—1.6. Size of eggs at least 0.070 × 0.042 mm. Parasitic in snakes of southern and south-eastern Asia 4
4 Spicular sheath with dense fine transverse striation. Length of spicule 0.56—0.81 mm. Parasites of snakes of family Colubridae in Taiwan (China) . . . . *P. kuntzi*
— Spicular sheath without transverse striation. Length of spicule about 0.5 mm. Parasites of snakes of family Crotalidae in Sumatra (Indonesia) *P. modiglianii*
5 Parasites of snakes of family Boidae in South America. Body length of male 14—15 mm, that of female 18—23 mm; length of spicule 1.20 mm *P. murinae*
— Parasites of snakes of families Colubridae and Boidae of other continents 6
6 Membraneous bursa on male tail not well developed, its length 0.006—0.009 mm; dorsolateral caudal projections (rays) very short, reaching to posterior border of bursa. Length of eggs including protruding polar plugs 0.090 mm. Length of spicule 1.63—1.88 mm. Parasites of Colubridae (*Grayia ornata*) in Central Africa (Zaire) . . . . *P. congolensis* sp. n.
— Membraneous bursa on male tail well developed, its length 0.012—0.021 mm; dorsolateral caudal projections elongate, not reaching to posterior border of bursa. Length of eggs including protruding polar plugs at most 0.081 mm. Length of spicule 1—4.5 mm. Parasites of snakes of other continents . 7
7 Parasites of snakes of family Boidae of southern and south-eastern Asia. Spicule usually longer than 3.5 mm (only 2 mm according to Parona 1897). Body length of male about 40 mm, that of gravid females some 50—70 mm . . . . *P. longispicula*
— Parasites of snakes of family Colubridae of southern part of holarctic region (Europe, eastern Asia, North America). Spicule usually shorter than 3.5 mm. Body length of male mostly 15—30 mm, that of gravid females up to 40 mm, exceptionally up to 60 mm . . . . *P. sonsinoi*

1. *Paracapillaria (O.) sonsinoi* (Parona, 1897) Moravec, 1982, (Figs. 1—3)

Syn.: *Trichosoma sonsinoi* Parona, 1897; *T. mingazzinii* Rizzo, 1902; *Capillaria heterodontis* Harwood, 1932; *C. xochimilcensis* Caballero et Cerecero, 1943; *C. colubra* Pence, 1970; *C. ptyasi* Wang, 1982;*Paracapillaria viperae* Biserkov, Georgiev et Genov, 1985.

Following description based on specimens from *Natrix maura* from southern France; measurements of specimens (4 ♂♂ + 7♀♀) from *N. rhombifera* from the USA given in brackets.
Description: Comparatively big nematodes. Head end slender, elongate, oral papillae indistinct. Two well visible lateral bacillary bands present. Mus-

cular oesophagus long. Stichosome formed by single row of 38—47 (40—46) elongate stichocytes, their subdivision into transverse annuli indistinct; always one darker (more granular) stichocyte alternating with one, more rarely two lighter coloured stichocytes; nuclei of stichocytes considerably large, their nucleoli always containing several corpuscles.

Male (2 specimens): Length of body 18.14—19.49 (32.64—39.78), maximum width 0.082 (0.079—0.095). Width of lateral bacillary bands 0.027 (0.024). Length of entire oesophagus 6.60 (32—33 % of body length) [6.58—9.18 (23—24 %)], of which muscular oesophagus 0.504—0.561 (0.459—0.462), stichosome 6.04—6.09; number of stichocytes 41—45 (43—46). Distance of nerve ring from anterior extremity 0.105—0.117 (0.081—0.090). Spicule thin, well sclerotized, with rounded distal tip. Length of spicule 2.271—2.448 (4.230—4.401), its width 0.009 (0.009—0.015). Spicular sheath nonspiny, densely transversely folded. Posterior end of body rounded, provided with short cuticular membrane forming three-lobed bursa; bursa supported by two wide dorsolateral rays with somewhat expanded distal ends. Pair of large postanal papillae present. Cloacal opening subterminal. Length of male tail including bursa 0.024 (0.024), that of bursa itself (0.012—0.015). In ventral view, oblique precloacal musculature distinctly visible.

Female (3 specimens): Body length of gravid females 24.96—29.10 (49.71—56.71), maximum width 0.095—0.122 (0.095—0.109). Width of lateral bacillary bands 0.039—0.045 (0.033—0.036). Length of entire oesophagus 6.53—7.40 (26—29 % of body length) [8.91—10.20 (18—19 %)], of muscular oesophagus 0.540—0.624 (0.480—0.621), of stichosome 5.99—6.85 (8.25—9.63); number of stichocytes 38—47 (40—46). Distance of nerve ring from anterior end 0.096—0.108 (0.090—0.102). Vulva situated 0.105—0.195 (0.075—0.189) below level of oesophagus end, its anterior lip slightly elevating (nonelevating). Eggs in uterus arranged in one row near vulva, more distant eggs in several rows. Eggs oval-shaped, their polar plugs slightly (strongly) protruding. Outer layer of egg wall light coloured, with not well visible (with rough) sculpture on surface; content of eggs uncleaved. Size of eggs including polar plugs 0.075—0.081 × 0.033—0.036 (0.072—0.081 × 0.033—0.036), thickness of their wall being 0.004—0.005 (0.004). Height of complete polar plug 0.009 (0.009), of its protruding part 0.003 (0.003), its width 0.009 (0.007). Posterior end of body rounded, anus subterminal, length of tail being 0.006—0.009 (0.006—0.012). Posterior end of ovary reaching approximately to junction of intestine and rectum.

Localization: intestine and rectum; also posterior regions of oviducts and urinary bladder, penetrating there apparently from cloaca.

Hosts: Snakes of the family Colubridae — *Coluber viridiflavus* (type host), **C. constrictor priapus, Natrix natrix sicula, *N. maura, *N. rhombifera, N. sipedon, N. sipedon fasciata, N. erythrogaster, *Heterodon contortrix, Thamnophis angustirostris melanogaster* and *Ptyas mucosus.*

Distribution: A holarctic species distributed in warm regions of Europe, eastern Asia and North and Central Americas. From Europe it is known from Italy (Pisa, Catania) (Parona, 1897a, b, Rizzo, 1902) and southern France (Bagnas — Agde, Hérault) (new data), from Asia from China (Fuzhou, Prov. Fujian) (Wang, 1982), and from America from Mexico (Caballero and Cerecero, 1943) and southern states of the USA (Texas, Louisiana, North Carolina) (Harwood, 1932, Collins, 1969, 1973, Pence, 1970, new data).

Table 1. Comparison of *T. mingazzinii*, *C. ptyasi* and *C. xochimilcensis* with *P. sonsinoi*

	T. sonsinoi		*T. mingazzinii*	
	after Parona 1897		after Rizzo 1902	
	♂♂	♀♀	♂♂	♀♀
Length of body	10—11	11.5—13	14—16	21—24
Width of body	0.056	0.070—0.084	0.065	0.085
Length of entire oesophagus	6	4.5	4.5	6
No. of stichocytes				
Length of spicule	about 1	—	1.5—1.8	—
Length of eggs	—	0.070—0.084	—	0.052—0.058
Width of eggs	—	0.056	—	0.026—0.030
Length of female tail	—		—	
Localization	intestine		intestine	
Host	*Coluber viridiflavus* (Colubridae)		*Natrix natrix sicula* (Colubridae)	
Distribution	Italy (Pisa)		Italy (Catania)	

Specimens: National Museum d'Histoire Naturelle, Paris — lot 670 BA; USNM Helm. Coll., Parasitology Institute, USDA, Maryland — syntypes of *C. heterodontis* (Cat. No. 31 710) and paratypes of *C. colubra* (Cat. No. 70 555); Aquatic Station, Southern Texas State University, San Marcos. I did not succeed in obtaining the type specimens of *T. sonsinoi*, *T. mingazzinii*, *C. xochimilcensis* and *C. ptyasi.*

Comments: This species was first described by Parona (1897) as *Trichosoma sonsinoi* on the specimens from the intestine of *Zamenis* (= *Coluber*) *viridiflavus* from Italy (Pisa), its description being, however, poor; after the

Table 2. Comparison of *P. sonsinoi* from different host species in North America (own data in *C. heterodontis* and *C. colubra* in brackets)

	C. heterodontis (= *P. sonsinoi*) after Harwood 1932	
	♂♂	♀♀
Length of body	16.5—22.5	24—26 (17.2)
Width of body	0.045—0.080 (0.054)	0.100—0.115 (0.082)
Length of entire oesophagus	7—11.5	7.4—8.4 (6.25)
No. of stichocytes		
Length of spicule	2.55—3.25 (2.73)	—
Length of eggs	—	0.045—0 055 (0.063—0.066)
Width of eggs	—	0.025—0.030 (0.030)
Length of female tail	—	(0.009)
Localization	rectum	
Host	*Heterodon contortrix* (Colubridae)	
Distribution	USA (Texas)	

C. mingazzinii (= *P. sonsinoi*) new data		*C. ptyasi* after Wang 1982		*C. xochimilcensis* after Skryabin et al. 1957	
♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
18.14—19.49	24.96—29.10	9.92—12.40	10.2—11.92	10.05—10.14	13.67—13.87
0.082	0.095—0.122	0.072—0.074	0.078—0.088	0.080—0.084	0.082—0.104
6.60	6.53—7.40	5.0—5.4	5.0—5.2	3.87—4.42	4.55—4.86
41—45	38—47	32	32—34		
2.27—2.45	—	0.92—1.12	—	1.46—1.60	—
—	0.075—0.081	—	0.063—0.072	—	
—	0.033—0.036	—	0.028—0.032	—	
—	0.006—0.009	—		—	
rectum		intestine		large intestine	
Natrix maura		*Ptyas mucosus*		*Thamnophis angustirostris melanogaster*	
(Colubridae)		(Colubridae)		(Colubridae)	
France		China		Mexico	
(Bagnas)		(Fuzhou)			

author, the length of the spicule of this species was about 1 mm. The type specimens of *T. sonsinoi* are not present in the collection of the Museo civico in Genoa and it is probable that they have been lost. Later Rizzo (1902) described from the intestine of *Tropidonotus (= Natrix) natrix* also from Italy (Catania, Sicily) another species, *T. mingazzinii*, differing allegedly from *T. sonsinoi* in possessing a somewhat longer spicule (see Table 1) and in the presence of a small bursa on the male tail, containing two papillae; since this finding was from Sicily, it can be supposed that the type host belonged to the subspecies *N. natrix sicula*. Also the description of *T. mingazzinii* is poor, not containing data on many important features (e. g. the structure of the stichosome, a detailed structure of the caudal end of male, eggs, etc.).

C. colubra (= *P. sonsinoi*) after Pence 1970		*P. sonsinoi* new data	
♂♂	♀♀	♂♂	♀♀
19.56—26.40 (22.60)	29.15—36.46 (38.96)	32.64—39.78	49.71—56.71
0.068—0.078 (0.068)	0.077—0.100 (0.109)	0.073—0.095	0.095—0.109
5.54—6.90 (6.26)	2.76—6.84	6.58—9.81	8.91—10.20
40—59 (47)	40—52 (43)	43—46	40—46
2.22—2.96 (2.55)	—	4.23—4.40	—
—	0.061—0.070 (0.069—0.078)	—	0.072—0.081
—	0.028—0.031 (0.033—0.036)	—	0.033—0.036
—	(0.009)		0.006—0.012
posterior region of oviducts		urinary bladder	
Coluber constrictor priapus		*Natrix rhombifera*	
(Colubridae)		(Colubridae)	
USA (Louisiana)		USA (Texas)	

Through the courtesy of Dr. O. Bain I was able to study up the nematodes identified as *Capillaria mingaziinii* from the Museum National d'Histoire Naturelle in Paris; these were obtained from the rectum of *Natrix maura* from southern France (Bagnas — Agde, Hérault) in 1974 (leg. M. Monod). It is obvious from the comparison of these nematodes with the original descriptions of *T. sonsinoi* and *T. mingazzinii* (Table 1) that all these forms are conspecific, this being also confirmed by the same localization in the host, their geographical distribution (southern Europe) and a close relationship of their hosts. Certain metrical and morphological differences among them can be explained by an intraspecific variability (e. g. the size of the body, the length of the spicule) and an inaccuracy in observations of previous authors (e. g. the structure of the male tail). Accordingly, a valid name is *P. sonsinoi* (Parona, 1897), whereas *T. mingazzinii* Rizzo, 1902 becomes its junior synonym. In addition, also *Capillaria ptyasi* Wang, 1982 from the snake *Ptyas mucosus* from China can be considered as a junior synonym of *P. sonsinoi;* although the description of this species is inadequate and its illustration too schematic, by its measurements it corresponds, on the whole, to *P. sonsinoi* (Table 1) and also the hosts are related.

The study of *P. sonsinoi* from European snakes has shown that the general morphology of this species is very similar to that of *P. longispicula* and at present there are no reliable morphological features by which the two species can be differentiated from each other. Although the present study of the male caudal end of *P. longispicula* has revealed some differences against *P. sonsinoi* (see p. XX), only one damaged male was studied in this case; however, according to the drawing given by Baruš and Kornalík (1963), the structure of the male tail of *P. longispicula* is almost identical with that of *P. sonsinoi*. Also differences in the size of body and the length of the spicule between the two species are unimportant, especially if the American materials of *P. sonsinoi* are taken into account. Therefore, it cannot be excluded that *P. longispicula* and *P. sonsinoi* will prove to be identical in future. However, because of insufficient knowledge of the morphological variability of *P. longispicula*, and because both these species occur in different zoogeographical regions and their hosts belong to different families (Boidae versus Colubridae), I consider, for the time being, *P. longispicula* and *P. sonsinoi* two independent species

In 1932, Harwood described a new species, *Capillaria heterodontis*, from the rectum of the North American snake *Heterodon contortrix* from Texas in the USA and later Pence (1970) established another new species, *C. colubra*, on specimens from the oviducts of *Coluber constrictor priapus* from Louisiana. Collins (1973) mentions that the nematodes reported in his earlier paper as *C. heterodontis* (see Collins, 1969) belonged, in fact, to the species *C. colubra*, for which he established new hosts (*Natrix sipedon*, *N. sipedon fasciata* and *N. erythrogaster*) from North Carolina in the USA. A re-examination of the type specimens of *C. heterodontis* and *C. colubra* showed conspecificity of both these species and, moreover, their morphology was found to be identical with *P. sonsinoi* from European snakes (see Table 2, Fig 2); small metrical differences can be taken for intraspecific variability. Therefore I consider *C. heterodontis* Harwood, 1932 and *P. colubra* Pence, 1970 junior synonyms of *P. sonsinoi*.

Through the courtesy of Prof. D. G. Huffman I could examine capillariid specimens found in the urinary bladder of *Natrix rhombifera* in Texas

(Smiley) in 1975; also the morphology of these specimens (Fig. 3) corresponds to that of *P. sonsinoi*, but the nematodes are noted for the large body and organ measurements (see description), reminding thus *P. longispicula;* the length of their spicule exceeds 4 mm. A comparison of various American and European samples of *P. sonsinoi* suggests, however, that in this species the length of the spicule depends very much on the size of the nematode body, being thus subjected to a considerable intraspecific variability. The size differences of these nematodes may be associated with their age, localization and host types; *P. sonsinoi* seems to be a very plastic species creating host forms. Records of these parasites in the posterior region of oviducts or in the urinary bladder of the host may be explained by their migration to these sites from the cloaca, possibly only secondarily after the death of the host. From these reasons I consider the nematodes from *N. rhombifera* as *P. sonsinoi* too. Also the species *C. xochimilcensis* Caballero et Cerecero, 1943, described from the snake *Thamnophis angustirostris melanogaster* from Mexico, being metrically comparable with European materials (Table 2), can be considered a synonym of *P. sonsinoi*.

Consequently, the hitherto data indicate that *P. sonsinoi* is a widespread parasite of the digestive tract of snakes of the family Colubridae, widely distributed in the subtropical zone of the holarctic region.

2. *Paracapillaria (O.) cesarpintoi* (Freitas et Lent, 1934) comb. n.

Syn.: *Capillaria cesarpintoi* Freitas et Lent, 1934; *C. amarali* Freitas et Lent, 1934.

Following description combinated from the description of *C. cesarpintoi* and *C. amarali* after Freitas and Lent (1935).

Description: Cuticle smooth, with two lateral bacillary bands. Oesophagus 2.8—4.5 long, length of its muscular section 0.31—0.34; distance of nerve ring from anterior extremity 0.05—0.18.

Male: Length of body 4.8—9.9, maximum width 0.028—0.056. Length of spicule 0.40—0.57, its width 0.008. Spicular sheath smooth, length of evaginated sheath up to 0.59, width 0.012. Posterior end of body blunt, with two lateral projections or papillae situated in small membraneous bursa. Cloaca subterminal. Length ratio of anterior oesophageal portion of body to posterior portion 1 : 2—2.3.

Female: Length of body 6.3—14.5, maximum width 0.048—0.064. Vulva situated 0.016—0.027 below oesophagus end level, its anterior lip sometimes somewhat elevating. Length of vagina 0.08—0.13. Eggs thick-walled, size 0.040—0.057 × 0.022—0.024. Posterior end of body blunt, in smaller specimens with two minute conical papilla-like formations. Length ratio of anterior oesophageal portion of body to posterior portion of body 1 : 3.

Localization: stomach and small intestine.

Hosts: Snakes *Leimadophis poecilogyrus* (type host) and *Liophis miliaris miliaris* (both of the family Colubridae).

Distribution: Brazil (Manguinhos, Rio de Janeiro) (Freitas and Lent, 1934a, b, 1935).

Specimens: According to information by Prof. J. J. Vicente, the type specimens of *C. cesarpintoi* and *C. amarali* are at present in the collection of Instituto Oswaldo Cruz in Rio de Janeiro, but due to their poor condition they could not be sent for reexamination.

Comments: Freitas and Lent (1934a) described this species as *Capillaria cesarpintoi* on the specimens from the stomach and the small intestine of the Brazilian snake *Leimadophis poecilogyrus.* In the same year, from the same locality (Manguinhos) and from the related host *Liophis miliaris miliaris* they (Freitas and Lent, 1934b) described another new species, *C. amarali,* differing from the first species principially in having a shorter spicule, an elevated anterior lip of the vulva and in the presence of two very small papilla-like formations on the female tail. However, these differences are negligible, being apparently associated with different state of advantagement of these nematodes. A shorter length of the spicule in *C. amarali* (0.40—0.48 mm against 0.56—0.57 mm in *C. cesarpintoi)* is in correlation with smaller size of the body of males (4.8—6.7 mm against 7.6—9.9 mm) in this species. The presence of minute papilla-like formations on the female tail was also observed, for example, in some small specimens of *P. longispicula* and it is probable that these may be sometimes observable also in other members of *Pacacapillaria* from snakes. In view of the fact that there are no substantial morphological differences between *P. cesarpintoi* and *P. amarali* and that both these forms were described from the same locality, their hosts are related and both species have the same localization in the host's body, it is necessary to consider *P. amarali* (Freitas et Lent, 1934) a junior synonym of *P. cesarpintoi* (Freitas et Lent, 1934). The identity of these species is also suggested by the fact that Freitas and Lent (1935) in their later paper reported also *Liophis miliaris miliaris* (a type species of *C. amarali)* as the host of *C. (= P.) cesarpintoi*.

According to Freitas and Lent (1934a), *C. cesarpintoi* is very similar to the older Brazilian species *C. (=P.) murinae* Travassos, 1914, described from the anaconda *Eunectes murinus;* but the latter is noted for the generally greater measurements of the body and organs and a transverse and longitudinal striation of the cuticle. Although both these species may be identical, the given differences representing only an intraspecific viariability, I consider, for the time being, both these species independent, because their available descriptions are inadequate and their hosts belong to different families (Colubridae versus Boidae).

In view of the erroneous description of *C. cesarpintoi* in the monograph by Skryabin et al. (1957), Moravec (1982) provisionally listed this species in the genus *Pseudocapillaria.* However, according to the original data given by Freitas and Lent (1935), the caudal end of male of this species is provided with a membraneous bursa with two lateral projections. Although the existing description of *P. cesarpintoi* is insufficient, mainly as to a detailed structure of the male caudal end and that of the stichosome, the general morphology of this species indicates its appurtenance to the genus *Paracapillaria.*

3. *Paracapillaria (O.) congolensis* sp. n. (Fig. 4)

Following description based on stained and mounted specimens from *Grayia ornata* from Zaire, borrowed from British Museum.

Description: Fairly big nematodes. Two considerably wide lateral bacillary bans extending to posterior end of body present. Stichosome composed of single row of relatively short stichocytes provided with large nuclei; stichocytes appearing to be subdivided into transverse annuli.

Male (posterior ends of 2 specimens) (measurements of holotype in brackets):

Length of body fragments 2.72 and 14.96 (14.96), maximum width 0.075—0.095 (0.095). Length of oesophagus could not be established. Spicule well sclerotized, slightly transversely striated, 1.636—1.877 (1.636) long, with round distal tip; its width at proximal end 0.024—0.027 (0.027), at mid-length 0.015 (0.015) and at distal end 0.012 (0.012). Spicular sheath nonspiny, densely transversely striated. Caudal end provided with very short membraneous bursa supported by two short, round dorsolateral projections reaching to posterior border of bursa. One pair of large subventral postanal papillae present. Length of tail including membraneous bursa 0.021—0.030 (0.021), of bursa itself 0.006—0.009 (0.006).

Female (fragment of gravid specimen without oesophageal part of body — allotype; measurements according to 6 other short fragments given in brackets): Length of fragment 41.00, maximum width 0.122. Width of lateral bacillary bands at uterus region 0.075 (0.120), at posterior end of body 0.033. Vulva situated 0.120 below end of oesophagus; vulvar lips nonelevating. Eggs in uterus arranged at most in two rows (Fig. 4B). Eggs oval-shaped, with strongly protruding polar plugs; their content uncleaved. Egg wall appearing to be two-layered, outer layer fairly thick, with rough sculpture on its surface (dotted). Length of eggs including polar plugs 0.090, width 0.033; thickness of egg wall 0.003; height of protruding part of polar plugs 0.003. Posterior end of body bluntly rounded, anus terminal; length of tail 0.021, that of rectum 0.300.

Localization: penis (original localization being probably in cloaca).

Host: The snake **Grayia ornata* (fam. Colubridae).

Distribution: Kassai in Zaire (October 1925).

Specimens: British Museum (Nat. Hist.), London — holotype (Cat. No. 1926.4.22.4), allotype (1926.4.22.2) and paratypes (1926.4.22.1 and 1926.4.22.3).

Comments: *P. congolensis* sp. n. has been established on the basis of specimens from the British Museum, collected by H. W. Parker from *Grayia ornata* from Kassai in Zaire in October 1925. By its length of the spicule and the size of the body, this species is most similar to *P. sonsinoi*, differing from it mainly in the structure of the male tail (the less developed membraneous bursa and the different shape and size of caudal projections) and a considerably larger size of eggs. Moreover, also the zoogeographical distribution of *P. congolensis* sp. n. should be taken into account, because this species is the first member of the subgenus *Ophidiocapillaria* described from the African continent. The only other species known from the Ethiopian Region is *P. madagascariensis* occurring in Madagascar, differing from *P. congolensis* sp. n. by its markedly short spicule (0.055 mm). A comparison of *P. congolensis* sp. n. with other congeneric species from reptiles is apparent from the key on p. XXX.

4. *Paracapillaria (O.) kuntzi* Moravec et Gibson, 1986 (Fig. 5)

Description (after Moravec and Gibson 1986): Comparatively small nematodes, cuticle with fine longitudinal striation. Lateral bacillary bands present, not clearly visible. Head end narrow, rounded, oral papillae indistinct. Stichosome consisting of single row of 37—42 short stichocytes, their subdivision into transverse annuli indistinct; always 1—2 darker (more granular) stichocytes alternating with 1 lighter coloured stichocyte; nuclei of stichocytes large, their nucleolus containing several distinct corpuscles. Pair of small wing-like cells present at junction of oesophagus and intestine.

Male (10 specimens): Length of body 7.38—9.55, maximum width 0.095—0.150. Width of lateral bacillary bands 0.030—0.033. Length of entire oesophagus 3.47—4.54 (45—50 % of body length), of muscular oesophagus 0.273—0.312, and of stichosome 3.17—4.23; stichocytes 37—40 in number. Distance of nerve ring from anterior extremity 0.075—0.105. Spicule slender, well sclerotized, with rounded distal end; length 0.564—0.810, width 0.009—0.012. Spicular sheath nonspinose, with dense transverse striations; length of evaginated sheath 0.810, its width 0.024. Middle part of invaginated spicular sheath with many distinct transverse folds. Seminal vesicle oval, conspicuously short (length 0.090—0.135). Posterior end of body rounded, provided with short cuticular membrane forming bluntly rounded bursa; bursa supported by two wide dorsolateral projections (rays) with somewhat expanded distal ends. One pair of large postanal papillae present at base of caudal projections. Cloacal opening subterminal; anterior lip of cloaca usually distinctly elevated. Length of tail including bursa 0.018—0.024, that of bursa itself 0.006—0.009.

Female (7 specimens): Body length of gravid females 9.28—11.97, maximum width 0.122—0.204. Maximum width of lateral bacillary bands 0.045. Length of entire oesophagus 4.24—4.62 (38—45 % of body length), of muscular oesophagus 0.294—0.518, and of stichosome 3.93—4.33; stichocytes 39—42 in number. Stichocytes very short, their length slightly exceeding their width. Distance of nerve ring from anterior extremity 0.078—0.096. Vulva normally situated at level of posterior end of oesophagus, rarely somewhat below this level (up to 0.075). Anterior lip of vulva usually distinctly elevated, often very markedly (Fig. 5D), rarely only slightly elevated (Fig. 5C). Eggs near vulva not in single file, but irregularly arranged in two rows. Mature eggs oval, with flat, slightly protruding polar plugs; egg shell two-layered, outer layer with irregular reticulate sculpturing on surface; content of eggs in uterus uncleaved. Polar plugs of young eggs conspicuously protruded. Length of mature eggs including polar plugs 0.081—0.087, their width 0.036—0.042, and thickness of their wall 0.004—0.005. Height of whole polar plug 0.009, of its protruding part 0.003, width of plug 0.009. Posterior end of body distinctly tapered from level of posterior end of intestine (Fig. 5G); length of rectum 0.141—0.177. Anus subterminal, length of tail 0.015; tail bluntly rounded. Posterior end of ovary approximately at level of junction of intestine and rectum.

Localization: unknown (? intestine).

Hosts: Snakes **Liopeltis major* (type host) and **Zaocys dhumnades* (both fam. Colubridae).

Distribution: Taiwan (China) (Moravec and Gibson, 1986).

Specimens: British Museum (Nat. Hist.), London — holotype (Cat. No. 1984.3293), allotype (1984.3294), paratypes (1984.3295—3325) and other specimens (1984.3326—3331); Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice (Cat. No. N 159 — paratypes).

Comments: This species has recently been established by Moravec and Gibson (1986) on the basis of specimens from *Liopeltis major* collected in Taiwan by Dr. R. E. Kuntz; conspecific females were also found in *Zaocys dhumnades* of the same collection.

Characteristic features of *P. kuntzi* are principally small body measurements, shape of stichocytes, a comparatively short spicule, shape of the seminal vesicle and the posterior end of female body, structure and size of eggs and a usually conspicuously elevated anterior vulvar lip in females.

5. *Paracapillaria (O.) longispicula* (Sonsino, 1889) Moravec, 1982 (Figs. 6—7)

Syn.: *Trichosoma longispiculum* Sonsino, 1889.

Following description based on specimens from *Python* sp. from India, borrowed from British Museum.

Description: Large nematodes with smooth cuticle. Head end rounded, mouth elevated, oral papillae indistinct. Two lateral bacillary bands of rough structure present. Stichosome formed by single row of stichocytes provided with huge nuclei; stichocytes subdivided into several not well distinct transverse annuli; number of stichocytes 42—48. Nuclei of stichocytes containing voluminous nucleolus with several distinct corpuscles.

Male (2 incomplete specimens): Length of fragments about 20, their width 0.163. Length of entire oesophagus 12.88, of muscular oesophagus 0.501, of stichosome 12.38; stichocytes 42 in number. Distance of nerve ring from anterior extremity could not be established. Testis reaching anteriorly to short distance below level of oesophagus end. Spicule slender, well sclerotized, transversely striated, length 4.55; width at its mid-length 0.015, at its posterior end 0.009; distal end of spicule rounded. Spicular sheath nonspiny, finely transversely folded. Posterior end of body blunt, with medial depression, provided with short cuticular membrane forming bursa; posterior border of bursa straight (not convex) in dorsoventral view. Bursa supported by two short dorsolateral rays with rounded end. Cloacal opening subterminal; one pair of large, round subventral papillae present below it. Length of male tail including bursa 0.039, length of membraneous bursa itself 0.015.

Female (4 incomplete specimens): Length of largest fragment (without part of oesophageal portion) of gravid female 5.95, its maximum width 0.177—0.204. Length of entire oesophagus 10.80—14.31, of muscular oesophagus 0.525—0.570, of stichosome 10.28—13.74; number of stichocytes 47—48. Distance of nerve ring from anterior extremity 0.090—0.108. Vulva situated 0.225—0.360 below level of oesophagus end, its lips not elevated. Uterus containing large number of mature eggs, these not being arranged in one row but forming irregular mass (Fig. 6E). Mature eggs barrel-shaped, with slightly elevating polar plugs; their content uncleaved. Egg wall three-layered, inner layer hyaline, thin, middle layer somewhat more compact, darker, outer layer forming very fine coating with rough sculpture; edge of outer layer forming elevated ring around polar plug. Size of eggs including polar plugs 0.072—0.081 × 0.037—0.039, height of protruding part of polar plugs 0.003—0.006. Posterior end of body rounded, anus subterminal, length of tail 0.015—0.030. Posterior end of body rounded, anus subterminal, length of tail 0.015—0.030. Posterior end of ovary not attaining region of rectum; rectum 0.231 long.

Localization: intestine.

Hosts: Pythons, *Python molurus* (type host), **P. molurus bivattatus*, **Python* sp., *Liasis amethystinus* and *Morelia spilotes* (all fam. Boidae).

Distribution: Southern and South-eastern Asia — India (Sonsino 1889), China (in pythons imported to zoological garden in Czechoslovakia) (Baruš and Kornalík, 1963), and Australia (Jones, 1979).

Specimens: British Museum (Nat. Hist.), London (Cat. No. 1966.259—260); Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice.

Comments: This species was described as *Trichosoma longispiculum* on the specimens from the type host from India by Sonsino (1889); but the description is poor and drawings were not provided. The type specimens were later studied by Parona (1897a, b) who made the specific description more precise, giving also the drawings of some features. At present, the type specimens of *T. longispiculum* are no longer maintained in Museo civico di storia naturale in Genoa and it is probable that they have been lost. Some additional data concerning the morphology of this species were given by Kowalewski (1900, 1901, 1902). Later Freitas and Lent (1935) worked out a description of *C. longispicula* on the basis of data given by previous authors.

Also the description given by Freitas and Lent (1935) is inadequate According to these authors, the length of the male and female body of *C. longispicula* is 40 mm and 50—60 mm, respectively, the length of oesophagus being $^{2}/_{3}$—$^{2}/_{5}$ of the whole body length. The length of the spicule is 2—3.82 mm; the male tail is provided with small bursa with two lateral papillae. According to Baruš and Kornalík (1963), the male bursa is supported by two conspicuous ventrolateral papillae (i. e. caudal lobes), a pair of sessile papillae being present at the level of the cloacal opening; the length of females is 50—69 mm A reexamination of the material of these authors (Baruš and Kornalík, 1963) confirmed their data on the structure of the male tail (Fig. 7) and showed that the spicule of the only available male was 4.04 mm long and 0.009—0.012 mm wide, with fine transverse striations; the length of membraneous bursa was 0.021 mm. The size of eggs including polar plugs was 0.066—0.069 × 0.033—0.036 mm, the eggs in uterus being arranged in one or two longitudinal rows.

Own description of *P. longispicula* is based on the specimens from *Python* sp from India (Bombay) (leg. H. Sen, 1964) that have been deposited in the British Museum. Although as the site of location is given the trachea, it is probable that the nematodes got there secondarily after the host's death. The structure of the tail of the only available male is somewhat different from that of the conspecific male from the material of Baruš and Kornalík (1963), this being more similar to species from European and North American snakes; small differences are as well in the structure of the egg shell and the number and arrangement of eggs in the female uterus. These differences can be interpreted by different age of the nematodes and a use of different procedures during their fixation and preparation of mounts. The present study has shown that the stichosome structure of *P. longispicula* resembles that of other congeners from snakes. While Parona (1897a, b) gives the spicule length of *P. longispicula* as only 2 mm, it exceeds 3.6 mm according to subsequent authors (Kowalewski, 1900, 1901, 1902, Baruš and Kornalík 1963) and own observations. As far as the data by Parona (1897a, b) is correct, then the spicule length in this species is subjected to a considerable intraspecific variability, this being probably associated mainly with the age of nematodes.

Considering that *P. longispicula* is the oldest known capillariid species from snakes, its detailed redescription, based on more numerous topotypic materials, enabling to recognize an intraspecific variability in this species, is desirable, it would be very important for the taxonomy of the capillariids parasitizing snakes.

6. *Paracapillaria (O.) madagascariensis* (Ghadirian, 1968) Moravec, 1982

Syn.: *Capillaria madagascariensis* Ghadirian, 1968.

Description (adapted from Ghadirian, 1968):

Male: Length of body 11—12.5, maximum width 0.075. Length of entire oesophagus 5.5 ($^1/_2$—$^1/_3$ of body length), of which muscular oesophagus 0.240; distance of nerve ring from anterior extremity 0.085. Spicule very short, length 0.055. Short caudal bursa present, being supported by two lateral projections (rays); one pair of sessile papillae present at base of latter.

Female: Length of body 20.5—23, maximum width 0.100. Length of entire oesophagus 8 ($^1/_3$ of body length), of which muscular oesophagus 0.275; distance of nerve ring from anterior end 0.090. Stichosome formed by 44 stichocytes subdivided into transverse annuli (9—10 per stichocyte). Ovary posteriorly reaching to 0.080 from posterior end of body. Vulva situated 0.100 below level of oesophagus end, its lips nonelevated. Eggs with superficial sculpture, their size being 0.065—0.070 × 0.030—0.035; content of eggs uncleaved. Posterior end obtuse, anus subterminal.

Localization: not given (? intestine).

Host: The snake *Liopholidophis sexlineatus* (fam. Colubridae).

Distribution: Madagascar (Sambaina Province) (Ghadirian, 1968).

Specimens: According to Dr. O. Bain's information, the type specimens of *C. madagascariensis* are deposited in the collection of Museum National d'Histoire Naturelle in Paris, but because of their poor condition it was not possible to send them for reexamination.

Comments: According to the original description, this species differs from all other capillariids from snakes by its markedly short spicule. It appears from its drawing that the general structure of body of this species, particularly that of the stichosome and the male tail, is typical of the genus *Paracapillaria*. Although the character of the spicular sheath has not been described, an assignment of *C. madagascariensis* to *Paracapillaria* seems to be fully justified.

7. *Paracapillaria (O.) modiglianii* (Parona, 1897) comb. n.

Syn.: *Trichosoma modiglianii* Parona, 1897.

Description (adapted from Parona, 1897b and 1898):

Male: Length of body 9, width 0.042. Length of oesophagus about 5. Spicule transversely striated, length some 0.5. Spicular sheath not striated, allegedly covered with spines (?). Posterior end of body with very short genital bursa.

Female: Length of body 10—13, maximum width 0.070. Oesophagus very short, about 5. Two large cells present at junction of oesophagus and intestine. Vulva situated 0.084 below level of oesophagus end. Size of eggs 0.070 × 0.042. Posterior end of body obtuse, anus subterminal.

Localization: intestine.

Host: The snake *Lachesis sumatranus* (fam. Crotalidae).

Distribution: Indonesia (Mentawei Island near Sumatra) (Parona, 1897a, b, 1898).

Specimens: According to information by Dr. G. Arbocco the type specimens of *T. modiglianii* are no longer present at Museo civico in Genoa and have been probably lost.

Comments: This species was described by Parona (1897a, b) from the specimens found by Prof. E. Modigliani in the intestine of the snake *Trimeresurus formosus (= Lachesis sumatranus)* from Mentawei Island near Sumatra; it has not been recorded since.

In contrast to other capillariid species parasitizing snakes, P. *modiglianii* is allegedly noted for the presence of minute spines on the spicular sheath in the male. Although Parona (1897a, b) mentions the presence of these spines in the original specific description, in the same paper, while comparing three capillariid species from snakes, he characterizes the spicular sheath of *T. modiglianii* only as "non striata", without mentioning a presence of spines; the presence of spines is neither obvious from the original drawing. In his following paper containing a description of this species (Parona, 1898) the author does not mention the presence of spines on its spicular sheath.

The presence or absence of spines can often be reliably established only on the spicular sheath protruding out of the nematode body; however, because the spicular sheath of *P. modiglianii* was observed only within the capillariid body, data concerning this feature seem to be doubtful in this case. It appears that neither Parona himself was sure of the presence of spines on the spicular sheath of *P. modiglianii* and, consequently, he did not attach a greater importance to this feature. Considering the general morphology of this species and the fact that all other capillariids from snakes belong to *Paracapillaria*, I am recommending to transfer *T. modiglianii* tentatively to this genus. This generic appurtenance can be confirmed only on the basis of a more detailed species redescription.

8. *Paracapillaria (O.) murinae* (Travassos, 1914) comb. n.

Syn.: *Capillaria murinae* Travassos, 1914.

Description (adapted from Freitas and Lent, 1935): Body with cuticle slightly longitudinally and transversely striated. Length of entire oesophagus 5.5—7.5, that of muscular oesophagus 0.486. Distance of nerve ring from anterior end 0.170.

Male: Length of body 14—15, width 0.031—0.071. Spicule long, thick, with blunt end, length 1.20, width 0.008. Spicular sheath nonspiny, 0.024 wide. Cloacal opening subterminal. Caudal end of body with two lateral projections situated in small membraneous bursa. Length ratio of anterior oesaphageal part of body to posterior part of body 1 : 1.7.

Female: Length of body 18—23, width 0.035—0.078. Vulva situated 0.073 below level of oesaphagus end, its anterior lip slightly elevated. Length of vagina 0.18—0.24. Posterior end of body blunt, anus subterminal. Ratio of anterior oesophageal part of body to posterior part of body 1 : 1.4—2.

Localization: stomach.

Host: The anaconda, *Eunectes murinus* (fam. Boidae).

Distribution: Brazil (Matto Grosso) (Travassos, 1914).

Specimens: According to information by Prof. J. J. Vicente the type specimens of *C. murinae* were lost.

Comments: This species was described under the name *Capillaria murinae* by Travassos (1914) as the first capillariid from South American snakes (the earlier reported species *Trichosoma crotali* Rudolphi, 1819 from *Crotalus terrificus* from Brazil had not been described and, therefore, it was designated as *nomen nudum* by Travassos (1915)). However, its description is inadequate, particularly as to the structure of the stichosome and the male tail making its comparison with species from North American and European snakes impossible.

9. *Paracapillaria (O.)* sp. 1 (Fig. 8)

Description: Males unknown. Body length of gravid females 14.28—19.92, maximum width 0.109. Bacillary bands indistinct. Cuticle appearing to be

densely covered by very fine cuticular projections, distinct mainly near tail end. Length of entire oesophagus 3.93—6.00 (28—30 % of body length), of muscular oesophagus 0.405—0.420, of stichosome 3.52—5.58. Distance of nerve ring from anterior end 0.059—0.069. Stichosome consisting of single row of long stichocytes with large nuclei, subdivided into transverse annuli; number of stichocytes in smallest female 33. Darker (more granular) stichocytes alternating with lighter coloured ones. Vulva situated 0.015—0.030 below level of oesophagus end, vulvar lips not elevating or only anterior lip slightly elevated. Eggs in uterus numerous. Eggs barrel-shaped, with strongly protruding polar plugs; length of eggs including polar plugs 0.066—0.075, its width 0.036—0.039; height of protruding part of polar plugs 0.003. Content of eggs uncleaved. Egg wall two-layered, outer layer light, of very fine structure, with distinct superficial sculpture; thickness of shell at equatorial part of egg 0.0015—0.0020, near poles 0.0045—0.0060. Anus subterminal, length of tail 0.015; length of rectum 0.180.
Localization: not given (digestive tract?).
Host: The snake **Dryophis nasuta* (fam. Colubridae).
Distribution: Thailand.
Specimens: British Museum (Nat. Hist.), London (Cat. No. 1974.79—86) (leg. J. F. A. Sprent).
Comments: Although no males of this species were obtained, it can be supposed according to the structure of eggs and the host type that the nematodes belong to the genus *Paracapillaria*. Some features (e. g. superficial structures on the cuticle) suggest that these parasites belong to a new, hitherto undescribed species.

10. *Paracapillaria (O.)* sp. 2

Description: Males unknown. Body length of one complete gravid female 12.88, maximum width 0.109. Bacillary bands not observed. Length of entire oesophagus 6.46 (50 % of body length), of muscular oesophagus 0.324, of stichosome 6.14; number of stichocytes 43. Stichocytes elongate, distinctly subdivided into several transverse annuli. Distance of nerve ring from anterior end 0.087. Vulva situated 0.039 below level of oesophagus end, anterior vulvar lip somewhat elevated. Eggs 0.075—0.081 long and 0.036 wide, with weakly protruding polar plugs; height of protruding part of polar plug 0.003. Content of mature eggs uncleaved. Anus subterminal, length of tail 0.018.
Localization: not given.
Host: The snake **Elaphe carinata* (fam. Colubridae).
Distribution: Taiwan (China) (Moravec and Gibson, 1986).
Specimens: British Museum (Nat. Hist.), London (Cat. No. 1984.3332—3333).
Comments: The general morphology of these female nematodes is very similar to that of the species *P. kuntzi*, also a parasite of the Colubrinae in Taiwan, differing from it, however, in having more elongate stichocytes that are distinctly subdivided into transverse annuli. But it cannot be excluded that these nematodes are conspecific with *P. kuntzi*.

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REFERENCES

Baruš, V., Kornalík, F., 1963: On some interesting parasites of snakes (Ophidia) Bitis gabonica A. Dum., Vipera russelli Shaw and Python molurus bivittatus Schl. *Čs. parasitol. (Praha)*, 10: 61—71.

Caballero, C. E., Cerecero, M. C., 1943: Nematodes de los reptiles de Mexico. VIII. Descripcion de tres nuevas especies. *An. Inst. Biol. Mexico*, 14: 527—539

Collins, R. F., 1969: The helminths of Natrix spp. and Agkistrodon piscivorus piscivorus (Reptilia; Ophidia) in Eastern North Carolina. *J. Elisha Mitchell Soc.*, 88: 141—144.

Collins, R. F, 1973: New host and locality records for Capillaria colubra Pence, 1970. *J. Parasitol.*, 59: 1020.

Freitas, J. F. T., Lent, H., 1934a: Capillaria cesarpintoi n. sp., parasita de Leimadophis poecilogyrus (Wied.). *Mem. Inst. Oswaldo Cruz*, 28: 263 + Pl. 49.

Freitas, J. F. T., Lent, H., 1934b: Capillaria amarali n. sp., parasita de Liophis miliaris miliaris (L.). *Mem. Inst. Oswaldo Cruz*, 28: 271—272 + Pl. 53.

Freitas, J. F. T., Lent, H., 1935: Capillariinae de animaes de sangue frio (Nematoda: Trichuroidea). *Mem. Inst. Oswaldo Cruz*, 30: 241—284 + 11 Plts.

Ghadirian, E., 1968: Nématodes parasites d'ophidiens malgaches. *Mém. Mus. nant. Hist. nat., Paris, Ser. A, Zool.*, 54: 1—54

Harwood, P. D., 1932: The helminths parasitic in the Amphibia and Reptilia of Houston, Texas and vicinity. *Proc. U. S. Nat. Mus.*, 81 (17): 1—71 + Plts 1—5

Jones, H. I., 1979: Gastrointestinal nematodes, including three new species, from Australian and Papua New Guinean pythons. *Proc. Helm. Soc. Wash.*, 46: 1—14.

Kowalewski, M., 1900: O czterech gatunkach rodzaju Trichosoma Rud. (Studya helmintologiczne 6). (Sur quatre espèces du genre Trichosoma Rud. Etudes helminthologiques 6) (summary of a paper). *Bull. Inter. Acad. Sc. Cracovie, Cl math. et nat.*, 5: 183—186.

Kowalewski, M., 1901: O czterech gatunkach rodz. Trichosoma Rud. (Studya helmintologiczne 6). *Rozpr. wydz. matemat.-przyr. Akad. Um. Krakow.*, 38 (2) s., 18: 268—285 + Pl. 6.

Kowalewski, M., 1902: Materyaly do fauny helmintologicznej pasorzytniczej polskiej. 3(Material for Polish helminthological fauna. 3). *Spraw. Kom. fizyogr. Akad. Um. Krakow.*, 36: 21—30.

Moravec, F., 1982: Proposal of a new systematic arrangement of nematodes of the family Capillariidae. *Folia parasit. (Praha)*, 29: 119—132.

Moravec, F., 1986a: Review of capillariid nematodes (Capillariinae) parasitic in amphibians and reptiles. Part. 1. General introduction, genera Capillaria, Aonchotheca and Paratrichosoma. *Věst. čs. Společ. zool.*, 50: 120—131 + 3 Plts.

Moravec, F., 1986b: Review of capillariid nematodes (Capillariinae) parasitic in amphibians and reptiles. Part 2. Genus Amphibiocapillaria. *Věst. čs. společ. zool.*, 50: 217—230 + 6 Plts.

Moravec,F., Gibson, D. I., 1986: A new capillariid, Paracapillaria kuntzi sp. n. (Nematoda: Trichuridae), from colubrid snakes in Taiwan. *Folia parasit. (Praha)*, 33: 151—155.

Parona, C., 1897a: I tricosomi degli ofidii. *Atti Soc. ligust. sc. nat. geogr.*, Genova, 8: 380—385 + Pl. 10.

Parona, C., 1897b: I tricosomi degli ofidii. *Boll. Mus. Zool. Anat. Comp. R. Univ. Genova*, No. 58, 5 pp + 1 Pl.

Parona, C., 1898: Elminti raccolti dal Dott. Elio Modigliani alle isole Mentawei, Engano e Sumatra. *Ann. Mus. civico di storia nat. di Genova, Ser. 2,* 19 (39): 102—124 + Pl. 1.

Pence, D. B., 1970: Capillaria colubra sp. n. from the oviduct of Coluber constrictor priapus. *J. Parasitol.*, 56: 261—264.

Rizzo, A., 1902: La fauna elmintologica dei rettili nella provincia di Catania. *Arch. Parasit., Paris,* 6: 26—41.

Skryabin, K. I., Shikhobalova, A. A., Orlov, I. V., 1957: (Trichocephalids and capillariids of animals and man and the diseases caused by them.) Osnovy nematodologii 6. Izd. AN SSSR, Moscow, 587 pp. (in Russian).

Sonsino, P., 1889: Studie e notizie elmintologische. *Atti. Soc. tosc. sc. nat., Pisa, proc. verb. (1887—1889),* 6: 224—237.

Travassos, L., 1915: Contribuiçoes para o conhecimento da fauna helmintolojica brasileira. Sobre as especies brasileiras do genero Capillaria Zeder, 1800. *Mem. Inst. Oswaldo Cruz,* 7: 146—172.

Travassos, L., 1932: Sobre dois parasitos de batrachios de Portugal. *Bolet. Biol.,* 21: 60—64.

Wang, P. Q., *1982: (Studies on nematodes of the family* Capillariidae from Fujian). *Acta Zootaxonom. Sinica,* 7: 117—126 (in Chinese, Engl. summary).

Figures 1—8 will be found at the end of this issue.

Addendum

Since this paper was submitted for publication, another recent publication containing description of a new species of *Paracapillaria* has come to the author's attention. Biserkov et al. (1985) described the new species, *Paracapillaria viperae,* from the viper *Vipera ammodytes* in Bulgaria; *this species is undoubtedly conspecific* with *P. sonsinoi* (Parona, 1897) in accordance with the present revision and can be considered its junior synonym.

Biserkov, V. Y., Georgiev, B. B., Genov, T., 1985: Paracapillaria viperae sp. n. (Nematoda, Capillariidae) — a parasite of Vipera ammodytes L. in Bulgaria. *Dokl. Bolgar. Akad. Nauk* 38: 251—254.

Author's address: Dr. F. Moravec, Institute of Parasitology, Czechoslovak Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czechoslovakia.

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Kreismuseum in Tachov

ZUSAMMENSETZUNG DER BRUTVOGELSYNUSIEN IN FELDWÄLDCHEN MIT UNUNTERSCHIEDENER BAUM- UND STRAUCHSCHICHT

Pavel ŘEPA

Eingegangen am 22. Oktober 1985

Abstract. The author investigated the composition of breeding bird synusiae in a further type of tree and shrub stands in the fields. This time the groves were subjected to studies in which the tree and especially the shrub layers are richly developed, both layers passing countinously into each other without any separation in space. Nine stands of this kind were investigated in the territory of the dale called Tachovská brázda (quadrate 6242, district Tachov, southwestern Bohemia). The method of breeding territory mapping was used. On total, 38 species were established, the total density of birds fluctuated between 12.7 and 32.2 pairs per 1 hectare. The most important species of the bird synusia were *Emberiza citrinella, Sylvia curruca, Fringilla coelebs, Turdus merula, Phylloscopus trochilus, Erithacus rubecula, Sylvia communis, Phylloscopus collybita* and *Prunella modularis.*

EINLEITUNG

In der vorliegenden Mitteilung knüpfe ich an meine vorhergehende Arbeit (Řepa 1985) an und setze die Beschreibung von Brutvögelsynusien in verschiedenen Baum- und Strauchbeständen inmitten der Felder fort. Diesmal wurden Bestände mit dichtem Kronenschluss untersucht, in denen vor allem die Sträucher von verschiedener Höhe sowie höhere Bäume vertreten sind. Die Baum- und Strauchschicht sind nicht deutlich voneinander getrennt, da hier die angehäuften Bäume und Sträucher verschiedenster Höhen nebeneinander wachsen. Dieser Bestandtyp ist nicht nur im Raum Tachover Furche häufig, wo unsere Untersuchungen durchgeführt wurden. Er kommt üblich auch in anderen Teilen unserer Republik vor.

UNTERSUCHUNGSFLÄCHEN

Die Untersuchungen wurden auf zwei etwa 50 ha grosse Flächen der offenen Agrarlandschaft im Raum der Tachover Furche durchgeführt, auf denen die Baum- und Strauchbestände zerstreut sind. Die Beschreibung des Gebietes und der erwähnten Flächen sowie deren genaue Lage ist in den vorigen Arbeiten (Řepa 1985, 1985a) angeführt. Dem obenerwähnten Typ entsprachen auf beiden Flächen insgesamt 9 Bestände. Eingehendere Informationen über diese Bestände sind in Tab. 1 zu finden: genaue Lokalisierung, Fläche in ha, Anteil der Fläche, auf der ausser der Strauch- auch die Baumschicht ausgebildet ist, Anteil der Nadelgehölze im Bestand, Entfernung von Siedlungen (Ortschaften und Gemeinden) und insbesondere die Entfernung von den in der offenen Landschaft einsam stehenden Gebäuden, schliesslich die Entfernung von Waldrand. Ebenfalls ist die Diversität des Bestandes angeführt, die folgendermassen ermittelt wurde: Auf der bezüglichen Fläche wurden die im groben Umriss homogenen Abschnitte mit Rücksicht auf die Bestandhöhe, Anwesenheit der

Tab. 1. Grundlegende Angaben über die untersuchten Baum- und Strauchfeldbestände

Lokalität	Quadrat des Netzes	Untersuchungsjahre	Fläche in ha	Anteil der Abschnitte mit Baumschicht	Anteil der Nadelgehölze	Bestanddiversität	Entfernung in m 1.	2.	3.	Wichtigste Gehölzarten
A) Hlinné, Damm des Teiches Modrý	6242	1974–1984	0,80	70%	20%	1,029	20	100	50	P. tremula, Salix sp., P. silvestris,
B) St. Sedliště, Damm des Teiches Nový	6242	1976–1984	0,80	20%	—	0,500	1000	1000	50	Salix sp., A. glutinosa
C) Tisová, Damm des Teiches V. Podveský	6242	1976–1984	0,75	70%	5%	0,790	500	500	300	Salix sp., P. tremula P. excelsa
D) St. Sedliště, Damm des Teiches Mělký	6242	1977–1984	0,60	10%	—	0,324	700	700	500	A. glutinosa, Salix sp., P. tremula
E) Bor, Damm des Teiches Tážný	6242	1975–1984	0,45	95%	—	0,195	400	800	200	Q. robur, Salix sp., A. glutinosa
F) Tisová, Damm des Teiches Dlouhý	6242	1976–1984	0,40	70%	—	0,610	800	800	200	Salix sp., P. tremula, B. verrucosa
G) Čečkovice, unterhalb des Kälberstalls	6242	1979–1982	0,40	30%	20%	0,730	200	200	1000	Salix sp., P. excelsa
H) Tisová, Damm des Teisches Choboty	6242	1976–1984	0,37	60%	10%	0,942	700	700	50	P. tremula, Salix sp., P. excelsa
I) Hlinné, Damm des Teiches M. Hlinský	6242	1974–1975 1983–1984	0,25	95%	—	0,195	500	800	1000	P. tremula, P. spinosus
Teiches M. Hlinský	6242	1983–1984	0,25	95%	—	0,195	400	800	1000	P. tremula, P. spinosus

Erläuterungen: 1. — Entfernung von einsamen Gebäuden
2. — Entfernung von Dorfern
3. — Entfernung von zusammenhängendem Wald

Tab. 2. Durchschnittswerte der Densität, Dominanz und Frequenz des Vorkommens aller festgestellten Vogelarten aus allen neun untersuchten Baum- und Strauchfeldbeständen.

Art	Densität Paar.ha^{-1}	Dominanz	Frequenz
Emberiza citrinella	2,52	11,5	100
Sylvia curruca	2,45	11,2	100
Fringilla coelebs	2,30	10,6	100
Turdus merula	1,82	8,3	100
Phylloscopus trochilus	1,72	8,2	100
Erithacus rubecula	1,32	6,1	100
Sylvia communis	1,26	5,9	88
Phylloscopus collybita	1,20	5.5	88
Carduelis chloris	1,15	5,3	88
Prunella modularis	0,74	3.4	88
Parus major	0,58	2,6	66
Carduelis carduelis	0,48	2,2	66
Turdus philomelos	0,48	2.2	55
Sylvia borin	0,45	2.1	66
Parus caeruleus	0,41	1,9	88
Serinus serinus	0,36	1,6	33
Motacilla alba	0,36	1,6	33
Carduelis cannabina	0.24	1,1	33
Sturnus vulgaris	0,22	1,0	66
Parus palustris	0,22	1,0	44
Passer montanus	0,22	1,0	33
Pica pica	0,17	0,7	33
Phoenicurus phoenicurus	0,17	0,7	55
Streptopelia decaocto	0,15	0,7	22
Hippolais icterina	0,12	0,5	22
Sylvia atricapilla	0,10	0,4	33
Troglodytes troglodytes	0,10	0,4	33
Lanius collurio	0,10	0.4	33
Saxicola rubetra	0,10	0,4	22
Lanius excubitor	0,07	0,3	22
Locustella naevia	0,07	0,3	22
Streptopelia turtur	0,05	0,2	22
Turdus pilaris	0,05	0.2	22
Dendrocopos minor	0,02	8,1	11
Garrulus glandarius	0,02	0,1	11
Oriolus oriolus	0,02	0,1	11
Motacilla flava	0,02	0,1	11
Pyrrhula pyrrhula	0,02	0,1	11

Strauch- und Baumschicht oder beider Schichten und auf die Zusammensetzung aus Laub- oder Nadelgehölzen kartiert. Prozentuale Teilwerte, die die Fläche dieser Bestände in der Gesamtfläche des Bestandes darstellten, wurden in die Shannon-Weaver'sche Diversitätsformel eingesetzt (Odum 1977).

In den Beständen wurde in den Jahren 1974—1984 die qualitative und quantitative Zusammensetzung der Brutvogelsynusie festgestellt. Einzelne Bestände wurden nur in einigen Jahren untersucht; die Anzahl der Untersuchungsjahre sowie deren Zeitabgrenzung sind ebenfalls in Tab. 1 angeführt.

METHODIK

Es wurde die Methode der Kartierung der Nestterritorien benutzt. Wie in der vorigen Arbeit (Řepa 1985), auch hier wurden die Paarzahlen für einzelne Bestände

Tab. 3. Grundlegende Charakteristiken der Brutvogelsynusien in neun untersuchten Baum- und Strauchfeldbeständen.

Bestand	Densität Paar.ha^{-1}	Artenzahl	Diversität der Synusie	Äquitabilität der Synusie	Durchschnittliche Frequenz	Dominanzindex
A	20,2	28	3,049	0,950	47,0	0,0558
B	18,7	21	2,831	0,930	57,2	0,0736
C	19,1	30	3,310	0,973	43,5	0,0554
D	28,1	17	2,589	0,914	64,5	0,952
E	12,7	12	2,263	0,910	46,7	0,1266
F	32,2	18	2,605	0,901	54,7	0,939
G	19,4	14	2,337	0,885	48,2	0,1049
H	32,4	20	2,698	0,898	50,6	0,0898
I	32,0	13	2,356	0,918	51,9	0,1210

aus den Artenkarten für die ganzen grossen, 50 ha messenden Landschaftsabschnitte erwählt.

Für jeden Bestand wurde die durchschnittliche Paarzahl aller nistenden Arten aus den Angaben für alle Untersuchungsjahre berechnet. Dann wurden die Densität (pro 1 ha der Fläche) und die Dominanz festgestellt (Palmgren 1930). Es wurden auch die Gesamtdensität der Brutvogelsynusie, deren Diversität nach Shannon et Weaver und Äquitabilität nach Pielou ermittelt (Odum 1977). Wiederum entstand hier die Gefahr (s. auch Řepa 1985), dass die Durchschnittswerte von diesen Charakteristiken der Vogelsynusie davon abhängig würden, aus wie vielen Jahren der Durchschnittswert berechnet wurde. Wir haben wiederholt bekräftigt, dass wenn es sich um einen Durchschnitt aus vier oder mehr Jahren handelt, der Wert durch Hinzuzählen der Angaben aus einem folgenden Jahr nicht mehr wesentlich verändert wird. Deshalb werden zur Wertung nur die Ergebnisse aus den mindestens vier Jahre lang untersuchten Beständen benutzt.

Bei einzelnen Arten werden auch die Frequenz, der prozentuale Teilwert der Jahre, in denen die betreffende Art als Brutvogel in der Gesamtzahl der Untersuchungsjahre angetroffen wurde, angegeben. Es geht um ein Stabilitätsmass des Vorkommens einzelner Arten. Der Durchschnittswert aller Frequenzen von festgestellten Arten stellt dann das Stabilitätsmass der ganzen Brutvogelsynusie im betreffenden Bestand dar.

Zur Bewertung der Beziehung zwischenn einzelnen Charakteristiken der Bestände und ihrer Brutsynusien und der Densität der wichtigsten Vogelarten wurden einfache Korrelationskoeffizienten nach Turček (1956) berechnet.

ERGEBNISSE

Die Ergebnisse unserer Untersuchung sind in den Tabellen zusammengefasst. In Tab. 2 ist die gesamte Zusammensetzung aller untersuchten Bestände zusammen angegeben. Es sind alle in den neun untersuchten Beständen festgestellten Arten mit Angaben über ihre durchschnittliche Densität und Dominanz (die als arithmetischer Durchschnitt der für einzelne untersuchte Bestände ermittelten Werte gewonnen worden sind) angeführt. Die Frequenz gibt dann das Prozent an, das die Anzahl der Bestände, in denen betreffende Art nistete, aus der Gesamtzahl der untersuchten Bestände bildet.

In Tab. 3 sind die Grundcharakteristiken der Brutvogelsynusien von untersuchten Beständen angeführt. In Tab. 4 sind die Densitäten einzelner Arten für alle untersuchten Bestände dargestellt. Es handelt sich immer un den Durchschnittswert aus allen Untersuchungsjahren. Die numerischen Angaben sind in dieser Tabelle nur für die zehn wichtigsten Arten angegeben. Das Nisten

Tab. 4. Densität der wichtigsten Vogelarten an neun untersuchten Baum- und Strauchfeldbeständen.

Bestand	EC	SCu	FC	PhT	TM	CCh	ER	PhC	PMo	SCo
A	1,8	1,4	2,0	0,5	1,3	1,5	1,1	1,1	0,5	0,2
B	1,8	1,9	1,9	2,5	1,2	0,5	1,1	1,2	0,5	0,8
C	1,8	1,0	2,4	0,9	1,5	1,0	1,0	1,2	0,5	—
D	2,7	3,5	3,1	4,4	1,9	2,1	1,9	1,5	1,9	2,9
E	1,8	1,6	2,2	1,8	2,0	0,7	0,4	0,2	0,4	1,1
F	4,4	5,8	2,5	1,7	3,0	1,7	1,7	2,2	1,1	2,2
G	3,8	2,5	0,6	1.3	1,9	2,5	1,3	—	0,6	1,3
H	4,5	4,8	3,3	1,8	2,1	2,7	2,4	1,5	2.7	1,8
I	6,0	4,0	3,0	1,0	4,0	1,0	2,0	2,0	1,0	4,0

Bezeichnung einzelner Arten: EC — *Emberiza citrinella* SCu — *Sylvia curruca*, FC — *Fringill* *coelebs*, PhT — *Phylloscopus trochilus*, TM — *Turdus merula*, CCH — *Carduelis chloris*, ER — *Erithacus rubecula*, PhC — *Phylloscopus collybita*. PMo — *Prunella modularis*, SCo — *Sylv* *communis*.

von übrigen Arten ist in Tab. 5 dargestellt, wo nur angeführt wird, in welchem Bestand die betreffende Art nistete.

Die Densität der Brutsynusie war hoch. In keinem Fall sank sie unter 1 Paare pro Hektar, bei drei untersuchten Beständen überschritt sie den Wer von 30 Paaren . ha^{-1}. Die Densität schwankt erheblich, was auf die Unterschie

Tab. 5. Vorkommen weitere nistender Vogelarten in untersuchten Baum- und Strauchfeldbeständen.

Art	Bestand								
	A	B	C	D	E	F	G	H	I
Parus caeruleus	+	+	+	+	+	+	+	+	—
Parus major	+	+	+	+	+	—	—	+	—
Carduelis carduelis	+	—	+	+	—	+	+	+	—
Sylvia borin	+	+	+	+	—	+	—	+	—
Turdus philomelos	+	+	+	+	—	+	—	—	—
Phoenicurus phoenicurus	+	—	—	+	—	—	—	+	+
Parus palustris	+	+	+	+	—	—	—	—	—
Serinus serinus	+	—	+	—	—	—	—	+	—
Motacilla alba	+	+	—	—	—	—	—	+	—
Carduelis cannabina	+	—	+	—	—	—	+	—	
Pica pica	+	—	+	—	—	—	+	—	—
Sylvia atricapilla	+	+	+	—	—	—	—	—	—
Troglodytes troglodytes	+	+	—	—	—	—	—	—	+
Lanius collurio	+	—	—	—	—	—	—	—	+
Turdus pilaris	+	—	+	—	—	—	—	—	—
Locustella naevia	+	—	+	—	—	—	—	—	—
Passer montanus	+	—	+	—	—	—	—	—	—
Streptopelia decaocto	+	—	+	—	—	—	—	—	—
Saxicola rubetra	—	—	+	—	—	—	+	—	—
Lanius excubitor	+	—	+	—	—	—	—	—	—

Bemerkung: Nur in einem einzigen Bestand wurden noch folgende Arten festgestellt: *Streptope* *turtur*, *Garrulus glandarius*, *Oriolus oriolus*, *Locustella fluviatilis*, *Sturnus vulgaris*, *Dendrocop* *minor*, *Pyrrhula pyrrhula*.

Tab. 6. Anzeiger der statistischen Signifikanz der Korrelationen zwischen den Charakteristiken der Baum- und Strauchfeldbestände und den Charakteristiken ihrer Vogelsynusien.

Charakteristiken des Bestandes	Charakteristiken der Brutvogelsynusien				
	Densität	Artenzahl	Diversität der Synusie	Äquitabilität der Synusie	Durchschnittliche Frequenz
Flache	—!!	+!!	+!!	+!!	—
Anteil der Abschnite mit Baumschicht	+	—	—	+	—ô
Anteil der Nadelgehölze	—	+ô	+	—	—!!
Diversität des Bestandes	—	+!!	+!!	+ô	—!
Entfernung von Dörfern	+!	—!!	—	+!	+!!
Entfernung von einsamen Gebäuden	+ô	—	+	—	+!!
Entfernung von zusammenhängendem Wald	—	—!!	—!!	—ô	—

de in der Grösse der Bestände zurückzuführen ist. Es wird hier die allgemeine Regel bestätigt, dass mit der abnehmenden Fläche des Feldwäldchens die Densität der Avifauna zunimmt (Peitzmeier 1950), es kommt jedoch auch der Einfluss der Bestandstruktur zum Ausdruck (vgl. Erdelen 1978). Zur genaueren Bewertung des Einflusses der Bestandstruktur auf die Avifauna wurden die Korrelationskoeffizienten für die Beziehung zwischen den Charakteristiken der Wäldchen und der Brutsynusie berechnet. In Tab. 6 ist die statistische Signifikanz einzelner Korrelationen auf Grund dieser Koeffizienten ausgedrückt.

Für die Gesamtdensität spielte — ausser dem Bestandausmass — die Entfernung von bewohnten Orten die wichtigste Rolle. Bei entfernteren Wäldchen war die Densität höher. Die gesamte Artenzahl in der Brutsynusie stieg markant mit zunehmendem Wäldchenausmass, was ebenfalls eine allgemein bekannte Erschienung ist (Peitzmeier 1950). Dementgegen war eine Senkung der Artenzahl mit zunehmender Entfernung vom zusammenhängenden Waldkomplex erkennbar, eine kleinere Senkung der Artenzahl liess sich auch mit zunehmender Entfernung von Siedlungen feststellen. Die Bestanddiversität erhöhte durch ihre Zunahme bedeutend die Anzahl nistender Vogelarten.

Die Diversität der Brutsynusie erhöhte sich mit zunehmendem Bestandausmass wie auch mit zunehmender Bestanddiversität. Im Gegenteil sank sie mit zunehmender Entfernung vom zusammenhängenden Waldkomplex. Auch die Äquitabilität der Brutsynusie erhöhte sich mit zunehmendem Wäldchenausmass und mit zunehmender Entfernung von Siedlungen. Die durchschnittliche Frequenz stieg bedeutsam mit zunehmender Entfernung von Siedlungen und sank mit zunehmendem Anteil von Nadelgehölzen im Bestand.

Insgesamt wurden in den untersuchten Beständen 38 nistende Vogelarten festgestellt (Tab. 2). Die wichtigsten Arten waren *Emberiza citrinella, Sylvia curruca, Fringilla coelebs* und *Turdus merula*. Sehr bedeutsam sind auch *Phylloscopus trochilus, Ph. collybita, Erithacus rubecula, Sylvia communis* und *Carduelis chloris*. Alle sind dominant (Dominanz über 5 %). Zu diesen kann auch *Prunella modularis* zugezählt werden, deren Dominanz zwar 3,48 % beträgt, aber Frequenz deren Vorkommens 85 % übersteigt. Die angeführten 10 Arten

Tab. 7. Anzeiger der statistischen Signifikanz von Korrelationen zwischen den Charakteristiken der Baum- und Strauchfeldbeständen und der Densität wichtigster Brutvogelarten.

Densität	Charakteristiken des Bestandes						
	Fläche des Bestandes	Anteil der Abschnitte mit Baumschicht	Anteil der Nadelbäume	Diversität des Bestandes	Entfernung von Dörfern	Entfernung von einsamen Gebäuden	Entfernung von zusammenhängendem Wald
EC	−!!	+!	−	−	+	+	+ô
SCu	−!!	+	−ô	+	−	+!	−
FC	−ô	+ô	−!!	−	+!	+!	−
PhT	+	−!!	−!!	−ô	+!	+!!	−
TM	−!!	−!	−ô	−!	+	+	+!
CCh	−!	−!	+!!	+!	−!	−	−
ER	−!	−	−ô	+	−	+ô	+
PhC	−	−ô	−!!	−	+!	+!!	−!
SCo	−!!	+	−!	−ô	+!	+ô	+!
PMo	−!	−ô	−ô	−	+ô	+!!	−

Erläuterungen: + positive Korrelation
− negative Korrelation
ô — Korrelation ist möglich statistisch signifikant
! — Korrelation ist statistisch signifikant
!! — Korrelation ist hoch statistisch signifikant

EC — *E. citrinella*, SCu — *S. curruca*, FC — *F. coelebs*, PhT — *Ph. trochilus*, TM — *T. merula*, CCh — *C. chloris*, ER — *E. rubecula*, PhC — *Ph. collybita*, SCo — *S. communis*, PMo — *P. modularis*

stellen demnach die Grundlage der Brutsynusie vom untersuchten Typ der Baum- und Strauchfeldebeständen dar. Ausser zwei frei auf Bäumen nistenden Arten, *F. coelebs* und *C. chloris*, nisten alle übrigen Arten von dieser Zehnergruppe in Sträuchern. Angesichts der reichen Vertretung von Sträuchern in diesem Bestandtyp ist das nicht überraschend, dass die in Sträuchern nistenden Arten isgesamt 69 % aller nistenden Paaren in der Synusie repräsentieren. Die auf Bäumen nistenden Arten bilden schon nur 19 % und die in Höhlen nistenden Arten nur 8 % Synusie. Die auf Boden nistenden Arten sind in geringem Mass vertreten (etwa 2 %).

Tab. 7 zeigt, wie bei den wichtigsten Arten ihre Densität von einzelnen Charakteristiken der Bestände abhängig ist. Gleich wie in Tab. 6, auch hier ist die statistische Signifikanz der Korrelationen nach der Höhe der Korrelationskoeffizienten bezeichnet. Mit zunehmender Bestandfläche sinkt bei meisten Arten signifikant die Densität, was der allgemeinen Regel entspricht. Bei *F. coelebs* tritt jedoch ein bedeutsames Anwachsen der Densität mit zunehmender Bestandfläche. Offensichtlich braucht diese in Baumkronen nistende Art einen grösseren Bestand um in einer grösseren Anzahl nisten anzufangen.

Mit zunehmendem Anteil der Abschnitte mit Baumschicht sinkt die Densität von *Ph. trochilus*. Bei dieser Art wird tatsächlich angeführt, dass sie zum Unterschied von der *Ph. collybita* Gebüsche bewohnt, über denen sich keine Baumschicht befindet. Eine schwächere Senkung der Densität wurde bei weiteren typischen Gebüscharten *T. merula* und *P. modularis*, aber auch bei der auf Bäumen nistenden *C. chloris* vermerkt.

Der zunehmende Anteil von Nadelgehölzen hatte bei den meisten verfolgten Arten eine Senkung der Densität zur Folge. Bei *C. chloris*, die ihre Nester auf Nadelbäumen mit Vorliebe baut, ist das Anwachsen der Densität mit zunehmendem Anteil der Nadelbäume im Bestand nachweisbar.

Die Bestanddiversität beeinflusste nachweisbar die Densität nur bei zwei Arten. Bei *T. merula* sinkt die Densität mit zunehmender Diversität, bei *C. chloris* nimmt sie dagegen zu.

Mit zunehmender Entfernung von den Siedlungen nimmt die Densität durchweg zu (bei *F. coelebs* ,*Ph. trochilus*, *Ph. collybita*, *P. modularis* und bei *S. curruca*, *S. communis* weniger markant). Nur bei der stark urbanisierten Art *C. chloris* sinkt die Densität mit zunehmender Entfernung von Siedlungen. Mit zunehmender Entfernung vom Wald sank die Densität von *Ph. collybita* und *F. coelebs*. Bei den an die freie Landschaft angepassten Arten *S. communis* und *E. citrinella* wie auch bei der stark urbanisierten *T. merula* nahm dagegen die Densität mit zunehmender Entfernung vom Wald zu.

DISKUSSION

In der Literatur gibt es mehrere Arbeiten über die Brutvogelsynusien der Gehölzfeldbestände von analoger Struktur aus der ČSSR,, Polen, BRD, DDR, Ungarn und England (Czarnecki 1956, Turček 1956, Preywisch 1960, Puchstein 1966, Sperling 1966, Schmidt 1967, Köhler 1972, Reder 1973, Tomek 1973, Riess 1974, Morgan 1975, Williamson 1975, Sellin 1976). In unserem Gebiet wurden sehr kleine Bestände mit Aussmass bis 1 ha untersucht. Die Mehrheit übriger Autoren untersuchte entweder lange Gebüschstreifen, oder grosse Gebüschflächen. Deshalb sind die Angaben über die Gesamtdensität der Brutsynusie kaum vergleichbar, da die Densität von der Grösse der inselartigen Bestände stark abhängig ist.

Aussichtsvoller ist der Vergleich der Vertretung von einzelnen Arten. Es wurde eine Liste der von obenangeführten Autoren in betreffenden Beständen festgestellten Arten angefertigt. Die Arten wurden nach der Frequenz ihres Vorkommens auf allen von diesen Autoren untersuchten Flächen geordnet. Beim Vergleich dieser Liste mit unseren Angaben in Tab. 2 wird eine im ganzen gute Übereinstimmung ersichtlich. Von den zehn wichtigsten, in Beständen der Tachover Furche ermittelten Arten gehörten nur zwei (*E. rubecula* und *P. modularis*) nach den zitierten Autoren nicht zu den wichtigsten, indem ihre Frequenz unter 50 % war. Beide diese Arten wurden jedoch von vielen Autoren festgestellt, sie nisteten auf 40 % der untersuchten Flächen. Im Gegenteil, von den Arten, die nach den zitierten Autoren am häufigsten waren, 7 waren in der Tachover Furche schon in der Gruppe weniger wichtiger Arten.

Ferner führen die zitierten Autoren zusammen weitere 55 Vogelarten an, die sie auf weniger als einer Hälfte der untersuchten Flächen festgestellt haben. In der Tachover Furche wurden 28 influente und akzessorische Arten festgestellt, von denen alle in der nach zitierten Autoren zusammengefassten Liste vertreten sind. Mann kann daher sagen, dass sich die Zusammensetzung der Brutvogelfauna in den Baum- und Strauchbeständen ohne unterschiedene Baum- und Strauchschicht in der Tachover Furche von der Zusammensetzung der Avifauna im analogen Biotop von anderen europäischen Ländern keinerlei wesentlich unterscheidet.

Ich verglich auch die Ergebnisse mit den Angaben über die Zusammensetzung Waldgehölzgrüns, den die Wäldchen mit gut ausgebildeter, von der Strauchschicht unterschiedener Baumschicht und mit vorwiegend älteren Bäumen in der Brutvogelfauna im vorher untersuchten Typ von Fragmenten des Nicht-Bestands darstellen (Řepa 1985). Die Densität der Brutsynusie war im jetzt untersuchten Typ etwas höher. Dies ist allerdings im Zusammenhang mit der Grösse des Bestandes. Während die hier untersuchten Bestände einen Ausmass von höchstens 1 ha hatten, waren die vorher untersuchten Bestände 1—6 ha gross. Was die Diversität und Äquitabilität der Brutsynusie anbelangt es wurden keine wesentlichen Unterschiede gefunden.

Grössere Unterschiede gab es natürlich in der Vertretung einzelner Arten. Zu den wichtigsten Arten zählten in beiden Typen übereinstimmend *F. coelebs, Ph. trochilus, T. merula* und *Ph. collybita*. In den vorher untersuchten Wäldchen mit älteren Bäumen (Řepa 1985) gehörten zu den wichtigsten Arten auch *P. major, P. caeruleus* und *T. philomelos*, die in den jetzt untersuchten Beständen schon von geringerer Bedeutung in der Synusie waren, und *Sylvia atricapilla* und *Turdus pilaris*, die hier nur als akzessorische Arten vorkamen. *E. citrinella, S. curruca, E. rubecula, C. chloris* und *S. communis* vertreten wir dagegen in den jetzt untersuchten Wäldchen als die bedeutendsten Arten; in den Wäldchen mit älteren Bäumen (Řepa 1975) gehörten sie schon zu influenten Arten.

Bei den beiden Typen verglich ich ebenfalls die nachgewiesenen Korrelationen zwischen den Charakteristiken der Bestände und den Charakteristiken der Brutsynusie. Übereinstimmend stand in beiden Fällen die Gesamtdensität der Synusie mit dem Flächenausmass in negativer Korrelation, was eine allgemein bekannte Erscheinung ist. Die Artenzahl stand in beiden Typen der Gehölzfeldbestände in positiver Korrelation mit dem Wäldschenausmass und auch mit der Diversität des Bestandes. Es ist interessant, dass in beiden Fällen die Artenzahl mit der Entfernung von Siedlungen abnahm.

Bei den Typen der Gehölzfeldbestände wurden auch die nachweisbaren Korrelationen zwischen der Densität einzelner wichtiger Vogelarten und den Charakteristiken der Bestände verglichen. Die Senkung der Densität mit zunehmender Fläche des Wäldchens erschien bei meisten verglichenen Arten, unnachweisbar war sie nur bei *Ph. trochilus*. Mit der Diversität des Bestandes steht die Densität von *S. curruca* in nachweisbar positiver, die von *C. chloris* in negativer Korrelation. Die gennanten Fälle deuten an, dass die Abhängigkeiten der Densität des Vorkommens verschiedener Vogelarten von einzelnen Charakteristiken der Bestände allgemein gültig sein können. Die Bekräftigung dieser Abhängigkeiten erfordert allerdings das Zusammentragen von umfangreichen Unterlagen über weitere Typen der Gehölzfeldbestände auch aus weiteren Gebieten.

ZUSAMMENFASSUNG

1. In den Jahren 1974—1984 wurde die Zusammensetzung von Brutvogelsynusien der Baum- und Strauchfeldbestände untersucht. Es wurden solche Bestände ausgewählt, die gut entwickelte Strauch- und Baumschicht besassen, wobei diese Schichten im Raum voneinander nicht deutlich getrennt waren Die Untersuchungen wurden im Gebiet des Tachover Furche (Quadrat 6242 des Kartierungsnetzes der Tschechoslowakischen Zoologischen Gesellschaft — Kreis Tachov, Südwestböhmen) durchgeführt.
2. Es wurden 9 Baum- und Strauchfeldbestände mit Ausmass von 0,25—0,80 ha untersucht. In jedem Bestand wurden die Untersuchungen einige Jahre lang (min. 4 max. 11 Jahre) durchgeführt.

3. Für die Untersuchung wurde die Methode der Kartierung von Nestterritorien erwählt. Für jeden Bestand wurden die Densität, Dominanz und Frequenz des Vorkommens jeder nistenden Art, ferner die Gesamtdensität, Diversität und Äquitabilität der Synusie, Anzahl nistender Arten, durchschittliche Frequenz und der Dominanzindex ermittelt.
4. Die Gesamtdensität der Brutvogelsynusie betrug in einzelnen Beständen 12,7—32,2 Paar . ha^{-1}. Die Diversität der Synusie schwankte von 2,26 bis 3,31 und die Äquitabilität der Synusie von 0,88 bis 0,97. Die Anzahl der in einem Bestand nistenden Arten bewegte sich zwischen 12 und 30.
5. Die wichtigsten in den untersuchten Gehölzfeldbeständen nistenden Arten waren: *Emberiza citrinella, Sylvia curruca, Fringilla coelebs, Turdus merula, Phylloscopus trochilus, Sylvia communis, Phylloscopus collybita, Carduelis chloris* und *Prunella modularis*. Insgesamt wurden 38 Arten festgestellt.

LITERATUR

Czarnecki, Z., 1956: Obserwacje ekologiczne nad ptakami Lasku Golecinskego pod Poznaniem w roku 1952. *Acta Orn.*, 5(4): 113—158.

Gromadzki, M., 1970: Breeding communities of bird in mid-field afforested areas. *Ekol. Pol.*, 18(14): 308—350.

Köhler, K. H., 1972: Die Vogelwelt eines Bahndammes im Sommer und Winter. *Orn. Mitt.*, 24(12): 255—259.

Morgan, R., 1975: Breeding bird communities on chalk downland in Wiltshire. *Bird Study*, 22(2): 71—83.

Odum, P. E., 1977: Základy ekologie. Academia, Praha.

Palmgren, P., 1930: Quantitative Untersuchungen über die Vogelfauna in den Wäldern Südfinnlands. *Acta Zool. Fenn.*, 7: 1—218.

Peitzmeier, J., 1950: Untersuchungen über die Siedlungsdichte der Vogelwelt in kleinen Gehölzen in Westfalen. *Natur u. Heimat*, 10(1): 35—37.

Preywisch, K., 1960: Zum Vogelbestand zweier Heckengebiete im Kreise Höxter. *Natur u. Heimat*, 20(1): 20—25.

Puchstein, K., 1960: Vogelökologie gemischter Fläche. *Vogelwelt*, 87(6): 161—176.

Reder, U., 1973: Die Siedlungsdichte der Vögel einer Feldgehölz- und Heckenlandschaft des Eichsfeldes. *Mitt. IG Avifauna DDR*, 6: 41—44.

Riess, W., 1974: Untersuchungen an Vogelpopulationen zweier Heckengebiete im Naturpark Hoher Vogelsburg. *Luscinia*, 42/3/4/: 109—133.

Repa, P., 1985: Composition of the breeding bird synusiae in the field groves with high lod trees. *Fol. mus. rer. nat. Bohem. occid., Zool.*, 21: 1—29.

Řepa, P., 1985: Hnízdní společenstva ptáků v intenzivně zemědělsky obdělané krajině. *Zprávy MOS*, 43: 21—27.

Schmidt, E., 1967: Vogelbestandsaufnahmen in Feldhecken in der Umgebung von Budapest. *Zool. Abh. staatl. Mus. Tierk., Dresden*, 29(8): 77—84.

Sellin, D., 1976: Der Brutvogelebestand einer Feldhecke in der Gemarkung Putzar im Jahre 1971. *Orn. Rundbr. Mecklenburgs, N. F.*, 17: 22—24.

Sperling, F., 1966: Die Vogelwelt einer Knicklandschaft im Kreis Pinneburg. *Hamb. Avafaun. Beitr.*, 3: 1—8.

Tomek, W., 1973: Ptaki zachodniej czasci Pogorza Ciezkowickiego. *Acta zool. Cracov.*, 18(16): 529—558.

Turček, F. J., 1956: Úvod do kvantitívneho vyskumu populácií vtákov a cicavcov. SAV Bratislava.

Turček, F. J., 1958: Dreviny, vtáky a cicavce z niektorých pásov kriačin v poliach. *Biol. prace*, 4(8): 47—67.

Vlček, M., 1983: Obratlovci státní přírodní rezervace Rač v Českém Středohoří. *Sborn. Severočes. muz., Ser. Natur, Liberec*, 13: 121—134.

Williamson, K., 1975: The breeding bird community of chalk grassland scrub in the Chiltern Hills. *Bird Study*, 22(2): 59—70.

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Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice

OBSERVATIONS ON THE ECOLOGY OF FIVE SPECIES OF INTESTINAL HELMINTHS IN PERCH (PERCA FLUVIATILIS) FROM THE MÁCHA LAKE FISHPOND SYSTEM, CZECHOSLOVAKIA

Tomáš SCHOLZ

Abstract. Seasonal dynamics of the occurrence of five species of intestinal helminths, *Bunodera luciopercae* (Müller, 1776), *Bothriocephalus claviceps* (Goeze, 1782), *Proteocephalus percae* (Müller, 1780), *Camallanus lacustris* (Zoega, 1776), *Acanthocephalus lucii* (Müller, 1776) was observed on the basis of helminthological examination of 373 specimens of perch (*Perca fluviatilis* L.) from the Mácha Lake fishpond system. Three of these species, *B. luciopercae, C. lacustris, A.* lucii, occurred there throughout the year, the remaining two species, *B. claviceps* and *P. percae*, were found from June to October and from October to May, respectively. Two species, *B. luciopercae* and *P. percae*, exhibited prominent seasonal cycles of maturation, whereas *C. lacustris* and *A. lucii* did not. The size of body of perch was found to affect the degree of their infestation with all helminths. Distinct seasonal changes in the location of *B. luciopercae, B. claviceps* and *P. percae*, but not in *C. lacustris* and *A. lucii* were noted.

INTRODUCTION

Detailed studies on seasonal dynamics of the occurrence and maturation of intestinal helminths in perch have hitherto not been performed in Czechoslovakia. The bionomy of some of these helminths species has been described by Dyk et al. (1954), Vejnar (1956), Vojtková (1959) and Lucký and Navrátil (1983). The presence of helminths in the gut was observed, e. g., in Norway (Andersen, 1978) and in the GDR (Priemer, 1979). Cannon (1972), Wootten (1973, 1974), Skorping (1980, 1981), Lee (1981) and other writers studied the biology of intestinal helminths in perch.

The biology of the most frequent intestinal helminths, *Bunodera luciopercae* (Müller, 1776), *Bothriocephalus claviceps* (Goeze, 1782), *Proteocephalus percae* (Müller, 1780), *Camallanus lacustris* (Zoega, 1776), *Acanthocephalus lucii* (Muller, 1776) in perch from the Břehyně Brook in the Mácha Lake fishpond system was studied to find their seasonal cycles of occurrence and maturation in the hosts, seasonal changes in the location in the gut of perch and the effects of the size of fish on the degree of their infestation.

Nine more species of endoparasitic helminths were noted in perch of that locality (Scholz, 1986). The helminthofauna of several fish species from the Mácha Lake fishpond system was studied also by Moravec (1978, 1979). The author found 8 species of helminths, including *B. luciopercae, P. percae, C. lacustris* and *A. lucii* in 48 perch, however, their occurrence throughout the year in perch was not studied.

MATERIAL AND METHODS

A total of 373 perch from the Mácha Lake fishpond system, northern Bohemia, were examined from Oct. 1981 to Nov. 1982. Fish were collected using an electric fishing machine in the Břehyně Brook. This brook connects Břehyně fishpond (270 ha), a natural reservation, and Mácha Lake (350 ha) serving for recreation purposes. Additional data on this locality are presented in the papers of Moravec (1979) and Scholz (1984).

Following numbers of perch were collected in individual months: Oct. 1981 — 19, Nov. — 26, Dec. — 14, Jan. 1982 — 15, Feb. — 12, March — 19, April — 39, May — 31, June — 18, July — 53, Aug. — 32, Sept. — 32, Oct. — 44, Nov. — 19.

The prevalence (i. e. the percentage of infected fish from the sample studied) and the mean intensity values (i. e. mean number of helminths per an infected fish) were calculated for each monthly sample of perch (see Margolis et al, 1982). Body length of fish examined ranged from 5.5 cm to 23.5 cm. To observe the differences in the degree of infestation in perch of different size all fish examined were divided into 5 groups: group 1 — body length 8.5 cm and less, group 2 — 9—12 cm, group 3 — 12.5—15.5 cm, group 4 — 16—19 cm, group 5 — 19.5 and more cm.

The number of perch in individual size groups in monthly samples fluctuated throughout the year. Therefore, the prevalence and the mean intensity values were calculated for each months for a total sample of perch and for fish of size groups 2 and 3 (body length 9—15.5 cm). Small perch from size group 1, usually little infected, and heavily infected large fish (size groups 4 and 5) were not included in this sample. The total sample included 173 perch 9—15.5 cm long (Oct. 1981 — 9, Nov. — 19, Dec. — 9, Jan. 1982, — 14, Feb. — 12, March — 16, April — 9, May — 12, June — 9, July 14, Aug. — 9, Sept. — 9, Oct. — 21, Nov. — 11.

Seasonal dynamics of the maturation was observed in 4 helminths species. The sample of helminths observed was collected at random each month. The specimens of a particular species in a monthly sample were divided into several groups and the percentage of each group in the total number of worms in the sample was calculated.

The trematodes *B. luciopercae* were divided in to 5 groups (according to Skorping, 1981): group 1 — gonads undeveloped or testes only slightly developed (length of posterior testes 100 μm and less); group 2 — testes well developed, vitellaria undeveloped; group 3 — vitellaria well developed; group 4 — onset of egg production, the eggs do not reach the upper part of uterus above ovarium; group 5 — uterus containing eggs. A total of 577 spec. *B. luciopercae* were examined: Oct. 1981 — 36, Nov. — 8, Dec. — 19, Jan. 1982 — 84, Feb. — 75, March — 130, April — 43, May — 26, June — 9, July — 10, Aug. — 34, Sept. 41, Oct. — 38, Nov. — 24.

Several *P. percae* specimens from each monthly sample were stained and mounted in synthetic balsam (damara). The cestodes were divided into 4 groups (according to Wootten, 1974): group 1 — immature worms, body unsegmented, gonads absent; group 2 — maturing worms, body segmented, developing gonads; group 3 — mature worms, gonads fully developed; group 4 — mature worms with eggs in uterus. The quantitative evaluation of the presence of parasites in individual groups was not performed due to small numbers of cestodes in monthly samples.

C. lacustris found were divided into 6 groups: third-stage larvae, fourth-stage larvae, males females without eggs, females containing eggs and females containing larvae. A total of 773 nematodes were investigated: Oct. 1981 — 72, Nov — 31, Dec. — 43, Jan. 1982 — 8, Feb. — 8, March — 33, April — 12, May —109, June — 54, July — 111, Aug. — 119, Sept. — 65, Oct. — 65, Nov. — 43.

A. lucii were divided into 3 groups: males, females without eggs and females containing eggs. A total of 632 worms were examined: Oct. 1981 — 18, Nov. — 14, Dec. — 5, Jan. 1982 — 19, Feb. — 48, March — 71, April — 69, May — 59, June — 47, July — 121, Aug. — 74, Sept. — 28, Oct. — 36, Nov. 23.

Monthly percentages of specimens found in the digestive tract parts examined (stomach, pyloric region, anterior, middle and posterior part of gut) were calculated based on a total number of specimens of individual species found in the monthly sample.

RESULTS

Bunodera luciopercae

Seasonal Dynamics of Occurrence

A total of 5834 *B. luciopercae* were found in 214 perch (prevalence 57.7 %, mean intensity 27 spec./fish). The intensity of infection ranged from 1 to 324 spec. The parasites were found throughout the year (Fig. 1). The prevalence reached the maximum in Nov. (1981 — 80.8 %, 1982 — 89.5 %) and early spring (Feb. — 83.3 %, March — 89.5 %). The mean intensity values fluctuated analogically, reaching the peak in autumn (Oct. 1981 — 50 spec./fish, Oct. 1982 — 69). The number of parasites in the hosts sharply reduced in winter and spring, reaching the minimum in June when only 9 trematodes were found in 5 fish (Fig. 1). Similar results were obtained in fish 9—15.5 cm long in which the decrease in the prevalence at the end of spring, reaching the minimum values in May, and a gradual decrease in the mean intensity values in winter and spring were observed (Fig. 1).

Seasonal Cycle of Maturation

Conspicuous seasonal changes were observed in maturation of *B. luciopercae* — none of groups examined appeared longer than 6 months (Fig. 3). Group 1 specimens were found only from June to Aug., group 2 specimens appeared in July and were present in the sample until Nov. The trematodes with fully developed vitellaria without eggs (group 3) were found from Nov. to April,

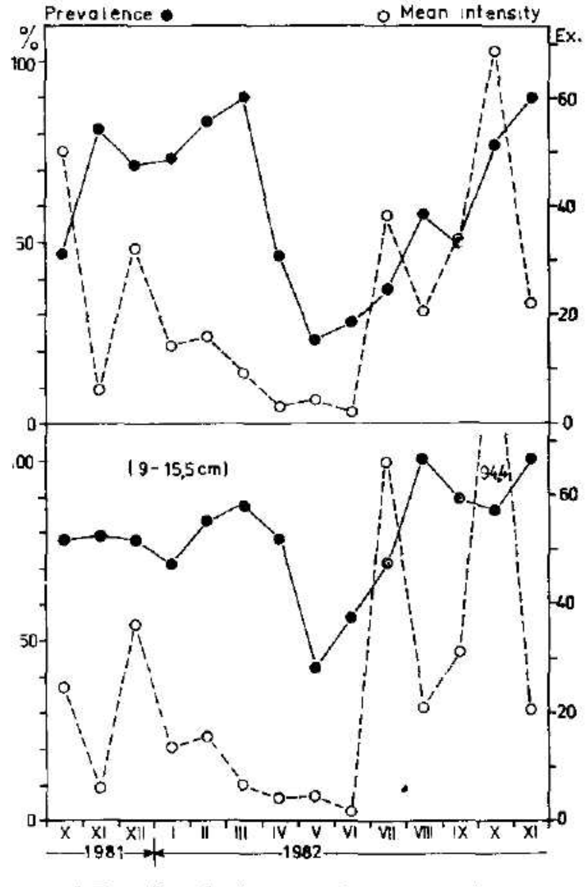

Fig. 1. Occurrence of *Bunodera luciopercae* throughout the year.

The first parasites containing eggs in uterus (group 4) were found in Jan. but they did not represent a significant part until Feb. Group 5 specimens were found for the first time in Feb. and appeared together with group 4 until May when the last trematodes of an old generation left their hosts (Fig. 3). Body length of the trematodes increased together with the development of gonads (Fig. 4) and reached the maximum in April. New B. *luciopercae* infections in perch occurred in the observed locality from June to Aug. (i. e., months with the highest temperature of water — Fig. 5). The trematodes matured during the winter months and left their hosts in spring, after maturation of eggs.

Dependence of Infestation on the Size of Perch

B. luciopercae were found in fish of all size groups (Fig. 6). The prevalence increased with the host's size and reached the maximum in groups 4 and 5 (87.2 % and 85.7 %, respectively). However, the mean intensity was the highest (43 spec./fish) in perch of size group 3 (length 12.5—15.5 cm), while the largest

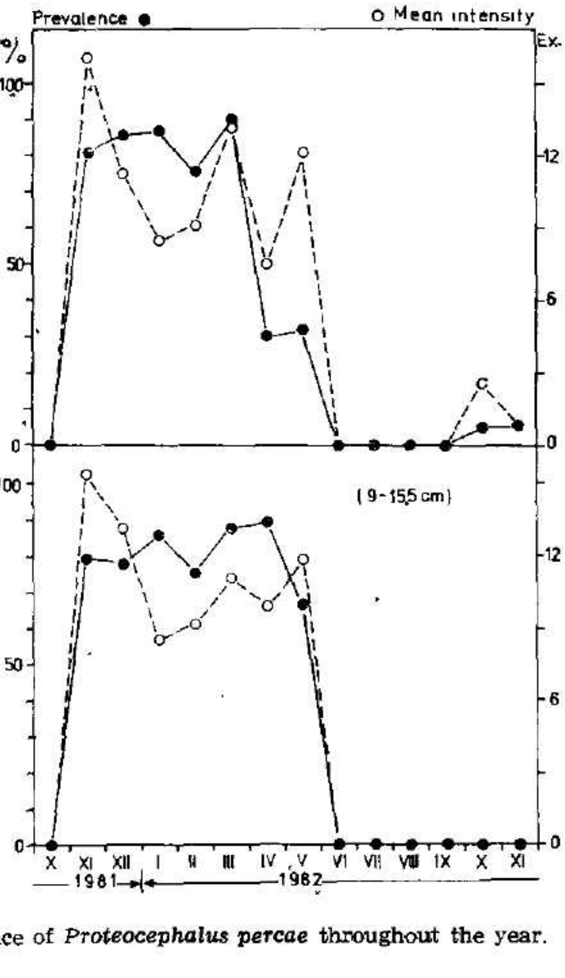

Fig. 2. Occurrence of *Proteocephalus percae* throughout the year.

fish were infected by much smaller numbers of trematodes (Fig. 6). *B. luciopercae* was found also in the smallest perch (length 5.5 cm).

Seasonal Changes in the Location of Parasites

The trematodes were noted in all parts of the digestive tract. 111 spec. (1.9 %) *B. luciopercae* were found in the stomach, 2947 spec. (50.5 %) in pyloric region, 913 spec. (15.7 %) in anterior, 809 spec. (13.9 %) in middle and 1054 spec (18.1 %) in posterior part of gut. The location of the parasites considerably changed during the year (Fig. 9). In June and July, the period of new infections, the trematodes inhabited the pyloric region (66.7 % and 91.0 %, respectively), or the anterior part of gut (33.3 % and 9.0 %, respectively). In contrast

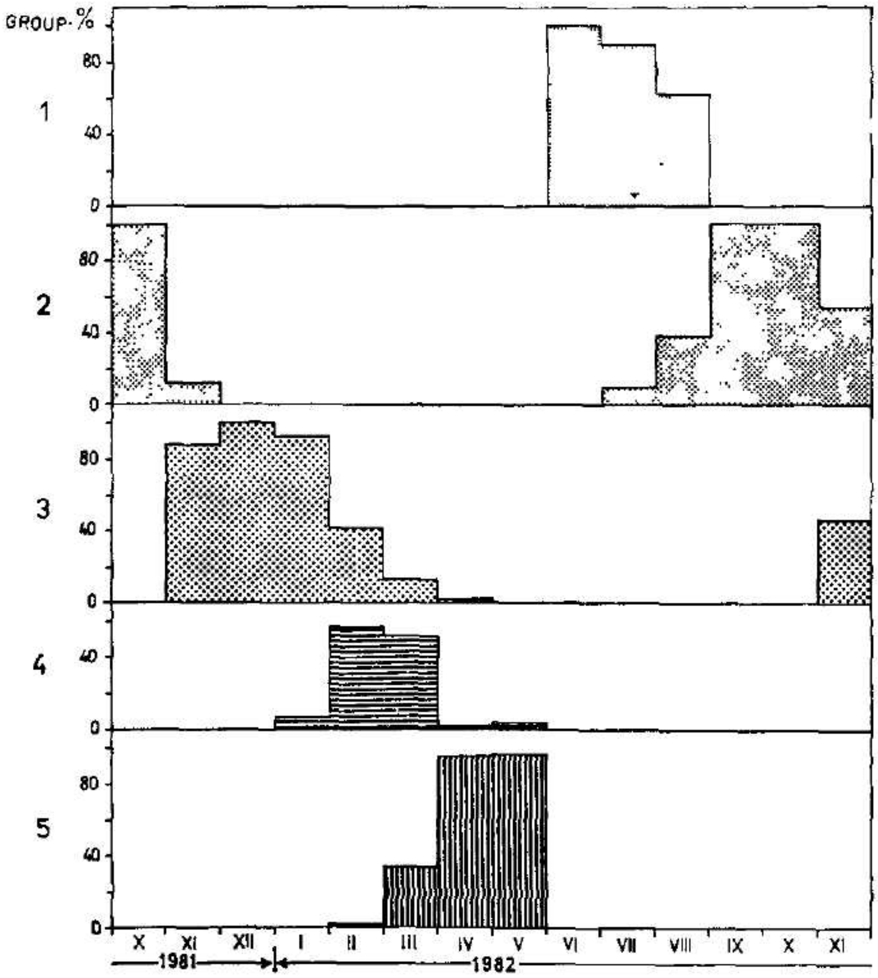

Fig. 3. Monthly changes in the state of maturation of *Bunodera luciopercae* in perch The data are expressed as percentages of the total number of trematodes examined in individual months.

much higher numbers of parasites were noted in the middle and posterior parts of the gut in spring when trematodes containing eggs left their hosts (Fig. 9). Changes in the location of *B. luciopercae* provide evidence of its seasonal shifting in the host's intestine during the year.

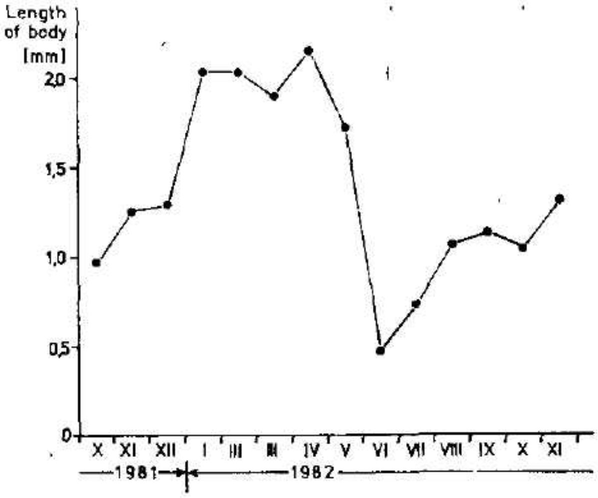

Fig. 4. Seasonal variation in body length of *B. luciopercae.*

Bothriocephalus claviceps, larvae

All cestodes found in perch were only juvenile specimens (stage "caudate" or "acaudate bothrio-plerocercoids" according to Freeman, 1973). One of two species of the genus *Bothriocephalus* from Czechoslovakia — *B. claviceps* — was found in eels *(Anguilla anguilla)* in the same locality (Moravec, 1978). Its juvenile stages are similar in morphology to the larvae from perch. Also

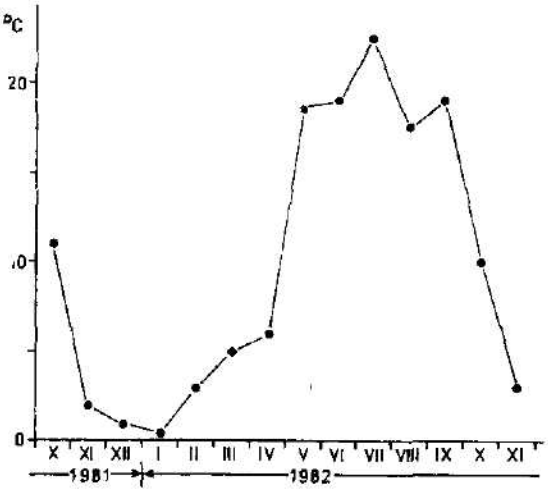

Fig. 5. Temperature of water in the Břehyně Brook in individual months.

B. claviceps procercoids from copepods described by Jarecka (1964) resemble those found in perch from the Břehyně Brook. In addition, the shape of scolex in juvenile *B. acheilognathi* (= *B. gowkongensis*) parasitizing in carps in some localities in Czechoslovakia differs from that of *B. claviceps*.

Seasonal Dynamics of Occurrence

A total of 762 juvenile *B. claviceps* were found in 39 perch (prevalence 10.5%, mean intensity 20 spec./fish). Intensity of infection ranged from 1 to 189 cestodes. The cestodes were noted only from June to Oct. (Fig. 7). The degree of infestation in perch was the highest in July when the mean intensity reached the maximum (27 spec./fish). The prevalence has the highest (37.5 %) in Aug. but the mean intensity sharply decreased in that month in comparison with preceeding period. The degree of infestation in perch was very low from Sept. to Oct. (Fig. 7).

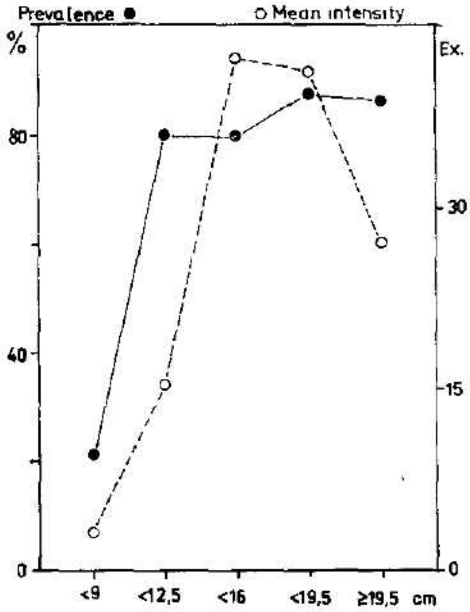

Fig. 6. **Relationship** of the prevalence and the mean intensity **to body length of perch:** ***Bunodera luciopercae.***

Dependence of Infestation on the Size of Perch

B. claviceps larvae were found in perch of all size groups (Fig. 8 A). The prevalence and the mean intensity reached the maximum in fish of group 3 (length 12.5—15.5 cm) while the remaining groups were less infected. Very weak infections were observed in group 1 (length 8.5 cm and less).

Seasonal Changes in the Location of Parasites

B. claviceps larvae were found in all parts of the digestive tract examined (Fig. 10 C). Six *B. claviceps* specimens were found in the stomach (0.08 %), 546 spec. (71.7 %) in pyloric region ,185 spec. (24.3 %) in anterior, 7 spec. (0.9 %) in middle and 18 spec. (2.4 %) in posterior part of gut. The parasite inhabited primarly the pyloric region, however, the proportion of worms detected at that site gradually decreased from July together with the increasing numbers of *B. claviceps* in the gut (Fig. 10 C).

Proteocephalus percae

Seasonal Dynamics of Occurrence

A total of 1101 *P. percae* were found in 97 perch (prevalence 26.2 %, mean intensity 11 spec./fish). The intensity of infection ranged from 1 to 64 cestodes. The cestodes were found only from Nov. to May and from Oct. of the following year (Fig. 2). The prevalence increased from Nov., reaching the maximum (89.5 %) in March. Thereafter, the prevalence sharply decreased and in June the parasites left their hosts. New infection were observed in Oct. The mean intensity values maintained a high level during the entire course of infection in perch (7–16 spec./fish) and reached the peak in Nov. (Fig. 2). New infections were weaker in Oct. and Nov. 1982 than in autumn 1981. Similar results have been obtained by examining perch 9–15.5 cm long (Fig. 2). The prevalence

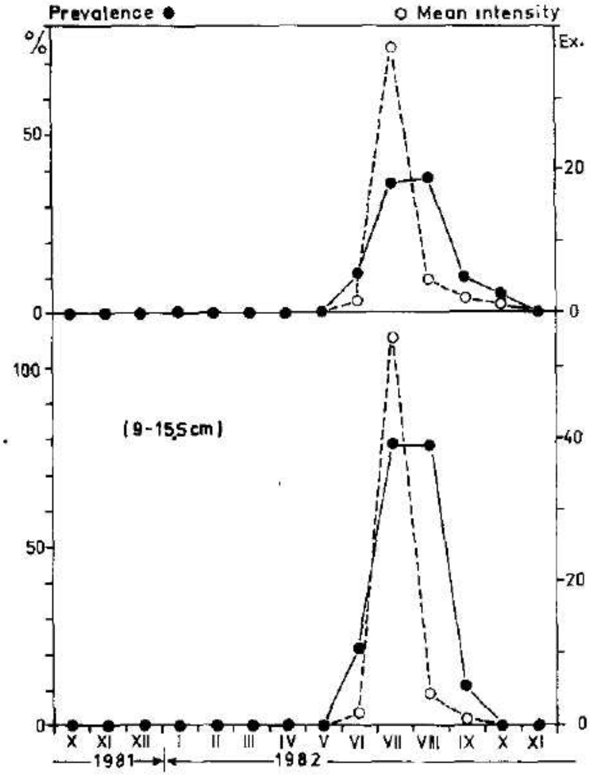

Fig. 7. Occurrence of *Bothriocephalus claviceps* throughout the year.

was high (above 65 %) until May. The mean intensity values ranged less in individual months than in a total sample of fish.

Seasonal Cycle of Maturation

Cestodes in the groups examined showed a distinct seasonal cycle of maturation. Immature worms (group 1) were found from Nov. to Jan., group 2 parasites were noted from Nov. to Feb. Mature cestodes (group 3) occurred from Jan. to March. The first cestodes containing eggs (group 4) were found in April The parasites disappeared from perch in May. New infections of fish were observed in autumn and in winter (from Oct. to Jan., primarly in Nov.).

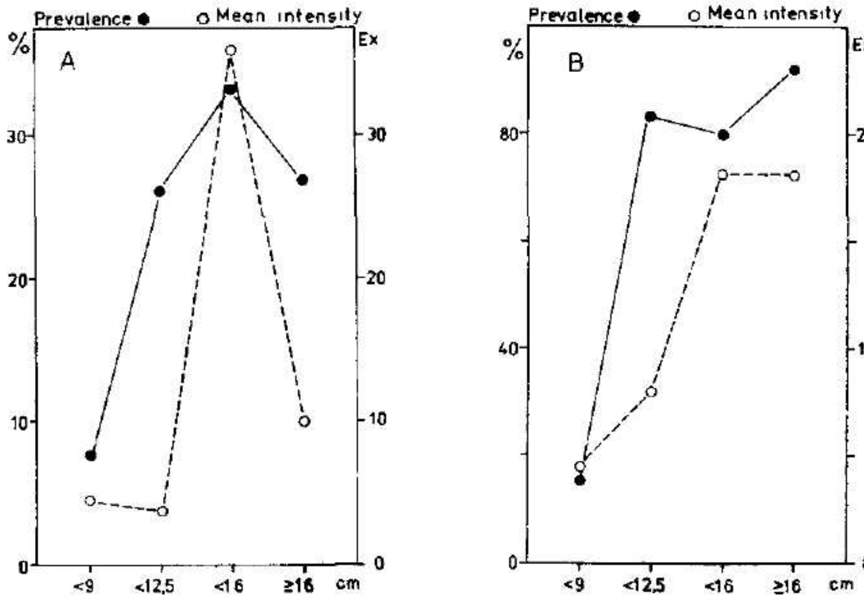

Fig. 8. Relationship of the prevalence and the mean intensity to body length of perch *Bothriocephalus claviceps* (A), *Proteocephalus percae* (B).

Dependence of Infestation on the Size of Perch

The cestodes were found in fish of all size groups and even the smallest perch (length 5.5 cm) were infected. The prevalence and the mean intensity values increased substantialy with the size of perch, reaching the maximum (92.3 % and 18 spec./fish, respectively)in groups 4 and 5 (Fig. 8 B). The degree of infestation in fish above 8.5 cm was high (prevalence 80 % and more), whereas only weak infections were observed in the smallest perch.

Seasonal Changes in the Location of Parasites

The cestodes P. *percae* were found in all parts of the digestive tract examined 55 spec. (5.0 %) P. *percae* were found in the stomach, 401 spec. (36.4 %) in pyloric region, 509 spec. (46.2 %) in anterior, 89 spec. (8.1 %) in middle and

47 spec. (4.3 %) in posterior part of gut. The location of parasites showed distinct seasonal changes (Fig. 10 B). Most cestodes (53.6 %) were found in the pyloric region in Nov. (the period of the highest numbers of new infections), whereas primarily anterior parts of gut of perch were affected in the subsequent months until April. However, in May (the months when parasites left the hosts), more than a half of *P. percae* specimens occurred in the middle and posterior parts of the gut (Fig. 10 B).

Camallanus lacustris

Seasonal dynamics of Occurrence

A total of 2024 *C. lacustris* were found in 219 perch (prevalence 59.0 %, mean intensity 9 spec./fish). The intensity of infection ranged from 1 to 72 parasites. The lowest prevalence values were noted in spring. A more or less regular

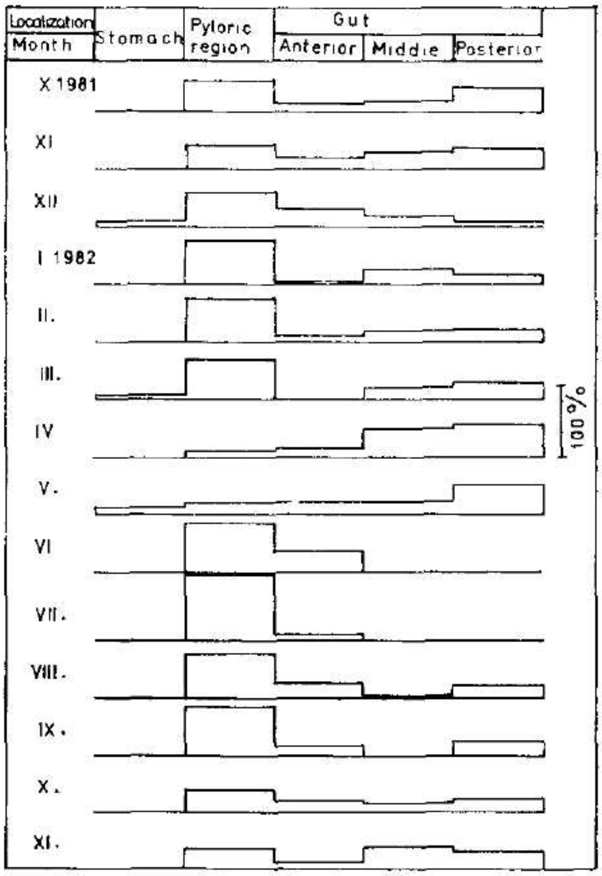

Fig. 9. Seasonal changes in the percentage distribution of *Bunodera luciopercae* in the gastrointestinal tract of perch.

increase in the prevalence values was observed from summer until Nov., reaching the peak in Dec. (85.7 %). The lowest mean intensity values were reached at the end of winter and in spring, with the minimum in April (Fig. 11). The highest mean intensity was observed for May to Aug. (17 spec./fish). The lowest prevalence values in spring were more conspicuous in a sample of perch 9 – 15.5 cm long than in the total sample (Fig. 11). The mean intensity decreased sharply in these size groups from Oct. 1981 until April (excluding Dec.). Thereafter, a gradual increase in the mean intensity values followed until the maximum was reached in Aug. (Fig. 11).

Seasonal Cycle of Maturation

Males and the fourth-stage larvae were recorded throughout the year (Fig. 13). Females without eggs, females containing eggs and females containing larvae were absent in Feb., Jan. and April, respectively (Fig. 13). The third-stage larvae were rare, occurring only in April, May, July, Oct. and Nov. The percentage of individual groups in the sample changed throughout the year

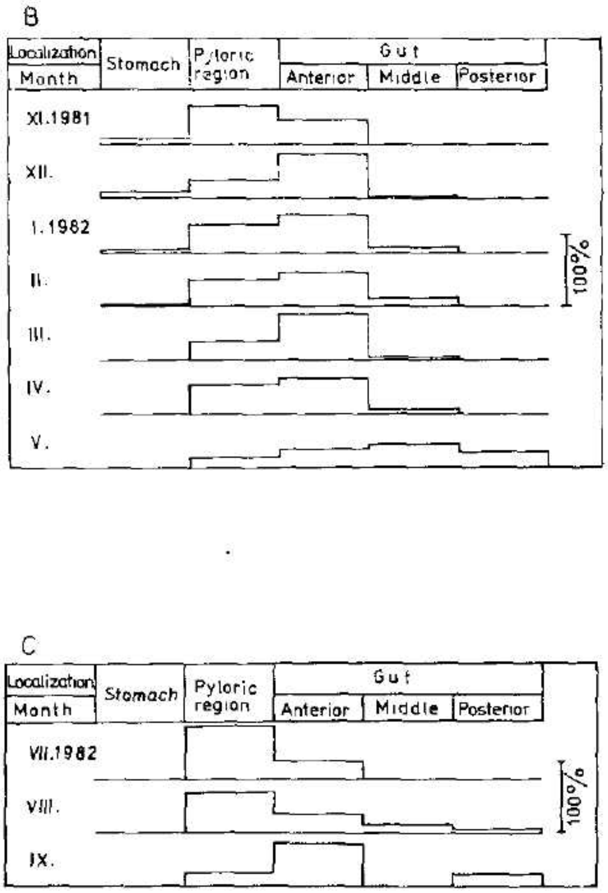

Fig. 10. Seasonal changes in the percentage distribution of *Proteocephalus percae* (B) and *Bothriocephalus claviceps* (C) in the gastrointestinal tract of perch.

however, these changes did not indicate an expressive seasonal cycle of maturation of C. *lacustris* (Fig. 13). New C. *lacustris* infections in perch were likely to occur throughout the year in the locality studied.

Dependence of Infestation on the Size of Perch

The nematodes occurred in fish of all size groups examined (Fig. 14 B). The degree of infestation was much higher in large perch than in smaller fish. All perch 16 cm long and more (groups 4 and 5) were infected, the mean intensity reaching 20 spec./fish and more (Fig. 14 B).

Seasonal Changes in the Location of Parasites

Nematodes were found in all parts of the digestive tract examined. Forty-four C. *lacustris* specimens (2.2 %) were noted in the stomach, 1390 spec. (68.7 %) in pyloric region, 449 spec. (22.9 %) in anterior, 109 spec. (5.4 %) in middle and 32 (1.6 %) in posterior part of gut. The majority of C. *lacustris* specimens were found in the pyloric region throughout year (Fig. 16). The parasites was frequently found also in the anterior parts of the gut in all monthly

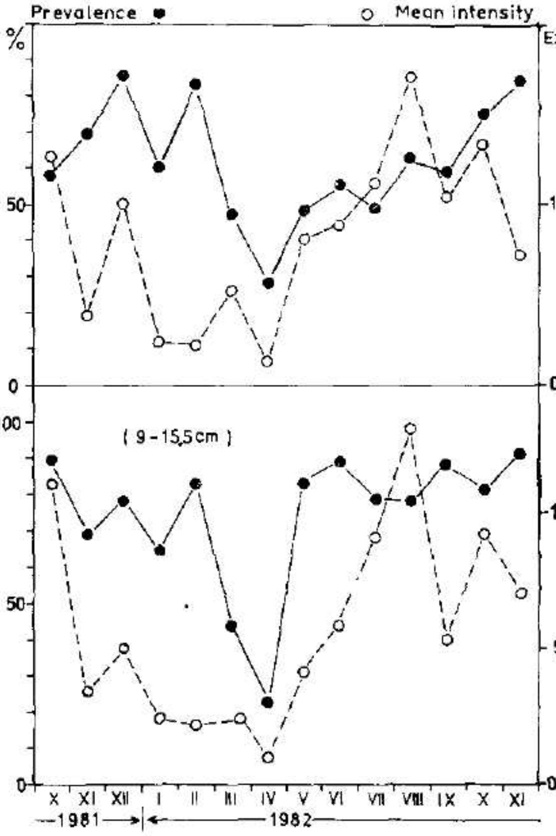

Fig. 11. Occurrence of *Camallanus lacustris* throughout the year.

samples excluding May and Oct. 1982. Marked seasonal changes in the location of nematodes in the intestine of perch were not revealed (Fig. 16).

Acanthocephalus lucii

Seasonal Dynamics of Occurrence

A total of 1413 acanthocephalans were found in 206 perch (prevalence 55.5 %, mean intensity 7 spec./fish). The intensity of infection ranged from 1 to 159 spec. The acanthocephalans were detected in all monthly samples. The highest prevalence values were observed in winter, early spring (84.2 %) and summer (83.3 %), the mean intensity reached the peak in summer (18 spec./fish) (Fig. 12). The prevalence and the mean intensity were the lowest in May and in the winter months, respectively. The lowest prevalence in May was not observed in perch 9–15.5 cm long and in contrast with the total sample of fish, it was the highest in July and Aug. (Fig. 12). The highest mean intensity values recorded in July were due to a heavy infection in one perch examined (159 spec.).

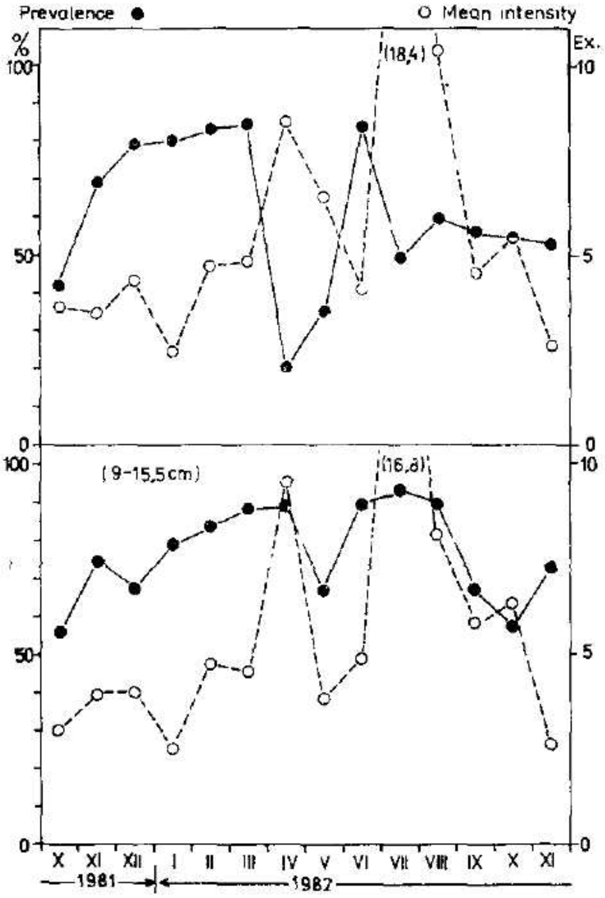

Fig. 12. Occurrence of *Acanthocephalus lucii* throughout the year.

Seasonal Cycle of Maturation

Males and females containing eggs were found throughout the year. Females without eggs were absent in Oct. 1981, Dec. and Aug. (Fig. 15). The maturation of the acanthocephalan *A. lucii* did not indicate expressive seasonal cycle in the locality observed, however, the numbers of females in individual monthly samples fluctuated, reaching the peak in spring (females without eggs), at the end of summer and in early autumn (females containing eggs) (Fig. 15). Great fluctuations in the numbers of males in monthly samples were not recorded.

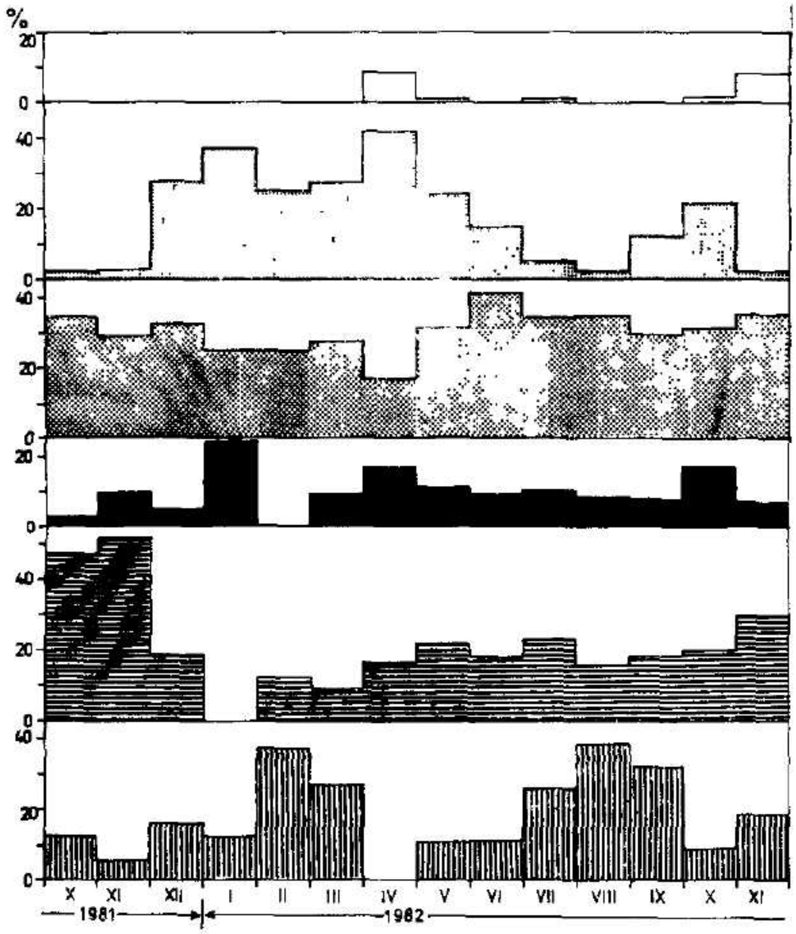

Fig. 13. Monthly changes in the state of maturation of *Camallanus lacustris*. The data are expressed as percentages of the total number of nematodes examined in individual months: third-stage larvae (unsheaded), fourth-stages larvae (longitudinally stippled), males (obliquely stippled), females without eggs (blackened), females containing eggs (longitudinally hatched), females containing larvae (perpendicularly hatched).

Dependence of Infestation on the Size of Perch

The parasites occurred in perch of all size groups (Fig. 14 A). The prevalence and the mean intensity values markedly increased with the host's size, reaching the maximum in size groups 4 and 5 (89.7 % and 24 spec./fish, respectively) (Fig. 14 A).

Seasonal Changes in the Location of Parasites

The acanthocephalans were noted *in all parts of the digestive* tract examined. In stomach, 7 spec. (0.5 %) *A. lucii* were found, 21 spec. (1.5 %) in the pyloric region, 445 (31.5 %) in the anterior, 729 spec. (51.6 %) in the middle and 211 spec. (14.9 %) in the posterior part of the gut. Therefore, the gut is probably *preferred as the site of the parasite's location*. The findings of *A. lucii* in stomach and in the pyloric region were probably incidental. The numbers of worms in individual parts of the digestive tract slightly differed during the year but seasonal shift in the location of parasites was not indicated (Fig. 17)

DISCUSSION

Small numbers of the five helminth species were found *in the stomach* of perch in addition to intestine. It is probably an atypic location of these helminths as they are regarded as intestinal parasites of their hosts. These findings are probably incidental and, as the case may be, the infections are secondary (the parasites reached the *stomach after the* death of the hosts).

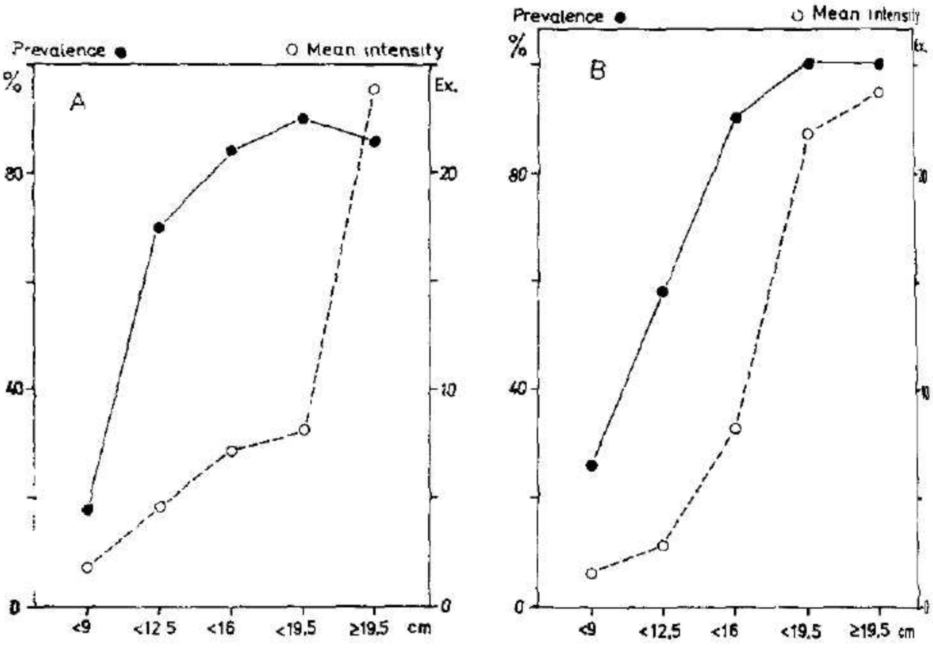

Fig. 14. *Relationship of the* prevalence and the mean intensity to the body length of perch: ***Acanthocephalus lucii*** (A), ***Camallanus lacustris*** (B).

Four of five helminth species examined are common parasites of perch and have been reported from other localities (Wierzbicki, 1970; Rauckis 1977; etc.). The remaining species- the cestode *Bothriocephalus claviceps* — is a specific parasite of eel *(Anguilla anguilla)*. However, Kennedy (1974) reported pike *(Esox lucius)* and three-spined stickleback *(Gasterosteus aculeatus)* to serve as its definitive hosts. The data on the occurrence of this cestode in perch are still lacking. Mishra and Chubb (1969) were the only authors to find the juvenile cestodes identified as *Bothriocephalus* sp. in perch from the Shropshire Union Canal, Great Britain. Andrews (1979) reported on the presence the larvae of the cestode identidied as *Bothriocephalus sp.* or *Eubothrium* sp. in perch from Llyn Tegid, Wales. Small size of the cestodes in perch from the Břehyně Brook (body length 0.49—5.51 mm, maximum width 0.20—0.38 mm) indicate their growth retardation or weak development in the hosts. Therefore perch serves probably as a paratenic host in the locality studied. Similarly, Jarecka (1959) did not recorded growth of the larvae in carp fry experimentally infected with copepods containing *B. claviceps* procercoids. Although the cestodes were found in perch from the Břehyně Brook during 5 months, the longevity of parasites in the gut of the host was probably much shorter. This is indicated by a very low mean intensity in individual months (excluding July).

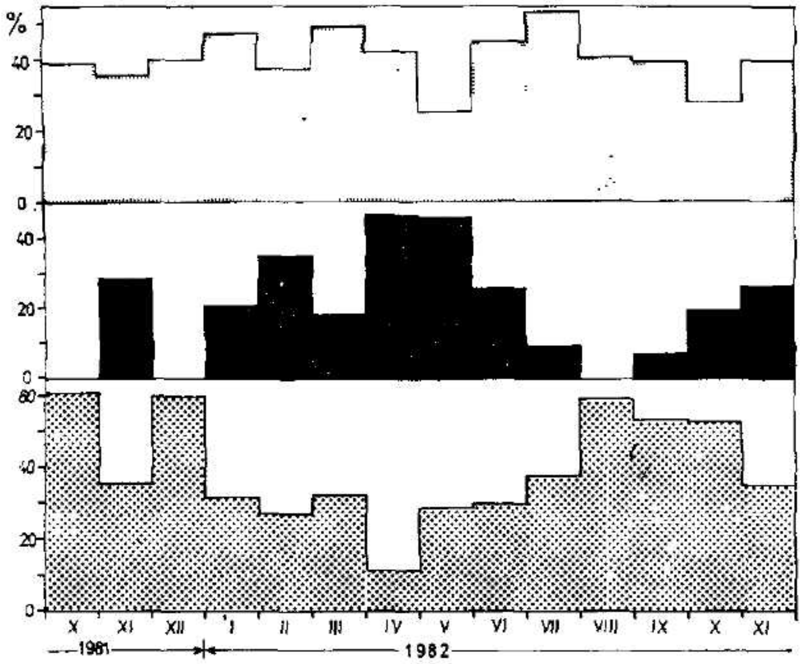

Fig. 15. Monthly changes in the state of maturation of *Acanthocephalus lucii* in perch. The data are expressed as percentages of the total number of acanthocephalans examined in individual months: males (longitudinally stippled), females without eggs (blackened) and females containing eggs (obliquely stippled).

A marked seasonal cycle of occurrence and maturation of *Bunodera luciopercae* and *Perca percae* and seasonal changes in the location of these parasites in the intestine of perch were noted. New *B. lucioperca*e and *P. percae* infections in perch occurred in summer and autumn, respectively. Parasites containing eggs left their hosts in spring. Many authors (see Chubb, 1979, 1982) described a similar seasonal cycle of the two helminths in other localities However, different periods of new infections, egg appearance and the period of absence of helminths in the hosts were reported. Some other authors found the parasites in perch throughout the year (Wierzbicki, 1970; Wootten, 1974; Andersen, 1978, etc.), recording a marked seasonal cycle of maturation in *B. lucioperca*e and *P. percae*. These differences are probably due to different ecological conditions, mainly temperature of water, in the localities studied. The results of Cannon (1972), Anikieva (1983) and others demonstrated that temperature of water affects the seasonal cycles of occurrence and maturation of many helminths in freshwater fish.

Conspicuous seasonal cycles of occurrence and maturation of *C. lacustris* and *A. lucii* in perch from the locality studied were not found; however, the degree

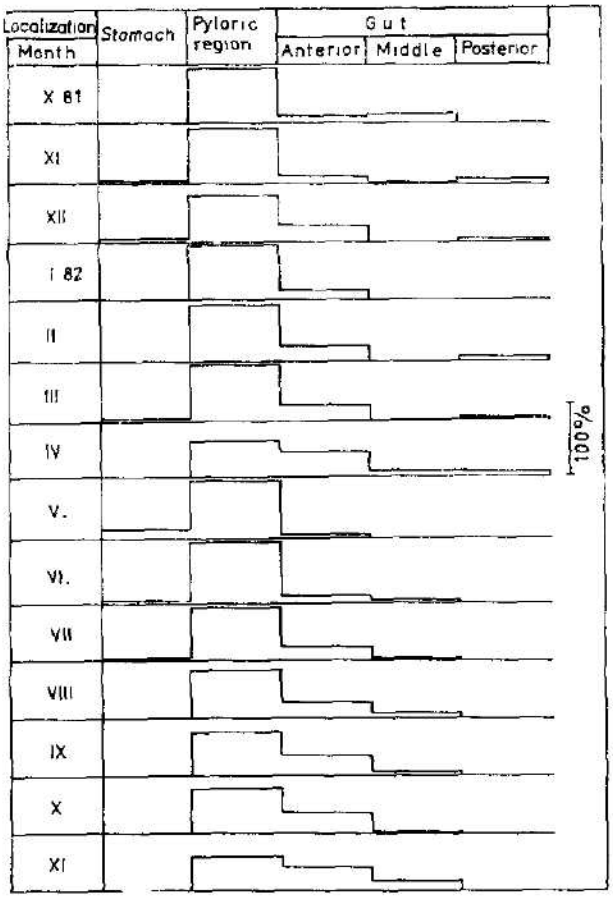

Fig. 16. Seasonal changes in the percentage distribution of *Camallanus lacustris* in the gastrointestinal tract of perch.

of infestation changed markedly throughout the year. *C. lacustris* occurred in perch in each monthly samples. The highest prevalence and mean intensity values were noted in summer and in early autumn. Seasonal pattern of occurrence found in the locality studied resembles that described by Andersen (1978) and Skorping (1980) in Norway. However, the period of the lowest infections in perch reported by them was shifted to the end of spring and early summer. Other authors (see Chubb, 1982) demonstrated a year-round occurrence of *C. lacustris* in perch. The seasonality of maturation of *C. lacustris* was studied by many authors (Wierzbicki, 1970; Andrews, 1977 ex Chubb, 1979; Andersen, 1978; Skorping, 1980, etc.). They assume this parasite not to have the expressive seasonal cycle of maturation. However, Törnquist (1931) described a specific cycle of maturation of this nematode in perch from Sweden with new infections occurring in summer and early autumn. According to this author, the females containing larvae left their hosts in May and June. *A. lucii* was found in perch from the Břehyně Brook throug-

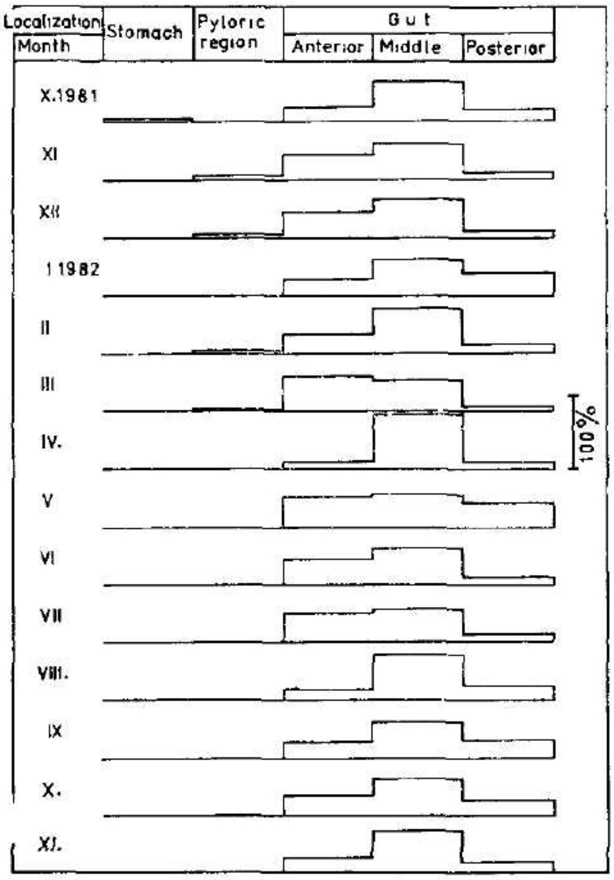

Fig. 17. Seasonal changes in the percentage distribution of *Acanthocephalus lucii* in the gastrointestinal tract of perch.

out the year. The degree of infestation fluctuated throughout the year, with the highest prevalence and the mean intensity values in early spring and summer, and in summer months, respectively. Most authors studying the occurrence of the parasites in perch found the acanthocephalans throughout the year, with the highest prevalence in summer; however, a marked seasonal cycle of *A. lucii* maturation was not recorded (Izjumova, 1958; Malachova, 1961; Wierzbicki, 1970; Andersen, 1978, etc.). On the other hand, Komarova (1950) described a distinct seasonality of occurrence and maturation of *A. lucii* in perch from the Dněpr (the period of new infections in autumn, the maturation of parasites in summer, after the release of eggs).

The degree of infestation markedly differed in perch of all size groups from the Břehyně Brook and reached the maximum in middle size fish (*B. claviceps*), middle and large size fish (*B. luciopercae*) and in large fish (*P. percae*, *C lacustris* and *A. lucii*). That was probably due to the quantity and composition of food of perch. The quantity of food (intermediate hosts of helminths included) increased with the growth of fish and thus the probability of the infection increased.in larger fish. Composition of food of fish changed with the incerasing size — the portizon of plankton in the diet sharply increased in middle size perch. According to McCormack (1970), plankton represented more than 40 % of food of perch 11.5—18.4 cm long. On the other hand, plankton constituted less than 20 % in small (9.0—11.4 cm) and large 18.5 cm fish and more. As plankton crustaceans (excluding *A. lucii*) serve as the intermediate hosts of intestinal helminths studied, heavy infections in size groups 3 and 4 (length 12—19.5 cm) could be explained by an increased consumption of plankton. However, the portion of plankton in the diet of the largest perch decreased with increasing numbers of fish ingested (McCormack, 1970; Cannon, 1973, etc.). A very high degree of infestation in large fish, mainly with *C. lacustris* and *A. lucii*, is probably due to secondary infections. This way of transmission of helminths from one fish to another has already been confirmed experimentally in several species (in *C. lacustris* — Moravec, 1969; *P. percae* — Priemer, 1980, etc.).

Great differences in the degree of infestation in perch of different size or age were reported by many authors (Cannon, 1972; Wootten, 1973; Kennedy and Burrough, 1978). However, somewhat less conspicuous or no differences have been reported by other authors (Andersen, 1978; Skorping, 1980; Lee, 1981). That may be due to different ecological conditions in the locality under study, mainly the differences in the composition and quantity of food of perch.

Seasonal changes in the location of parasites in the digestive tract of perch from the Břehyně Brook were noted in *B. luciopercae*, *B. claviceps* and *P. percae*. It corresponds with the seasonal cycle of occurrence and maturation of these helminths. Higher numbers of worms are supposed to occur in the anterior parts of the digestive tract of perch (pyloric region, anterior part of gut), particularly in the period of new infections of fish after the ingestion of the infected intermediate hosts. Higher numbers of specimens are likely to occur in the middle and posterior parts of gut, in the period when the parasites leave the hosts. Expressive seasonal changes in the location of the two remaining species — *C. lacustris* and *A. lucii* — were not found. On the other hand, Skorping (1980) described the seasonal changes in the location of *C. lacustris* in the gut of perch from a small oligotrophic lake in Norway, however, a distinct seasonal cycle of the occurrence and maturation of this nematode explaining such great shift in the parasite's location was not observed by the author.

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REFERENCES

Andersen, K., 1978: The helminths in the gut of perch (Perca fluviatilis L.) in a small oligotrophic lake in southern Norway. Z. Parasitenkd., 56: 17—27.

Andrews, C. R., 1979: Host specifity of the parasite fauna of perch Perca fluviatilis L. from British Isles, with special reference to a study at Llyn Tegid (Wales). *J. Fish Biol.*, 15: 195—209.

Anikieva, L. V., 1983: Dynamics of the number of Proteocephalus exiguus (Cestoidea: Proteocephalidae) in water reservoirs with different thermal regimes. 1st Intern. Symp. Ichthyoparasitol. "*Parasites and Parasitic Diseases of Fish*", 8—13, August 1983, České Budějovice. Abstracts of papers, p. 6.

Cannon, L. R. G., 1972: Studies on the ecology of the papillose Allocreadid trematodes of the yellow perch in Algonquin Park, Ontario. *Can. J. Zool.*, 50: 1231—1239.

Cannon, L. R. G., 1973: Diet and intestinal helminths in a population of perch, Perca flavescens. *J. Fish Biol.*, 5: 447—457.

Chubb, J. C, 1979: Seasonal occurrence of helminths in freshwater fishes. Part II. Trematoda. *Adv. Parasitol.*, 17: 141—313.

Chubb, J. C., 1982: Seasonal occurrence of helminths in freshwater fishes. Part IV. Adult Cestoda, Nematoda and Acanthocephala. *Adv. Parasitol.*, 20: 1—292.

Dyk, V., Lucký, Z., Valenta, Z., 1954: Příspěvek k rozlišení digenetických trematodů z rodu Bunodera a Crepidostomum, jejich výskyt, hostitelé i pathogenita. *Sborník VŠZ a lesnické fak. v Brně,* 225, 2—3: 105—115.

Freeman, R. S., 1973: Ontogeny of cestodes and its bearing on their phylogeny and systematics. *Adv. Parasitol.*, 11: 481—557.

Izjumova, N. A., 1958: Sezonnaja dinamika parazitofauny Rybinskogo vodochranilišča (lešč, čechoň, sudak, okuň). *Tr. biol. stancii "Borok"*, 3: 384—398.

Jarecka, L., 1959: On the life-cycle of Bothriocephalus claviceps (Goeze, 1782). *Acta parasitol. Pol.*, 7: 527—532.

Jarecka, L., 1964: Cycle évolutif a un seul hôte intérmédiare chez Bothriocephalus claviceps (Goeze, 1782) Cestode de Anguilla anguilla L. *Annal. Parasitol. Hum. Comp.*, 39: 149—156.

Kennedy, C. R., 1974: A checklist of British and Irish freshwater fish parasites with notes on their distribution. *J. Fish Biol.*, 6: 613—644.

Kennedy, C. R., Burrough, R. J., 1978: Parasites of trout and perch in Malham Tarn. *Field Stud.*, 4: 617—629.

Komarova, M. S., 1950: K voprosu o žizněnnom cikle skrebňa Acanthocephalus lucii Müll. *Dokl. Akad. nauk SSSR, ser. biol.*, 70: 359—360.

Lee, R. L. G., 1981: Ecology of Acanthocephalus lucii (Müller, 1776) in perch, Perca fluviatilis, in the Serpentine, London, UK. *J. Helminthol.*, 55: 149—154.

Lucký, Z., Navrátil, S., 1983: Invazní choroby okouna říčního (Perca fluviatilis) ve vodárenských nádržích povodí Moravy. Katedra chorob drůbeže, ryb, včel a lovné zvěře VŠV v Brně, ms.

Malachova, R. P., 1961: Sezonnyje izměněnija parazitofauny někotorych presnovodnych ryb ozer Karelii (Končezero). *Tr. Karel fil. Akad. nauk SSSR*, 30: 55—78.

Margolis, L., Esch, G. W., Holmes, J. C., Kuris, A. M., Schad, G. A, 1982: The use of ecological terms in parasitology (report of an HOC committee of the American Society of Parasitologists). *J. Parasitol.*, 68: 131—133.

McCormack, J. C., 1970: Observations on the food of perch (Perca fluviatilis L) in Windermere. *J. Animal. Ecol.*, 39: 255—267.

Mishra, T. N., Chubb, J. C., 1969: The parasite fauna of the fish of the Shropshire Union Canal, Cheshire. *J. Zool., Lond.*, 157: 213—224.

Moravec, F., 1969: On the problem of host specifity, reservoir parasitism and secondary invasions of Camallanus lacustris (Nematoda: Camallanidae). *Helminthologia*, 10: 107—114.

Moravec, F., 1978: Přehled endoparazitických červů zjištěných v rybách rybničního systému Máchova jezera. *Scripta Fac. Sci. Natur. UJEP Brunensis, biol.* 2, 8: 77—80

Moravec, F., 1979: Occurrence of the endoparasitic helminths in pike (Esox lucius L.) from the Mácha lake fishpond system. *Věst. čs. Společ. zool.*, 43: 174—193.

Priemer, J., 1979: Darmhelminthen von Perca fluviatilis L. und Acerina cernua (L.) (Pisces) aus Gewässern des Berliner Randgebietes. *Zool. Anz., Jena*, 203: 241—253.

Priemer, J., 1980: Vorkommen, Morphologie und Lebenszyklus einiger Fischbandwürmer der Gattung Proteocephalus (Proteocephalidea). Dissertation — Math.-Natur. Fak., Humboldt Univ., Berlin.

Rauckis, E. J., 1977: Sezonnaja zaraženosť okuňa parazitami v raznotipnych po termičeskomu režimu ozerach Objalija, Šlavantas a Galstas. *Tr. Akad. nauk Litev, SSR, ser. B*, 4: 63—73.

Scholz, T., 1984: Helmintofauna ryb Břehyňského potoka a Botiče. Dipl. práce — Přír. fak. Univ. Karlovy, Praha.

Scholz, T., 1987: On the occurrence of endoparasitic helminths in perch (Perca fluviatilis L.) from the Mácha Lake fishpond system, Czechoslovakia *Acta Univ. Carolinae — Biologica* 1985 (in press).

Skorping, A., 1980: Population biology of the nematode Camallanus lacustris in perch, Perca fluviatilis L., from an oligotrophic lake in Norway. *J. Fish Biol.*, 16 483—492.

Skorping, A., 1981: Seasonal dynamics in abundance, development and pattern of infection of Bunodera luciopercae (Müller) in perch, Perca fluviatilis L. from an oligotrophic lake in Norway. *J. Fish Biol.*, 18: 401—410.

Törnquist, N., 1931: Die Nematodenfamilien Cucullanidae und Camallanidae nebst weiteren Beiträgen zur Kenntnis der Anatomie und Histologie der Nematoden *Göteborg. Kungl. Vet. Vitterh. Samh. Handl. Ser.* B, 2: 441 pp.

Vejnar, F., 1956: Příspěvek k helmintofauně našich okounovitých ryb *Sbor. VŠZ a lesnické fak. v Brně, řada B*, 4: 161—176.

Vojtková, L., 1959: Příspěvek k poznání cizopasníků ryb řeky Svitavy a Svratky. *Publ. Fac. Sci. Univ. Brno*, 401: 97—123.

Wierzbicki, K., 1970: The parasite fauna of the perch, Perca fluviatilis L., of lake Dargin. *Acta Parasitol. Pol.*, 18: 45—55.

Wootten, R., 1973: Occurrence of Bunodera luciopercae (Digenea: Allocreadiidae) in Fish from Hanningfield Reservoir, Essex. *J. Helminthol.*, 47: 399—408.

Wootten, R., 1974: Studies on the life history and development of Proteocephalus percae (Müller) (Cestoda: Proteocephalidea). *J. Helminthol.*, 48: 269—281.

Author's address: Dr. T. Scholz, Institute of Parasitology, Czechoslovak Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czechoslovakia.

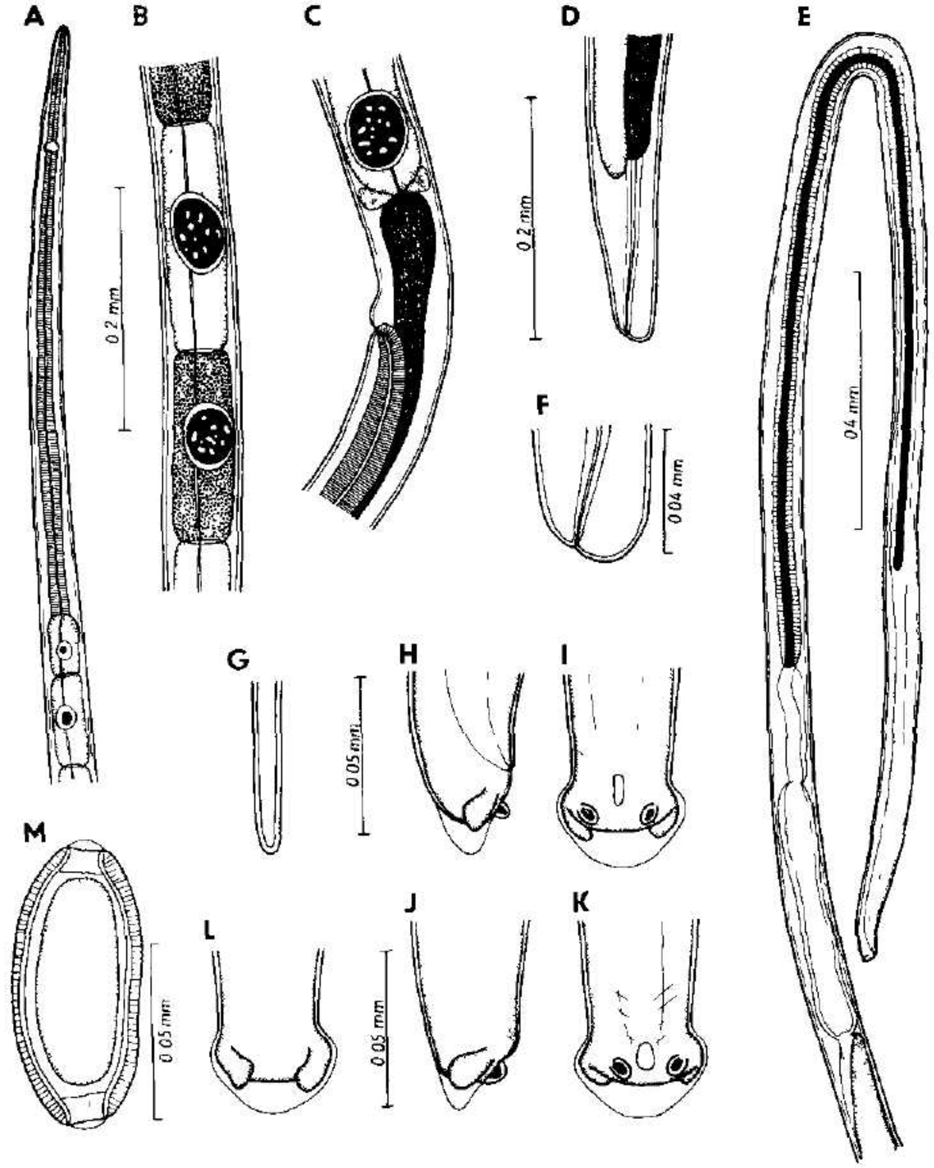

Fig. 1. *Paracapillaria (O.) sonsinoi* (Parona, 1897) from rectum of *Natrix maura* from France. A — head end; B — stichosome region; C — vulva region; D — posterior end of female; E—posterior end of male; F — tail of female; G — distal end of spicule; H–K — tail of male, lateral and ventral views; L — tail of male, dorsal view, M — mature egg

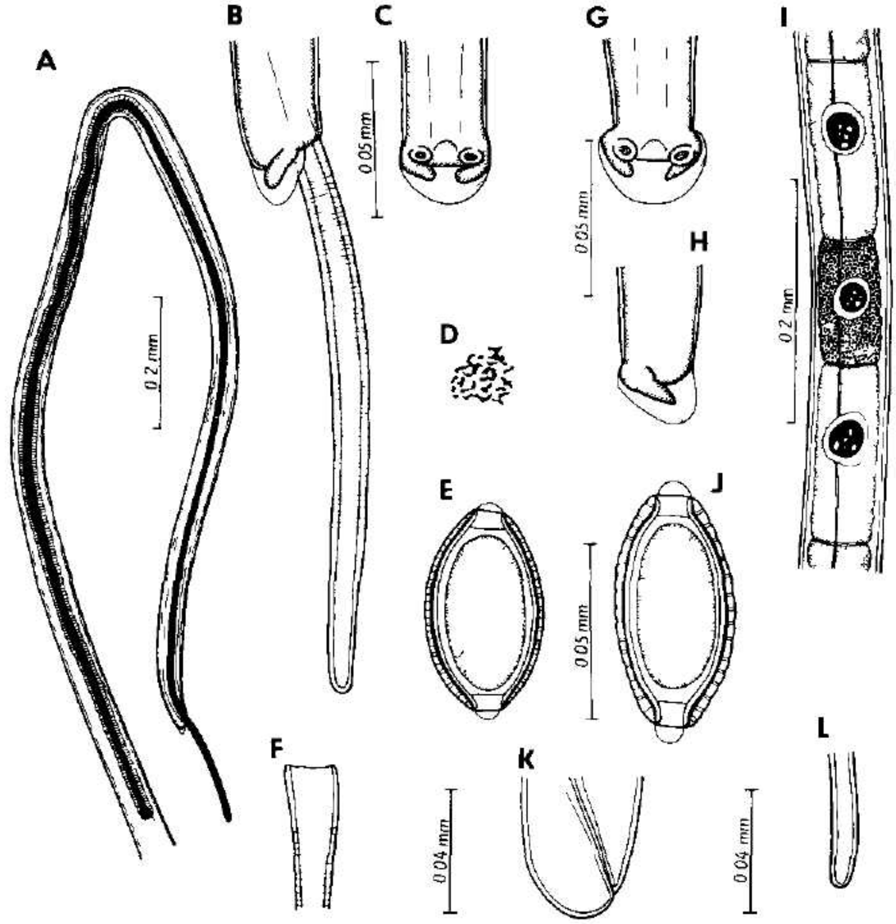

Fig 2 *Paracapillaria (O.) sonsinoi* (Parona, 1897) from North American snakes A — posterior end of male, B, C and G, H — tail of male, lateral and ventral views, D — sculpture on egg E, J — egg I — stichosome region F — proximal end of spicule K — tail of female, L — distal end of spicule (A—F — syntypes of "C. *heterodontis*" from *Heterodon contortrix*, G—L — paratypes of "C. *colubri*" from *Coluber constrictor priapus*).

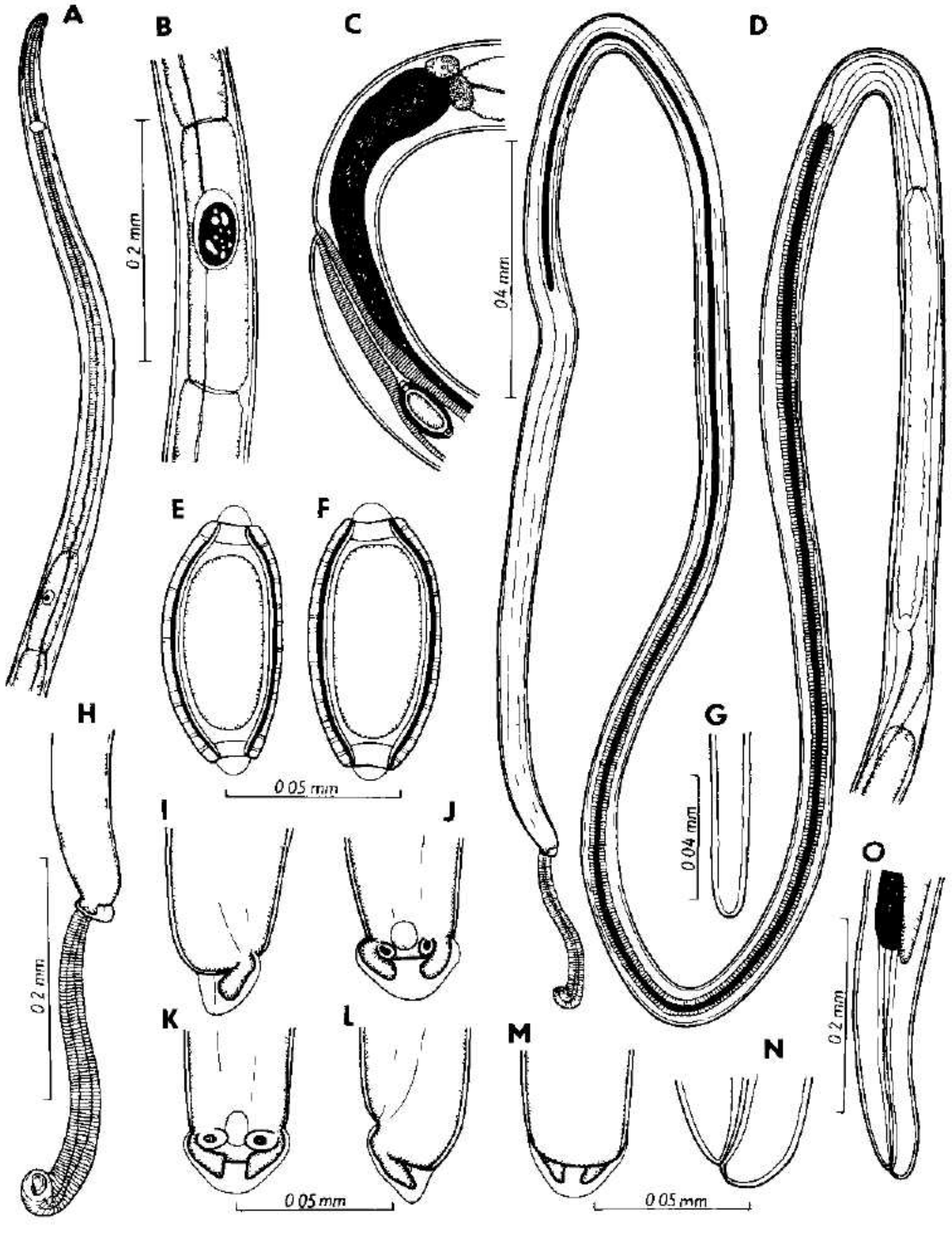

Fig. 3. ***Paracapillaria (O.) sonsinoi*** (Parona, 1897) from urinary bladder of ***Natrix rhombifera*** from USA. A — head end. B — stichosome region, C — vulva region. D — posterior end of male, E, F — mature egg; G — distal end of spicule. H — posterior end of male, I—L — tail of male, lateral and ventral views, M — tail of male, dorsal view, N — tail of female. O — posterior end of female

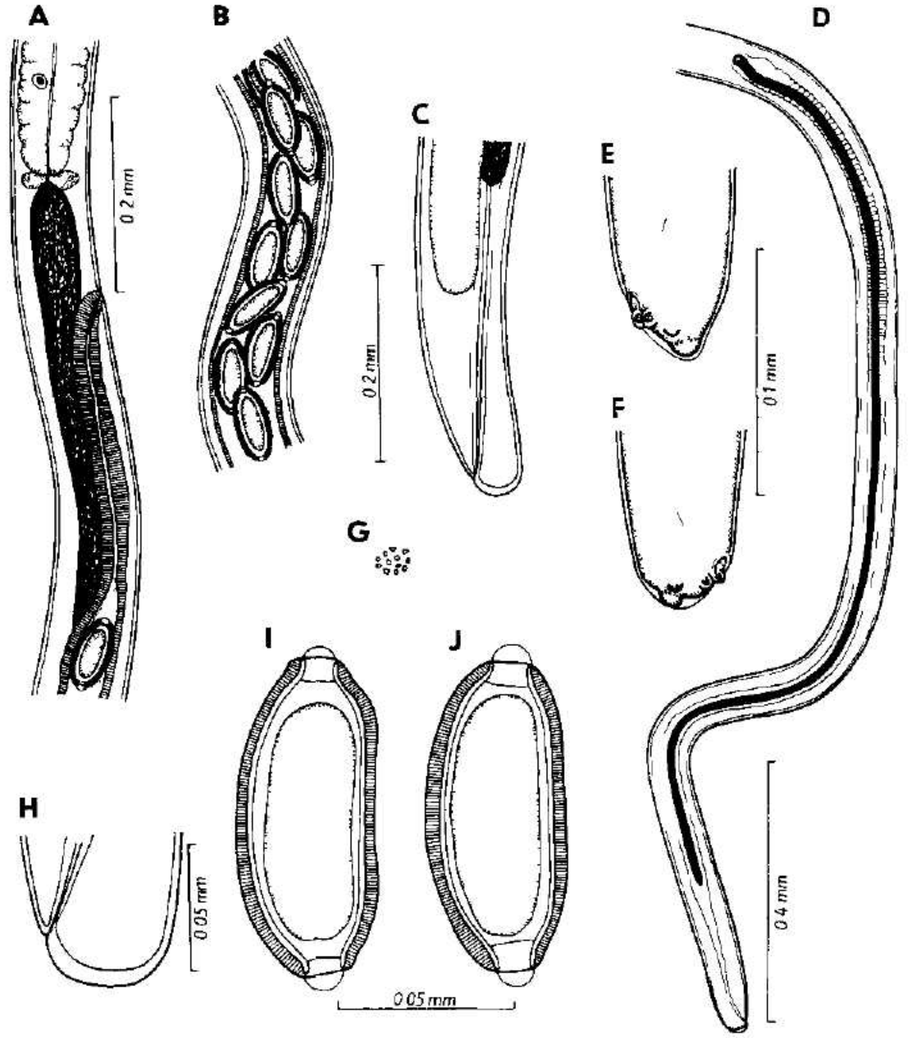

Fig. 4. *Paracapillaria (O.) congolensis* sp. n. from *Grayia ornata* from Zaire. A — vulva region, B — uterus region, C — posterior end of **female**, D — posterior end of male, E, F — tail of male, lateral views, G — sculpture on egg, H — tail of female, I, J — egg

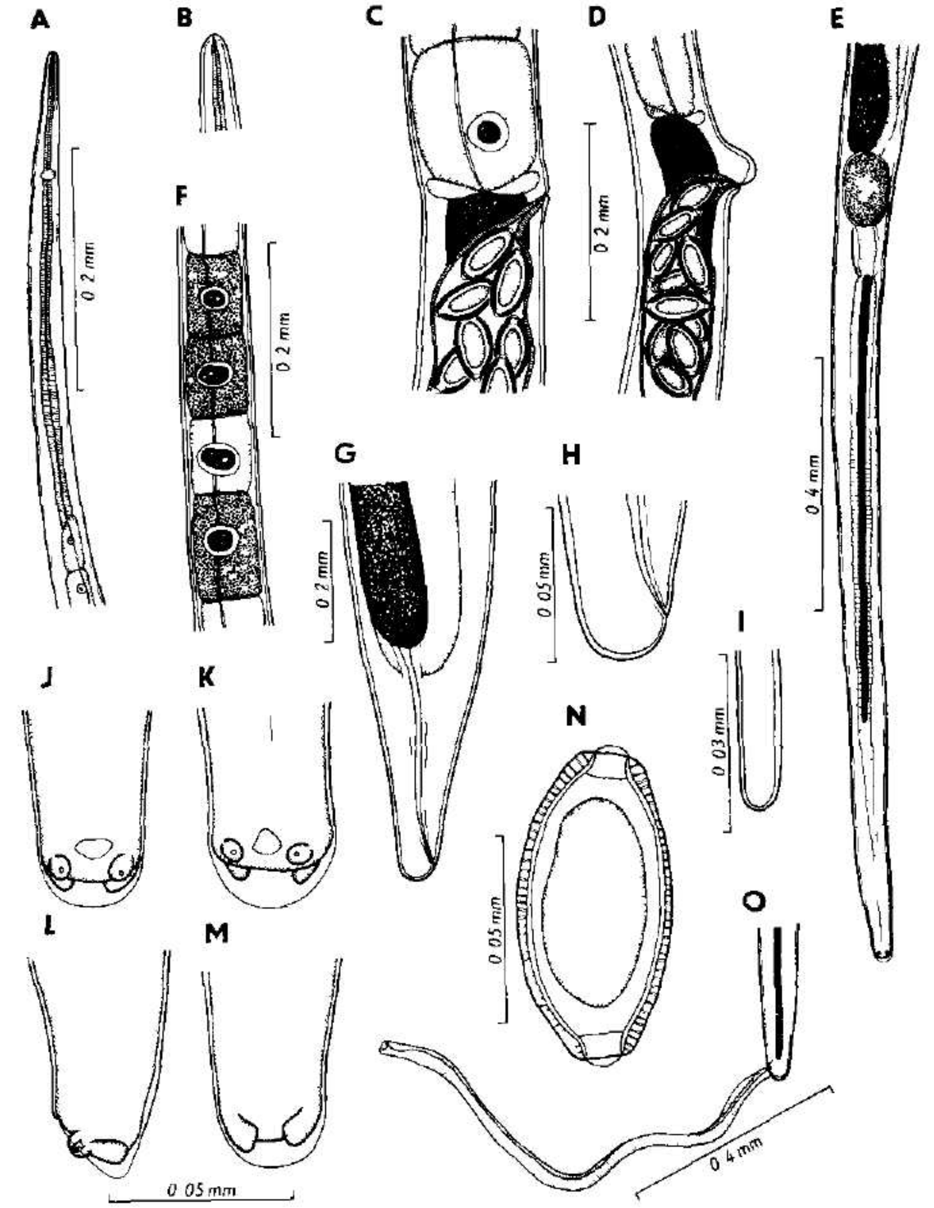

Fig 5 *Paracapillaria (O) kuntzi* Moravec et Gibson 1986 from *Liopeltis major* A, B — head end of female C, D — vulva region, E — posterior end of male, F — stichosome region of gravid female, G — posterior end of female H — female tail I — distal tip of spicule J, K — tail of male, ventral view, L M — tail of male lateral and dorsal views, N — mature egg O — posterior end of male with evaginated spicular sheath (After Moravec and Gibson 1986)

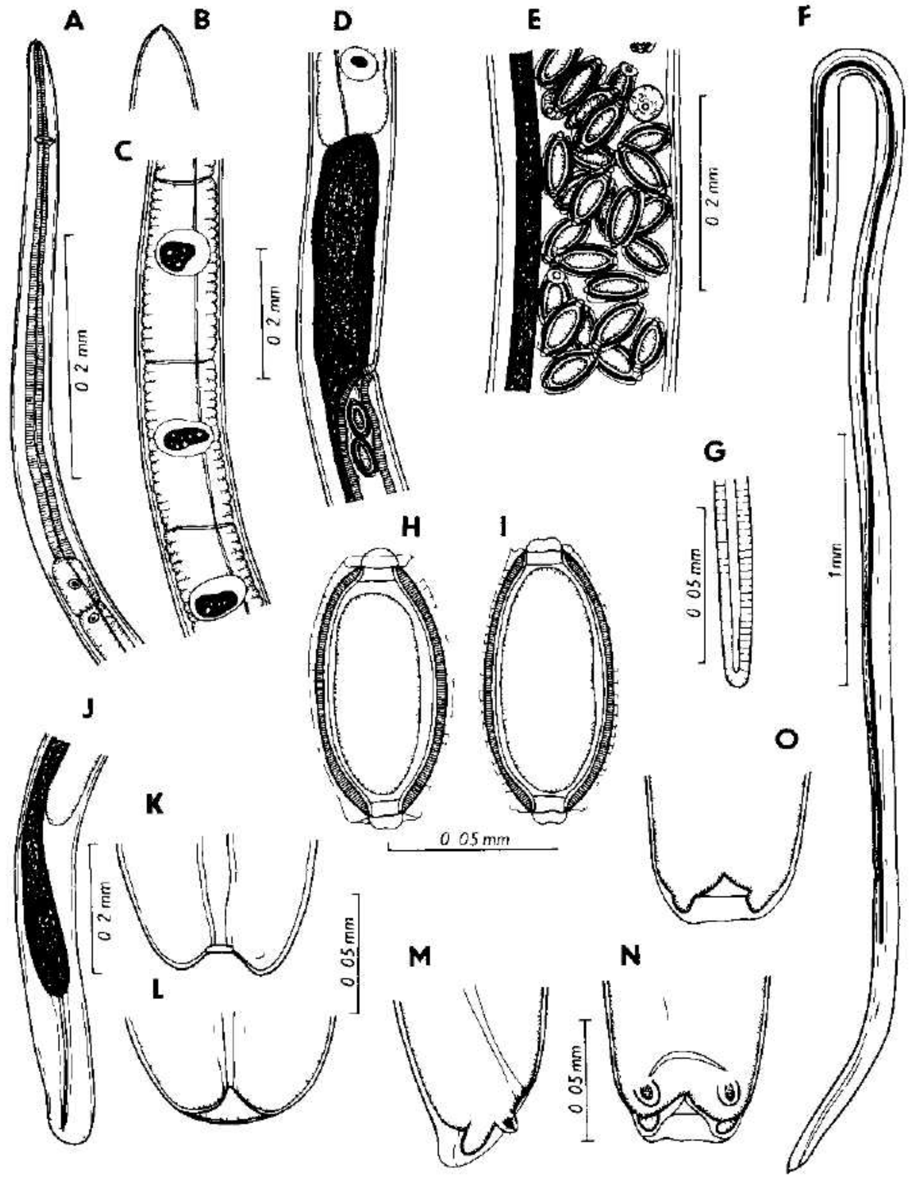

Fig. 6. *Paracapillaria (O.) longispicula* (Sonsino, 1889) from *Python* sp. from India. A, B — head end; C — stichosome region; D — vulva region, E — uterus region, F — posterior end of male, G — distal end of spicule, H, I — egg, J — posterior end of female, K, L — tail of female, ventral views, M—O — tail of male, lateral, ventral and dorsal views.

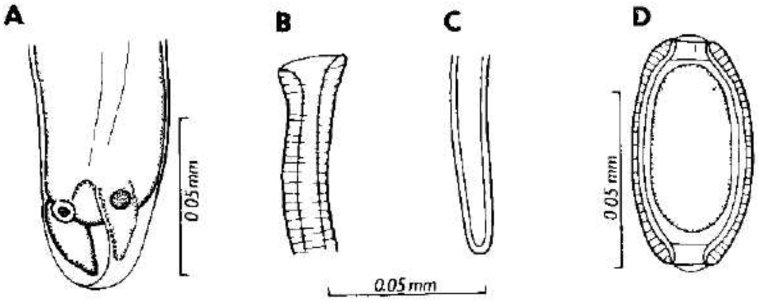

Fig. 7. ***Paracapillaria (O.) longispicula*** (Sonsino, 1889) from ***Python molurus bivittatus*** (material of Baruš and Kornalík, 1963). A — tail of male, B, C — proximal and distal ends of spicule, D — egg.

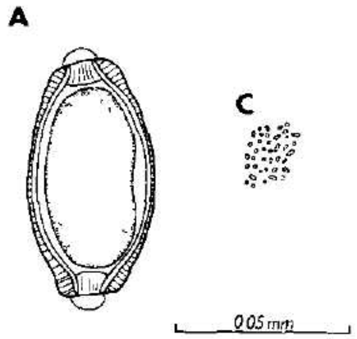

Fig. 8 *Paracapillaria* (O.) sp. 1 from *Dryophis nasuta* from Thailand. A, B – egg; C – sculpture on egg

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