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**MORTALITY OF THE EARLY DEVELOPMENTAL STAGES OF THE ROACH —
RUTILUS RUTILUS (LINNAEUS, 1758)**

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Abstract: Mortality of the early developmental stages was studied on five samples of roach embryos (*Rutilus rutilus*) for a period of the first 50 days after hatching. In three of the samples kept in different temperatures (8.9° C, 16.4° C and 22.1° C), mortality was highest in the sample kept at the lowest temperature, lowest in the sample kept at the highest temperature. An average temperature of 8.9° C was found unsuitable for a satisfactory development of the roach. At this temperature, the swim bladder of the embryos filled with difficulty and, hence, their locomotion was slow and their food was greatly reduced. Even a transfer of these early developmental stages from the low to a higher temperature (16.4° C) on the day 15th after hatching did not prevent a 100% mortality. Of the two starving samples of roach embryos kept at 16.4° C and 22.1° C respectively, the declivity of mortality was considerably faster in the sample kept at the higher temperature. A marked increase of mortality started in all samples of roach larvae at approximately the same time, i.e., within the first days after the complete resorption of the yolk sac. We compared these results with those obtained by other authors, and discussed the "critical period" of development.

INTRODUCTION

Information is scarce on the dynamics and the efficacy of reproduction processes in a natural fish population, on the intensity of survival and the completion of the number of fishes in a population reduced by predators, and also on the individual effect of each of these factors. Le Cren (1962) found that mortality was higher during the first year of life than at any other time. Nikolskij (1965) maintained that mortality was particularly high during the initial stages of life mainly in species with a high fecundity. Numerous authors confirmed for a number of species that the major part of this high mortality period occurred during the embryonic and larval stages. References to most papers on this subject are given by Peňáz and Lusk (1965) and Peňáz (1970). Peňáz (l.c.) made a list of the most important factors participating in the regulation of mortality during the early stages of fish development. According to this author, the principal factors involved were hydrological influences, the quality of the water, the effect of various predators (invertebrates and vertebrates), parasitic moulds etc., the influence of the quality of parental sex products, diseases, trophic, social and stress influences. Certain differences in the total height of mortality of a certain species may be due to interactions of these factors and their different influence on mortality in either different or the same localities in

different years. A different rate of mortality of early developmental stages in the individual years together with factors influencing the annual egg production (a different percentile participation of male and female individuals in the spawning grounds, differences in absolute fecundity, etc.) are responsible for considerable fluctuations in the abundance of fishes during the individual years. Fluctuation in the abundance of the individual year classes of a population were reported first by Hjort (1914) for several species of marine fishes, and later by Carlander (1944), Le Cren (1955) and Nikolskij (1965) for freshwater species. In Czechoslovakia, this subject was discussed by Holčík (1969), Pivnička (1971) and Černý and Pivnička (1973). It is indicated by the knowledge obtained that this phenomenon is statutory in population dynamics of fishes. In addition to these factors, mortality of the early developmental stages and, simultaneously, fluctuation in the abundance of the individual year classes of a fish population is influenced to a certain degree also by the water temperature during the period of spawning and during embryonic and larval development. A relationship between the water temperature during this period and the abundance of the individual year classes of a fish population has been pointed out, e.g., by Le Cren (1955) for *Perca fluviatilis*, Kramer and Smith (1962) for *Micropterus salmoides*, Lawler (1965) for *Coregonus clupeaformis*, Pinus (1970) for members of the genus *Clupeonella*, and others. Braum (1964) observed in *Coregonus wartmanni* that temperature during the incubation of the eggs, and at the period during which the larvae resorb their yolk sac determine the time at which the larvae start to feed on exogenous food, and the supply of yolk is still available. At a higher temperature, food consumption of the larvae started earlier. He also confirmed by his results that locomotion of the fry of this species was accelerated by a higher temperature which, simultaneously, increased their efficacy in catching their food. Beverton (1962) observed in plaice larvae that an unsuitable temperature may be largely responsible for mortality, because it damages the osmotic balance of the larvae. The influence of temperature on mortality was studied by McCormick et al. (1971) on the larvae of *Coregonus artedii*, by Florez (1972) on embryos, larvae and juvenile individuals of *Idus idus*, and by numerous other authors on various fish species. In Czechoslovakia, the possible influence of fluctuating water temperatures on the mortality of early developmental stages is discussed by Peňáz and Lusk (1965) and Pivnička (1971). While estimating the abundance of roach in the Klíčava reservoir during the years 1967–1971, Pivnička (l.c.) observed that abundance was highest in the year classes hatched in 1963 and 1967. By contrast, the number of fishes hatched in 1965, 1966, 1968 and 1969 was low. A comparison of these data with air temperature (daily records of water temperature were not available) during the various periods, i.e., before, during, and one month after the spawning of the roach, disclosed that the abundance of the individual year classes was highest in the years with a marked increase of temperature prior to spawning and a sudden decrease after the termination of the spawning period.

In order to determine whether changes in the temperature, particularly those occurring after the termination of spawning, are, actually, an important factor with a marked influence on the abundance of the individual year classes, I started, in 1971, my experimental study on the influence of tem-

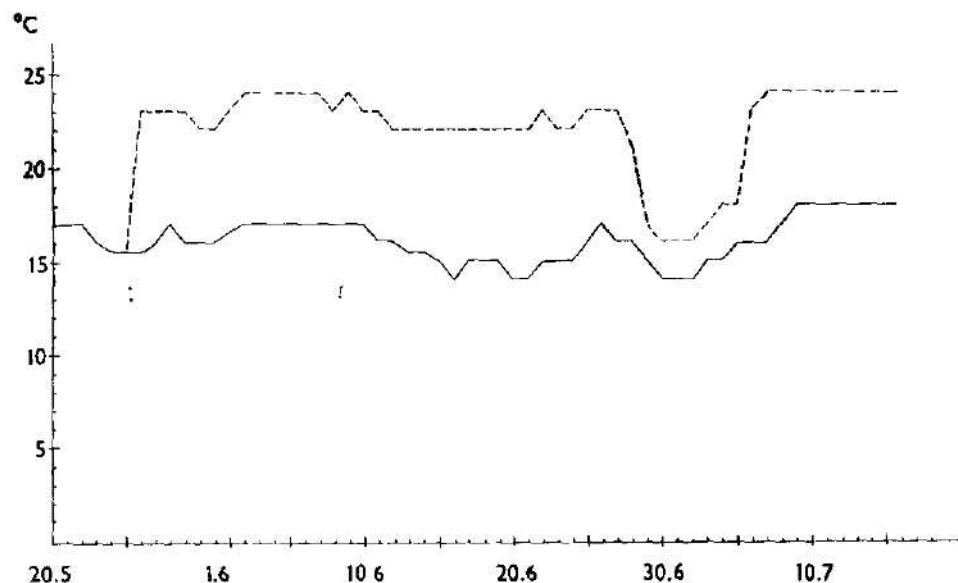


Fig. 1 Course of temperature in experimental vessels during experiments.

perature on the early developmental stages of the roach. Simultaneously, I tried to assess the influence of nutritive conditions on roach mortality. The results obtained may be important both for the theory and practice.

MATERIAL AND METHODS

The influence of temperature and nutritive conditions on the mortality of the early developmental stages of the roach was studied on roach eggs collected from three spawning grounds at the Klčava dam-lake, and hatched in the laboratory at an average water temperature of 16.2 °C. The eggs were taken together with the substrate (stones) on May 19, 1971 at approximately 4 p.m. when spawning was at its height. Immediately after collection the material was placed in plastic bags filled with reservoir water and transported to the laboratory. The stones from the individual spawning sites with the eggs attached to them were placed in glass vessels (10 l) containing lake water taken from a depth of 15 m. All vessels were well-aerated.

Hatching of the first embryos in the individual vessels occurred after 120 hr of incubation in the laboratory. At 132 hr of incubation we collected from each of the three experimental sets 166–167 hatched embryos (a total of 500 embryos). These were equally divided into five different samples on which the mortality of roach embryos and larvae was studied under conditions of three different average temperatures. The *Rutilus* sample kept at 8.9 °C was fed normally; of the samples kept at an average temperature of 16.4 °C and 22.1 °C respectively, we studied always two samples, one of these with starving embryos and larvae, the other with normally fed embryos and larvae. The food for the larvae was obtained from little pools situated in the courtyard of the Faculty of Natural Sciences, Charles University, Prague. At first, the food was strained and contained various protozoans, rotatorians, naupli and copepod stages. Throughout the experiment lasting for a period of 50 days, temperature conditions of the individual samples were unstable and depended on atmospheric conditions. In the sample kept at an average of 8.9 °C, changes in temperature were influenced also by artificial lightening during the day. Temperature changes in the individual samples are shown in Fig. 1.

The description of development in the individual samples, and the differences observed will be discussed in a separate paper and, therefore, no details are given in this paper. Classification of the development is based on the theory suggested by Vánskeov (1953); it was elaborated in detail by Balon (1960 a, b) for conditions in Czechoslovakia. The daily rate of mortality

was calculated with the equation $Z = \frac{\log_e N_0 - \log_e N_t}{t}$

Tab. 1. Daily mortality of roach embryos and larvae during separate time-periods after hatching under different temperature and food conditions. Eleuterembryos hatched on May 25, 1971

Date	Number of days	Daily mortality "Z" in %	Remarks
26. 5. — 1. 6. 1971	6	0	22.1 °C, fed
1. 6. — 9. 6. 1971	8	4.46	22.1 °C, fed
9. 6. — 17. 6. 1971	7	0.207	22.1 °C, fed
26. 5. — 13. 6. 1971	18	2.1	22.1 °C, fed
26. 5. — 1. 6. 1971	6	0.168	22.1 °C, starved
1. 6. — 9. 6. 1971	8	57.42	22.1 °C, starved
26. 5. — 9. 6. 1971	14	32.9	22.1 °C, starved
26. 5. — 1. 6. 1971	6	0.337	16.4 °C, fed
1. 6. — 9. 6. 1971	8	8.92	16.4 °C, fed
9. 6. — 17. 6. 1971	7	3.71	16.4 °C, fed
26. 5. — 13. 6. 1971	18	5.1	16.4 °C, fed
26. 5. — 1. 6. 1971	6	0.337	16.4 °C, starved
1. 6. — 9. 6. 1971	8	3.68	16.4 °C, starved
9. 6. — 17. 6. 1971	7	51.38	16.4 °C, from June 6, the larvae were fed
26. 5. — 13. 6. 1971	18	16.1	16.4 °C
26. 5. — 1. 6. 1971	6	0.579	8.9 °C, fed
1. 6. — 9. 6. 1971	8	2.12	8.9 °C, fed
9. 6. — 17. 6. 1971	7	25.05	8.9 °C (16.4 °C), fed
5. 6. — 23. 6. 1971	18	14.54	8.9 °C (16.4 °C), fed
17. 6. — 27. 6. 1971	10	1.03	8.9 °C (16.4 °C), fed

RESULTS

The results of our experiments are surveyed in Tables 1, 2 and Fig. 2. In a series of experiments we determined that the mortality of the roach embryos and larvae depended greatly on the temperature. Of the three samples with fed roach larvae, the lowest mortality occurred in the sample with the highest average water temperature (22.1 °C), the highest in the sample with the lowest temperature (8.9 °C). The course of mortality in the sample kept at 8.9 °C of water temperature indicated that this temperature was absolutely unsuitable for a satisfactory development of roach embryos and larvae.

The embryos and larvae (some of these already at the L_1 stage as indicated by the remaining signs) had difficulties in filling their swim bladder and in catching their food. Even 7 days after hatching, 40% of the embryos in the sample had not as yet filled the posterior chamber of their swim bladder. Several of them had attained already the L_1 stage as indicated by various developmental features such as the ossification of the skull bones, the degree of digestion of the yolk sac. In order to confirm the influence of temperature on the development of the embryos, we transferred 15 embryos with an

incompletely filled swim bladder at the age of 7 days to water with an average temperature of 16.4 °C. Of these, two larvae filled the posterior chamber of their swim bladder within 20 hr after the transfer. In 7 of the 15 specimens, the swim bladder was filled within 3 days. On day 8, five embryos in the sample had not yet filled their swim bladder. At this time, i.e., on day 15 after hatching, 10 embryos of the sample with a temperature of 8.9 °C had not filled even the posterior chamber of their swim bladder; several of these embryos died within the last 15 days. In view of the fact that larvae kept at an average temperature of 8.9 °C had difficulties in catching their food, and that the digestion of the yolk sac had been completed in most of the larvae of our stock (a diagnostic sign of the L_1 stage), we transferred the larvae on the 15th day after hatching to a room in which the temperature of the water was raised within several hours to 17 °C. At this time, however, the larvae had weakened too much to be able to improve substantially their food-catching capability. A mortality of 19% recorded at the time of transfer increased to 90% within the next 11 days. The last larva of the sample kept for the first 15 days at an average temperature of 8.9 °C, died on the 46th day after hatching. On the 50th day after hatching, two larvae only survived, but these were from the set of 15 larvae transferred to an average temperature of 16.4 °C on the 7th day after hatching. Although the embryos and larvae of this sample had received sufficient food supplies from as early as the second half of the third stage of the eleuterembryonic phase, the final mortality was 98% on the 50th day after hatching. A considerable increase of mortality occurred after the resorption of the yolk sac.

The finding that average temperature 8.9 °C proves to be absolutely unsuitable for a satisfactory development of the roach is in the harmony with results of Kokurewicz (1970) which inform that the temperature of 8 °C is limit temperature for the early stages of embryonal and post-embryonal development of the roach.

The final mortality of the sample kept at an average temperature of 16.4 °C was 66% on the 50th day after hatching, that of the sample kept at an average water temperature of 22.1 °C was 32% at the same time. The mortality of roach larvae exposed to starvation was 100% at an average temperature of 22.1 °C on the 14th day after hatching, and 8 days after the complete resorption of the yolk sac. In the sample kept at an average water temperature of 16.4 °C, the final mortality was 98% on the 50th day after hatching which is similar to that of unstarved larvae kept at 8.9 °C during the first 15 days after hatching. In the former sample (16.4 °C) roach larvae were kept at a stage of complete starvation for 15 days after hatching at which time their mortality was 27%. Their yolk sac had been resorbed for 7–10 days before they first received food. However, in most of these larvae both locomotion and their capability to catch food was highly reduced, and on the 22nd day after hatching the mortality was 98%. Data on the time at which the mortality of the early developmental stages of roach attained a certain height in the individual samples, and on several important points in their development are given in Table 2.

The rate of mortality for the individual samples is shown in Fig. 2; the values of daily mortality "Z" are given in Table 1 calculated for longer and shorter periods. Both the figure and the table indicate that differences in the rate of mortality were negligible within the first six days following the

Tab. 2. Some important points in the development and course of mortality of early developmental stages of the roach under different temperature and food conditions

	Date	Number of days after hatching	Number of days after yolk-sac resorption	Number of day-degrees in °C after transfer to the laboratory	Remarks
Spawning (some eggs has been spawned also during days 15.-18. 5., probably)	19. 5. 1971				
Hatching	25. 5. 1971			90	
Beginning of exogenous feeding	30. 5. 1971	5			
Termination of the yolk-sac resorption	31. 5.-1. 6. 1971	6-7		177	
25% mortality	6. 6. 1971	12	5-6	193-209	fed sample, average temperature 16.4 °C
50% mortality	9. 6. 1971	15	8-9	294	
Final mortality - 66%	15. 7. 1971	50	44-45	345	
				915	
Beginning of exogenous feeding after period of starvation	9. 6. 1971	15		345	
Termination of the yolk sac resorption	31. 5.-2. 6. 1971	6-8		193-226	starved sample, average temperature 16.4 °C
25% mortality	9. 6. 1971	15	7-9	345	
50% mortality	10. 6. 1971	16	8-10	362	
75% mortality	11. 6. 1971	17	9-11	378	
Final mortality - 97%	15. 7. 1971	50	43-45	915	
Beginning of exogenous feeding	29. 5. 1974	4		181	
Termination of the yolk sac resorption	30. 5. 1971	5		203	fed sample, average temperature 22.1 °C
25% mortality	6. 6. 1971	12	7	369	
50% mortality	15. 7. 1971	50	46	1220	
Final mortality - 32%					
Termination of the yolk sac resorption	30. 5. 1971	5		203	starved sample, average temperature)
25% mortality	3.-4. 6. 1971	9-10	4-5	297-321	
50% mortality	4.-5. 6. 1971	10-11	5-6	321-345	
75% mortality	5.-6. 6. 1971	11-12	6-7	345-369	
100% mortality	8. 6. 1971	14	9	416	
Beginning of exogenous feeding	4.-10. 6. 1971	10-16		190-262	fed sample, average temperature 8.9 °C (on June 9, 1971, the sample was transferred to an average temperature of 16.4 °C
Termination of the yolk-sac resorption	5.-10. 6. 1971	11-16		199-262	
19% mortality (on the day of transfer to a higher temperature)	9. 6. 1971	15	1-4	245	
50% mortality	13.-14. 6. 1971	19-20	3-9	309-325	
75% mortality	16. 6. 1971	22	6-11	354	
Final mortality - 96%	15. 7. 1971	50	35-40	815	

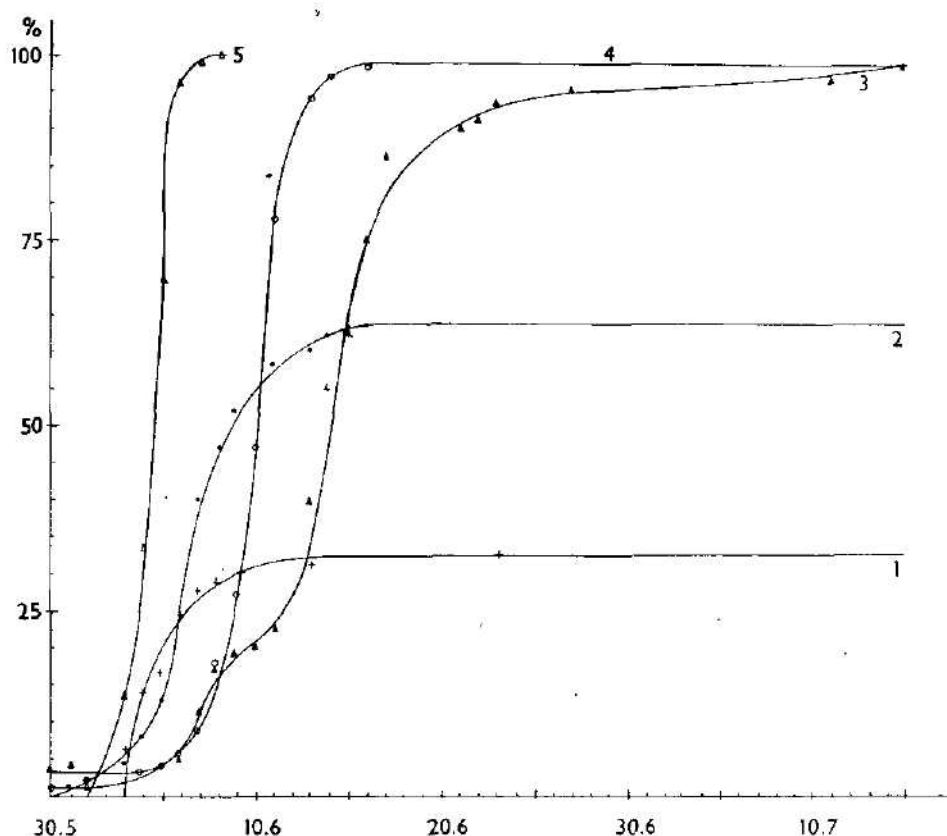


Fig. 2. Total course of mortality of early developmental stages of the roach in experimental vessels. 1 — 22.1 °C, fed; 2 — 16.4 °C, fed; 3 — 8.9 °C (16.4 °C), fed; 4 — 16.4 °C, starved; 5 — 22.1 °C, starved.

division of the hatched embryos into groups with different environmental conditions. However, within the next eight days, we observed differences in daily mortality: it was highest in starving larvae kept at the highest temperature (22.1 °C), lowest in larvae kept at the lowest temperature (8.9 °C). The values of daily mortality increased in the latter sample even as late as during the following 7 days, while in the remaining samples except for the sample of starving larvae kept at 16.4 °C, the values of daily mortality first decreased considerably and then became stable. Increased mortality occurred always in the first days following the complete resorption of the yolk sac, i.e., approximately at the developmental stage attained by the larvae of the individual samples at a different age in view of different living conditions. Within the 50 days after hatching, this was the only period with an increased mortality.

The results of our experiments confirmed a number of important facts, but mainly that the water temperature during the period from hatching to the first uptake of exogenous food has a considerable influence on the

survival of the early developmental stages of the roach. If the temperature was too low (8–10 °C), larval locomotion was reduced to a minimum and the larvae were almost unable to catch their food. The longer the duration of low water temperature, the higher the degree of weakening and the lower the possibility that these larvae might still be capable to catch their food in warmer water. It has been confirmed in experiments that high mortality could not be prevented in larvae kept for 7–15 days at 8–10 °C and then transferred to an average water temperature of 16.4 °C. In low temperature, also larval development was very protracted, and the swim bladder of the embryos filled with difficulty. Mortality (66%) was high also in the sample fed regularly and kept at an average water temperature of 16.4 °C. These facts indicate the necessity to confirm the height of mortality of roach embryos and larvae, and that of other fish species, under conditions of differently long periods in the individual temperatures, and to compare experimental and field temperature conditions during this period.

DISCUSSION

The influence of starvation on the mortality of *Rutilus rutilus heckeli* has been studied by Cunikova (1972). *Rutilus* larvae were kept under conditions of complete starvation for 4, 5, 8, 9 and 11 days respectively after their transition to mixed food, in vessels at 16.5 °C (in my experiments, the L₁ stage which starts with the transition to mixed food and terminates with the complete resorption of the yolk sac, lasted for 48–68 hr at an average temperature of 16.4 °C). According to Cunikova, *R. r. heckeli* larvae survived for 8 days without exogenous food and, if fed on this day, continued normally in their development without increased mortality. If, however, these larvae were fed on the 9th day of starvation, the majority of them (73.3%) died regardless to whether they did or did not start to take up food. In several parts of their gut, the walls were almost coalescent thus preventing, sometimes, the passage of food. The tissues of the digestive tract seemed to have started to disintegrate. Larvae starved for 11 days following the first uptake of exogenous food, kept mostly to the bottom of the vessel after this period, and refused food. At the end of the 11-day-period following the transition to mixed food, mortality of the sample was 100%.

In my sample of starving roach larvae kept at 16.4 °C, the increase of mortality was less sudden than that recorded by Cunikova (l.c.). It was 78% on the 12th day following transition to mixed food, and its final value (98%) was attained as late as on the 17th day. Closely coalescent intestinal walls and sites blocking the passage through the gut were present in several larvae of the sample kept originally at 8.9 °C.

Peñáz (1971) observed a similar resistance to starvation in *Chondrostoma nasus* at temperatures ranging from 14–18 °C. A mortality of 100% occurred on the 18th day after transition to exogenous food (in the control sample). The same author recorded an even higher resistance to starvation for *Barbus barbus*, i.e., at 20 °C, a 100% mortality occurred on the 21st day following the transition to exogenous food. In both species, however, and particularly in *Chondrostoma nasus*, mortality was considerably lower than in my stock of *Rutilus rutilus*.

A temperature of 8—10 °C used in my study on the mortality of embryos and larvae of *Rutilus rutilus*, had not been measured at the Kličava reservoir in the years 1967—1971, either by myself or by Pivnička (personal communication). On the other hand, a temperature below 17 °C has been recorded for, e.g., 1967, 1970 (at this temperature I recorded a mortality of 66%) spawning started at 13 °C and, after 14 days of spawning, the temperature did not increase above 15 °C. Since the height of mortality occurring under experimental conditions was not influenced by other important factors participating in nature (Zuromska, 1967) mortality in our experimental set may be considered to be high.

Marr (1956) found three types of mortality curves in marine fishes during their first year of life. In addition to species which reduce heavily in number within a short period (species with a critical period), he observed a gradual decrease of mortality in several other fish species and, finally, in various other species, a continuous decrease of mortality during the first year of life. In my stock, a vehement increase of larval mortality occurred within the first days following the complete resorption of the yolk sac. This indicates that the roach belongs to mortality type No. 1 according to Marr (l.c.). Certain differences in the increase of mortality in the samples are shown in Fig. 1 and Table 1. In larvae kept at an average temperature of 22.1 °C, the first marked increase of mortality occurred on the 3rd—4th day after resorption of the yolk sac; a decrease and the final suppression of mortality was recorded on the 8th day after resorption of the yolk sac. At 16.4 °C, a marked increase occurred on the 5th day after resorption of the yolk sac in fed larvae, on the 7th day in starving larvae; a decrease and subsequent suppression of mortality occurred on the 10th and 12th day respectively after resorption of the yolk sac. Of interest was the increase of mortality in larvae first kept at an average temperature of 8.9 °C, later at 16.4 °C. In this sample, the yolk sac of several larvae was resorbed already on the 11th day after hatching and, at the latest on the 16th day after hatching. If we considered the 13th day after hatching to be the average day of complete resorption of the yolk sac, then the first increase of mortality occurred on this day already. In this sample, an increase to 16—17 °C was followed by a decrease of mortality within the next three days, while from that day onwards the increase of mortality was similar to that in starving larvae kept at the same temperature.

In this sample, the period of increased mortality was closest to the accepted concept of the "critical period" first defined by Fabre - Domerque and Biatrix (1897) as the period of resorption of the yolk supply and transition to exogenous food. In the remaining samples, however, increased mortality started as late as after the complete resorption of the yolk sac.

Also Hjort (1914, 1926), Balon (1956, 1961), Tesch (1962) and others considered the "critical period" to be the time of massive death of larvae of various fish species occurring during the period of transition from endogenous to exogenous food. They explained its existence by a shortage of suitable food at this time, and by subsequent starvation. The results of our experiments with fed and starved roach larvae indicated, however, that the influence of trophic factors was less high than often expected. This has been confirmed by our observations on larvae of our stock which had received sufficient suitable food and been kept at an average temperature of 16.4 °C. In these, the increase of mortality started even earlier than in

larvae exposed to the effect of starvation (see foregoing text). An increase of mortality starting prior to the complete resorption of the yolk sac was observed in both fed and starved specimens of *Acipenser güldenstadti* from the Volga and Dnieper by a number of authors (cited from Vladimirov (1964) - Zarjanova (1951), Semenov (1958), Vladimirov and Semenov (1959). At the same developmental stage, an increase in the mortality of *Leuciscus cephalus* larvae has been observed by Peňáz and Štěrba (1969), although these larvae had started to feed on exogenous food. By contrast, Marr (1956) recorded on the basis of data given by other authors that mortality of *Scomber scombrus* and *Sardinops sagax* did not increase at the time of final resorption of the yolk sac. The same was reported by Vladimirov (1964) for *Rutilus rutilus heckeli* and *Abramis brama*, and by Bogdanova (1972) for *Coregonus lavaretus ludoga*. Even in starving larvae of these species did Vladimirov (1964) not observe an increase of mortality.

These facts indicate clearly that increased mortality occurring in several fish species shortly before and after the final resorption of the yolk sac cannot be explained simply by a shortage of convenient food available at this period. Also the term "critical period" should not be used in general for the designation of this period, because increased mortality has not been observed during this time in a number of fish species. Olifan (1945), e.g., found three periods of increased mortality in larvae of *Acipenser stellatus*. Privolnev (1949) also recorded three periods of increased mortality for larvae of *Salmo salar*, Vernidub (1949) two periods for larvae of *Scardinius erythrophthalmus* and *Rutilus rutilus* after a short exposure to 31 °C, Kaufman (1967) two periods for *Clupea harengus pallasii* natio *maris-albi*.

These facts indicate that apart from causes responsible for increased mortality during certain developmental stages, the term "critical period of development" should not be restricted in its use to only the period of the final resorption of the yolk sac and the transition to exogenous food. If this term were to be used to designate certain periods in the development of the individual fish species, their closer definition should be based on concepts of the Soviet ichthyologists Olifan (1945), Privolnev (1949), Trifonova (1949), Vernidub (1949, 1957) and others, who consider critical periods to be separate periods of differentiation of the organism, during which regulative mechanisms are reduced and susceptibility to influences of the external environment greatly increased. According to these authors, massive death occurs if conditions of the external environment are unsatisfactory at the time, during which the organism passes through a critical period. This might be the reason why no increase of mortality was observed in several cases at the time of transition to exogenous food. Vladimirov (1964) ascribed increased mortality during early developmental stages mainly to the accomplishment of defects during the organogenesis which originated in the parents and their sexual products, and to unfavourable conditions during embryonic development. Under such conditions, the development of these defects in the larvae is facilitated during the organogenesis. By contrast to Vladimirov (l.c.), Nikolskij (1965) suggested that the period of increased mortality ("critical period") is one of the forms reflecting the homogeneity of the organism and its environment, and not an autogenetic process occurring without close association with the environment.

Present knowledge of the development and mortality of early developmental stages of fishes does not allow as yet to take an unanimous view on one or the other concept as regards the existence of critical periods during the development, and on the importance of the individual causes of total mortality particularly in numerous cases which still lack experimental confirmation on a wider scale. It might, however, be inferred in accord with Peňáz (1970) that increased mortality of fishes during early developmental stages is the outcome of complicated interactions between a number of external, ecological and internal factors which, for understandable reasons, change in their sequence of importance. Therefore, it is hardly possible to ascribe importance to one of these factors only.

It has been confirmed by the results of this study that the temperature of the water is one of the important factors influencing mortality of the early developmental stages. Knowledge of mortality of the early developmental stages of fishes, its influence on the survival of the progeny and mainly knowledge of the individual causes are of considerable importance for practice. On the basis of this knowledge it will be possible to estimate the increase of populations of economically important fish species in the following years and the size of catches. In order to obtain this knowledge, it will be necessary to employ biological, biochemical and physiological methods in the study on the causes responsible for mortality.

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SUMMARY

Our study on the mortality of early developmental stages of the roach under different conditions of temperature and food disclosed these facts:

1. Mortality of roach larvae is closely associated with the temperature. In three samples kept at different average temperatures of 8.9, 16.4 and 22.1 °C respectively, the lowest mortality was recorded in the sample kept at the highest temperature, the highest mortality in the sample kept at the lowest temperature.

2. An average temperature of 8.9 °C proved to be absolutely unsuitable for a satisfactory development of the roach. At this temperature, the larvae had difficulties in filling their swim bladder, their locomotion was slow and they were almost incapable to catch their food. The longer the stay of the larvae in water of this temperature, the higher the degree of weakening and the lower the possibility that these larvae might be able to catch their food after an increase of the water temperature.

3. In samples of starved larvae, the declivity of mortality was faster in the sample kept at a higher temperature. At an average temperature of 22.1 °C, a 100% mortality was recorded on the 14th day after hatching, and on the 8th day following the complete resorption of the yolk sac. In the sample kept at an average temperature of 16.4 °C, mortality at this time was 18%.

4. If we started to feed roach larvae kept at an average temperature of 22.1 °C, on the 15th day after hatching, the final mortality was reduced negligibly, because the larvae were very weak already and almost incapable

to catch their food. In this sample, the final mortality was 98% on the 22nd day after hatching.

5. Of the three types of mortality suggested by Marr (1956), the type with a vehement reduction of numbers during a short span of time ("critical period") is typical of the roach. In all roach samples we observed a sudden increase of mortality during the first days following the final resorption of the yolk sac, i.e., at a time, when the larvae had stopped to feed on a mixture of endogenous and exogenous food. This period is considered by numerous authors to be the proper "critical period" of development.

6. The influence of trophic factors on mortality is evidently lower than expected. Mortality increased considerably even in samples fed with a good supply of suitable food (at 16.4 °C it occurred earlier than in the sample kept under unfavourable food conditions). This indicates that the increase of fry mortality during the period following the complete resorption of the yolk sac cannot be explained as a consequence of food shortage.

7. The term "critical period of development" should be used with great caution, because the knowledge available at present does not allow to take an unanimous view on this or the other concept as regards the existence of these periods.

8. Increased mortality of fishes during the early developmental stages is the result of complicated interactions of a number of external ecological and internal factors. The sequence of importance of the individual factors changes from case to case and it is impossible to infer which of these factors is the decisive one.

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Zoologischer Garten Dvůr Králové nad Labem

VERLAUF DES HAARWECHSELS BEI EINIGEN HIRSCHEN II.
(ARTIODACTYLA: CERVIDAE)

LUDĚK J. DOBRORUKA

Eingegangen am 18. März 1974

Abstrakt: Es wird die topographische Sukzession des Haarwechsels bei erwachsenen Individuen der Arten *Capreolus capreolus*, *Alces alces*, *Rangifer tarandus*, *Mazama gouazoubira*, *Mazama nana* und *Odocoileus virginianus* beschrieben. Die Zusammenhänge des Haarwechsels mit dem natürlichen System der Cerviden werden diskutiert.

Diese Arbeit stellt eine Fortsetzung einer früheren Studie dar, welche die Plesiometacarpal-Hirsche bearbeitete (Dobroruka, 1969). Diesmal wollen wir den Haarwechsel bei einigen Telemetacarpal-Hirschen beschreiben und damit zeigen, dass es sich bei der Reduktion der Metacarpalia II. und V. höchstwahrscheinlich um ein adaptives Merkmal handelt.

Es wurden folgende Formen untersucht:

Capreolus capreolus capreolus (Linnaeus, 1758) — Europäisches Reh — 10 Exemplare
Capreolus capreolus transylvanicus (Matschie, 1907) — Karpaten-Reh — 4 Exemplare
Capreolus capreolus pygargus (Pallas, 1771) — Sibirisches Reh — 6 Exemplare
Alces alces alces (Linnaeus, 1758) — Europäischer Elch — 6 Exemplare
Alces alces cf. tymensis (Zukowsky, 1915) — Sibirischer Elch — 3 Exemplare
Alces alces americana (Clinton, 1822) — Amerikanischer Elch
Rangifer tarandus tarandus (Linnaeus, 1758) — Skandinavisches Ren — 8 Exemplare
Rangifer tarandus sibiricus Murray, 1866 — Sibirisches Ren — 16 Exemplare
Mazama gouazoubira gouazoubira (G. Fischer, 1814) — Grauer Spießhirsch — 2 Exemplare
Mazama nana (Hensel, 1872) — Zwerg-Spießhirsch — 1 Exemplar
Odocoileus virginianus borealis (Miller, 1900) — Weisswedelhirsch — 5 Exemplare

Die Angaben über *Alces a. americana* sind aus der Arbeit Peterson's (1955) übernommen.

Es wurden die Tiere in den Bedingungen des Zoologischen Gartens in Prag, Zool. Gartens Plzeň, Zool. Gartens Leipzig, Tierparks Berlin und Zool. Garden Regent's Park, London, beobachtet. Die Resultate wurden durch gelegentliche Beobachtungen in freier Wildbahn (*Capreolus capreolus*) unterstützt.

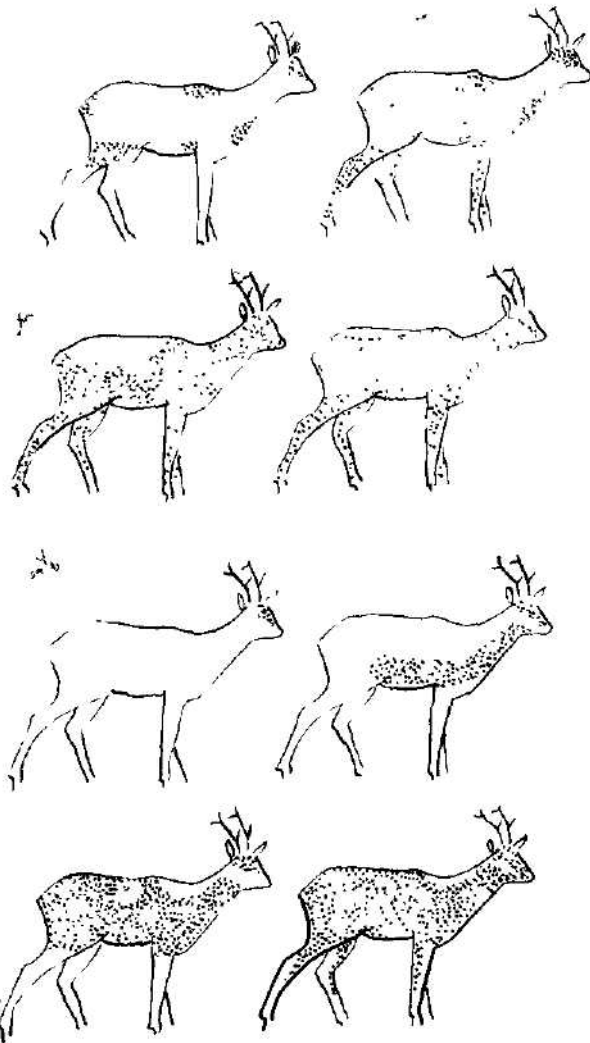
Die Beobachtungen wurden in den Jahren 1959—1972 durchgeführt.

HAARWECHSEL EINZELNER ARTEN

Capreolus capreolus (Tab. 1)

Frühjahr-Haarwechsel: Im März bis im April wächst das Sommerhaar auf dem Kopf durch, dann fällt das alte Winterhaar aus zuerst auf dem Widerrist, hinter dem Ellbogen, auf der Halsunterseite, in der Spiegelregion und in einem Streifen auf den Keulen. Der Haarwechsel erstreckt sich auf den ganzen Kopf, auf die Seiten und auf die Extremitäten. Dann haart der Hals

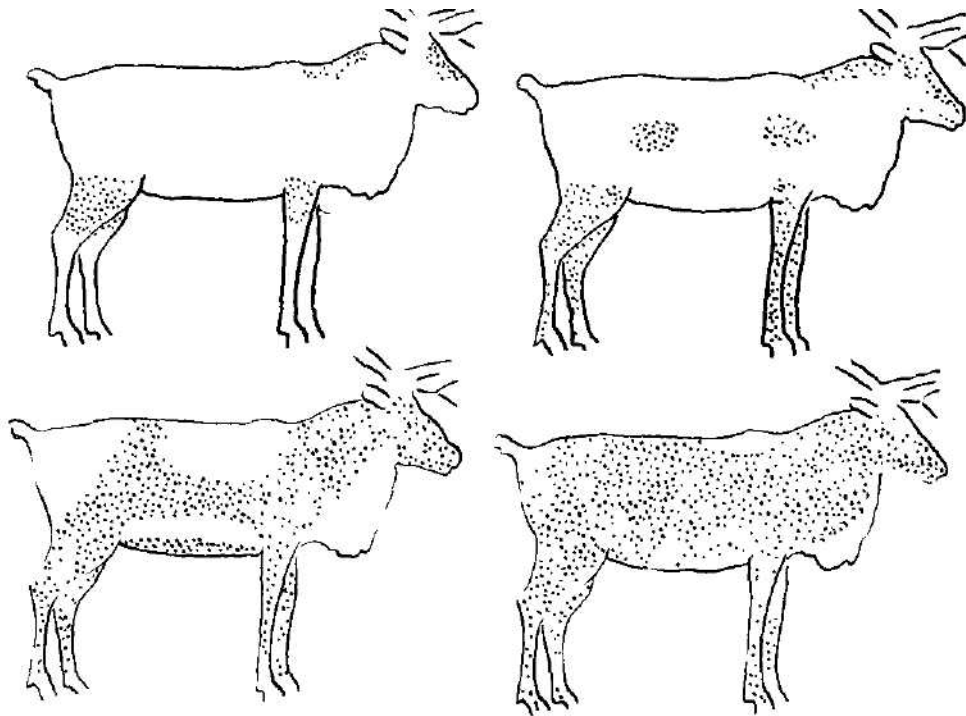
um. Die letzte Stelle der Umhaarung ist der Rücken. Der Frühjahr-Haarwechsel endet im Mai oder Anfang Juni, er dauert also etwa $2\frac{1}{2}$ bis 3 Monate. Herbst-Haarwechsel: Ende August sieht man das graue Winterhaar durch das rote Sommerhaar durchzuwachsen. Der Haarwechsel beginnt am Kopf, wo das neue Haar eine Maske bildet, und setzt dann vom Halse über die Seiten an die Extremitäten fort. In der Endphase kann man keine genaue Sukzession beobachten und der Haarwechsel läuft diffus durch. Als die letzten Stellen des Haarwechsels kann man die Kopfseiten, die Dorsalseite der Vorder- und die Plantarseite der Hinterextremitäten und den Widerrist nennen.



Tab. 1. — Schema der topographischen Sukzession des Haarwechsels bei *Capreolus capreolus*. Oben: Frühjahr-Haarwechsel; unten: Herbst-Haarwechsel

Unsere Beobachtungen widersprechen solchen von Flerov (1928) und Sokolov (1959), die erwähnten, dass der Herbsthaarwechsel auf dem Rücken beginnt und auf dem Kopf und auf den Extremitäten endet. In allen Beobachtungsjahren und bei allen drei Subspezies haben wir nur den nach dem obenerwähnten Schema verlaufenden Haarwechsel festgestellt.

Wie wir schon bei anderen Arten erwähnt haben (Dobroruka 1969), können wir auch bei der Art *Capreolus capreolus* einen wesentlichen Unterschied zwischen nördlichen und südlichen geographischen Rassen feststellen. Wir konnten dieses Phänomen sehr gut z. B. im Jahre 1966 in dem Zoologischen Garten Prag beobachten, wenn in den benachbarten Ausläufen die Europäische (*C. c. capreolus*) und Sibirische (*C. c. pygargus*) Rehe gehalten wurden. Bei den beiden Subspezies begann der Herbst-Haarwechsel im August. In der Hälfte September war das Sibirische Rehwild ausser kleinen



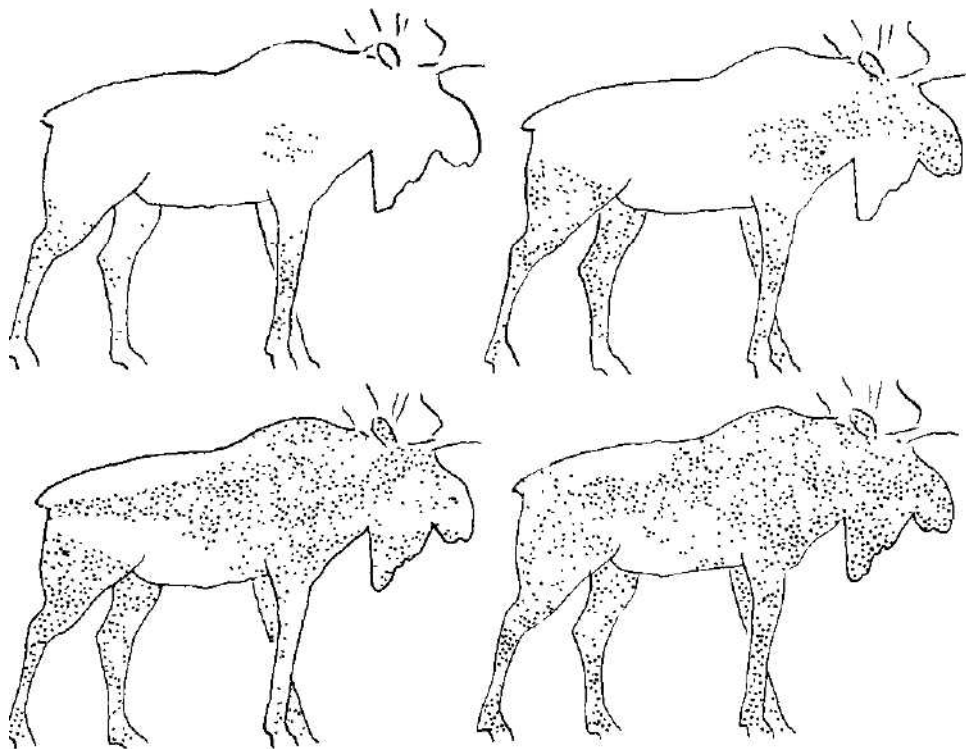
Tab. 2. — Schema der topographischen Sukzession des Haarwechsels bei *Rangifer tarandus*

Bezirken auf den Kopfseiten, auf der Dorsalseite der Vorder- und Plantarseite der Hinterextremitäten umgehaart, während das Europäische Rehwild noch im Sommerhaar stand und das neue Winterhaar nur die typische Maske im Gesicht bildete. Es ist also klar, dass auch hier das Gesetz gilt, das für die Art *Cervus elaphus* Flerov (1952) emporhob (übersetzt aus dem russischen): „Die Schnelligkeit des Haarwechsels ist von den klimatischen Bedingungen abhängig; die Subspezies . . . die die nördliche Teile des Areals bewohnen, beenden früher den Haarwechsel“. Wir haben schon früher gezeigt (Dobroruka, 1969), dass dieser Unterschied lange Generationen in der Gefangenschaft bei unter gleichen Bedingungen lebenden Tieren dauert. Zur Ehre des bekannten Cerviden-Spezialisten schlagen wir vor dieses Phänomen als Flerov'sches Gesetz in die „Klimagesetze“ einzureihen.

Rangifer tarandus (Tab. 2)

Die Reine haaren nur einmal im Jahre — im Frühling — um. In dieser Zeit fällt das dichte Unterhaar sowie die Grannenhaare aus und das alte Haar ist durch das neue Haar ersetzt. Im Herbst fällt das Haar nicht aus, sondern wächst weiter und ist durch die neue Unterwolle durchgewachsen. Gelegentlich wachsen auch neue Winter-Grannenhaare, so dass das Haarkleid den rauen Klima-Bedingungen entsprechend sehr dicht ist.

Der Frühjahr-Haarwechsel beginnt meistens im Mai, manchmal aber schon im April (bei *R. t. tarandus*), oder erst im Juni (einige Exemplare von *R. t.*



Tab. 3. — Schema der topographischen Sukzession des Haarwechsels bei *Alces alces*

sibiricus). Einige Autoren (z. B. Flerov, 1952) stellen aber den Haarwechsel und das Herausfallen der alten Unterwolle schon im März fest. Der Haarwechsel beginnt auf dem Kopf. Fast gleichzeitig wechselt das Haar auf den Extremitäten, auf der Dorsalseite des Halses, auf den Schultern und auf den Flanken. Diese Bezirke vereinigen sich bald miteinander und mit den umhaarten Bezirken auf den Extremitäten. Am spätesten haaren der Widerrist, die Ventralseite des Halses und der Schwanzwurzel um.

Bei trächtigen Weibchen ist die Verspätung des Umhaarens noch besser ausgeprägt als bei anderen Arten der Familie. Die trächtigen Weibchen haaren nicht um und meistens werfen das Geweih nicht ab. Beides kommt erst nach der Geburt vor.

Das Heranwachsen des Winterhaares ist diffus. Es beginnt meistens im September und dauert etwa 1 Monat.

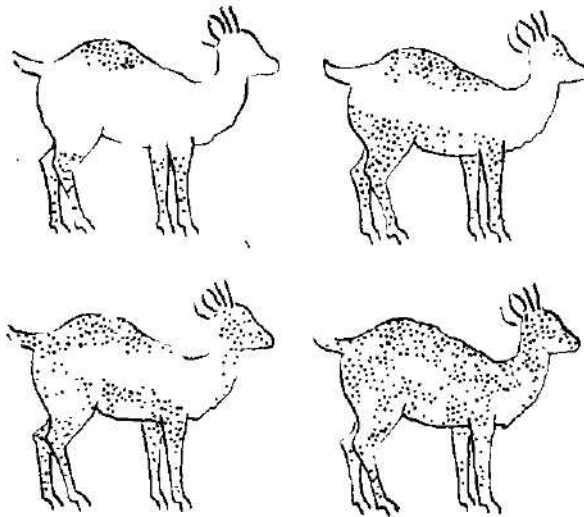
Alces alces (Tab. 3)

Auch beim Elch ist nur ein Haarwechsel vorhanden, u. zw. der Frühjahr-Haarwechsel. Im Herbst fällt das Haar nicht aus, sondern wächst die Unterwolle und die Wintergrannenhaare aus.

Der Haarwechsel beginnt manchmal schon Ende März (Flerov, 1952), aber meistens erst im April oder Anfang Mai. Er beginnt auf den Seiten des Brustkorbes; bei *Alces alces alces* (Exemplare aus Schweden und aus der

Archangelsk-Umgebung) und bei *A. a. cf. tymensis* (Exemplare aus der Novosibirsk-Umgebung) beginnt der Haarwechsel mehr ventral, in der Umgebung des Schultergelenkes; bei *A. a. americana* (Exemplare von der St. Ignace Island, Ontario) erscheinen die ersten Haarwechselspuren auf der Oberseite des Schulterblattes. Die Haarwechsel-Bezirke erweitern sich hals-

bzw. kopfwärts. Gleichzeitig haaren die Extremitäten um, von wo sich der Haarwechsel auf die Bauchregion erstreckt. Als die letzte Stelle haart die Lumbal- und Sacralregion des Rückens um.



Tab. 4. — Schema der topographischen Sukzession des Haarwechsels bei *Mazama gouazoubira* und *Mazama nana*

Der Frühjahr-Haarwechsel endet im Juli, er dauert also etwa 3 bis 3 ½ Monate.

Der Herbst-Haarwuchs ist diffus. Er beginnt meistens im September und endet im Oktober-November; er dauert also 1 bis 1 ½ Monate.

Mazama gouazoubira und *Mazama nana* (Tab. 4)

Bei diesen Arten verläuft der Haarwechsel mit so unbedeutenden Unterschieden, dass man über sie zusammen berichten kann.

Die Gattung *Mazama* hat nur einen Haarwechsel — im Frühjahr. Im Herbst fällt das alte Sommerhaar nicht aus, sondern wächst das neue Winterhaar durch und überdeckt sie.

Der Frühjahr-Haarwechsel beginnt manchmal schon Ende März, meistens aber erst im April. Der Haarwechsel beginnt auf dem Rücken und auf den Extremitäten. Dann haart der Bauch, die Halsunterseite und der Kopf um. Der Haarwechsel erstreckt sich centripetal auf die Seiten, welche die letzten Stellen des Haarwechsels bilden.

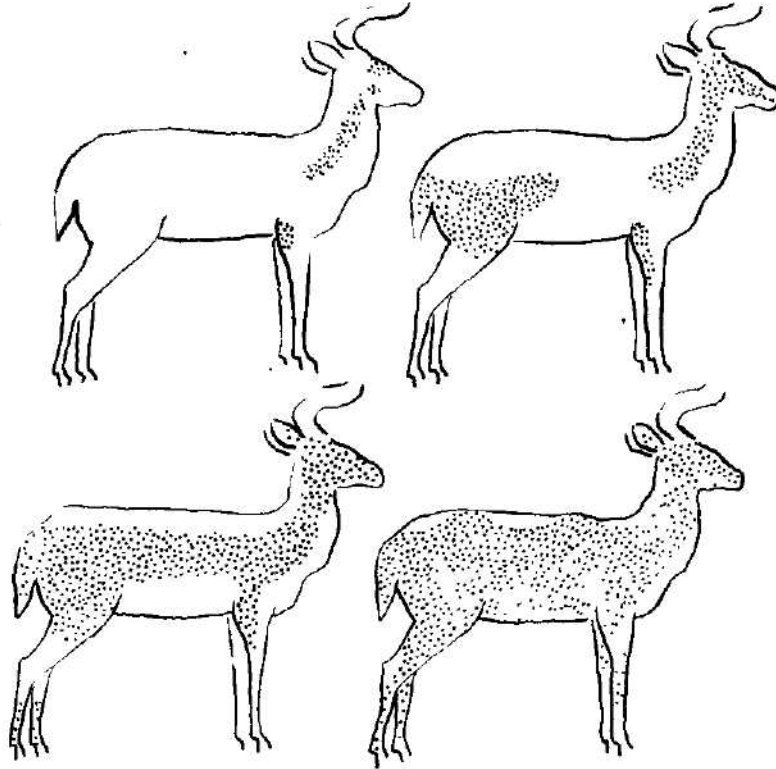
Der Frühjahrwechsel endet im Mai oder Anfang Juni. Es dauert also etwa 2 bis 2 ½ Monate.

Ungefähr im August beginnt das diffuse Aufwachsen des Winterhaares, das ohne jeden erkennbaren System vor sich geht. Das Aufwachsen des Winterhaares endet im September — Anfang Oktober, es dauert also etwa 1 bis 1 ½ Monate.

Odocoileus virginianus (Tab. 5)

Die Weisswedelhirsche zeigen nur einen Haarwechsel im Jahre, den Frühjahr-Haarwechsel.

Er beginnt im April, höchstens Anfang Mai auf der Unterkiefer, in der Stirngegend, auf der lateralen Seite des Halses und auf der kaudalen Seite



Tab. 5. — Schema der topographischen Sukzession des Haarwechsels bei *Odocoileus virginianus*

der Keulen. Dann erstreckt sich der Haarwechsel auf den Rücken, auf die Extremitäten und auf die Seiten. Die letzten Stellen der Umhaarung sind die Ventral- und Dorsalseite des Halses, Frontalseite der Vorderextremitäten, einige Partien des Rückenkammes, die Schwanzgegend und die Sprunggelenke der Hinterextremitäten.

Der Haarwechsel dauert etwa 2 bis 2 ½ Monate, da er in der ersten Hälfte Juni endet.

Ungefähr im August wächst diffus das Winterhaar auf und im September stehen die Weisswedelhirsche im vollen Winterhaar.

DISKUSSION

Es wurde schon in früheren Arbeiten festgestellt, dass die Sukzession des Haarwechsels ein sehr gutes taxonomisches Kriterium bildet, das auch die

Erkennung der Phylogenesis den untersuchten Arten erklären kann (Mazák, 1962; Dobroruka, 1969).

In dem ersten Teile dieser Arbeit (Dobroruka, 1969) und in dieser Fortsetzung sind insgesamt 14 Arten in 27 Subspezies aus dem Standpunkt der topographischen Sukzession des Haarwechsels bearbeitet. Ausserdem wurden Beobachtungen an weiteren Arten durchgeführt, die zwar eine genaue Bearbeitung bisher nicht ermöglichen, die aber mindestens die Prinzipie des Haarwechsels zeigen und so zum Vergleich dienen können.

Alle untersuchten Arten kann man nach den Ergebnissen des Studiums des Haarwechsels in zwei Gruppen teilen: In der ersten Gruppe sind die Arten, bei welchen das Haar zweimal im Jahre wechselt (im Frühjahr und Herbst), in die zweite Gruppe reihen wir solche Arten, bei welchen das Haar nur einmal im Jahre (im Frühjahr) wechselt (ausfällt) und im Herbst nur das neue Haar aufwächst.

In die erste Gruppe gehören aus den untersuchten Arten: *Axis axis*, *Hyalaphus porcinus*, *Rusa unicolor*, *Rusa equina*, *Dama dama*, *Elephurus davidianus*, *Cervus nippon*, *Cervus elaphus* und *Capreolus capreolus*. In die zweite Gruppe gehören: *Rangifer tarandus*, *Alces alces*, *Mazama gouazoubira*, *Mazama nana*, *Odocoileus virginianus* und nach den noch nicht beendeten Untersuchungen *Odocoileus hemionus*.

Die erste Gruppe wurde — mit der Ausnahme von *Capreolus capreolus* — schon in der früheren Arbeit besprochen (Dobroruka, 1969). Jetzt haben wir festgestellt, dass hierher auch das Reh gehört. Manche Autoren haben schon mehrmals die taxonomische Zugehörigkeit der Art *Capreolus capreolus* diskutiert und es gibt noch heute zwei Meinungen. Die erste kommt aus der alten Klassifikation heraus, die die Familie *Cervidae* in *Plesiometacarpalia* und *Telemetacarpalia* teilt (Brooke, 1878). Nach dieser Klassifikation gehört *Capreolus* laut der Reduktion von Metacarpale II, und V. den telemetacarpalen Hirschen zu. Wie aber schon Leisewitz (1925 ex Weber, 1927) zeigte, muss diese Reduktion nicht unbedingt mit der Phylogenesis der Gattung verbunden sein. Aus modernen Autoren, die verschiedene Modifikationen des Brooke-schen Systems unterstützen, nennen wir z. B. Pocock (1923), Simpson (1945), Frechkop (1955), Geptner (1961) und Hattenorth (1963).

Die zweite Meinung, von Carrette (1922) entworfen, basiert hauptsächlich auf den Schädelmerkmalen. Carrette nimmt aus den Telemetacarpal-Hirschen die Gattungen *Hydropotes*, *Alces* und *Capreolus* heraus (die hintere Choanenöffnung durch Vomer nicht in zwei Kammern geteilt) und die restlichen Telemetacarpalhirsche, bei welchen die hintere Choanenöffnung in zwei Kammern durch Vomer geteilt ist und die alle ihren Ursprung auf dem amerikanischen Kontinent haben reiht er in die neu emporgehobene Subfamilie *Neocervinae* ein. Dieses System halten aus modernen Autoren z. B. Jacobi (1931) und Flerov (1950, 1952) für richtig. Die Gattungen *Capreolus* und *Alces* sind dann in die Subfamilie *Cervinae* gereiht. Die Gattung *Hydropotes* unterscheidet sich von anderen Gattungen so wesentlich, dass sie ohne Zweifel eine eigene Subfamilie *Hydropotinae* Trouessart, 1898 bildet.

Das geologische Alter der Spezies *Capreolus capreolus* ist ziemlich hoch. Nach Schlosser (1924) können wir die Ursprünge der Gattung *Capreolus* schon im oberen Miozän bei der Art +*Procervulus aurelianensis* finden. Die Gattung *Capreolus* erschien im Unterpliozän im Griechenland (+*Capreolus*

pentelici), die Art *Capreolus capreolus* finden wir zum erstenmal im Pleistozän. Auf dem amerikanischen Kontinent sind weder fossilen noch rezenten Arten zu finden, die mit der Gattung *Capreolus* verwandt sind.

Die Art *Capreolus capreolus* bildet zwei Prospezies (von Lehmann, 1958, 1960, 1966), *C. capreolus* und *C. pygargus*. Die Prospezies *pygargus* ist wahrscheinlich älter, da noch im Pleistozän in dem ganzen Areal der Gattung nur solche Rehe zu finden sind. Die Entwicklung zeigt einige Analogien mit der Subfamilie *Neocervinae*, z. B. eine phylogenetische Diminution-Tendenz (Miranda Ribeiro, 1919, von Lehmann, 1960), eine Reduktion der Suborbitaldrüsen (cf. *Pudu-Pudella*) usw.

Die topographische Sukzession des Haarwechsels bei *Capreolus capreolus* zeigt gewisse Analogien mit der Sukzession des Haarwechsels bei der Art *Cervus elaphus* (cf. Tab. 1 in Dobroruka, 1969 und Tab. 1 dieser Arbeit). Es scheint also, dass es sich bei der Art *Capreolus capreolus* auch um einen spezialisierten, hochstehenden Typus des Haarwechsels handelt. Das unterstützt die Ansicht Flerov's (1950, 1952) von zwei Entwicklungs-Linien: die eine geht über +*Pliocervus* zum *Capreolus*, die zweite von +*Cervavitus* zum *Cervus*.

Ohne Zweifel kann man aber die Sukzession des Haarwechsels bei *Capreolus* als prinzipiell gleich einer solchen bei anderen Vertreter der Subfamilie *Cervinae* bezeichnen. Später werden wir noch sehen, dass sie sich von der Sukzession des Haarwechsels bei *Neocervinae* erheblich unterscheidet.

Aus diesen Gründen halten wir die Zugehörigkeit der Gattung *Capreolus* zu der Subfamilie *Cervinae* für richtig, was noch die von Carrette (1922) und Flerov (1950, 1952) erwähnten morphologisch-anatomischen Merkmale unterstreichen. Parasitologische Befunde sprechen dafür, dass die Gattung *Capreolus* vielleicht eine ganz isolierte Form darstellt (Pryadko, 1972).

In die andere Gruppe der Cerviden gehören solche, die das Haar nur einmal im Jahre wechseln. Hierher gehören, wie schon oben gesagt, aus den untersuchten Arten folgende: *Alces alces*, *Rangifer tarandus*, *Mazama gouazoubira*, *Mazama nana*, *Odocoileus virginianus* und *Odocoileus hemionus*. Mit der Ausnahme von *Alces alces* handelt es sich also um die Vertreter der Subfamilie *Neocervinae*.

Die Gattung *Alces* kommt schon im älteren Pleistozän vor und ihre Verwandten sind wahrscheinlich +*Cervalces* und +*Eucladoceros*, also die Ausläufer derselben Linie, die bis zum +*Cervavitus* in den Anfang Pleistozäns Nordamerikas führt (Flerov, 1950; Thenius, 1969). Es handelt sich gewiss um eine Linie, die sich zwar stark spezialisiert hat, die aber doch mit der Subfamilie *Cervinae* stark verwandt ist. Da sich die monotypische Gattung *Alces* durch viele Merkmale von der Subfamilie *Cervinae* unterscheidet, ist es besser sie in eine eigene Subfamilie *Alcinae* Jerdon, 1847, zu trennen.

Die Gattung *Alces* ist eine hochspezialisierte Form, wie es folgende Merkmale zeigen: Bau der Extremitäten, Adaption der Nase (Jacobi, 1919), Schädelmerkmale, Einfarbigkeit der Jungen, Farbdifferentiation einiger Körperpartien usw. Wie bei *Capreolus capreolus* sehen wir auch hier die Tendenz zur Ausbildung zweier Prospezies, die sich aber noch stärker unterscheiden, als beim Reh. Die Prospezies *Alces americana* hat eine lange, schlanke Rostralpartie des Schädels und kurze Nasenteile der Prämaxille, die Prospezies *Alces alces* hat ein kurzes, breites Rostrum und lange, am Ende sich verbreitende Nasenteile der Prämaxille. Beide Prospezies unter-

scheiden sich auch in der Färbung (grössere Farbdifferentiation bei *americana*) und durch weitere morphologische Merkmale. Bei den beiden Prospezien sehen wir eine Deminution in der Richtung zu den Rändern des Verbreitungsareals. Auch hier sehen wir also die gleiche Analogie mit der Subfamilie *Neocervinae*, die wir schon bei der Gattung *Capreolus* erwähnten.

Wie wir aus dem Schema der Tab. 2 bis 5 sehen, können wir der Haarwechsel-Sukzession nach zwei Gruppen erkennen: in die erste gehören die Arten *Alces alces*, *Rangifer tarandus* und *Odocoileus virginianus* bzw. *O. hemionus*, die grundsätzlich das Haar nach dem gleichen Schema wechseln (zentrifugal), in die zweite Subgruppe gehören die Arten der Gattung *Mazama* (zentripetaler Haarwechsel).

Die erstgenannten Arten entwickelten sich auf der Nord-Hemisphäre (Mathew, 1908), während die Gattung *Mazama* (gleich *Pudu*) autochthon neotropisch ist und sehr nahe der südamerikanischen Ursprungslinie steht (Herschkovitz, 1969), obwohl sie Krumbiegel (1969) für eine Form mit sekundär vereinfachtem Geweih hält und Thenius (1964) sie als ein über eine Landbrücke von Nord- bzw. Zentralamerika eingewandertes Element ansieht.

Die Fossilfunde geben leider keine eindeutliche Hinweise auf die stammesgeschichtlichen Zusammenhänge. Die unterschiedliche Sukzession des Haarwechsels unterstützt aber die Annahme, dass die Subfamilie *Neocervinae* aus zwei Entstehungslinien herauskommt.

ZUSAMMENFASSUNG

1. Die Sukzession des Haarwechsels zeigt klar die Einigkeit der Subfamilie *Cervinae*, zu der sowie Plesiometacarpal-, so auch Telemetacarpal-Hirsche gehören.

2. Der Haarwechsel der Subfamilie *Cervinae* findet zweimal im Jahre statt, im Frühjahr und im Herbst. Der Haarwechsel der Subfamilie *Neocervinae* kommt nur einmal im Jahre, im Frühling, vor.

3. Die Gattung *Alces* haart zwar nur einmal im Jahre um (im Frühjahr), aber die Sukzession des Haarwechsels zeigt die gleichen Prinzipien, welche wir auch bei der Subfamilie *Cervinae* finden, und unterscheidet sich wesentlich von der Sukzession bei der Subfamilie *Neocervinae*. Das unterstützt die Annahme, dass die Subfamilie *Alcinae* mit Recht ausgetrennt ist.

4. Alle studierten Kriterien zeigen, dass die Systeme, die auf der Teilung der Cerviden in Plesiometacarpalia und Telemetacarpalia basieren (Brooke, 1878; Pocock, 1923; Simpson, 1945; Haltenorth, 1963 u. a.) künstlich zusammengestellt sind. Als ein natürliches System darf man das System von Carrette (1922) halten, bzw. seine Modifikationen (Flerov, 1950, 1952).

5. Der Haarwechsel, hauptsächlich aber seine topographische Sukzession, hat sich als ein wertvolles taxonomisches Kriterium bewährt, das auch mit der Phylogenie den untersuchten Formen zusammenhängt.

6. Es wurde das von Flerov (1952) emporgehobene Phänomen bestätigt, dass die Schnelligkeit des Haarwechsels von den klimatischen Bedingungen abhängig ist. Die Subspezies, die die nördlichen Teile des Areals bewohnen, beenden den Haarwechsel früher. Wir schlagen vor, dieses Phänomen als Flerov'sches Gesetz in die „Klimagesetze“ einzureihen.

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**NOSEMA POLYGRAMMAE SP.N. AND PLISTOPHORA FIDELIS SP.N.
(MICROSPORIDIA, NOSEMATIDAE) INFECTING POLYGRAMMA
UNDECIMLINEATA (COLEOPTERA: CHRYSOMELIDAE) IN CUBA**

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Abstract Two new microsporidia infecting the gut epithelium of the Cuban potato beetle *Polygramma undecimlineata* are described: *Nosema polygrammae* sp.n. with oval spores of 4.8 by 2 μ m and *Plistophora fidelis* sp.n. with minute oval spores 2 by 1 μ m in irregular pansporoblasts. They cause chronic infections with a cumulative mortality up to 80% before pupation. Both pathogens are infectious for *Leptinotarsa decemlineata*, the Colorado potato beetle.

INTRODUCTION

Long years of research devoted to the investigation of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), mainly in Europe, brought some knowledge of its ecology, biology, physiology and its parasitism in new areas of its distribution. But there are two serious gaps in its investigation which are important for studies of its control, mainly biological control. There is no information about any "original region" of its distribution in America and the parasites and diseases occurring there in the endemic population and there is no information about the parasitism and the diseases of closely related species distributed in Central and South America which could be used as source of material for introductions. Studies of *Perillus bioculatus* Fabr. and all efforts to introduce it to Europe brought no permanent results, and lack of positive evidence of parasitism was recorded from experimental introductions of *Doryphorophaga doryphorae* Riley. The Colorado potato beetle, on the other hand, continues its progress into the centre of the Eurasian continent, and owing to increasing resistance and ban of some insecticides it is a more and more common pest in our region, occurring in large populations. The investigation of all kinds of candidate biological factors for its control is a very important task.

During a thematic course of cooperation with the Institute of Biology, The Cuban Academy of Sciences, Havana, Cuba, both authors had the opportunity to study the parasitism of a Cuban Chrysomelid closely related to *L. decemlineata*, *Polygramma* (L.) *undecimlineata* Stal. This insect is recorded from the area of southern Florida and some Caribbean islands. It is very rare in southern Florida and we could not collect any material there during two excursions in the last years. On the territory of Cuba,

on the other hand, the species is very common, connected with its food plant *Solanum torvum* which is a common weed on the sides of roads and in ruderal, devastated areas. All stages of this beetle, the mode of living of all instars are very close to the living habits of the potato beetle in Europe. Eggs are laid in batches of 20–30, first two larval instars live in groups close together, later they spread over the host plant. Last larvae migrate to the soil and pupate there. The cycle turns during the spring in one month, and seems to be shorter in summer, all in all four to five cycles as there is some estivation and hibernation during high summer and winter. The animal lives only on one food plant and does not attack the field potato crops.

First experiments with the evaluation of the natural control agents showed the tachinid flies as the most efficient parasite. As shown earlier (Weiser and Hostounský, 1967), two species, *Doryphorophaga australis* Reinhard and *Tachinophyton floridensis* Townsend, cause as much as 94% mortality of larvae collected as first instars in nature. The pupae of the tachinids push their spiracula through the dorsal cuticle of pupating *Polygramma* and infected animals are easily recognized and selected. The climatic conditions of the region give no fair chance to the two parasites to survive in Europe and help to bring the introduced *Leptinotarsa decemlineata* by parasitization efficiently in the field under control. Some experiments showed that under subtropical conditions the flies are attracted to *Leptinotarsa decemlineata*. Experiments did not proceed farther behind this. We collected in Cuba infected larvae from the lowlands to the high peakst of the mountains of Sierra Maestra. The very short periods of temperatures around 0 °C in these localities (Pico Cuba, Gran Piedra) were met by the parasites in the soil during a short hibernation. These conditions could not be compared with hard winters in the main area of distribution of the potato beetle.

In a second series of observations we studied other possible parasites or pathogens of *P. undecimlineata* in Cuba. In 1964 Dr. I. Hrdý collected some material which contained some microsporidian. The material was not good for histological evaluation and later the spore suspension was lost. After a negative search in 1966, in the period of 1971–1972 further material was collected with viable spores and infected larvae and adults so that it was possible to study the infection. This study is a part of a larger investigation which will be published subsequently.

MATERIAL AND METHODS

Eggs, larvae of all instars and adult beetles were collected in practically all regions of Cuba. They were reared separately in plastic containers on *Solanum torvum* leaves. All dead animals were inspected for signs of infections and smears or suspensions of parts of the dead body were studied under the microscope. Living animals with aberrant behaviour were inspected, their feces were spread under cover slip and inspected under the microscope and later they were dissected after some days of isolation in individual vials and all tissues were studied separately from dissected bodies.

Smears were stained with Giemsa azur-cosin stain and spores of Microsporidia were identified. Fresh material was used for measuring the spore size. It was clear later that mainly gut-infections were present and for this investigation feces of whole groups in boxes were washed from the walls and inspected. Only groups with sporadic occurrence of spores were investigated. For histology, different stages were fixed in Bouin's fluid and cut in paraffin. Different stainings were used, but Heidenhain's iron hematoxylin was the most useful. Feces of infected groups and one part of the dissected bodies were stored in distilled water in the refrigerator and spores were

washed and concentrated by centrifugation and used for laboratory infection. The specific gravity of the spores is very close to some parts of food plants and the separation of the spores was very difficult.

List of localities with positive material

1. Paso Real, province of Pinar del Rio, ruderal vegetation on the side of a highway. On Nov. 9, 1971, 350 larvae (L₃) were collected; 170 of them died before pupation. In homogenised dead bodies scarce spores were found, in other animals spores were present in the feces. One part of the positive larvae was parasitised by tachinids.

2. Viñales, province of Pinar del Rio. On the highway to the well known tourist centre 200 larvae were collected on plants intensively defoliated, on January 7, 1972. In the feces of larvae and in animals kept in laboratory rearing spores were found.

3. Cayo Güin, province of Oriente. In a deep valley 48 living larvae were collected of the 4th instar on March 9, 1972. They were reared till pupation at the laboratory, spores were recognized in the feces and in the meconium of the adults.

4. Gran Piedra, province Oriente, one of the peaks of Sierra Maestra. On both sides of the highway from 600 to 1200 m larvae were collected on June 2nd, 1972. During the next 14 days of rearing in the laboratory spores appeared in the feces.

5. Cayo la Rosa, near Havana. In mid-June prepupae and adults active in depositing their eggs were collected. There were spores in the feces of adult beetles.

Many other collections from different localities in different biotopes and altitudes were negative at the time of the collection.

Living larvae and adults of *P. undecimlineata* were brought to the laboratory in Prague for final investigation and histological evaluation. In many cases of heavy infection the fixation of the infected tissues was difficult because of the early destruction of the infected tissues even in animals still moving around on leaves.

SYMPTOMS OF THE INFECTION

At first, infected animals did not differ from others of the same group. The feces which brought evidence of the infection with one or with a combination of infections showed an increased amounts of spores which were distributed with the moist feces on leaves. With intensive use of leaves on experimental plants, the re-infection was common. In the second half of the development of larvae the number of liberated spores in feces was more and more reduced. Mainly before pupation larvae of the last instar ceased feeding, were very slow in motions and finally died. For some time they reacted on irritations when lying on their back.

During dissections there was no important symptomatology in infected animals. The fat body had its normal structure and the gut had the ordinary yellow semitransparent appearance. Only after dissection and in native preparations of the gut under the cover slip, groups of spores were clearly seen in the posterior part of the midgut.

After pupation the adults which emerged from infected larvae showed again the liberation of spores in the feces. Some of them, with only low infections, lost the infected gut cells during the pre-pupal period and did not show any spores in adults.

Spores of different size were isolated from different larvae. We wish here to study two infections most common during the period of collecting.

Nosema polygrammae sp.n.

Host: Larvae, pupae and adults of *Polygramma undecimlineata* from the localities of Paso Real (Nov. 7, 1971) and Gran Piedra (June 2, 1972). The infection attacks the epithelial cells of the midgut. Mononuclear and binuclear schizonts are present, oval in shape, $5 \times 3 \mu\text{m}$. Elongated sporoblasts,

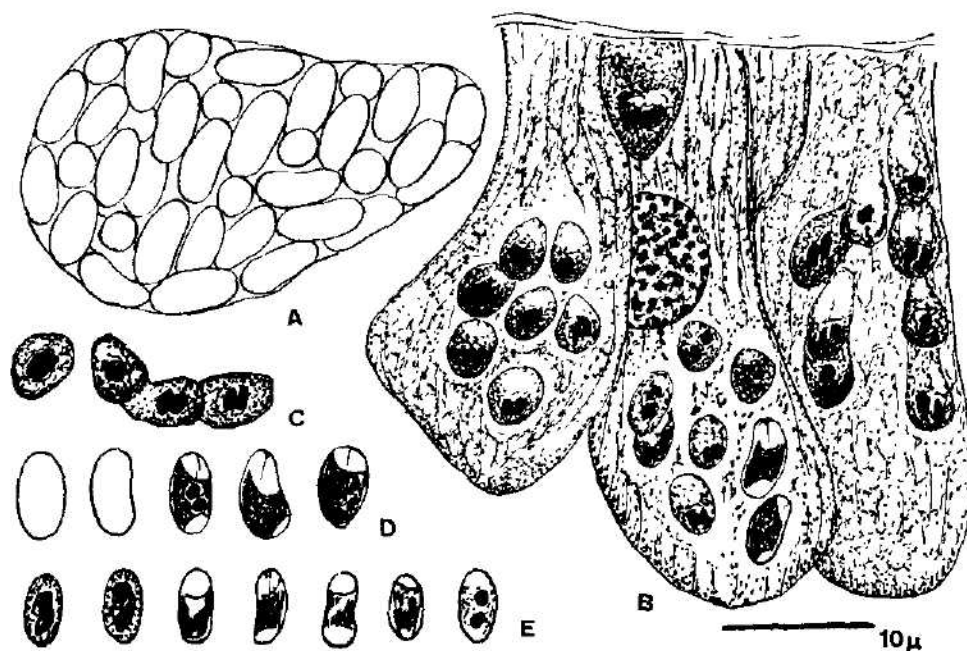


Fig. 1. *Nosema polygrammae* sp. n. A. Pseudocyst with spores in remains of the host cell. B. Section of the gut epithel with schizonts and young spores, all binuclear. C. Schizonts, D, E different pictures of the fixed and stained spores and position of the nuclei.

$5 \times 2.5 \mu\text{m}$ have a pair of nuclei in their centre. They mature into broad oval spores with both blunt ends equal, not arched, without a vacuole in one end. Stained after Robinow for spore nuclei they show two spherical nuclei in each spore. Fresh mature spores measure 4.8 ± 0.6 by $2.05 \pm 0.3 \mu\text{m}$ and spores on dry smears 4.9 ± 0.4 by $1.8 \pm 0.3 \mu\text{m}$. The polar filament is not extruded regularly and was not measured. (Fig. 1)

Infected cells are concentrated in the central and posterior part of the gut in the flat epithelial wall. Spores are concentrated in the protruding part of the infected cell. They are produced from long rows of schizonts and sporoblasts deposited in infected cells from the gut cavity to its muscular sheet. Around late schizonts and sporoblasts a digested vacuole is formed and its space is filled with maturing spores. In the same way as it is the case in *Nosema apis*, infected cells are broken at their protruding ends and groups of spores leave the cell with remains of food, sometime closed up in the cell membrane. The peritrophic membrane is usually unaltered in the first third of the gut. Then it is broken and mixed up with some remains of food and masses of spores liberated from infected cells. There is no secondary bacterial infection in the gut, the nuclei of destroyed cells are granulated and degenerating. Destroyed cells are replaced by regeneration from regeneration centers.

The microsporidian is present only in the gut. Other tissues, including the muscular layer of the gut; body musculature, fat body, Malpighian tubes, hypoderm or neural ganglia are not infected. In adults there was no infection in the gonads or in deposited eggs. The only way of transmission is

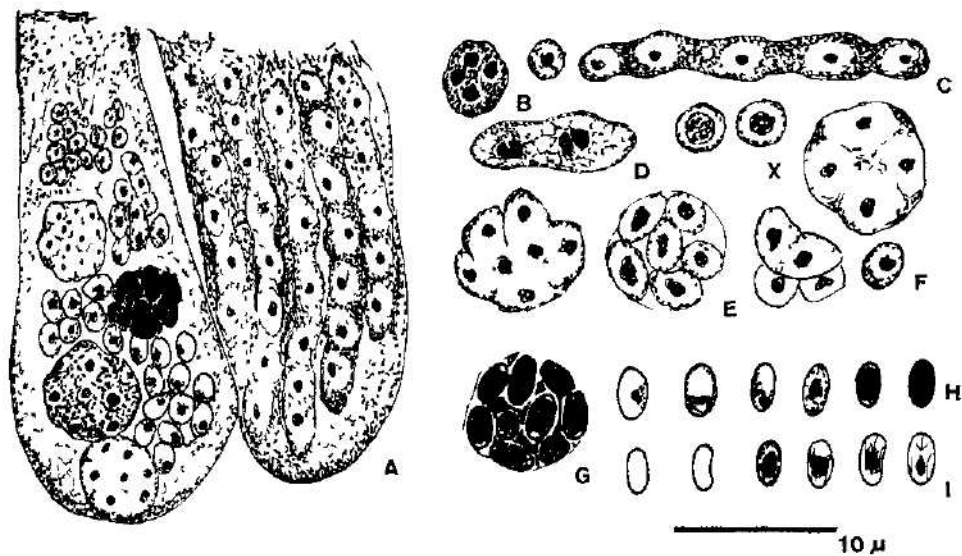


Fig. 2 *Plistophora fidelis* sp.n. A Different stages in the cells of the midgut B Multinuclear first schizont C Merozoite and its development to flat ribbons of second schizonts D Diplokaryon stage X The autogametes E Sporogony with production of pansporoblasts (G) F Fragmentation of the plasmodium and maturation of single sporoblasts and spores H, I. Spores after different fixation.

via food contaminated with feces of infected animals. There is no transmission in or on the body of the parasitic flies. The transmission is well adapted to the gregarious living of young larvae and the rich liquid defecation on the food. The effect of the infection is reflected in decrease of feeding. In well infected larvae the daily feeding is reduced to a minimum and in the gut there are no remains of food.

The microsporidian is a specialized endemic pathogen of the Cuban potato beetle. We propose for it the name *Nosema polygrammae* sp.n.

Plistophora fidelis sp. n.

Host Larvae, pupae and adults of *Polygramma undecimlineata* from the localities Paso Real (Nov. 7, 1971), Cayo Guin (June 6, 1972) and Viñales (Jan. 7, 1972), often in mixed infections with *N. polygrammae*. The infection attacks the epithelial cells of the midgut. Primary disseminated lesions are later confluent and form large entirely destroyed areas of the gut with large masses of spores. Minute schizonts start the invasion near the basement membrane and grow through the cylindrical cells to the end of cells protruding into the gut cavity. Schizonts are mainly elongated and ribbon-like with nuclei located in rows (Fig. 2). By further divisions these grow into grape-like clusters of merozoites. In section preparations these stages have a typical appearance as droplets with asymmetrical concentration of the plasmodic content on the growing end. They fill the infected cells with sacs of stages, dissolve the cytoplasm and fill the vacuoles with dividing stages. The stages in sporogony grow to spherical plasmodia with an irregular

number of nuclei (5, 10, 15), and these transform to pansporoblasts with spores formed in groups. In most cases the wall of the sporoblast is formed at the time when the wall of the pansporoblast disappears so that sporoblasts and spores are free, concentrated in the empty space of the periparasitic vacuole in the gut. Sporoblasts are uninuclear, elongated elliptical, 3 by 2 μ m. They form regular oval spores with rounded ends, 2–2.5 μ m long and 1 to 1.2 μ m broad. In dry smears stained with Giemsa we find the anterior end narrowed. Stained after Robinow they show only one spherical nucleus.

In the flat epithelial cells the spores fill up all space around the nucleus. The functions of the cell are destroyed and the nucleus changes into a mass of granules. The cells are replaced by regeneration and liberated spores leave the gut with the feces. The cylindrical cells concentrate the spores in the posterior end and produce protrusions which separate from the cell and in form of spherical pseudocysts leave the gut. Some of the "decapitated" cells are still able to close up the wound and survive for some time. Massive spore production is typical for experimental laboratory infections. In nature the spore production is rather low and in mixed infections the result is not synergization but only co-existence of two infections. Infected larvae of *Polygramma undecimlineata* display irregular growth. The feces with spores are mostly liquid and they remain with the proteinic exudate and the peritrophic membrane of the gut sticking around the anal opening. With the spore size and shape the microsporidian from *Polygramma undecimlineata* is similar to *Plistophora schubergi*. But this microsporidian is a pathogen of Lepidoptera, its distribution and pathogenicity in the host gut is very different and also cross infection feeding experiments were negative. The microsporidian is a Cuban endemite with no analogy in European Chrysomelidae. We propose therefore the name *Plistophora fidelis* sp.n. for the studied parasite.

DISCUSSION OF THE INFECTIONS

Both pathogens of *Polygramma undecimlineata* described are species invading the gut only. *N. polygrammae* produces usually elongate foci well visible from the surface of compressed dissected guts. In experimental infections the foci were usually in the posterior part of the midgut whereas *P. fidelis* is more common in the first part of the midgut. There were no close-together invasions of the gut in natural infections. Both infections cause higher degree of destruction of the cells and increased regeneration. Decreased activity of the gut in digestion and resorption reflects in the decreased gain of weight of larvae and a larval mortality of 80 and more per cent before pupation. The mortality depends very much on the initial dosage. During pupation an essential part of the infected cells is rejected and the few adults which emerge from pupae of the infected lot start only with a very low infection, some of them have no more spores in their feces.

Separation of the spores from the remains of feces, the same as the separation of each microsporidian from the other one, are very difficult, in comparison with the microsporidia present in Lepidoptera. In field collections some positive larvae were infected with larvae of tachinids at the same time. The parasite was not infected with the microsporidia and there was no transmission of the microsporidia on ovipositors of adult females.

The two microsporidia described do not play any important role in natural control of *Polygramma undecimlineata* — here the tachinids are the most important reducing agents. But the microsporidia may play an important role in biological control of the Colorado potato beetle. In experimental infections of larvae of *Leptinotarsa decemlineata* both microsporidia were able to produce infections of the gut with symptoms identical with those described in the wild potato beetle.

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The plates will be found at the end of this issue.

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SECOND CONTRIBUTION TO THE KNOWLEDGE OF MARINE TUBIFICIDAE
(OLIGOCHAETA) FROM THE ADRIATIC SEA

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Abstract: The present paper contains the list of Oligochaeta known up to now from the Adriatic and Black Seas, the description of *Bohadschia monotheca* sp.n. (Tubificidae) and remarks to the description of *Bohadschia pierantonii* Hr., *Limnodriloides agnes* Hr., *L. maslinicensis* (Hr.) *L. fragosus* Fin., *Phalodrilus adriaticus* Hr., *Thalassodrilus gurwitschi* (Hr.) and *Adelodriloides kiselers* (Fin.).

During the second visit to the Šolta Island in the Adriatic Sea south-west of Split, I collected, on June 1—12, 1972, marine Tubificidae in the Maslinica Bay and the Krušica Bay on the Šolta Island and in Split, in the vicinity of the beach Ovčice.

In the Maslinica Bay on the western coast of the Šolta Island, I found *Limnodriloides agnes* described from the Black Sea at Nesebar (Hrabě, 1967), besides *Limnodriloides maslinicensis*, *Bohadschia pierantonii*, *Phalodrilus adriaticus* and *Thalassodrilus gurwitschi*, all described from the Maslinica Bay in my 1971b paper.

In the Krušica Bay on the northern coast of the Šolta Island I collected one specimen of the new species, *Bohadschia monotheca* sp.n., two specimens of *Limnodriloides fragosus*, described by Finogenova (1972) from the Bosphorus, and the same species as in the Maslinica Bay, except *Thalassodrilus gurwitschi*.

In the vicinity of the beach Ovčice in Split, only *Phalodrilus adriaticus*, *Limnodriloides agnes* and *Limnodriloides fragosus* occurred.

Thalassodrilus gurwitschi was found in the Maslinica Bay in places very polluted by decaying organic matter. For this reason, this species is probably absent in the samples from Krušica Bay and from the locality in the vicinity of the beach Ovčice.

On contrary, *Phalodrilus adriaticus*, obtained in the Maslinica Bay as well as from the Krušica Bay and Ovčice beach, from localities less polluted, prefers probably a less decayed substratum.

The investigation of the Oligochaeta of the Adriatic (1971) and Black Sea (1964) has just begun and thus it is very difficult to speak about the horizontal and vertical distribution of these worms in the mentioned seas.

Up to now, I have found, in the Adriatic Sea, *Phalodrilus adriaticus*, *Limnodriloides maslinicensis* and *Bohadschia monotheca*, besides *Thalassodrilus gurwitschi*, *Limnodriloides agnes*, *Limnodriloides fragosus* and *Bohadschia pierantonii*, which also live in the Black Sea.

From the Black Sea we now know *Nais elinguis*, *Paranais litoralis*, *Bacescuella pontica*, *Phallodrilus minutus*, *Adelodriloides borceai* and *kiselevi*, *Rhizodrilus ponticus*, *Tubifex maritimus* and *costatus*, *Pelosclex svirenkoi* and *euxinicus* besides four species mentioned, occurring in the Adriatic Sea as well (Hrabě, 1973). Table I.

I collected Oligochaeta only in the depth of 0.5–0.7 m. This fact has influenced our present knowledge of the vertical distribution of Oligochaeta in the mentioned seas. The majority of the species from the Adriatic and Black Seas are known from the depth of 0.5–0.7 m, only *Pelosclex euxinicus* occurs in the depth of 41–100 m, *Adelodriloides kiselevi*, in 50–150 m, *Pelosclex minutus*, in 100–120 m, *Adelodriloides borceai* and *Tubifex maritimus*, in 120 m. Three species can already now be regarded as "eurybath": *Pelosclex svirenkoi*, occurring in a depth of 0.6–79 m, *Limnodriloides fragosus*, in 0.5–85 m and *Bohadschia pierantonii*, in 0.5–200 m. Table I.

A better fixation of more numerous material in Bouin's and Navašin's fluid enabled me to supplement the description of some species described in my earlier papers (Hrabě, 1967, 1971a, b, 1973).

Table I

Oligochaeta from the Adriatic Sea known up to now

(The species found in the Adriatic and Black Seas are printed in italics)

<i>Thalassodrilus gurwitschi</i> (Hr., 1971a)	0.5–0.7 m	H	(Hr., 1971a, 1973)
<i>Limnodriloides agnes</i> Hr., 1967	0.5–0.7 m	H	(Hr., 1967, 1973)
<i>Limnodriloides maslinicensis</i> (Hr., 1971b)	0.5–0.7 m	H	(Hr., 1971b, 1973)
<i>Limnodriloides fragosus</i> Fin., 1972	0.5–0.7 m	H	(Hr., 1975)
<i>Bohadschia pierantonii</i> Hr., 1971b	0.5–0.7 m	H	(Hr., 1971b, 1973)
<i>Bohadschia monotheca</i> sp.n.	0.5–0.7 m	H	(Hr., 1975)
<i>Phallodrilus adriaticus</i> Hr., 1971b	0.5–0.7 m	H	(Hr., 1971, 1973)

Oligochaeta from the Black Sea known up to now

<i>Paranais litoralis</i> (Müll., 1784)	0.5–0.7 m	R, H	(Hr., 1973)
<i>Nais elinguis</i> Müll., 1773	0.5–0.7 m	H	(Hr., 1973)
<i>Rhizodrilus ponticus</i> Hr., 1967	0.5–0.7 m	H	(Hr., 1967, 1973)
<i>Thalassodrilus gurwitschi</i> (Hr., 1971a)	0.5–0.7 m	H	(Hr., 1971a, 1973)
<i>Bacescuella pontica</i> Hr., 1973	0–0.5 m	R	(Hr., 1973)
<i>Tubifex costatus</i> Clap., 1863	0.5–0.7 m	H	(Hr., 1973)
<i>Limnodriloides agnes</i> Hr., 1967	0.5–0.7 m	H	(Hr., 1967, 1973)
<i>Pelosclex svirenkoi</i> (Jar., 1948)	0.6–79 m	R	(Hr., 1964, 1966, 1971, 1973)
<i>Pelosclex euxinicus</i> Hr., 1966	41–100 m	R	(Hr., 1966, 1971a, 1973)
<i>Adelodriloides kiselevi</i> (Fin., 1972)	50–150 m	F	(Fin., 1972)
<i>Limnodriloides fragosus</i> Fin., 1972	85 m	F	(Fin., 1972)
<i>Adelodriloides borceai</i> Hr., 1973	120 m	R	(Hr., 1966, 1971a, 1973)
<i>Tubifex maritimus</i> Hr., 1973	120 m	R	(Hr., 1973)
<i>Phallodrilus minutus</i> Hr., 1973	100–120 m	R	(Hr., 1973)
<i>Bohadschia pierantonii</i> Hr., 1971b	140–200 m	R	(Hr., 1971b, 1973)

F — N. P. Finogenova descripsit, H — S. Hrabě legit et descripsit, R — Roumanian marine expeditions legerunt.

Bohadschia monotheca sp.n.

In the sample from the Krušica Bay I found one mature specimen of the new species, *Bohadschia monotheca* sp.n., besides 12 individuals of *Limnodriloides maslinicensis* and one specimen of *Phallodrilus adriaticus*. I name the new species *monotheca* according to the number of spermathecae.

The body of this species is 7 mm long, at most 0.2 mm wide and consists of 47 segments.

The prostomium is longer than broad, conical and rounded on the end. Anterior segments with numerous secondary furrows.

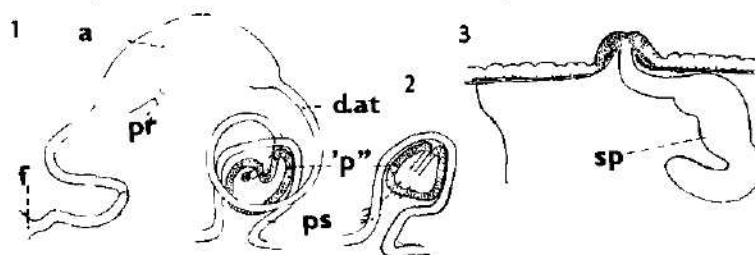


Fig. 1—3. *Bohadschia monotheca* sp. n.

Fig. 1. Male duct, $\times 250$. Fig. 2. Penis. Fig. 3. Spermatheca, $\times 115$. a — atrium, d at — ductus atrialis, d — dissepiment 9/10, f — male funnel, p' — penis (transversal section), p'' — longitudinal section, pr — prostate gland, ps — penial sac, sp — spermatheca.

All setae forked, with upper prong equally long as the lower one but much narrower at the base than the latter. On the segments 2—8 there are 2 setae in one bundle, in the middle and posterior segments only 1 (2) seta. The ventral setae of segment 10 and 11 absent.

The unpaired spermatheca opens on the exterior on a dome-shaped papilla in the medial dorsal line of segment 10 far from the dissepiment 9/10 (Fig. 3). The papilla is formed by high cylindrical epithelium, very distinct from the neighbouring epidermal cells. One pair of male pores in the line of the ventral setae in segment 11.

Dissepiments 3/4—7/8 and especially dissepiments 5/6 and 6/7 are thickened up to 20 μm .

Coelomocytes of *Rhyacodrilus*-type absent as in *Bohadschia pierantonii* and the species of the genus *Limnodriloides*.

Body of the pharyngeal glands in segments 4—5. Chloragogen cells cover the digestive tube from segment 6. One pair of hearts in segment 9.

Oesophageal sacs in the middle of segment 9 present.

Nephridia in segments 7—9 are missing.

One pair of testes in segment 10 on dissepiment 9/10, one pair of ovaria in segment 11 on dissepiment 10/11. Ripe ova in the ovarian sac in segment 12. The heads of the spermatozoa are not spirally twisted.

The spermatheca consists of a long cylindrical ampulla and a shorter duct (Fig. 3).

One pair of male funnels on dissepiment 10/11 extend into the spermduct, 25 μm wide, interiorly ciliated, shorter than the remaining portion of the male duct (Fig. 1). The spermduct does not form loops in the cavity of segment 11. It opens into the spindle-shaped atrial ampulla distinctly delimited from the narrow (17.5 μm) duct, nearly as long as the ampulla. This duct ends in the large conical penis lying in a not too deep penial sac (Fig. 2). Each atrium is furnished with one compact prostate gland. The interior epithelium in the atrial ampulla is filled up with numerous eosinophilous granules of secretion posterior to the entering of ductuli of prostate cells.

On the longitudinal sections, the penis is caught transversally on one side and longitudinally on the other one (Figs 1 and 2).

Locality Adriatic Sea Yugoslavia Šolta Isl., Krušica Bay, in sand behind large stones in front of the breakwater, in the depth of 50 cm June 9, 1972 S. Hrabě leg. (Collectio Hrabě No. Hr. 1870-17 V)

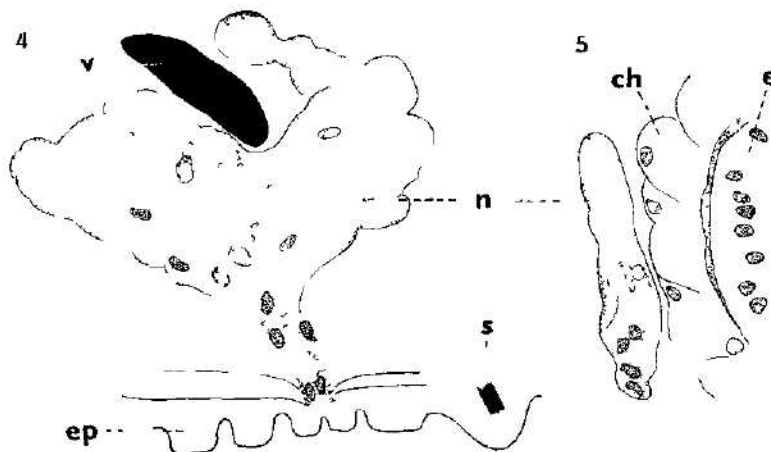


Fig. 4-5 *Laminodriloides aqnes* Hr

Fig. 4 Nephridium (longitudinal section), $\times 370$ Fig. 5 its transversal section, $\times 370$, e epithelium of the digestive tube, ep — epidermis, ch — chloragogen cells, n — nephridium, s — seta, v — vessel

Remarks. The new species differs from *Bohadschia pierantonii* by the following significant characters: it has a very long efferent portion of male duct between the long spindle-shaped atrial ampulla and the penis. Only one spermatheca is present. Its pore lies in the dorsal medial line on the tip of a papilla in the middle of segment 10. Spermatozoa form the so-called spermatozeugmata, large solid aggregations of definite shape.

Bohadschia pierantonii Hrabě, 1971

1971b *Bohadschia pierantonii* Hrabě Ser. fac. sci. nat. Univ. Brno, 1: 217-219

The male duct, ending directly in the penis, corresponds in all cases to figure 1 in my 1971b paper. The cavity of the distal end of the male duct is cylindrical, in sections round but not folding. Penis is retracted in a not too deep penial sac.

In *Bohadschia pierantonii*, nephridia occur in segment 7-9 (Fig. 11). They consist of a nearly globular ampulla and very nice vacuolate tissue surrounding the dorsal and ventral vessel. The ampulla opening before the ventral setae is 30 μ m long and 21 μ m wide, and contains some nuclei. Similar organs are found in the specimens from the Adriatic Sea from the depth of 0.5-0.7 m and from the Black Sea from the depth of 140-200 m.

Localities Adriatic Sea, Yugoslavia, Šolta Isl. Maslinica Bay (Hrabě, 1971b), also June 1 and 12, 1972 Krušica Bay, June 2 and 9, 1972

Black Sea. Loc. No 270, 378-382 of Roumanian marine expedition from the depth of 140, 160, 178 and 200 m. May 22, 1964 (Hrabě, 1973).

Limnodriloides agnes Hrabě, 1967

1967 *Limnodriloides agnes* Hrabě. Publ. Fac. Sci. Nat. Univ. Brno, No 425 : 339-344.
1971a *Limnodriloides agnes* Hrabě. Věst. čs. spol. zool., 35 : 32.

The individuals from the Adriatic Sea are smaller than those from the Black Sea, collected at Nesebar. The diameter of the former in the clitellar region is only 205-382 μm (arithmetical mean of 21 individuals, 288 μm); the diameter of the latter is 364-455 μm (arithmetical mean 414 μm established from 11 specimens).

The cells of the pharyngeal glands are situated in segment 4 and 5, their cellular ducts open between the cylindrical epithelial cells of the dorsal pharyngeal swelling into the cavity of the pharynx.

The nephridia occurring only in segment 6-8 are fan-shaped, oriented with their flat side parallel to the digestive tube (Figs 4-5). In their interior there is a ramified, rather wide duct. The protoplasm of the nephridial cells is very much vacuolate, filled with aqueous secretion. An ectal thick walled ampulla is absent.

The pseudopenial bulb of the specimens from the Adriatic Sea is shorter than that of the individuals from the Black Sea in spite of the fact that all specimens are quite mature. The pseudopenial bulbs of the worms from the Adriatic Sea are 95-105 μm long; those of the specimens from the Black Sea, 150-260 μm .

Localities. Black Sea, Bulgaria, Nesebar (Hrabě 1967, 1971a). Adriatic Sea, Yugoslavia, Šolta Isl. Maslinica Bay (in 5 localities) June 1 and 11, 1972. Kršica Bay, June 2 and 9, 1972. Split, vicinity of Ovčice beach, June 5 and 10, 1972.

Limnodriloides maslinicensis (Hrabě, 1971b)

1971b *Bohadschia maslinicensis* Hrabě. Ser. fac. sci. nat. Univ. Brno, 1 : 220

The new material makes it possible to correct the systematic position of this species. A careful study of the new transversal sections across the ectal end of the male duct shows that this duct ends with a pseudopenial bulb similar to that of *Limnodriloides agnes*, but not to the penis as in *Bohadschia pierantonii*.

In figure 7 the outlines of 12 transversal sections of the pseudopenial bulb are illustrated. In some of the longitudinal sections of imperfectly fixed specimens, a portion of the wall of this bulb is like a penis (Fig. 6, cl) and accounts for my erroneous inclusion of this species in the genus *Bohadschia*, belonging, in reality, to the genus *Limnodriloides*. The transversal sections have now shown that the atrium enters the pseudopenial bulb from the side turned to the digestive tube but not apically (Fig. 8).

In segment 7 and 8 there are two pairs of nephridia of the similar structure as those of *Limnodriloides agnes*.

Remarks. *Limnodriloides maslinicensis* has one pair of oesophageal sacs in segment 9, nephridia and pseudopenial bulbs as in *Limnodriloides agnes*. Through this last character it differs from *Limnodriloides appendiculatus* Pier. and *winckelmanni* Mich.

The differences distinguishing *Limnodriloides maslinicensis* from *Limnodriloides agnes* are the following: number of nephridia which occur only in segment 7-8, heads of spermatozoa are twisted, spermatozoa are not arranged regularly in bundles in the spermathecae (Hrabě, 1967, Figs 16 and 24).

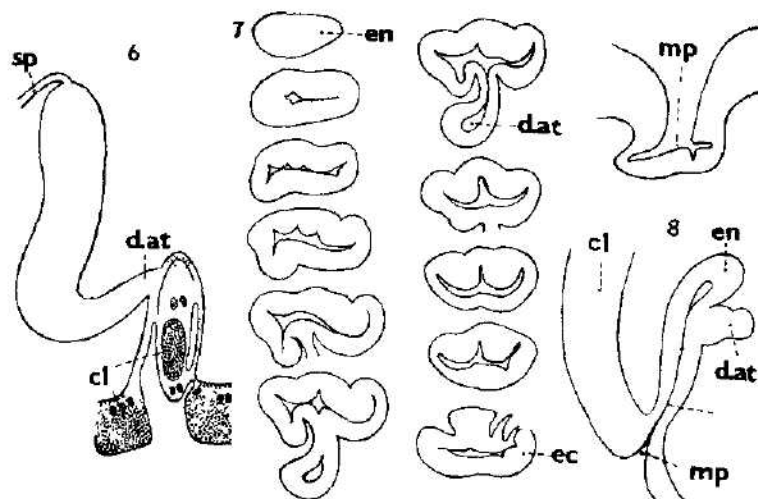


Fig. 6-8. *Limnodriloides maslinicensis* (Hr.)

Fig. 6. Male duct, $\times 235$. Fig. 7. Transversal sections of pseudopenial bulb, $\times 400$. Fig. 8. Longitudinal section of pseudopenial bulb, $\times 275$. Cl — clitellum, d. at — ductus artialis, ec — ectal end of pseudopenial bulb, en — its ental end, mp — male pore, sp — spermduct.

The spermatozoa with heads of the mentioned form occur in all 28 series of sections. The spiral is visible only with an oil-immersion.

Localities: Adriatic Sea, Yugoslavia. Šolta Isl. Maslinica Bay (Hrabě, 1971b), June 1, 8 and 12, 1972, too. Krušica Bay, June 2 and 9, 1972.

Limnodriloides fragosus Finogenova, 1972

1972 *Limnodriloides fragosus* Finogenova. Trudy zool. inst. AN SSSR, 52 : 98-101.

Finogenova (1972) described this species on the grounds of specimens collected from a depth of 85 m in the Bosphorus. They differ from the other species of the genus *Limnodriloides* by the spermathecal pores in the lateral line of segment 10. By this significant character I succeeded in exact determination of 4 specimens found in June, 1972, in Krušica Bay, Šolta Isl., and in the vicinity of the beach Ovčice in Split. Two specimens from the last locality are sexually mature and very well fixed. I am able to correct or supplement the description of this species published by Finogenova in Russian.

$$\text{Setal formula: } \frac{3-4(5) \dots | \quad | 2 | \dots 2}{3-4 \quad \dots | - | 2 | \dots 2}$$

All setae forked, with the upper prong shorter than the lower one. In each setal bundle there are large, deeply stained, formative cells in which setae develop.

The body surface is provided with a thin layer of cuticle, which has nothing to do with secretion of the *Pelosclex* species.

The anterior and posterior pharyngeal glands discharge their secretion among the cells of the dorsal pharyngeal diverticulum. The pear-shaped portion of the posterior pharyngeal glands occur in segment 4-5. The dif-

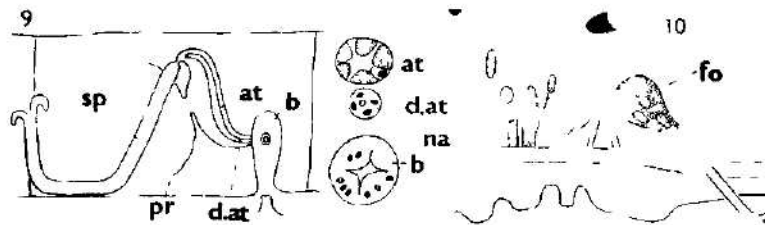


Fig. 9-10 *Limnodriloides fragosus* (Fm.)

Fig. 9. Longitudinal section of segment 11, $\times 130$ and $\times 352$ Fig. 10. Longitudinal section of segment 8, $\times 620$. At — atrium (longitudinal and transversal section), b — pseudopenial bulb, d. at — ductus atrialis, fo — formative cells, na — nephridial ampulla, pr — prostate gland, sp — spermduct.

ference in the appearance of the anterior and posterior pharyngeal glands is well evident from the photograph No 5 in my 1930 paper on the Oligochaeta from the Janina Lake (Věst. kr. čes. spol. nauk. Tř. II., 1930).

Chloragogen cells cover the digestive tube from segment 6.

In segment 9 there are two oesophageal sacs.

In front of the ventral setae of segments 7 and 8 there is a small pear-shaped nephridial ampulla containing some nuclei and a cavity, beginning at the level of nuclei and increasing in width in the ectal direction. I failed to find the opening of ampulla on the body surface. Finely vacuolate tissue covers the apical end of ampulla and reaches to the dorsal or ventral vessel (fig. 10, na). These nephridia are of different structure from the excretion organs of *Limnodriloides agnes* and *maslinicensis* and are similar to nephridia of *Bohadschia pierantonii* and *Thalassodrilus gurvitschi* also described in this paper (Figs 11 and 12).

Clitellum covers the body from the end of segment 10 and the whole segments 11 and 12.

One pair of spermathecal pores lie exactly in the lateral line between the setal bundles of segment 10.

One pair of male pores in place of the ventral setae of segment 11.

One pair of testes on dissepiment 9/10, one pair of ovaria on dissepiment 10/11.

Small male funnels on dissepiment 10/11 (Fig. 9). They are continued into the corresponding spermducts, 20 μ m wide, which descend to the ventral body wall, run backwards and then turn obliquely to the dorsal wall, where each of them opens into the wider apical end of the atrial ampulla. Before this opening the spermduct narrows and is thus well separated from the atrial ampulla. It is interiorly ciliated throughout the length. Atrial spindle-

shaped ampulla is swollen on one side, on which the ductuli of large prostate gland enter the atrial wall. In epithelium of the ectal half of the atrial ampulla there are granula of secretion of prostatic cells. Ampulla tapers gradually into the short atrial duct opening from the medial side into the pseudopenial sac, 90 μ m long, with an inconspicuous inner cavity. Fig. 9. illustrates also transversal sections of the ectal part of atrial ampulla with the secretory granula, the narrowed duct and the ectal portion of pseudopenial sac.

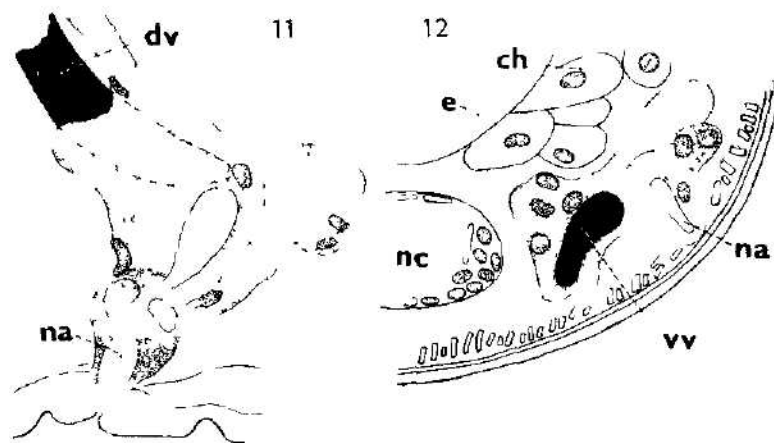


Fig. 11. *Bohadschia pierantonii* Hr., $\times 690$ Fig. 12. *Thalassodrilus gurwitschi* (Hr.) $\times 445$. Fig. 11 and 12. Longitudinal section of nephridium. Ch — chloragogen cells, dv — dorsal vessel, e — epithelium of the digestive tube, na — nephridial ampulla, nc — nerve cord, vv — ventral vessel.

Spermatozoa, with heads not twisted spirally, cover the funnels.

In description of *Bohadschia pierantonii*, the short heads of spermatozoa are probably parts of normal spermatozoa cut off obliquely.

The spermathecae of mature specimens consist of large spherical ampullae and short ducts. Epithelium covering the interior of the ampullae contains large vacuolae without resorbing spermatozoa. In the cavity of ampullae there are typical spermatozeugmata and free spermatozoa.

The anterior sperm sac developed in invagination of dissepiment 9/10 in segment 9. The posterior sac extends from dissepiment 10/11 to segment 12 or, in another specimen, to segment 13. Ripe ova are in segments 13 to 15 (16).

Localities. Adriatic Sea, Yugoslavia, Šolta Isl. Krušica Bay, June 2, 1972 (Collectio Hrabě No Hr. 1870-14 II, III). Split, vicinity of Ovčice beach, June 5, 1972 (Collectio Hrabě No Hr. 1870-18-I-II) — Black Sea, Bosphorus, depth of 85 m. Finogenova, 1972 descrip

Phalldrilus adriaticus Hrabě, 1971

1971b *Phalldrilus adriaticus* Hrabě Ser. fac sci nat Univ. Brno, 1: 220–223

Localities. Adriatic Sea, Yugoslavia Šolta Isl. Maslinica Bay. (Hrabě 1971b), June 8 and 11, 1972, too. Krušica Bay, June 2, 1972. Split, vicinity of Ovčice beach, June 5 and 10, 1972.

Thalassodrilus gurwitschi (Hrabě, 1971)

1971a *Limnodriloides gurwitschi* Hrabě. Věst. čs. spol. zool., 35 : 33–34

1971b *Thalassodrilus gurwitschi* Hrabě. Ser. fac. sci. nat. Univ., Brno, 1 : 224–225.

Nephridia of *Thalassodrilus gurwitschi* are found in segments 6–8 (fig. 12). In two series of transversal sections, I observed that they consists of a short ampulla with about 4 nuclei and finely vacuolate tissue, covering the dorsal vessel which is sunk ventrally on the right side of the body, and the ventral vessel on the left one as in *Bohadschia pierantonii* and *Limnodriloides fragosus*.

Localities: Black Sea. Bulgaria. Nesebar, June 10, 1968 (Hrabě, 1971a). Adriatic Sea. Yugoslavia. Solta Isl. Maslinica Bay. (Hrabě, 1971b) also June 6 and 12, 1972.

Addenda

Adelodriloides kiselevi (Finogenova, 1972)

1972. *Heterodrilus kiselevi* Finogenova. Trudy zool. inst. AN SSSR, 52 : 102–104

Heterodrilus kiselevi, described by Finogenova from the Black Sea, belongs to the genus *Adelodriloides*, characterised by Cook (1970) as follows: Hair setae absent. Penial setae highly modified. Male and spermathecal pores paired. I can add to this diagnosis: Prostate glands missing. Spermathecal pores immediately behind the intersegmental line 9/10. Penis absent.

Adelodriloides kiselevi is related to *Adelodriloides borceai* (Hrabě 1973). It differs from this species by the form of penial setae. In *A. borceai* as well as in *A. voraginus*, they are hook-shaped terminally, while in *A. kiselevi* they are spoon-shaped. Posterior to the large penial seta there are, in *A. kiselevi*, 3–7 normal ventral setae, in *A. voraginus*, 3–6 simple pointed setae while in *A. borceai* these additional setae are absent.

Pharyngeal glands occur in *A. kiselevi* in segment 3–5, in *A. borceai* in segment 5–6, in *A. voraginus* still in segment 7.

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NEW RECORDS OF NEMATODES FROM INDIAN BIRDS

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Abstract: Four spirurids and three filariids from seven different species of avian hosts of West Bengal, India, have been recorded. The nematode species are *Cyrnea (Cyrnea) eurycerca*, *Huŕjelŕia truncata*, *Dispharynx nasuta*, *Oxyŕpirura kaitingensis*, *Pseudaprocta decorata*, *Cardioŕfilaria paulowskyi* and *Chandlerella boei*. Some of these have been recorded from new hosts and from new geographical region. The variations in the morpho-metry have been mentioned. *O. (Oxyŕpirura) basiri* has been synonymised with *O. kaitingensis*.

Sixteen birds belonging to seven species occurring in West Bengal, India, were autopsied to examine the nematode parasites harboured by them. Of these, ten birds were found to contain parasitic worms belonging to Spirurata (four species) and Filariata (three species). The nematodes are already established. But some of them have been recorded for the first time in the present hosts and geographical regions. Moreover, variations exhibited by them have also been recorded. All the measurements are in mm. The parasites have been deposited at the Czechoslovak Institute of Parasitology, Prague.

SYSTEMATIC SURVEY

Spirurata

Fam. Habronematidae

1. *Cyrnea (Cyrnea) eurycerca* Seurat, 1914

Host: *Gracula religiosa indica*.

Location: Under tunic of gizzard.

Locality: Barrackpore, West Bengal, India.

One bird was examined and found to harbour one male and two female (one mutilated) nematodes.

This is the first record of occurrence of the species from India, and from a new host. Earlier the species has been recorded from Palaearctic and Ethiopian regions only (vide Skrjabin and Sobolev, 1963). The description of the species has been subtaxiated by Solonitsin (1928). The description of his species, after further examinations, was found to be *C. (Cyrnea) capitellata* (Schneider, 1866) Guschanskaja, 1937 (vide Baruš and Rutkowska, 1965). Determination of metrical range has been made from present material as also from available literature (Table 1).

Besides agreeing with the morphological details, the present worms bear affinities with *C. (Cyrnea) eurycerca* in metrical range also (vide Table 1).

¹ This study was supported by UNESCO and the University of 17th November, Prague, and was carried out in the Czechoslovak Institute of Parasitology, Prague.

Table 1: Metrical range of male *Cyrnea (Cyrnea) eurycerca* according to different authors (modified after Solonitsin, 1928)

Regions	Seurat (1914)	Semenov (1926)	Present data	Range
Body length	7.5	5.68 — 7.36	6.35	5.68 — 7.36
Body breadth	0.25	0.13 — 0.20	0.22	0.13 — 0.25
Oesophagus length	2.5	2.01 — 2.39	2.27	2.01 — 2.5
Small spicule length	0.38	0.31 — 0.46	0.34	0.31 — 0.46
Large spicule length	1.68	1.67 — 2.06	2.01	1.67 — 2.06
Accessory piece	0.07	0.036 — 0.054	0.042	0.036 — 0.07

Moreover, the ratio of the larger spicule to the body length of male (1 : 3.40) and spicular ratio (1 : 5.04 ± 0.34) are in conformity with the specific diagnosis. There are four pairs of preanal and six pairs of postanal papillae in male. Distal five pairs of small sessile papillae are separated from proximally located pedunculated ones by a gap as is the characteristic feature of the species. Only the paracloacal papillae are found to be wanting.

2. *Hadjelia truncata* (Creplin, 1825)

Host: *Alcedo atthis bengalensis*.

Location: Underneath the tunic of gizzard.

Locality: Burdwan, West Bengal, India.

Two of the three birds harboured four male (one mutilated) and two female (one mutilated) worms.

This parasite was recorded from birds belonging to orders Passeriformes, Cuculiformes, Coraciiformes and Caprimulgiformes of European and Asiatic (mainly Indian) regions (Skrjabin and Sobolev, 1963). The present record is an addition to the host list. The metrical evaluation of the present material indicates further variabilities from the recorded ones.

Male: $3.92-5.58 \times 0.135-0.158$. Highly chitinised vestibule (0.034 to $0.052 \times 0.008-0.009$) is followed by bipartite oesophagus (muscular part $0.171-0.260 \times 0.016-0.026$, glandular part $1.468-1.947 \times 0.049-0.059$). The shorter left spicule ($0.217-0.283$) bears a finger-like proximal end, while the longer right spicule ($1.303-1.306$) bears a broadened, flask-shaped proximal region. In addition to pedunculated papillae numbering four pairs of preanal and two pairs of postanal, there is an unpaired one on the right preanal side.

Female (based on one specimen excepting measurements of eggs which have been recorded from the matured but mutilated specimen): 3.725×0.115 . The vestibule measures 0.039×0.008 . The muscular oesophagus is 0.165×0.016 , and glandular oesophagus is 1.108×0.034 . The tail is finger-like and devoid of any papilla. The vulva is at 0.924 from anterior end. The vagina is directed caudad. The egg (0.043×0.026) is oval and embryonated.

Fam. Acuariidae

3. *Dispharynx nasuta* (Rudolphi, 1819)

Hosts: *Alcedo atthis bengalensis*; *Clamator jacobinus*.

Location: Glandular part of proventriculus.

Locality: Burdwan, West Bengal, India.

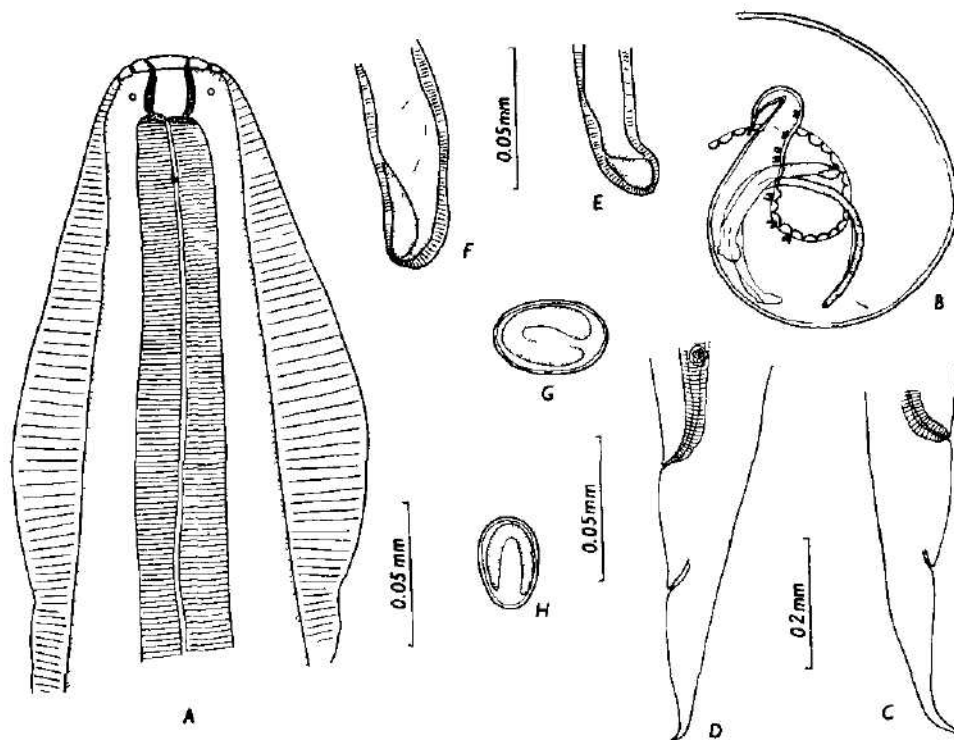


Fig. 1. *Oxyuris lattingensis* (Hsu, 1932) from *Sturnopastor contra*. A, B, D, F & H drawn from specimens bearing cephalic alae; C, E, & G from specimens devoid of cephalic alae. A — Anterior end of female (lateral view); B — Posterior end of male (lateral view); C — Posterior end of female (lateral view); D — Posterior end of female (lateral view); E — Distal end of right spicule (lateral view); F — Distal end of right spicule (ventral view); G & H — Eggs.

Three *A. atthis bengalensis* were found to contain eleven male and seven female parasites; three of four *C. jacobinus* harboured two male and eight female nematodes. (Of these a total of five males and three females have been processed for scanning EM.)

This cosmopolitan species has been recorded from a large number of hosts (vide Skrjabin, Sobolev and Ivaskin, 1965). The present two species of hosts are found to harbour this nematode for the first time. All the specimens confirm specific diagnosis excepting one female in which the cordons end just at the point of recurrence, a feature characteristic of *D. brevicordon* Schuurmans-Stekhoven, 1952. But the rest of the features of this specimen are in full agreement with that of *D. nasuta*. The occurrence of a terminal papilla at the tail end of female is not universal in this species as is evident from examinations of the present population. The computed metrical range (vide Sahay, 1966) in female explicits some variations: ratio of body length to extent of cordon 11.20—17.30 : 1, glandular to muscular oesophagus 3.79—4.43 : 1, and extent of cordon to pharynx 2.29—3.75 : 1. The males are $3.498-4.108 \times 0.161-0.264$, while the females $2.857-4.851 \times 0.234$ to 0.429.

Fam. Thelaziidae

4. *Oxyspirura kaitingensis* (Hsü, 1932)

Host: *Sturnopastor contra*.

Location: Orbital cavity.

Locality: Sagar islands, West Bengal, India.

One bird was autopsied and was found to bear six male (one mutilated) and five female (one mutilated) nematodes.

Although eleven specimens were recovered from the same host, five males and two females were found to bear cephalic alae being more prominent in males (Fig. 1 A), while the remaining specimens were devoid of such structures. But the metrical range, morphological details, especially of the cephalic end (excepting alate condition in some), spicules, disposition of caudal papillae in male and eggs in both these apparently heterogenous types are in full agreement. It is rather impossible to isolate these specimens as belonging to different specific populations. Moreover, the cephalic alae, when these are present, are not artifacts developed following fixation as they have clear shapes bearing distinct margin from the body surface and also contain transverse striae which are not confluent with those of the body. Therefore, these are considered to belong to a single species, *O. kaitingensis*. The deviations in metrical range is furnished hereunder. This is recorded from a new host and from a new geographical region.

Male: $4.105-6.180 \times 0.181-0.214$. Cephalic alae, when present, measure $0.115-0.122 \times 0.0165-0.0198$. The left spicule varies between 0.234 and 0.432 while the right spicule (Fig. 1 F-E) 0.102 and 0.211 bearing a ratio of $2.04-2.29 : 1$. There are four pairs of postanal and three pairs of preanal papillae (Fig. 1 B). But in one specimen an additional pair of preanal papillae is observed.

Female: $6.015-9.309 \times 0.221-0.402$. The cephalic alae, when present, are very narrow and measure 0.115×0.066 . The tail is attenuated (Fig. 1 C-D). The vulva is located between 0.330 and 0.478 from the posterior end, and the vulval ratio with the body length is $1 : 18.22-19.47$. The eggs are thick-shelled, oval ($0.029-0.033 \times 0.019$) and embryonated (Fig. 1 G-H).

It appears that, *O. (Oxyspirura) basiri* Siddiqi and Jairajpuri, 1964 is synonymous with *O. kaitingensis*. The possession of cervical alae, seven pairs of caudal papillae in male and the spicular ratio ($1 : 2.5$ in *O. basiri*) are almost identical in both. The former has been recorded from a different host which may be accounted for having a longer body length. The shape of spicules in both is identical.

Filariata

Fam. Aprocetidae

5 *Pseudaprocta decorata* Li, 1933

Host: *Copsychus saularis saularis*.

Location: Underneath the skin of neck region, especially in the site of larynx.

Locality: Burdwan, West Bengal, India.

One of the two birds was found to harbour one male and one female worms.

After Sonin (1964) the nematodes are identified with *P. decorata*. Besides other hosts belonging to Corvidae and Sturnidae, the species was recorded earlier from *C. saularis* and from India too (vide Sonin, 1964). Only morphometrical variabilities are mentioned. Beaded cordons at the anterior end are more prominent and extended farther in male than in its counterpart. The male is 13.129×0.521 and the female 24.979×0.600 . The oesophagus constitutes 1/28th part of the total body length in male, and 1/46th part

in female. Spicules are equal (0.316). The accessory piece is too small and lightly chitinated. The vulva is located in the oesophageal region at a distance of 0.331 from anterior end.

Fam. Splendidofilariidae

6. *Chandlerella bosei* (Chandler, 1924)

Host: *Copsychus malabarica indica*.

Location: Auricles.

Locality: Burdwan, West Bengal, India.

One bird was examined and found to harbour two male (one broken) and one female nematodes.

Occurrence of *C. bosei* in the present bird is a new host record. The morphology of the species is in conformity with the description of Sonin (1966). Only a few morpho-metrical variabilities are recorded.

Male: $11.869-13.002 \times 0.181-0.184$. The oesophagus constitutes $1/33$ part of the body length approximately. Of the three pairs of postanal papillae the second and third pairs approximate each other. Left spicule ranges between 0.0462 and 0.0693, while the right one between 0.0396 to 0.0627.

Female: 19.067×0.300 . The oesophagus occupies $1/27$ th part of the body. The vulva is in the oesophageal region (0.4092 from the anterior end). Microfilaria measures 0.494 in length.

Fam. Oswaldofilariidae

7. *Cardiofilaria pavlovskyi* Strom, 1937

Host: *Turdus unicolor*.

Location: Pericardial cavity.

Locality: Sagar islands, West Bengal, India.

Of the four birds one was found to contain two male and three female nematodes (one male and two females are mutilated, but measurements of all three females have been recorded).

The species has been reported from *Oriolus oriolus*, *O. chinensis*, *Hirundapus caudacutus*, *Hylocichla mustelina*, *Turdus musicus*, *T. ericetorum*, *T. hortulorum*, *Monticola gularis*, *Muscicapa narcissina*, *M. daurica*, *Anthus sp.*, *A. gustavi*, *Lanius cristatus*, *Falco subbuteo*, and *Gallinago media* (Sonin, 1968). Occurrence of the species in the present host is a new record. Besides other features the findings confirm specific diagnosis in possessing postoesophageal vulva. Evaluation of the metrical variabilities is furnished hereunder.

Male: 7.031×0.280 . The oesophagus is 0.329. The tail is 0.474 and its breadth at cloaca is 0.047. The spicules are small and subequal (left 0.0790, right 0.0711).

Female: $15.168-17.064 \times 0.284$. The oesophagus is 0.474—0.505. The tail (0.205) is smoothly rounded. The vulva is post-oesophageal and is located at a distance of 1.042—1.074 from anterior end. The highly muscular vagina runs at right angle to the long axis of the body and then turns anteriorly and after forming two loops runs caudad. The microfilaria is 0.237 in length.

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**CENTROPHANTES GEN. N. UND ZWEI NEUE LEPHYPHANTES ARTEN
AUS SLOVENIEN (CHELICERATA: ARANEA)**

FRANTIŠEK MILLER und ANTON POLENEC

Eingegangen am 18. März 1974

Abstrakt Es werden drei neue Taxa aus Slovenien beschrieben: *Leptyphantes triglavensis* sp. n., *Leptyphantes hadza* sp. n. und *Centrophantes* gen. n., das die Arten *Centrophantes crosbyi* (Fage et Kratochvíl, 1933) und *Centrophantes roeweri* (Wiehle, 1961) umfasst. Beide Vertreter der neuen Gattung werden redeskribiert und das Weibchen von *Centrophantes crosbyi* wird zum erstenmal beschrieben.

Die slovenische Spinnenfauna ist immer noch unzureichend erforscht. Das gilt besonders für die mikrokavernicol im Fallaub oder in der Bodenstreu lebenden Arten, sowie für die hochalpinen Spinnen. So wurden z. B. in den wenigen letzten Jahren nur aus der Gattung *Troglohyphantes* 4 neue Arten und 1 bisher unbekanntes Weibchen entdeckt, deren Beschreibung bereits druckfertig ist. Der vorliegende Beitrag vermehrt die Kenntnisse über diese Spinnenfauna um weitere neue oder unvollkommen bekannte Arten. Die zwei *Centrophantes*-Arten gehören zur mikrokavernicolen Fauna, die neu beschriebenen *Lepthyphantes* sind hochalpine Tiere.

Centrophantes gen. n.

(T. I. Abb. 1—9; T. II. Abb. 1—6)

Typische Art *Centromerus crosbyi* Fage et Kratochvíl, 1933 (♂). Ausser dieser typischen Art gehört zu dieser Gattung *C. roeweri* (Wiehle, 1961) (♂♀ sub *Lepthyphantes roeweri*).

Im J. 1961 beschrieb Wiehle eine neue Spinnenart aus Slovenien unter dem Namen *Lepthyphantes roeweri*. Es entging ihm jedoch, dass schon im J. 1933 von Fage und Kratochvíl aus der Grotte Luegg bei Postumia (Provinz Trieste) das ♂ einer äusserst nahe stehenden Art unter dem Namen *Centromerus crosbyi* beschrieben wurde. Diese Autoren wiesen auf gewisse aberrante Merkmale der neuen Art hin, darunter besonders auf die Bestachelung der Tibien, die, ähnlich wie bei den *Lepthyphantes*-Arten, auch laterale Stacheln tragen. Sie hielten deshalb ihre Eingliederung der Art in die Gattung *Centromerus* für provisorisch. Wir verfügen über reichlicheres Material von beiden Arten, was uns ein eingehenderes Studium besonders der für die Beurteilung der generischen Zugehörigkeit ausschlaggebenden Kopulationsorgane ermöglicht. Es ergab sich, dass beide Arten weder in die Gattung *Centromerus* noch in die Gattung *Lepthyphantes* gehören, und dass sie gewissermassen eine intermediäre Stellung zwischen beiden Genera einnehmen. Es ist deshalb durchaus begründet für sie eine neue Gattung aufzustellen.

Die neue Gattung ist durch folgende Merkmale charakterisiert: Beine lang, dünn, $ti\ I\ d/1 = 1/8 - 1/85$, $ti\ IV = 1/10$. Bestachelung: $fe\ 0$, $ti\ I-IV$ dorsal 1.1, $ti\ I$ (zuweilen auch II) zusätzlich noch prolateral apical 1, $ti\ III$, IV retrolateral apical 1, oft auch noch prolateral apical 1; $mt\ I-IV$ mit einer Stachelborste unweit der Mitte, $mt\ I-III$ mit einer Bothriotrichie (ihre Stellung 0,26–0,30).

Die ♂ Pedipalpen sind ähnlich gestaltet wie bei manchen *Centromerus*-Arten, was sich besonders in der Form und Beschaffenheit des mächtig entwickelten Paracymbiums, der basalen Apophyse (Radix), der Lamella charakteristica und auch des in einen spitzigen Fortsatz ausgezogenen Cymbiums offenbart. Sie unterscheiden sich von ihnen, gleich wie auch von denen der *Lepthyphantes*-Arten, grundsätzlich durch den langen peitschenförmigen Embolus. Die Unterschiede zwischen den beiden Arten sind aus den Abbildungen zu ersehen. Bei *C. crosbyi* ist das Paracymbium an der abgerundeten Ecke zwischen dem Gelenk- und Querast fein gekörnt und der Querast mit etwa 5 spitzigen, durch eine Lücke in zwei Gruppen ($3 + 2$) geteilten Zähnen versehen. Bei *C. roeweri* ist der ganze obere Teil des Querastes gekörnt und fein beschuppt, und mit 2 kleineren und 2 grossen Zähnen bewehrt. Auffallendere Unterschiede weist der Radix auf, der die gut entwickelte Fickertsche Drüse enthält. Bei *C. crosbyi* ist er breit tütenförmig oder kelchförmig und der Rand der weiten, schief nach unten und hinten gerichteten Öffnung ist hinten krallenartig ausgezogen und aussen in seiner hinteren Hälfte unregelmässig gezähnt. Bei *C. roeweri* ist er komplizierter gebaut, distalwärts nur wenig verbreitert, retrolateral mit einigen Zähnen und spitzigen Schuppen besät. Der Aussenrand der kleineren, nur die hintere Radixhälfte einnehmenden Öffnung ist mit einem platten, dreieckigen, zackigen, ventralwärts gerichteten Vorsprung versehen.

Die Lamella charakteristica beider Arten ist zwar im Grunde ähnlich gestaltet, doch das distale Ende weist gute Erkennungsmerkmale auf.

Der Embolus beider Arten ist im Gegensatz zu dem kurzen, zum Anlegen an die Öffnung der Einführungsgänge angepassten Emboli der *Lepthyphantes*- und *Centromerus*-Arten, ein Einführungsembolus: aus einer breiteren Basis verjüngt er sich in ein langes biegsames Röhrchen.

Ein weiteres, mit manchen *Centromerus*-Arten gemeinsames Merkmal betrifft die ♂ Cheliceren. Ähnlich wie bei *C. sylvaticus*, *sellarius*, *prudens*, *arcanus*, *alnicola*, *aequalis* und *persimilis*, und den ihnen sehr nahestehenden *Syedra*-Arten (*S. gracilis*, *S. myrmicarum**) sind die Cheliceren fronto-lateral mit einer Reihe (*C. crosbyi*) oder einem Längsstreifen (*C. roeweri*) von kurzen rigiden Stachelborsten bewehrt. Die bei den *Lepthyphantes*-Arten vorhandenen Schrilleisten sind nicht entwickelt.

Auch die weiblichen Geschlechtsorgane beider *Centrophantes*-Arten sind sehr ähnlich. Durch ihre grossen querelliptischen, mit einem Scapus verse-

*) Die Gattung *Syedra* Sim. wird von Simon (1929) und Wiehle (1956) in die Gruppe *Micronetidae* gestellt. Manche wichtige Merkmale weisen jedoch auf ihre sehr nahe Verwandtschaft mit der Gattung *Centromerus*. Die Cheliceren sind bei beiden Geschlechtern fast gleich, vorn mit 3 grossen, hinten mit 4–5 kleineren Zähnen bewehrt, bei den ♂♂ mit den erwähnten rigiden Börstchen. Das Paracymbium ist mit einer Reihe von Zähnen versehen, der Radix enthält die Fickertsche Drüse. Die ♀ Geschlechtsorgane sind ähnlich wie bei vielen *Centromerus*-Arten. Der ♀ Pedipalpus endet mit einer dünnen Krallen, die völlig glatt ist (*S. gracilis*), oder in der Mitte ein winziges Zähnechen trägt (*S. myrmicarum*).



henen Epigynengruben erinnern sie an manche *Centromerus*-Arten. Im Gegensatz zu diesen ist hier jedoch der Scapus nicht flach und gestreckt, sondern wie bei den *Lepthyphantes*-Arten und allen Vertretern der Gruppe *Microneteae* kompliziert verbogen und einwärts in die Epigynengrube gefaltet (Vulva mit eingefaltetem Scapus). Beim Mazerieren in Kalilauge faltet sich der Scapus aus.

Beschreibung des unbekannten Weibchens
von *Centrophantes crosbyi* (Fage et Kratochvíl)

(Tafel I, Abb. 1—9)

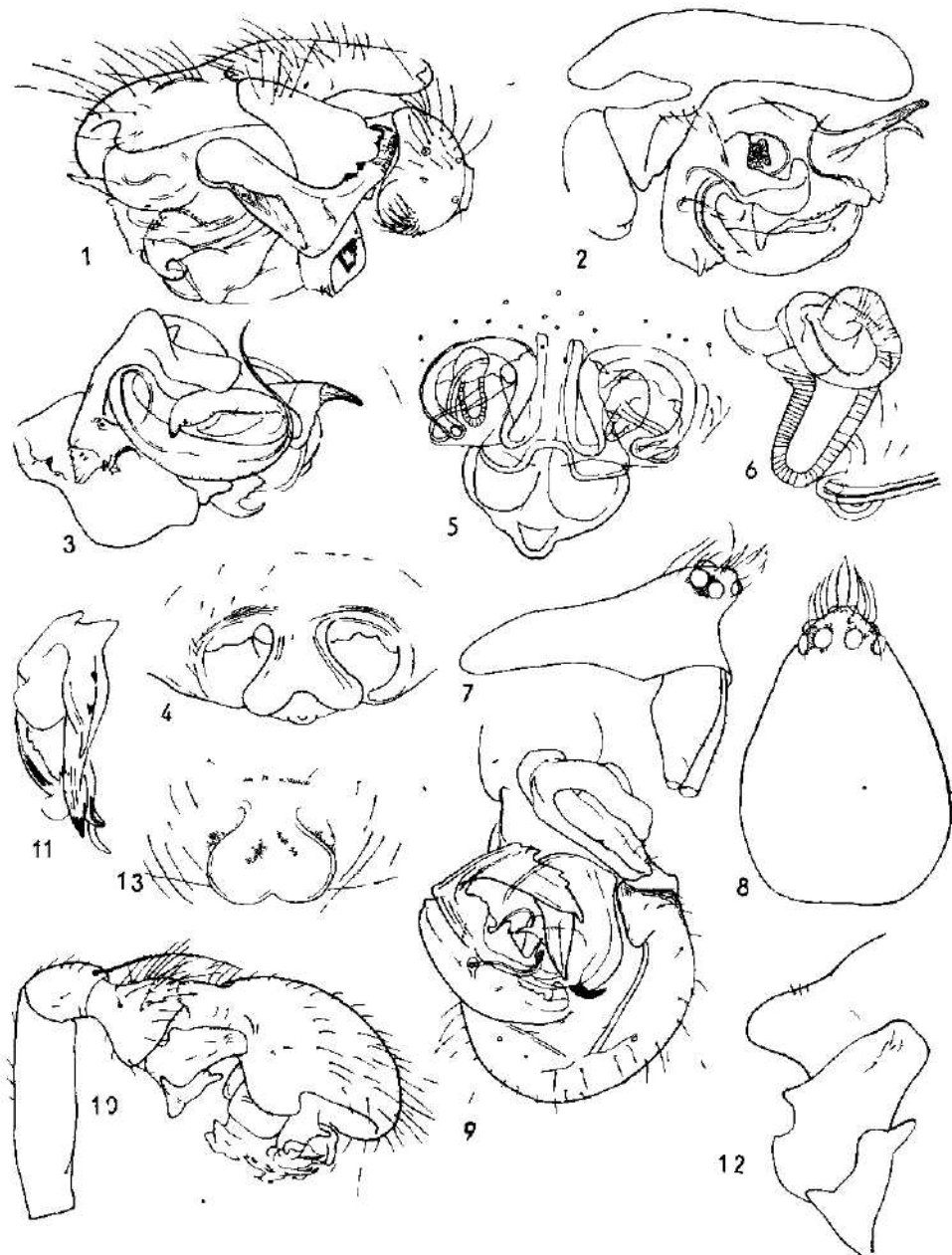
Kopfbrust birnenförmig, 1,3 mm lang, 1 mm breit, im Niveau der Hinteraugen auf 0,56 mm verschmälert, mit deutlichen Ausschweifungen zwischen Kopf- und Brustpartie. Die Rückenlinie flacher als bei *C. roeweri*, in der Mitte ganz leicht durchgesattelt. Hintere Augenreihe gerade, etwa 0,42 mm lang, Augen gleichweit gestellt, Abstände wenig kleiner als d des MA. Vordere Augenreihe procurv, MA sehr klein, genähert, von den grossen SA weit entfernt. Clypeus procurv, unter den Augen ausgehöhlt, etwa 0,23 mm lang. Cheliceren senkrecht, 0,54 mm lang, mit parallelen Aussenrändern; der vordere Falzrand mit 3 grossen, der hintere mit 6 kleinen Zähnen auf einer Leiste. Frontolateral eine unscheinbare Reihe von winzigen Börstchen. Sternum herzförmig, etwa 0,70 mm lang und ebenso breit, blassgelb. Coxen IV um ihren d voneinander entfernt. Beine lang, hellgelb, alle Glieder ventral lang beborstet. Stachelborsten ebenfalls sehr lang. Bein IV > I (beim ♂ I > > IV). Länge der einzelnen Glieder (bei 2 ♀♀ gemessen) in mm:

I	1,25 (1,34)	0,38 (0,42)	1,30 (1,38)	1,15 (1,20)	0,75 (0,82) = 4,83 (5,16)
II	1,20 (1,30)	0,36 (0,40)	1,20 (1,30)	1,05 (1,18)	0,72 (0,72) = 4,53 (4,90)
III	1,08 (1,18)	0,32 (0,35)	0,98 (1,02)	0,92 (0,99)	0,60 (0,72) = 3,90 (4,26)
IV	1,46 (1,50)	0,38 (0,40)	1,43 (1,50)	1,20 (1,32)	0,72 (0,80) = 5,19 (5,52)

Bestachelung ein wenig schwankend. Alle fe ohne Stacheln, alle pt am Vorderrande mit 1 langen Stachel, ti I—IV dorsal 1.1, ti I ausserdem prolateral distal 1, ti III zuweilen dicht am distalen Rande pro- und retrolateral je 1, ti IV zuweilen retrolateral apikal 1. Ti IV Stellung der dorsalen Stacheln 0,32—0,35 und 0,68, Länge des basalen 3,5 d. Mt I—IV mit einer Stachelborste (auf mt I = 0,52, mt IV = 0,43); mt I—III mit einer Bothriotrichie (auf mt I = 0,29). Tarsalorgane winzig, ihre Stellung etwa 0,85. Krallen I mit etwa 14 unscheinbaren Zähnchen, Afterkrallen mit 1 Zähnchen in der Mitte. Pedipalpus: 0,43, 0,15, 0,27, 0,59 mm, Krallen dünn, glatt, leicht geschweift.

Epigyne (Abb. 7) von ähnlicher Form wie bei *C. roeweri*, ihre grosse Quergrube jedoch viel schmaler und relativ breiter, der Scapus fast parallelrandig und hinten kaum ausgeschnitten der herausragende Clavus sehr gross, herzförmig. Vulva Abb. 8.

Tafel I — Abb. 1—9. *Centrophantes crosbyi* (Fage & Krat.). 1, 2, 3 — ♂ Pedipalpus retrolateral, dorsal und prolateral. 4 — Bulbuspartie ventral. 5 — ♂ Chelicere. 6 — ♀ Chelicere. 7 — Epigyne. 8 — Vulva. 9 — Pedipalpuskrallen von ♀. Abb. 10 11. *Centrophantes roeweri* (Wichle). 10 — ♂ Pedipalpus dorsal. 11 — ♂ Chelicere. (e Embolus f Fickertsche Drüse r Radix).



Tafel II - Abb 1-6 *Centrophantes roeweri* (Wiehle) 1, 2 - ♂ Pedipalpus retro und prolateral 3 - Bulbuspartie ventral 4 - Epigyne 5 - Vultura 6 - rechtes Receptaculum Abb 7-12 *Leptophantes triglavensis* sp. n. 7 8 - ♂ 9, 10 - ♂ Pedipalpus ventral und retrolateral 11 - La mella charakteristica 12 - Cymbiumhocker und Paracymbium retrolateral

C. cosbyi scheint in den Buchenwäldern von Julischen Alpen und deren Vorgebirge nicht selten zu sein. Fundorte Selška dolina, ca 15 km von

Škofja Loka am 7. XI. ♂♀; überall in Škofjeloško hribovje (auf Ratitovec, Blegoš, Lubnik, Tošč), auf Krim ca 15 km von Ljubljana, Črna prst (1844 m).

C. roeweri scheint ziemlich weit verbreitet zu sein. Sammelorte: Štoržič (2132 m) und mehrere Stellen in der Savinske Alpe. Einige Lokalitäten in Karavanken und zwei Fundorte weit von hier entfernt: Buchenwälder etwa 25 km sō von Ljubljana und auf Gorjanci Gebirge, etwa 60 km sō von Ljubljana.

Nach Beobachtung von Polenec soll es sich um langlebige Spinnen handeln. Ein adultes, mit kleinen Mücken gefüttertes ♂ von *C. roeweri*, lebte in Gefangenschaft vom 13. I. bis 1. VIII. Polenec nahm mit Recht an, dass es schon vom Herbst geschlechtsreif war.

Lepthyphantes triglavensis sp. n.

(T. II, Abb. 7–12; T. III, Abb. 1, 12)

Beine reichlich bestachelt, alle ti auch mit ventralen Stacheln, alle mt mit mehr als 1 Stachel.

♀: Kopfbrust 1,25 mm lang, 0,90 mm breit. HA Reihe leicht recurv, Augen gross, in schwarzen Flecken, equidistant, Abstände wenig grösser als d von MA. Färbung: gelbbraun, am Rande breit graubraun, Marginalsaum schwarz; Mittelfleck und 4 Paar Muskellinien angedeutet. Clypeus 0,25 mm, Cheliceren 0,70 mm, mit etwa 15 Schrilleisten. Vorderer Klauenfurchenrand mit 3 Zähnen, hinterer mit 5 kleinen, ziemlich lockeren Zähnchen. Sternum herzförmig, 0,65 × 0,65 mm, olivenbraun mit grauem Rand. Coxen gelbbraun, Cx IV um ihren d voneinander entfernt.

Beine gelbbraun. Länge der Glieder (fe, ti + pt, mt, ta):

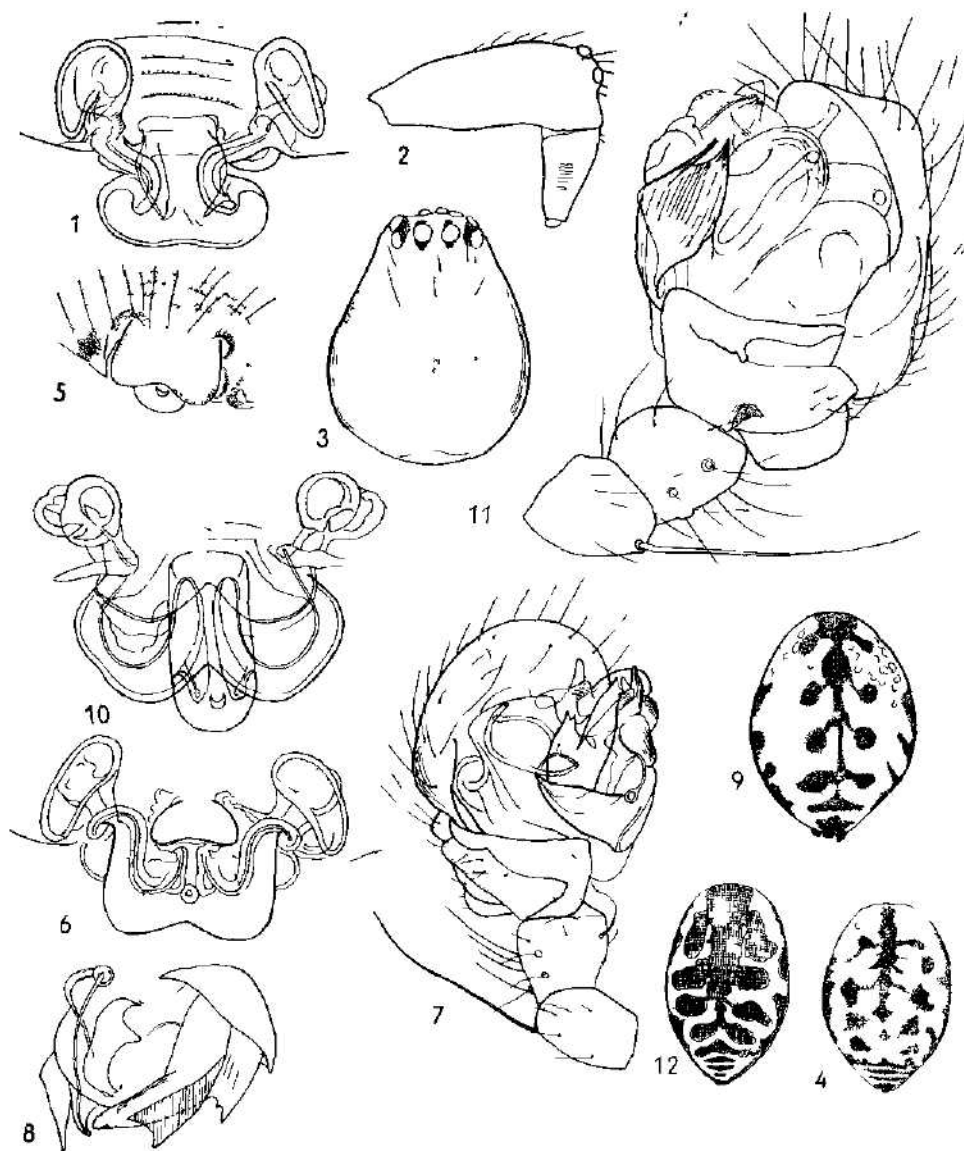
I	1,42	1,65	1,30	0,80 = 5,17 mm
II	1,36	1,50	1,18	0,78 = 4,82 mm
III	1,18	1,18	0,96	0,60 = 3,92 mm
IV	1,35	1,55	1,30	0,68 = 4,88 mm

Bestachelung: Fe I prolateral 1, fe II–IV stachellos. Ti I–IV am Vorderrande 1. Alle ti dorsal 1 . 1 (Stellung auf ti I = 0,25 und 0,65, Länge des basalen 2,3 d; auf ti IV = 0,20 und 0,66, Länge auf ti III, IV 3,5 d; I, II pro- und retrolateral 1 . 1, ventral 2 . 2 (auf ti II 1 . 1 . 2) ti III retrolateral 1, ventral 1 . 1, ti IV retrolateral 1 . 1, prolateral 1, ventral 1 . 1. Alle mt mit 3 (2) Stacheln (dorsal basal, ventral vor der Mitte, retrolateral zwischen den beiden). Mt I–III mit einer Bothriotrichie (auf mt I = 0,17–0,19). Krallen mit vielen winzigen, distal an Länge zunehmenden Zähnchen.

Pedipalpus 0,85, 0,30, 0,62, 1,05 mm, mit langen Stacheln (auf pt = 4d). Krallen sehr schlank, leicht geschweift, mit 3 unscheinbaren Zähnchen. Hinterleib dorsal mit dunkler Zeichnung (Abb. III/12).

Epigyne klein. Scapus herzförmig, blass, in der Mitte verdunkelt, mit rötlichgelbem Rand. Vulva Abb. III/6.

♂: Kopfbrust (Abb. I/7, 8) 1,30 × 0,95 mm. Kopfpartie schmal, gehoben, mit auffallenden, langen, nach vorn gerichteten Haaren besetzt. Clypeus sehr hoch (0,35 mm), tief ausgehöhlt. Hintere Augenreihe nimmt die ganze Stirnbreite ein. Färbung und Zeichnung wie beim ♀. Cheliceren 0,55 mm lang, mit



Tafel III — Abb. 1 — *Lepthyphantes triglavensis* sp. n. Vulva Abb 2—8 *Lepthyphantes hadzi* sp. n. 2, 3 — ♀ Cephalothorax 4 — ♀ Abdomen 5 — Epigyne 6 — Vulva 7 — ♂ Pedipalpus retrolateral 8 — Lamella charakteristica und Embolus mit Fickertschen Drüse Abb 9—11 *Lepthyphantes pulcher* (Kulcz.). 9 — ♀ Abdomen 10 — Vulva 11 — ♂ Pedipalpus retrolateral Abb 12. *Lepthyphantes triglavensis* ♀ Abdomen.

etwa 15 wohl ausgeprägten und ziemlich weit entfernten Schrilleisten. Sternum $0,70 \times 0,70$ mm, braunschwarz, am Rande dunkler, glanzend.

Länge der Beinglieder (fe, ti + pt, mt, ta):

I	1,60	2,00	1,60	0,88 = 6,08 mm
II	1,40	1,76	1,40	0,82 = 5,38 mm
III	1,28	1,30	1,08	0,65 = 4,31 mm
IV	1,45	1,62	1,42	0,74 = 5,23 mm

Bestachelung wie beim ♀. Alle mt mit 3 Stacheln vor der Mitte (auf mt I der proximalste 0,26, die übrigen zwei 0,40). Bothriotrichie auf mt I = 0,22. Pedipalpus (Abb. I/9—12). Cymbium basal aussen mit einem abgerundeten Höcker. Lamella charakteristica von unten gesehen schnallenförmig gebogen, zugespitzt, am Aussenrande mit etwa 5 unregelmässigen Zähnen.

L. triglavensis lebt nur oberhalb der Waldgrenze unter grösseren Steinen. Man kann ihn für eine vikarierende Art zu *L. variabilis* Kulcz. aus Tiroler Zentralalpen halten.

Fundorte: Kredarica unter Triglav, 2500 m, am 25. VIII. 1967 ♂♀; Prisornik 2547 m; Razor 2601 m; Bovški Gamsovec 2389 m; Prohodavei 2.183 m. Typenmaterial ♂♀ in der Sammlung von Miller, Paratypen bei Polenec.

Lepthyphantes hadzii sp. n. (T. III, Abb. 2—8)

Eine *Lepthyphantes pulcher* nahe stehende Art.

♀: Kopfbrust 1,30 mm lang, 1,0 mm breit, im Bereich der HA auf 0,55 mm verschmälert, gelbbraun, mit schwärzlichem Rand und dunklem fünfeckigem Mittelfleck. Sternum 0,65 × 0,60, graubraun. Cx IV um ihren d entfernen. Clypeus 0,18 mm hoch, Cheliceren fast 3 × länger, mit etwa 18 Schrilleisten. Vorderer Klauenfurchenrand mit 3 Zähnen (oberer kleiner, die übrigen gleich gross), hinterer mit 5 kleinen gedrängten Zähnchen.

Beine gelbbraun, reichlich bestachelt. Längenverhältnis der Glieder (fe, ti + pt, mt, ta):

I	1,30	1,62	1,20	0,80 = 4,92 mm
II	1,22	1,50	1,15	0,77 = 4,64 mm
III	1,12	1,18	1,00	0,64 = 3,94 mm
IV	1,36	1,50	1,30	0,78 = 4,94 mm

Bestachelung: Fe I prolateral apical 1 langer abstehender Stachel; fe II bis IV unbewehrt. Alle pt am Vorderrande 1. Alle ti dorsal 1. 1 (Stellung auf ti I 0,30 und 0,62, auf ti IV 0,23 und 0,72, Länge des basalen auf ti I = 2,8 d, auf ti IV = 3,4 d), pro- und retrolateral apical je 1; ti I, II ventral am Aussenrande 1 oder 1. 1; ti III ventral hinter der Mitte 1, ti IV ventral 1. 1. Alle mt dorsal mit 1 Stachelborste (auf mt I, II schwach, kurz, auf mt III, IV kräftig, lang, Stellung 0,32—0,34) und prolateral ebenfalls mit einer ähnlichen; mt I und IV zusätzlich noch mit einer ventralen, ihre Stellung 0,44 und 0,42). Mt I—III mit 1 Bothriotrichie (auf mt I = 0,23).

Pedipalpus: 0,68, 0,22, 0,45, 0,80 mm; ta mit mehreren langen Stacheln (ein besonders langer ventral hinter der Mitte), ohne Krallen. Hinterleib ähnlich gezeichnet wie bei *L. pulcher*: Rücken mit einer Längsbinde und jederseits mit einer Reihe von 4—5 paarig angeordneten, durch Querstreifen verbundenen Flecken. Flanken mit einem weissen gezähnten Streifen, Bauch dunkel.

Epigyne und Vulva Abb. III/5, 6.

♂: Kopfbrust 1,1 mm lang, ähnlich gefärbt wie beim ♀. Kräftige Cheliceren

mit etwa 13–14, proximal sehr Weit entfernten, distalwärts dichteren Schrilleisten. Beine relativ länger und schlanker als beim ♀.

Länge der Glieder (fe, ti + pt, mt, ta):

I	1,38	1,78	1,42	0,80 = 5,38 mm
II	1,30	1,60	1,23	0,70 = 4,83 mm
III	1,10	1,20	1,05	0,62 = 3,97 mm
IV	1,38	1,53	1,33	0,72 = 4,96 mm

Bestachelung wie beim ♀.

Pedipalpus: Paracymbium am Querast mit einem konischen Zahn in der hinteren Ecke. Cymbium von oben gesehen am Aussenrande mit 2 abgerundeten Höckern. Lamella charakteristica kompliziert, mit einer senkrecht aufsitzender Carina (T. III, Abb. 8).

Unterschiede der neuen Art von *L. pulcher* sind aus den Abb. T. III, 2–11 zu ersehen. (♂ Pedipalpen und Vulven beider Arten in gleicher Vergrößerung gezeichnet).

Lepthyphantes hadzii ist ebenso wie *L. triglavensis* eine hochalpine Art. Sie lebt an sonnigen Orten, wo sie sich ihre Netze zwischen Grashalmen und verschiedenen alpinen Kräutern und Stauden etwa 10 cm über dem Boden baut.

Derivatio nominis: Dem hervorragenden jugoslawischen Zoologen Jovan Hadži gewidmet.

Fundorte: Planjava, 2399 m (Slavinske Alpe) am 5. VIII. 1970 ♂♀; Grintavec 2558 m; Vogel (Julische Alpen) 1922 m. Typenmaterial (♂♀) in der Sammlung von Miller, Paratypen bei Polenec.

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LARVAL TREMATODE STAGES IN WATERSNAILS FROM THE AREA OF WARAK EL ARAB (A.R.E.)

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Abstract: During parasitological investigations of watersnails carried out in the irrigation systems and the left bank of the Nile in the area of Warak El Arab (ARE) we found a total of 17 types of cercariae consisting of one species of Amphistomae cercariae "pigmentata type" belonging to trematodes of the family Paramphistomatidae; three species of Gymnocephalous cercariae, one of these belonging to the fluke *Fasciola gigantica* Cobbold, 1855 (intermediate host *Lymnaea taillanudi*); one species of "cystophorous cercariae" apparently members of the family Halipegidae (parasites of frogs). Of the Echinostome cercariae we found the cercaria of *Echinostoma revolutum* (Frohlich, 1802), *Echinoparyphium biocallerosi* Dollfus, 1953, and Echinostome cercaria III with a large number of collar spines (50–52). Of the group Xiphidiocercariae we found 5 species, out of which three belonged to the "virgulae" group, three to the "armatae" group and one species to the "microcotylae" group. Of the Furcocercariae group we found 4 species, i.e., the cercaria of *Schistosoma haematobium* (Bilharz, 1852), the cercaria of *Schistosoma mansoni* Sambon, 1907, one species of the Apharyngeal, brevifurcous, monostome group, and one species of the Pharyngeal, longifurcous, distome group. Of the metacercariae, we found a total of nine species, out of these one Amphistome metacercaria, two of the Gymnocephalae group, two species of Echinostome metacercariae (*Echinostoma revolutum* (Frohlich, 1802) and *Echinoparyphium biocallerosi* Dollfus, 1953), three species of Xiphidiometacercariae, and one species *Tetracotyle* sp. Data are given on the incidence and distribution of the individual larval fluke stages in the watersnails and the individual sites of snail collection in the area of Warak El Arab.

INTRODUCTION

Within the agreements signed between the Czechoslovak Academy of Sciences and the Egyptian Academy for Scientific Research and Technology, investigations on the ecology of *Schistosoma haematobium* (Bilharz, 1852) and *Schistosoma mansoni* (Sambon, 1907) were started in 1971 by a joint Czechoslovak-Egyptian working team. The area north of Cairo, on the left bank of the Nile, was allotted for field trials, and a field station of the Ministry of Health (ARE) situated in this area at the village of Warak El Arab was made available for this work. At first, information had to be obtained on the incidence and distribution of the two snail intermediate hosts of schistosomes, i.e., *Biomphalaria alexandrina* (Ehrenberg) and *Bulinus truncatus* (Audoin), and of other watersnails frequently occurring in this area (associate snails) which may play a certain role in the ecology of schistosomes, particularly when acting as facultative intermediate hosts, or food

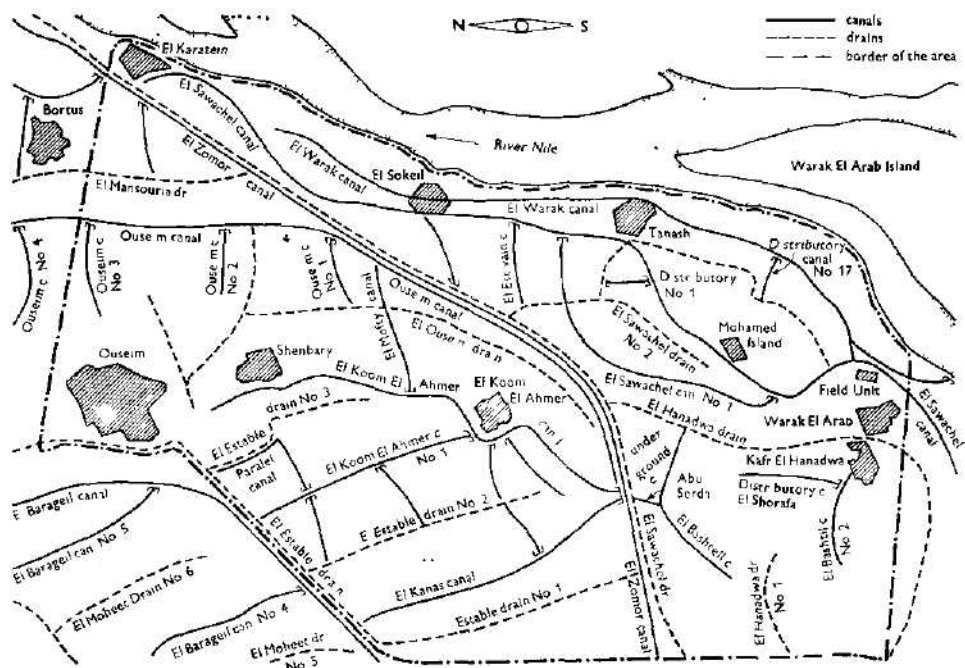


Fig. 1 The area of Warak El Arab and the localities with the incidence of schistosomes infected by snails. Scale 1 : 100 000.

competitors of the specific snail intermediate hosts of schistosomes. Since the possibility of antagonistic interaction between larval schistosomes and developmental stages of other fluke species in the intermediate hosts was part of our investigation programme, detailed knowledge on the incidence of other larval fluke species in watersnails of the studied area was required in order to find the most suitable competitive trematode species.

Another assignment of our work was the finding of sites in this area with an incidence of snail intermediate hosts infected simultaneously with both schistosome species. In the later stage of work these sites were under continuous observation in order to obtain information on population dynamics of double-infected snails in the various seasons of the year.

From the Egyptian side, our work was supported by Professor Touhamy, the Director of the National Research Centre in Cairo, by Professor A. Kira, Professor A. H. Moussa and by all workers of the field station at Warak El Arab, from the Czechoslovak side by Academician B. Rosický, Director of the Institute of Parasitology, Czechoslovak Academy of Sciences, and Vice-President of the Czechoslovak Academy of Sciences. To all those, our gratitude and thanks are due.

BRIEF CHARACTERISTICS OF THE AREA UNDER CONSIDERATION

The area situated to the north of Cairo extends along the left bank of the Nile (Fig. 1). Its southern border is formed by Imbaba, a suburb of Cairo, and the village of Warak El Hadr, in the north by the villages El Karatem and Ouseim, in the east by the Nile, in the west by the Estable drain and the suburb Imbaba. The main axis of this area is formed by the El Zomor canal, which is the principal canal of the Giza province running almost parallel to the left bank of the Nile. In parallel direction to the main axis through this area run the Ouseim canal and the

Table 1: Survey of water snails examined and localities in the area of Warak El Arab

Snail species	Locality	Total number of snails examined
GASTROPODA		
<i>Bulinus truncatus</i> (Audoin)	Nile shore Warak El Arab Nile shore El Sokeil Nile shore El Karatein Sawachel Canal Sawachel Canal branch No. 1 Sawachel Canal — distributory No. 61 Abu Sarda Canal — distributory Parallel Canal with Sawachel drain branch No. 3 Koom El Ahmer Canal	638
<i>Biomphalaria alexandrina</i> (Ehrenberg)	Nile shore Warak El Arab Nile shore El Sokeil Nile shore El Karatein Estable drain Estable drain br. No. 2 Estable drain br. No. 3 Sawachel drain El Mansouria drain Hanadwa drain br. No. 1 Koom El Ahmer canal Parallel Canal with Estable drain br. No. 3	3035
<i>Physa acuta</i> (Draparnaud)	Nile shore Warak El Arab Nile shore El Sokeil Nile shore El Karatein Sawachel Canal Sawachel Canal br. No. 1 Sawachel Canal distributory No. 61 Abu Sarda distr. canal Koom El Ahmer canal Bashtil canal Underground water-canal near Koom El Ahmer El Kanas canal El Warak Canal branch No. 17 Parallel Canal with Estable drain No. 3 Sawachel drain Sawachel drain br. No. 3 Ouseim drain El Mansouria drain	1566
<i>Lanistes bollenianus</i> (Chemnitz)	Nile shore Warak El Arab Nile shore El Karatein Koom El Ahmer canal Abu Sarda Distr. canal Bashtil canal El Kanas canal Ouseim canal Ouseim drain	131
<i>Cleopatra</i> sp.	Nile shore Warak El Arab Ouseim drain Nile shore El Karatein Nile shore El Sokeil	55

Table 1 — continued

Snail species	Locality	Total number of snails examined
<i>Bythinia</i> sp.	Sawachel Canal Sawachel Canal distributory No. 61 Abu Sarda distr. canal Bashtil canal El Warak Canal branch No. 17 Ouseim drain	188
<i>Lymnaea tailliaudi</i> (Bourgnignat)	Nile shore Warak El Arab Nile shore El Karatein Parallel canal with Estable drain br. No. 3 Sawachel drain El Mansouria drain Estable drain br. No. 3 Hanadwa drain br. No. 1	237
<i>Limparus unicolor</i> (Olivier)	Nile shore Warak El Arab Nile shore El Karatein Ouseim drain	50
<i>Gyraulus marroticus</i>	Nile shore El Karatein Sawachel drain	37
<i>Melanoides tuberculata</i>	Nile shore Warak El Arab Nile shore El Karatein Ouseim drain	42
BIVALVIA		
<i>Valvata</i> sp.	Nile shore El Karatein Estable drain br. No. 3	20
<i>Bivalvia</i> sp.	Nile shore El Karatein	15

El Sawachel drain with its numerous branches. In the east, the El Sawachel canal ("Shore canal") runs parallel to the Nile. In SW, the area is intersected by the Estable drain and by smaller canals such as El Koom, El Ahmer, El Kanas; in the South by the El Bashtil canal and the El Hanadwa drain. All these canals and drains have numerous side-branches, which subdivide into the so-called distributory canals and drains and, in this way, form a dense network of the irrigation system. Of importance is the left bank of the Nile forming numerous bays and small islets; dense stands of waterplants cover the shores up to a depth of 2–10 m. In this area, the fields reach the water edge. Several of the villages are large and densely populated (e.g., Ouseim, Warak El Arab). The village population works either in the fields or travels for work to Cairo.

The canals differ from the drains in their transverse profile and, mainly, in their phyto- and zoocenology. Since the water of the canals is used for the irrigation of the fields, the water column changes several times a week from its maximum to its minimum (20–30 cm), particularly during the time of intensive watering of the fields. The drains carrying surplus water off the fields have a more stable water column; generally, it remains low throughout the year. Therefore, the bottom of both primary and secondary drains is covered densely with waterplants. These factors are responsible for the considerable differences in the compositions of both flora and fauna in both types of the irrigation system and, consequently, in the incidence of watersnails.

The principal plants grown in this area are cereals (wheat), vegetables, melons, potatoes. Cotton and rice are less frequent. Large banana plantations are situated on the Nile bank near the village of El Sokel.

MATERIAL AND METHODS

In the area of Warak El Arab, watersnails were collected along the banks of 21 canals, drains and their distributories, in a total length of 114 km. The number of collecting sites was 118, in several of these watersnails were collected repeatedly. Records were made of the water- and shore fauna, of the state of the banks, of changes in the water column. The vegetation was studied in detail by Dr. S. Hejny, Botanical Institute, Czechoslovak Academy of Sciences. The results of these investigations will be published in a separate paper.

We examined microscopically a total of 8,009 watersnails belonging to 12 species, paying attention mainly to the most frequently occurring species and disregarding rare species. A survey of the snails examined and the sites of collection is given in Table 1.

All snails were examined microscopically in the laboratory by means of a compressorium, the majority of the snails was exposed to light in order to activate the release of trematode cercariae. The larval trematodes found were measured, figured, the cercariae stained with vital dyes (neutral red, trypan blue) in order to study their structure in detail: some parasites were fixed and stained with acid carmine or borax carmine. The parasites were identified provisionally, their incidence in the individual snails species and localities was recorded. Several flukes, particularly those of the family Echinostomatidae, were used for infection of laboratory animals (mouse, hamster, rabbit, chicken, duck) in order to identify precisely the species concerned. From these infected animals we obtained the initial material for further experiments on competitive interaction between larval schistosomes and other trematode species.

LARVAL STAGES OF TREMATODES

A. Cercariae*

a) Amphistome cercariae

1. "Pigmentata" type (Fig. 2A, B)

The snail *Bulinus truncatus* harboured two types of amphistome cercariae belonging to the type "pigmentata". Both types were identical as regards their morphology, but differed in the structure of the pigmented eyespots. In type "A" the eyespots were compact, heart-shaped, in type "B", they were starlike branched. Further studies disclosed that both types belonged to the same species, and that the differences were due to age only: younger cercariae have starlike eyespots, older cercariae compact, heart-shaped eyespots.

Overall length of cercarial body 0.296–0.540 mm, width 0.256–0.315 mm, body ovoid or heart-shaped. Cercarial body coloured by dark brown pigment, and filled with rectangular cystogennic elements obscuring the internal structure. Oral sucker replaced by spherical pharynx, 0.044–0.056 mm in diameter, intestinal branches indistinct reaching posterior extremity, acetabulum, 0.084–0.112 mm in diameter, abuts posterior body margin. Conical or spherical excretory bladder situated close above acetabulum; its two lateral canals are connected with a transverse anastomosis; they bifurcate in anterior body portion. Pigmented eyespots (either dark, heart-shaped, or starlike branched) occupy the space between these branches. Tail longer than cercarial body, length 0.566–0.712 mm, width 0.060 to 0.086 mm. Excretory canal extending along length of tail, bifurcating close to tail end.

A similar type of cercariae with starlike eyespots was reported by El Gindy and Rushdi (1963) from *Bulinus truncatus* in Egypt. The measurements of the individual organs were slightly smaller than those of our specimens, but close to the measurements of cercariae with starlike eyespots in

* A survey of the fluke species, hosts and localities is given in Table 2.

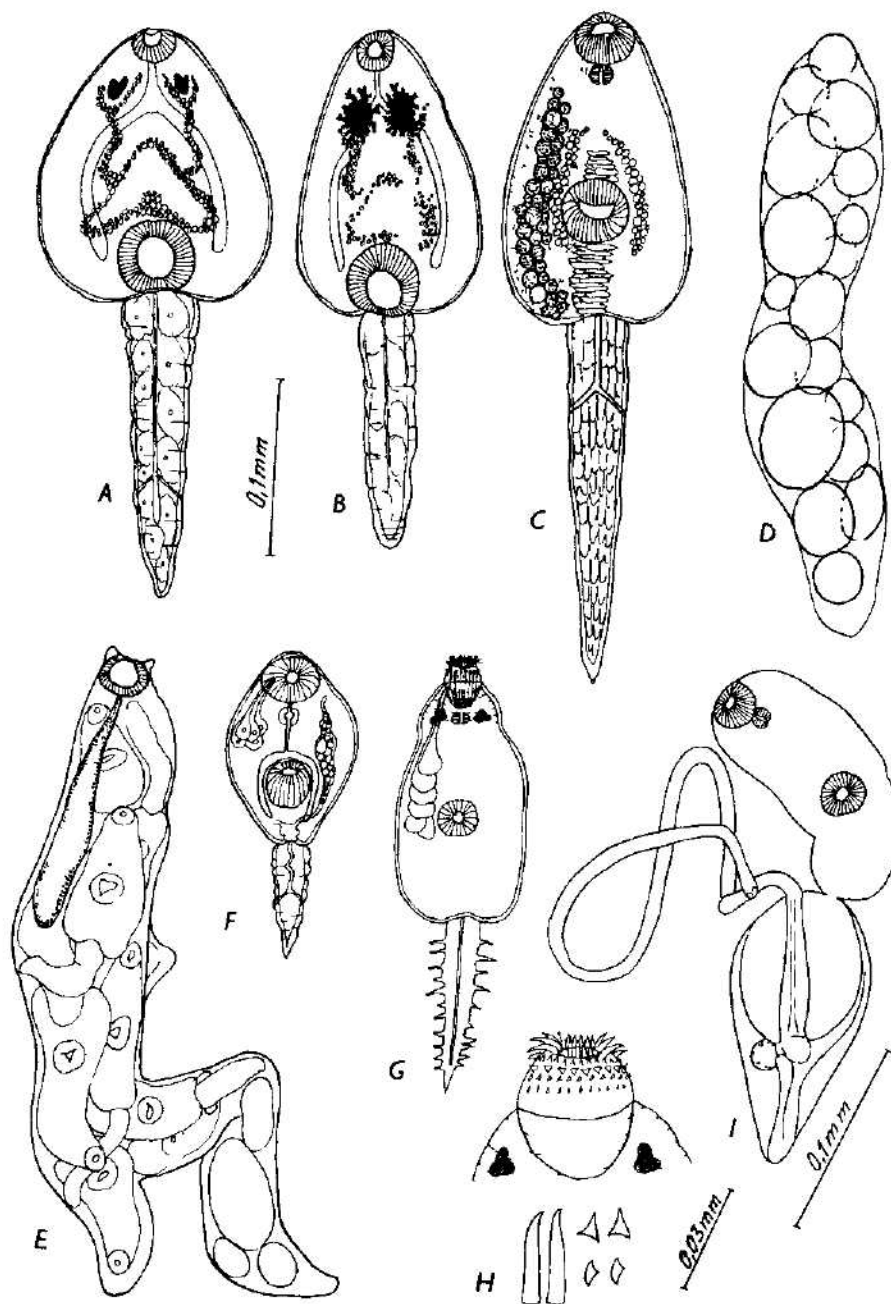


Fig. 2. A, B — Amphistome cercaria "pigmentata" type, C — Cercaria of *Fasciola gigantica*; D — young sporocyst, E — redia, F — Gymnococephalae cercaria type "A"; G, H — Gymnococephalae cercaria type "B", I — Cystophorous cercaria type I.

our material which, in our opinion, are younger cercariae. Therefore, we consider our cercariae to be identical to those found by El Gindy and Rushdi. These authors assumed that the cercariae found by them belonged to the species *Paramphistomum cervi* (Schränk, 1790). According to a number of older and recent authors (Nässmark, 1937; Kotlán, 1958; Kotrlá et Prokopič, 1973, etc.) the name *P. cervi* has been used for a number of species and even genera; therefore, the identification of cercariae from *B. truncatus* should be based on experimental confirmation.

b) Gymnocephalous cercariae

2. Cercaria of *Fasciola gigantica* (Fig. 2C, D, E)

These cercariae were found in *Lymnaea tailliaudi*. Body length 0.280 to 0.426 mm, width 0.230–0.252 mm. Oral sucker 0.060–0.068 mm in diameter, acetabulum 0.070–0.074 mm, pharynx 0.030–0.032 mm. Intestinal branches reach end of cercarial body. Tail 0.540–0.748 mm long, width 0.078–0.092 mm. Excretory canal extending through tail bifurcates in first fifth of tail length. Cercariae encyst on waterplants, but cysts were found also on the surface of the watersnail *Physa acuta*.

Other stages of *Fasciola gigantica* found in *Lymnaea tailliaudi* were young sporocysts measuring 0.210–0.256 × 0.096 to 0.0134 mm (Fig. 2D, E), and rediae (Fig. 2F) measuring 1.964–2.692 mm × 0.0368–0.0722 mm. Oral sucker 0.098 mm, length of rudimentary intestine 0.360 mm.

Nagaty et al. (1959) found slightly smaller cercariae than those found by us in *Limnaea tailliaudi*. These authors compared their finding with cercariae from *Lymnaea truncatula* collected in the Baharia Oasis and considered both species to be identical; therefore, they assigned them to the species *Fasciola gigantica* (Cobbold, 1855). We compared our finding with the description of *Fasciola hepatica* Linnaeus, 1758 given by Wessenberg-Lund (1934), and the description of *F. gigantica* given by Alicata (1938). Basing on the results of our comparison we assigned our finding to the species *Fasciola gigantica* (Cobbold, 1855).

3. Gymnocephalae cercaria type "A" (Fig. 2F)

This type of cercariae was found in *Bythinia* sp. Body length 0.105 to 0.120 mm, width 0.068–0.076 mm. Oral sucker subterminal, spherical, diameter 0.032–0.036 mm, pharynx 0.012 mm in diameter, acetabulum spherical, diameter 0.038–0.042 mm. Penetration glands: three pairs along both sides of body up to pharynx level. Excretory bladder Y-shaped, with two lateral canals. Intestinal branches reach posterior end of body. Flame cells: seven pairs present. Length of tail 0.072–0.084 mm, width 0.022 to 0.030 mm, excretory canal through tail bifurcates below posterior half of tail.

Morphologically, our cercariae are analogous to those recorded by Wessenberg-Lund (1934) from *Bythinia tentaculata* except for their considerably smaller size.

4. Gymnocephalae cercaria type "B" (Fig. 2G, H)

Also this cercaria was found in *Bythinia* sp. from the Abu Sarda distributory canal. Body length 0.332–0.350 mm, width 0.143–0.194 mm. Oral

sucker terminal, elevated above body surface, diameter 0.053 mm. Sucker armed with hooks, arranged in 6–7 parallel rows, the longest on the apical end of sucker (0.007–0.008 mm). Their length decreases towards the base, their shape changes. Pharynx 0.017 mm in diameter, acetabulum 0.049 mm. Two pigmented eyespots in anterior extremity, six pairs of penetration glands extended to acetabulum level. Tail 0.385 mm long, width 0.08 mm, with massive spines on the edges.

The structure of the body of this cercaria, its measurements, the arrangement of its internal organs and, mainly, the arrangement of the spines on the oral sucker is identical to that of *Cercaria atomica* from *Bythinia albertini* from the Congo described by Fain (1953), except for the spiny tail which is absent in the latter.

c) Cystophorous cercariae

5. Cystophorous cercaria type I (Fig. 2I)

This type of cercaria was found in *Biomphalaria alexandrina* from the Mansouria drain near the village of Bortus.

Body length 0.112–0.128 mm, width 0.054–0.062 mm. Oral sucker terminal, 0.022 mm in diameter, pharynx 0.010 mm, acetabulum 0.020 mm. A pear-shaped chamber measuring 0.125×0.070 mm abuts posterior extremity; it encloses the coiled tail-length 0.620 mm, width 0.012 mm. Cystophorous cercariae are larval stages of trematodes of the families Gorgoderidae and Halipegidae (according to Dawes, 1946). They parasitize frogs which are plentiful in the canals and drains of Warak El Arab. In its morphology our species is close to *Cercaria bulla* described by Fain (1953) from *Biomphalaria alexandrina tanganyicensis* from the Congo. The adult flukes parasitize frogs and belong to the genus *Halipegus*.

d) Echinostome cercariae

6. Cercaria of *Echinostoma revolutum* (Fröhlich, 1802) (Fig. 3C, D) from *Biomphalaria alexandrina* of the banks of the Nile and the Estable drain.

Body pear-shaped, length 0.332–0.446 mm, width 0.138–0.186 mm. Anterior end of cercarial body surrounded by typical kidney-shaped collar armed with 36–38 minute spines, length 0.020 to 0.025 mm. Oral sucker subterminal, 0.044–0.052 mm in diameter, pharynx 0.022–0.026 mm in diameter. Acetabulum close below midbody, 0.064–0.076 mm in diameter. Intestinal branches extended to almost posterior body margin. Excretory bladder variable in shape. Its two excretory canals extend to pharynx level, turn and proceed downwards to anterior margin of body. Body surface covered with minute spines. Tail 0.520–0.580 mm long, width 0.038–0.054, with an excretory canal passing through its centre.

7. Cercaria of *Echinoparyphium bioccalerouxii* Dollfus, 1953 (Fig. 3A, B)

from *Bullinus truncatus*. Body pear-shaped, length 0.580–0.064 mm, width 0.170–0.230 mm, collar on its anterior end armed with 40–44 spines in two rows. Lateral group of spines 0.018–0.021 mm, measurements of spines in central part of collar 0.012–0.016 mm. Oral sucker subterminal to terminal, 0.050–0.064 mm in diameter, pharynx 0.028–0.031 mm in diameter, acetabulum 0.068–0.064 mm. Intestinal branches reach posterior

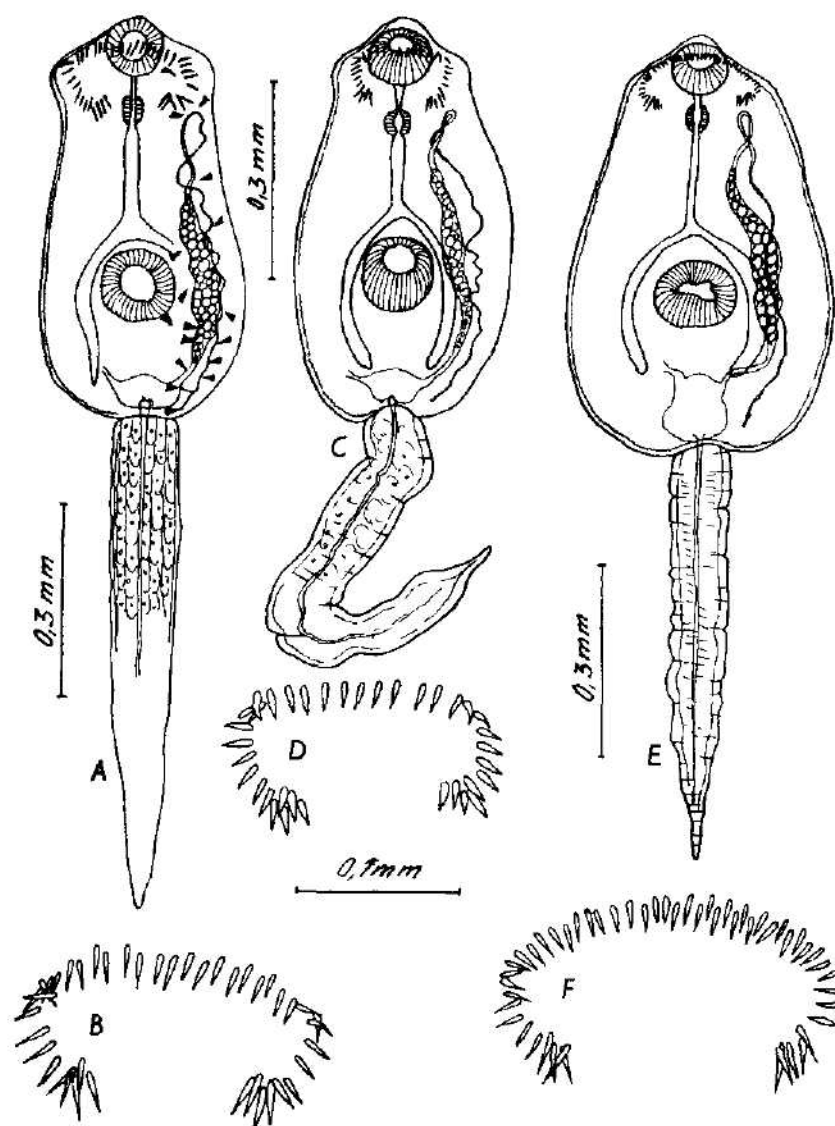


Fig. 3. A, B — Cercaria of *Echinoparyphium bioccalerouxii* Dollfus, 1953; C, D — Cercaria of *Echinostoma revolutum* (Frohlich, 1802); E, F, *Echinostome cercaria* III.

body margin and open in two lateral excretory canals; these extend to the level of oral sucker, turn backwards and reach posterior body margin. Exact number of flame cells not determined, apparently 32 pairs. Length of tail 0.420—0.480 mm, excretory canal through tail bifurcates at posterior end.

This cercaria is similar to that recorded by Dollfus (1953) as the cercaria of the species described by him as *E. bioccalerouxii* Dollfus, 1953. Our cercaria

has been arranged provisionally to this species although it may be identical with the species *E. recurvatum* (Linstow, 1873). This point will have to be settled in future studies.

8. Echinostome cercaria III (Fig. 3E, F) —

recovered from *Biomphalaria alexandrina*, Hanadwa drain branch no. 1. The morphology of this species is analogous to that of the foregoing species except for a larger number of collar spines (50—52).

e) Xiphidiocercariae

Virgulae group

9. Xiphidiocercaria type "A" (Fig. 4A, B, C) from *Bythinia* sp.

Body length 0.105—0.133 mm, width 0.035 mm, anterior third of body covered with fine spines arranged in transverse rows. Oral sucker terminal, 0.074—0.086 mm in diameter, with a "virgula" organ consisting of two lateral formations connected with a narrow anastomosis. Pharynx 0.044 mm in diameter, acetabulum 0.068—0.070 mm. Penetration glands: four pairs extended to level of acetabulum. Stylet 0.012—0.014 mm. Excretory bladder mostly Y-shaped with lateral excretory canals. Length of tail 0.049 to 0.060 mm, width 0.016—0.018 mm, with excretory canal extending throughout the length of tail.

10. Xiphidiocercaria type "D" (Fig. 4H, I, J) from *Bythinia* sp.

Length of cercarial body 0.140—0.180 mm, width 0.082—0.106 mm, anterior third of body covered with fine spines. Oral sucker terminal, 0.042 to 0.056 mm in diameter, pharynx 0.014 mm in diameter, acetabulum 0.026 to 0.032 mm. A "virgula" organ present on oral sucker, consisting of two semi-spherical sacs which are fused with a narrow anastomosis. Stylet length 0.023—0.025 mm. Penetration glands: four pairs reaching posterior third of body length. Intestinal branches wide, reaching posterior body margin. Excretory bladder flask-shaped. Length of tail 0.115 to 0.160 mm, width 0.040—0.046 mm.

11. Xiphidiocercaria type "E" (Fig. 4K, L, M) from *Lymnaea tailliaudi*, Sawachel drain and Mansouria drain.

Body oval or ovoid, length 0.186—0.204 mm, width 0.098—0.114 mm. Anterior fourth of body covered with fine spines. Oral sucker terminal, 0.050—0.056 mm in diameter, with a "virgula" organ formed by two lateral, spherical formations connected with a narrow anastomosis. Length of stylet 0.019—0.021 mm. Praepharynx situated below oral sucker, length 0.064 to 0.076 mm, pharynx 0.018—0.022 mm in diameter. Acetabulum 0.046 to 0.050 mm in diameter. Intestinal branches extended to posterior body margin. Penetration glands: six to seven pairs extending to below level of acetabulum. Excretory bladder hourglass-shaped. Length of tail 0.106 to 0.130 mm, width 0.024—0.026 mm.

Nagaty et al. (1959) found Xiphidiocercariae in *Lymnaea tailliaudi* from the Mansouria drain. Since these authors recorded the presence of 2—3 pairs of very short penetration glands, the cercariae are not identical with our finding.

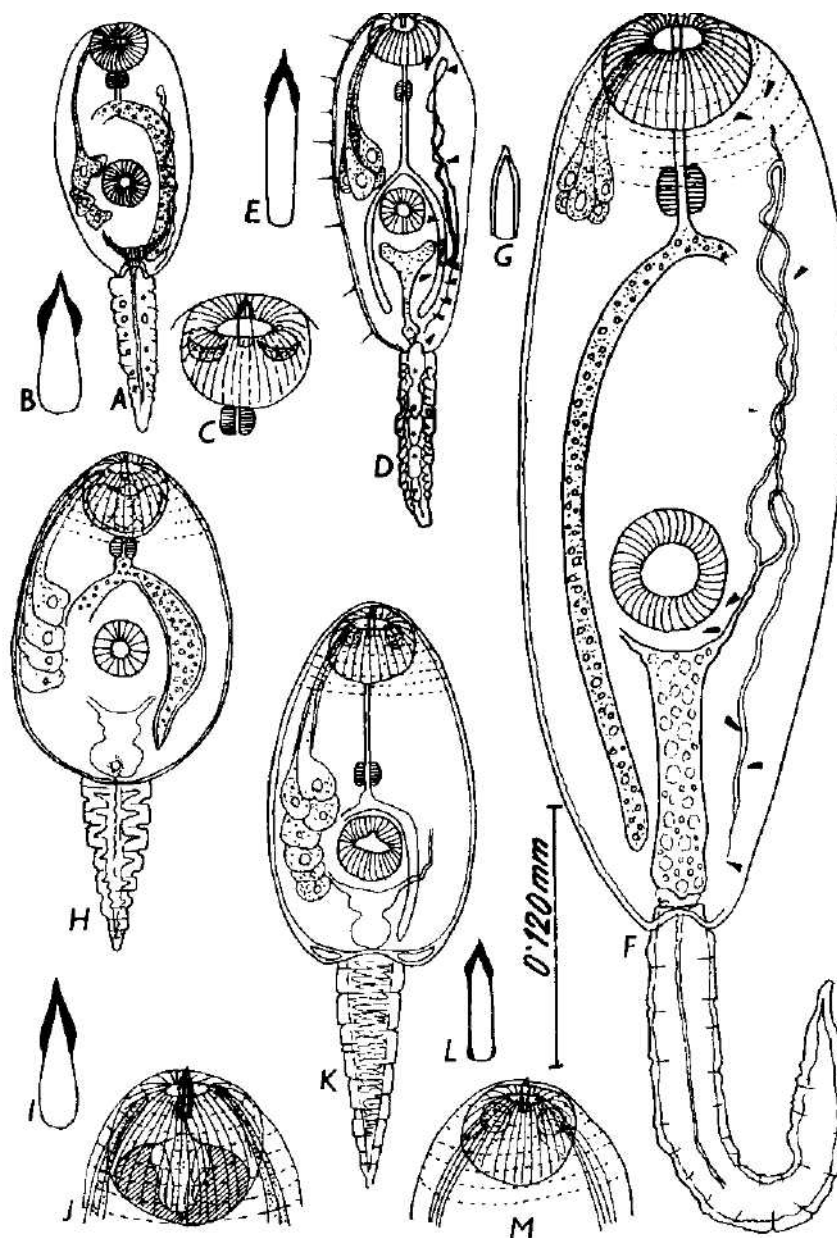


Fig. 4. A, B, C — Xiphidiocercaria type "A" from *Bythinia* sp.; D, E — Xiphidiocercaria type "B" from *Bythinia* sp.; F, G — Xiphidiocercaria type "C" from *Bulinus truncatus*; H, I, J — Xiphidiocercaria type "D" from *Bythinia* sp.; K, L, M — Xiphidiocercaria type "E" from *Lymnaea tailliaudi*.

Armatae group

12 Xiphidiocercaria type "C" (Fig. 4F, G) — from *Bulinus truncatus*, Nile shore near Warak El Arab, El Sokeil and El Karatein.

Length of body 0.490—0.596 mm, width 0.268—0.324 mm. Anterior third of body covered with fine spines. Oral sucker terminal, 0.106—0.130 mm in diameter. Stylet 0.025 mm long, pharynx 0.038 mm in diameter, acetabulum

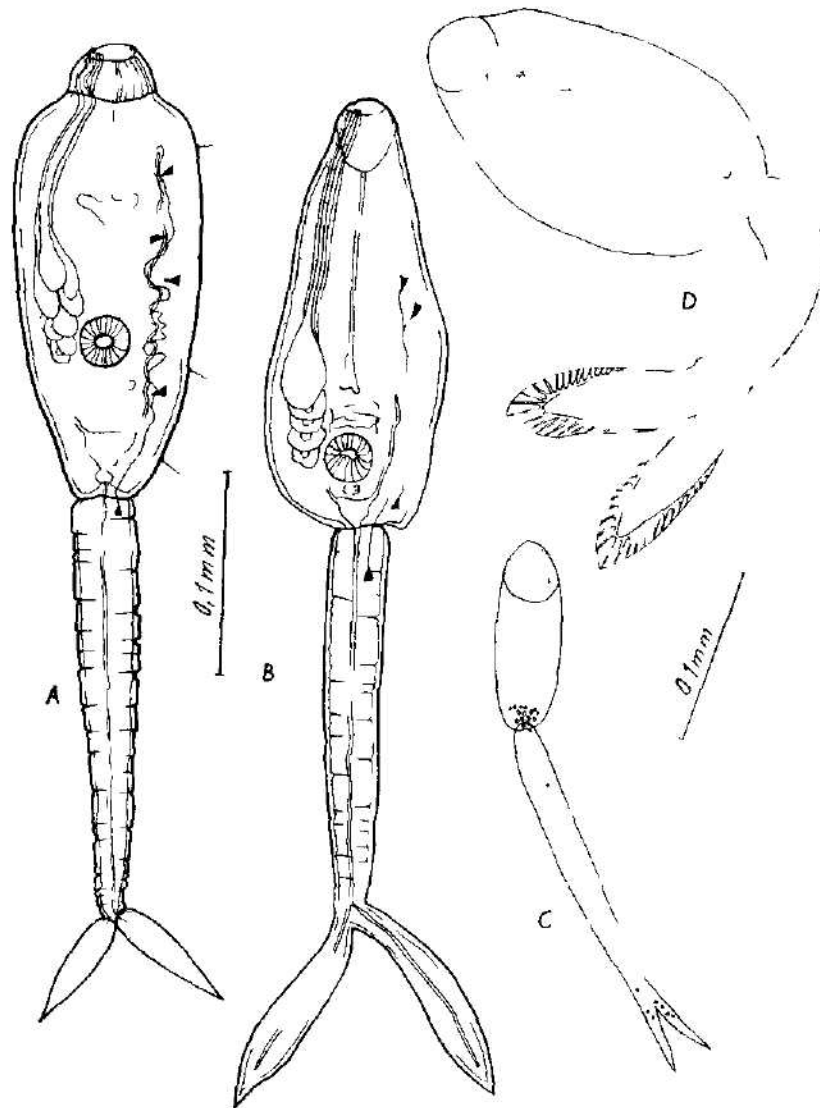


Fig. 5 A — Cercaria of *Schistosoma haematobium* from *Bulinus truncatus*, B — Cercaria of *Schistosoma mansoni* from *Biomphalaria alexandrina*, C — Furcocercaria sp. 1 from *Bythinia* sp. D — Furcocercaria sp. 2 from *Bythinia* sp.

0.072–0.084 mm. Caeca extended to posterior extremity. Excretory bladder mostly Y-shaped, its two lateral canals extend from anterior portion of bladder and proceed in both apical and distal direction to the area of oral sucker and posterior end of body respectively. Length of tail variable, 0.216–0.300 mm when contracted, up to 0.730 mm when expanded.

Microcotylae group

13. Xiphidiocercaria type "B" (Fig. 4D, E) from *Bythinia* sp., locality Sawachel canal distributory no. 61, and from *Lymnaea tailliaudi*, localities Sawachel branch no. 2 and Nile shore near Warak El Arab.

Body shape oval, length 0.182–0.210 mm, width 0.070–0.086 mm. Anterior extremity covered with fine spines. Oral sucker terminal, 0.040 to 0.048 mm in diameter, stylet 0.015 mm long, pharynx 0.017 mm in diameter. Intestinal branches extended to anterior end of body. Acetabulum shifted slightly below midbody, diameter 0.028–0.034 mm. Penetration glands: four pairs reaching level of intestinal bifurcation. Excretory bladder Y-shaped, length of tail 0.102–0.128 mm, with wide excretory canal throughout its length.

f) Furcocercariae

Apharyngeal, brevifurcate, distome cercariae

14. Cercaria of *Schistosoma haematobium* (Fig. 5A)

from *Bulinus truncatus*, from localities along the bank of the Nile near Warak El Arab, El Sokeil and El Karatein. Since the description of this cercaria is readily available from the parasitological literature, it is not given in our text.

15. Cercaria of *Schistosoma mansoni* (Fig. 5B)

from *Biomphalaria alexandrina*, Nile shore, at Warak El Arab, El Sokeil and El Karatein; Estable drain branch no. 3 close to the village of Shenbari. Description of this species available in parasitological literature.

Apharyngeal, brevifurcous, monostome cercariae

16. Furcocercaria sp. I (Fig. 5C)

from *Bythinia* sp., Ouseim drain near the village of Bortus. Our cercariae were young, brevifurcous cercariae, which had not completed their morphology. Body length 0.0120–0.0135 mm, width 0.010–0.014 mm. Oral sucker rudimentary, 0.03 mm in diameter. Acetabulum not observed. Length of tail 0.240 mm, width 0.020 mm, length of tail furcae 0.055 mm.

Pharyngeal, longifurcous, distome cercariae

17. Furcocercaria sp. II (Fig. 5D)

from *Bythinia* sp., Ouseim drain. Young mediofurcous or longifurcous cercaria, body length 0.254–0.270 mm, width 0.140 mm. Oral sucker terminal, 0.063 mm in diameter, pharynx 0.020 mm in diameter; it abuts oral sucker. Acetabulum indistinct, intestinal caeca extended to posterior

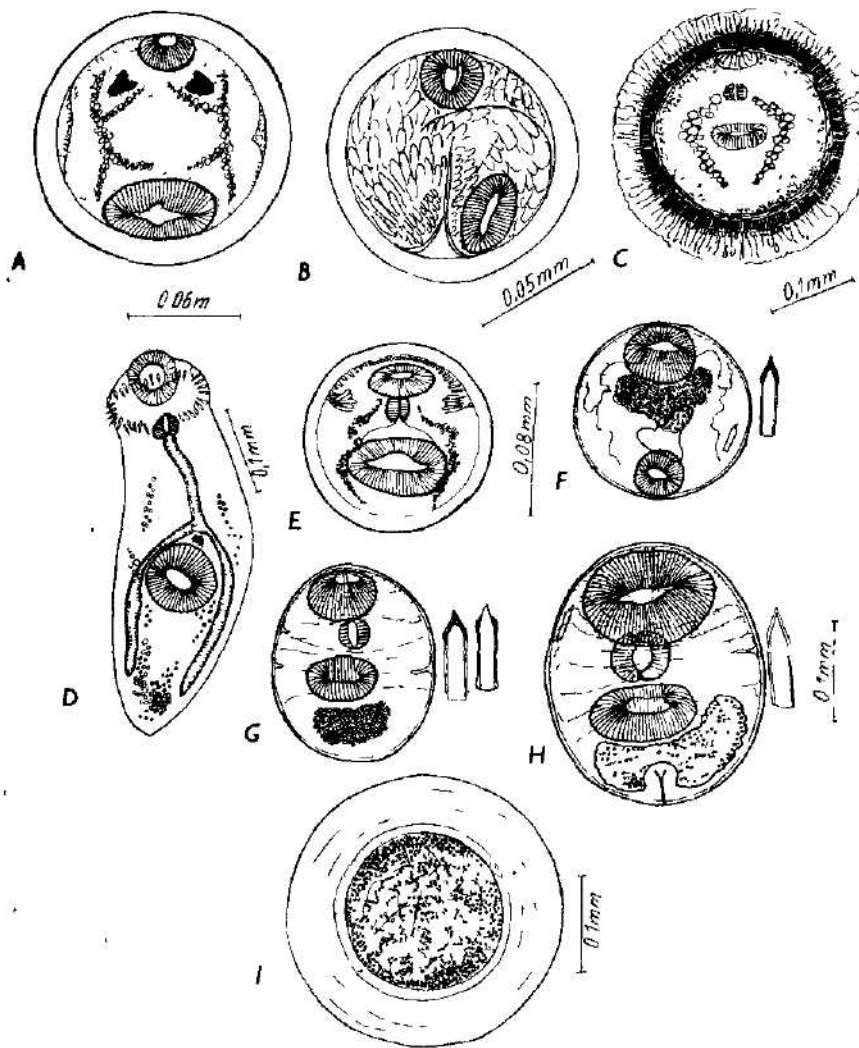


Fig. 6. A — Amphistome metacercaria from *Biomphalaria alexandrina*; B — Gymnocephalous metacercaria from *Biomphalaria alexandrina*; C — Metacercaria of *Fasciola gigantica*; D — Metacercaria of *Echinostoma revolutum* (Frohlich, 1802) (pressed out of the cyst); E — Metacercaria of *Echinoparyphium boocalerouxii* Dollfus, 1953 from *Bulinus truncatus*; F — Xiphidiometacercaria type "A" from *Bulinus truncatus*; G — Xiphidiometacercaria type "B" from *Physa acuta*; H — Xiphidiometacercaria type "C" from *Bulinus truncatus*; I — *Tetracotyle* sp. from *Bulinus truncatus*.

body margin. Tail 0.270—0.296 mm long, width 0.047—0.056 mm. Tail wide, furcae with ribbed fin-folds, furca length 0.140 mm.

Although these cercariae were not fully developed it was possible to assign them to the "vivax" group typical of an indistinctly developed or absent acetabulum. The measurements of our specimens are similar to those of the type *Cercaria vivax* Sonsino reported by Wesenberg-Lund (1934) from

Table 2: Types of cercariae found in the water snail species collected in the Warak El Arab area

Snail species	Type of cercariae	Locality
<i>Bulinus truncatus</i>	<i>Schistosoma haematobium</i>	Nile shore Warak El Arab Nile shore El Sokeil Nile shore El Karatein
	Amphistomae (Paramphistomatidae)	Nile shore Warak El Arab Sawachel canal br. No. 1 Sawachel canal distr. No. 61 Koom El Ahmer canal Abu Sarda distr. canal
	<i>Echinoparyphium recurvatum</i> (= <i>E. bioccalerouxii</i>)	Sawachel canal br. No. 1 Nile shore Warak El Arab Nile shore El Karatein
	Xiphidiocercaria "C"	Nile shore Warak El Arab
<i>Biomphalaria alexandrina</i>	<i>Schistosoma mansoni</i>	Nile shore Warak El Arab Nile shore El Sokeil Nile shore El Karatein Estable drain No. 3 (near Shenbari)
	<i>Echinostoma revolutum</i>	Estable drain Nile shore El Sokeil Nile shore Warak El Arab Nile shore El Karatein Mansouria drain (near Bortus)
	<i>Echinoparyphium</i> sp. ("Echinostomatidae III")	Hanadwa drain No. 1
	Cystophorous cercaria	Mansouria drain
<i>Lanistes boltienianus</i>	Xiphidiocercaria "B"	Sawachel drain
	Xiphidiocercaria "C"	Nile shore Warak El Arab
<i>Bythinia</i> sp.	Xiphidiocercaria "A" (virgulæ group)	Sawachel canal
	Xiphidiocercaria "B"	Sawachel canal distr. No. 61
	Xiphidiocercaria "D" (virgulæ group)	Abu Sarda distr. canal
	Gymnocephalæ "B"	Abu Sarda distr. canal
	Furcocercariae I (Apharyngeal brevifurcate monostome cercaria)	Ouseim drain
	Pharyngeal longifurcate distome cercaria (vivax group)	Ouseim drain
<i>Lymnaea taillandi</i>	Xiphidiocercaria "B"	Sawachel drain No. 2 Nile shore Warak El Arab

Table 2 — continued

Snail species	Type of cercariae	Locality
	Xiphidiocercaria "E"	Sawachel drain El Mansouria drain
	Cercaria Fasciolae giganticae	Sawachel drain El Mansouria drain

Bythinia tentaculata. The adults are members of the family Strigeidae and parasitize mainly waterbirds.

B. Metacercariae (Table 3)

Amphistome metacercariae

1. Amphistome metacercaria (Fig. 4A): this is a metacercaria belonging to the Amphistomae cercariae (family Paramphistomatidae). An occasional metacercaria of this type was found in *Biomphalaria alexandrina* from the Nile shore near Warak El Arab and in the Sawachel drain. Generally, these metacercariae encyst on waterplants. The spherical cysts measure 0.216 to 0.264 mm in diameter, the wall is 0.024—0.040 mm thick. Pharynx 0.064 mm in diameter, acetabulum 0.080—0.088 mm. Excretory canal and two eyespots visible through darkly coloured metacercarial body.

Gymnocephalous metacercariae

2. Gymnocephalous metacercaria I (Fig. 4B) from *Biomphalaria alexandrina*, Nile shore and Warak El Arab. Cyst 0.228 mm in diameter, oral sucker 0.070 × 0.046 mm, acetabulum 0.053—0.056 mm, thickness of wall 0.017 mm.
3. Metacercaria (Adolescaria) Fasciolae giganticae (Fig. 4C). An exceptional finding of this metacercaria on the surface of the shell of *Physa acuta* from the Nile shore near Warak El Arab. The normal site of encystment is the surface of waterplants. Body darkly coloured, diameter 0.302—0.342 mm. Thickness of outer, gelatinous layer on cyst surface 0.022—0.028 mm, thickness of cyst wall proper 0.020—0.024 mm. Oral sucker 0.060—0.064 mm in diameter, acetabulum 0.070—0.074 mm, pharynx 0.030—0.036 mm in diameter. Intestine and lateral excretory canals visible inside the cyst.

Echinostome metacercariae

4. Metacercaria of *Echinostoma revolutum* (Fig. 4D): these were present in various organs (kidney, pericardial sac) of *Bulinus truncatus* and *Physa acuta*, (Nile shore near El Karatein) and of *Biomphalaria alexandrina* (Nile shore near El Karatein, Estable drain, Sawachel drain).

Diameter of metacercarial cyst 0.148—0.164 mm, thickness of wall 0.006 mm. Diameter of oral sucker 0.050—0.056 mm, of acetabulum 0.072 to 0.078 mm, of small pharynx 0.030—0.036 mm. The number of collar spines (34—38) could be assessed only in metacercariae pressed out of the cyst.

5. Metacercaria of *Echinoparyphium bioccalerouxii* (Fig. 4E) found in *Bulinus truncatus*, *Physa acuta*, *Lanistes boltienianus* and *Cleopatra* sp from the Nile

Table 3: Types of metacercariae found in the water snail species from the area Warak El Arab

Snail species	Type of metacercaria	Locality
<i>Bulinus truncatus</i>	Echinoparyphium recurvatum (= <i>E. bioccalerouxii</i>)	Nile shore Warak El Arab Nile shore El Karatein Sawachel canal br. No. 1 Koom El Ahmer canal
	Echinostoma revolutum	Nile shore El Karatein Nile shore El Sokeil Nile shore Warak El Arab
	Xiphidiometacercaria "C"	Nile shore Warak El Arab
	Xiphidiometacercaria "A"	Nile shore Warak El Arab Nile shore El Karatein
	Tetracotyle sp.	Sawachel canal br. No. 1 Nile shore Warak El Arab
<i>Biomphalaria alexandrina</i>	Echinoparyphium recurvatum (= <i>E. bioccalerouxii</i>)	Nile shore Warak El Arab Nile shore El Sokeil Estable drain
	Echinostoma revolutum	Nile shore El Karatein Estable drain Sawachel drain
	Echinoparyphium sp.	Sawachel drain
	Gymnocephalous metacercaria sp. 1	Nile shore Warak El Arab
	Tetracotyle sp.	Sawachel drain
	Amphistomae (Paramphistomatidae)	Nile shore Warak El Arab Sawachel drain
	Xiphidiometacercaria "A"	Nile shore Warak El Arab Sawachel drain Nile shore El Sokeil Nile shore El Karatein Estable drain Mansouria drain
<i>Physa acuta</i>	Echinoparyphium recurvatum (= <i>E. bioccalerouxii</i>)	Nile shore Warak El Arab Nile shore El Karatein Sawachel canal Sawachel canal br. No. 1 Koom El Ahmer canal Abu Sarda distr. canal Ouseim drain
	Echinostoma revolutum	Nile shore El Karatein
	Xiphidiometacercaria "B"	Sawachel drain
	Xiphidiometacercaria "A"	Nile shore Warak El Arab

Snail species	Type of metacercaria	Locality
		Nile shore El Karatein Ouseim drain
	Tetracotyle sp.	Sawachel canal Sawachel canal br. No. 1 Ouseim drain
<i>Lanistes boltienianus</i>	Echinoparyphium recurvatum (= <i>E. bioccalerouxi</i>)	Nile shore Warak El Arab
	Xiphidiometacercaria "A"	Nile shore Warak El Arab
	Tetracotyle sp.	Ouseim drain
<i>Cleopatra</i> sp.	Echinoparyphium recurvatum (= <i>E. bioccalerouxi</i>)	Nile shore Warak El Arab
	Tetracotyle sp.	Ouseim drain
<i>Bythinia</i> sp.	Echinoparyphium recurvatum (= <i>E. bioccalerouxi</i>)	Sawachel canal Abu Sarda distr. canal
<i>Lymnaea tailliaudi</i>	Xiphidiometacercaria "A"	Nile shore El Karatein Sawachel drain Mansouria drain
<i>Viviparus unicolor</i>	Tetracotyle sp.	Ouseim drain

Shore near Warak El Arab and El Karatein, the Sawachel canal branch no. 1 and the Koom El Ahmer canal. Diameter of cyst 0.132–0.154 mm, thickness of cyst wall 0.006 mm. Size of oral sucker of metacercariae pressed out of the cyst 0.042–0.048 mm in diameter, acetabulum 0.060–0.066 mm, pharynx 0.020–0.024 mm. Number of collar spines 44–46.

Xiphidiometacercariae

6. Xiphidiometacercaria type "A" (Fig. 4F) from *Bulinus truncatus* (Nile shore near Warak El Arab and El Karatein); from *Physa acuta* (Nile shore near Warak El Arab, El Karatein, Ouseim drain); from *Lanistes boltienianus* (Nile shore near Warak El Arab), *Lymnaea tailliaudi* (Nile shore near El Karatein, Sawachel drain, Mansouria drain); from *Viviparus unicolor* (Nile shore near Warak el Arab, El Karatein); from *Gyraulus mareoticus* (Sawachel drain).

Measurements of cyst $0.144-0.154 \times 0.130-0.138$ mm, thickness of cyst wall 0.004 mm, oral sucker 0.049 mm in diameter, acetabulum 0.042 to 0.048 mm, pharynx 0.024 mm, measurements of dark urinary bladder $0.060-0.072 \times 0.032-0.038$ mm. Length of stylet 0.019 mm.

7. Xiphidiometacercaria type "B" (Fig. 4G) from *Physa acuta* (Sawachel drain); experimentally from *Lanistes boltienianus*.

Diameter of spherical cyst $0.100-0.112$ mm, thickness of wall 0.003 mm. Oral sucker $0.046-0.054$ mm in diameter, acetabulum $0.026-0.030$ mm, pharynx 0.016 mm. Length of stylet 0.017 mm.

8. Xiphidiometacercaria type "C" (Fig. 4H) from *Bulinus truncatus* (Nile shore, El Karatein). Cyst oval, $0.278-0.294 \times 0.250-0.262$ mm, thickness of cyst wall 0.008 mm. Oral sucker $0.110-0.116 \times 0.090-0.102$ mm, acetabulum $0.084-0.098 \times 0.062-0.070$ mm, pharynx $0.050-0.060$ mm in diameter; measurements of dark, urinary bladder $0.104-0.118 \times 0.090$ to 0.104 mm. Stylet length 0.025 mm.

Strigeidae metacercariae

9. Tetracotyle sp. 1 (Fig. 4I) from *Bulinus truncatus* (Sawachel canal branch no. 1, Nile shore near Warak El Arab), *Biomphalaria alexandrina* (Sawachel drain); *Physa acuta* (Sawachel canal, Sawachel canal branch no. 1, Ouseim drain); *Lanistes boltienianus* (Ouseim drain), *Bythinia* sp. (Abu Sarda distributory canal); *Viviparus unicolor* (Ouseim drain).

Cyst spherical, wall thick, refractile, thickness $0.046-0.054$ mm. Body of tetracotyle densely granulated, refractile, inner organs visible in tetracotyle densely granulated, refractile, inner organs visible in tetracotyle pressed out of the cyst. Oral sucker oval, size $0.052-0.058 \times 0.070-0.074$ mm, acetabulum 0.060×0.078 mm, pharynx 0.030 mm in diameter. Lobate hold-fast organ situated in posterior extremity, $0.168-0.220$ mm in diameter.

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**REDESCRIPTION OF PTENIDIOPHYES MIRABILIS REUTER
(HETEROPTERA: SCHIZOPTERIDAE)**

PAVEL ŠTYS

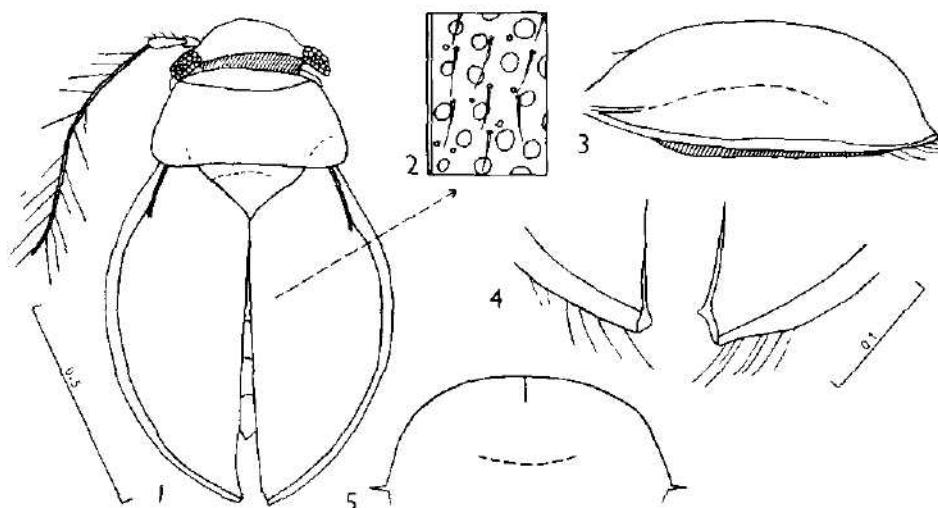
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Abstract: *Ptenidiophyes mirabilis* Reuter, 1891 from Brazil is known from the extremely coleopteroid female holotype only. The holotype is redescribed and the species is compared with other coleopteroid Schizopteridae.

The assessment of the systematic position and relationship of the predominantly tropical and edaphic species of Schizopteridae is based mainly on their fore wing venation and structures of the male abdomen and genitalia. The placement of uniquely found coleopteroid females is almost impossible. *Ptenidiophyes mirabilis* Reuter, 1891 was based on such a female, was insufficiently described, and the unique type specimen was believed to be lost (Emsley, 1969); no further specimens of this only species of the genus *Ptenidiophyes* Reuter, 1891 were discovered. However, the genus is probably valid, and its coleopteroid female morph represents the most extreme case of coleopterism in the Western Hemisphere fauna of Schizopteridae. I have rediscovered the holotype of *Ptenidiophyes mirabilis* in the Zoological Museum in Helsinki in 1971 (my thanks for its loan are due to Dr. M. Meinander), and in this paper its redescription is presented in order to facilitate the recognition of the species and future association of its coleopteroid female morph with taxonomically more significant phenae.

Historical

Ptenidiophyes mirabilis, subsequently to its original description by Reuter (1891), was recorded only by Uhler (1894) from Grenada (West Indies), but Uhler's specimens were misidentified and were later described as *Schizoptera uhleri* McAtee et Malloch, 1925. McAtee & Malloch (1925) redescribed Reuter's holotype and keyed the genus, but added no new significant data. China (1946) described *Ptenidiophytes trinitatis* China, 1946 from Trinidad, but this species was later correctly transferred by Wygodzinsky (1948) to the genus *Chinannus* Wygodzinsky, 1948. Emsley (1969) classified *Ptenidiophyes* among Schizopteridae incertae sedis.



Ptenidiophyes mirabilis, ♀ holotype. Fig. 1. Total view. Fig. 2. Sculpture of elytron. Fig. 3. Left elytron, lateral view. Fig. 4. Apices of elytra, dorsal view. Fig. 5. Transverse profile of the elytral dome at its widest point; dashed line indicates the level of abdominal venter. Figs. 1, 3, 5 and 2, 4 to the same scale.

Ptenidiophyes Reuter

Ptenidiophyes Reuter, 1891: 15 (keyed), 25 (descr.); McAtee & Malloch, 1925: 11 (keyed), 30 (redescr.); Emsley, 1969: 107 (catal.).

Type species: *Ptenidiophyes mirabilis* Reuter, 1891; monobasic.

Since only the female coleopteroid morph of the type species is known, I do not attempt to extract the characters of generic weight. For distinguishing the genus and species see Comparative notes.

Ptenidiophyes mirabilis Reuter

(Figs. 1–9)

Ptenidiophyes mirabilis Reuter, 1891: 26 (descr.), fig. 15; McAtee & Malloch, 1925: 30–31 (redescr.), pl. 2, fig. 27; Wygodzinsky, 1948: 147 (compared with *Chinannus bierigi* Wyg.); Emsley, 1970: 107 (catal.).

Holotype: coleopteroid ♀, Brazil, Sta. Catarina, Blumenau, leg. Reitter, deposited in the collection of Museum Zoologicum Universitatis, Helsinki (type no. 3930). A carded specimen, body fragmented in two parts, right appendages mutilated or missing, right legs mounted separately.

Measurements (in millimetres; L = length, W = width). Head, L (without neck) 0.10, max. W 0.36, vertex min. W 0.24. Pronotum, anterior W 0.34, posterior W 0.43, medial L 0.21, collum L 0.05. Scutellum, W 0.24, L 0.13. Elytra, L 0.77, commissural L 0.64, max. combined W 0.64. Antenna, L segment i 0.05, ii 0.08, iii 0.32, iv 0.29.

Total length 1.02 mm.

General facies distinctly coleopteroid, body 1.6 times as long as wide, its posterior part strongly inflated.

Colour, sculpture and pilosity.

Unicolorous brown (darker anteriorly), with contrastingly stramineous costal margins of elytra. Antennae and legs stramineous. Pterothoracic pleurae black-brown.

Opaque, pruinose, only anteroventral surface of head slightly lustrous. Dorsum finely shagreened, elytra also with numerous, small, glabrous (under certain observational angles lustrous), slightly depressed, irregularly scattered or in indistinct longitudinal rows arranged alveoles; the alveoles shallower, smaller and more widely spaced (interalveolar distance equal to about 1.5 alveolar diameter) discally, deeper, larger, and more crowded (interalveolar distance equal to about 1 alveolar diameter) along the costal margin and in the originally claval area; about 15 alveoles across the middle of each elytron, about 26 along costal margin. Pteropleuron markedly granulate.

Pubescence whitish to yellowish. Dorsum with numerous, short, slightly curved, adpressed sericeous hairs, pronotum and head also with some semierect, curved, subdecumbent hairs. Without outstanding macrochaetes, some straight erect hairs present anteroventrally on the head and on the posterolateral margins of elytra only.

Structure (because of its historical value I have not attempted the dissection of the unique available specimen; consequently, many important details, particularly of the abdominal anatomy, could not have been studied.)

Head short, vertex moderately declivent, the convex frontal region abruptly ventrally declivent, the non-produced clypeal region receding posteroventrally. Gula externally invisible. Eyes rather large, transverse, outstanding, coarsely faceted, and only slightly overlapping the antero-lateral pronotal margins; ocular index 4.00. Ocelli absent. Muscle scars indistinguishable. Posterior margin of vertex moderately concave and markedly high and sharp. Antennae 0.72 times as long as the body.

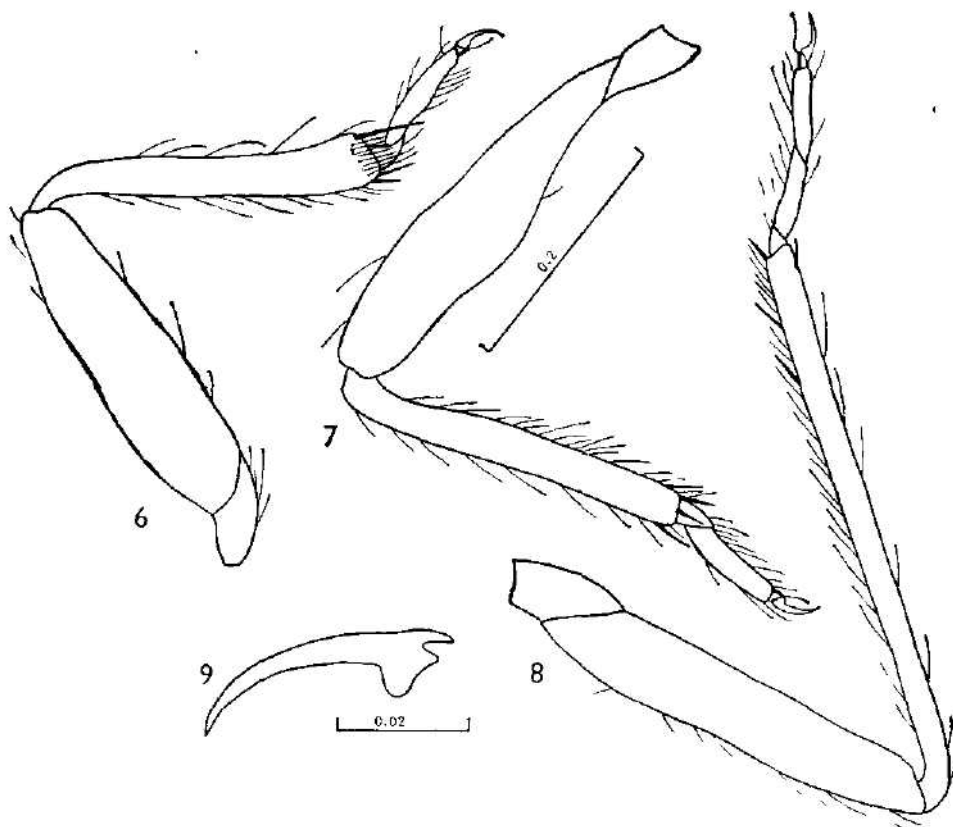
Labium 3-segmented, straight and thick, in natural position slightly exceeding the anterior margin of mesosternum. Segment 1 markedly wide, as long as the bucculae, not exceeding the basis of head, segments 2 and 3 conical, 2 shortest, 3 longest, apically pointed.

Pronotum trapezoidal, about twice as wide as long and about 1.3 times wider posteriorly than anteriorly, situated at a horizontal plane, only very slightly convex; collum sharply delimited, muscle scars and any marked discal structures absent; lateral margins moderately convex, posterolateral angles rounded and depressed, posterior margin straight; lateral margins formed by obtuse, not clearly defined ridges. Proepisterna swollen and produced below eyes.

Scutellum transversely triangular, its apex slightly pointed; proximal region concave, distal region moderately convex and sloping dorsocaudad.

Pterothoracic pleurae and sterna without particular modifications. Posterior margin of metapleuron convex, directed ventrocaudad, its postero-ventral angle acute.

Fore wings modified in homogeneous and strongly sclerotized elytra which meet in a straight commissural line without any overlap; both elytra strongly convex and forming a dome markedly exceeding the abdomen both posteriorly and ventrally; maximum width of combined elytra equal to their commissural length. Costal margin broadly and percurrently explanate and its lateral outline uniformly convex; hypocostal lamina wide, conspicuous, percurrent,



Ptenidiophyes mirabilis, ♀ holotype. Fig. 6. Left fore leg, anterior view. Fig. 7. Left middle leg, posterior view. Fig. 8. Left hind leg, posterior view. Fig. 9. Claw of the hind tarsus.

only gradually narrowing distad. Apices of elytra asymmetrical (the left one produced, the right one emarginate) and obviously forming a mechanism for the coaptation of the elytra. Any fractures or furrows absent, and also the venation completely obliterated except for a lateroproximal ridge continuing distally as a longitudinal, vaguely sculpturally indicated line traceable up to two thirds of elytral length. Hind wings absent.

Legs as illustrated, without specialized features. Femora very sparsely pilose, the middle ones medially incrassate. Anterior tibia gradually thickened and moderately curved distally. Pilosity of the external tibial surface long and markedly sparse, spiniform macrochaetes occurring apically only, hind tibia also with two subdistal spines on its ventral surface. Tarsal formula 2-2-3, tarsal segments simple. Claws slender, gradually curved, with rounded proximal expansions. Aroliar vesicles absent; hair-like, subcapitate pulvilli present.

Abdomen strongly sclerotized, its venter situated at much higher plane than the lateral margins of elytra. Ventrite 7 forming a subconical, apically rounded, laterally moderately concave, subgenital plate equal in length

to the three preceding ventrites. Apparently only the ventrites 4-7 fully formed. Terminal, dorsally situated and slightly the subgenital plate exceeding structures visible in ventral view, but the ovipositor probably absent.

Comparative notes.

The following combination of characters differentiates *Ptenidiophyes mirabilis* from the other Schizopteridae described: coleopteroid facies, somatic macrochaetae absent, eyes not exceedingly large, ocelli absent, head strongly declivous, labium short and thick, collum present, fore wings elytraceous, non-abbreviated, not overlapping, strongly inflated, without venation, finely alveolate, with costal margin percurrently explanate and uniformly convex, tarsal formula (♀) 2-2-3, femora and tibiae without conspicuous macrochaetes. The coleopteroid morphs in other genera of the Schizopteridae have usually some traces of venation on the fore wings retained and the wings overlap to some extent. The only genera in which the coleopteroid morphs have lost the fore wing venation are *Hypselosoma* Reuter, 1891, *Chinannus* Wygodzinsky, 1948 and *Voccoroda* Wygodzinsky, 1950.

The coleopteroid morphs in *Hypselosoma* species may have similarly developed elytra (Wygodzinsky, 1959) as *Ptenidiophyes*, but the costal margin is not explanate, clypeus is provided with 2+2 spiniform setae, femora and tibiae have rich armature of macrochaetes, and the eyes, like in all Hypselosomatinae, are extremely large; moreover, the genus is known from the Eastern Hemisphere only.

The elytra of the female coleopteroid morph of *Voccoroda carioca* Wygodzinsky, 1950 (Brazil) still slightly overlap, their costal margin is not explanate, they are very coarsely reticulate, and the claval fracture is retained; moreover, the collum is absent and labium apically truncate (Wygodzinsky, 1950).

The female coleopteroid morphs of *Chinannus* species (Trinidad, Costa Rica) are rather similar to *Ptenidiophyes* in the structure of their fore wings; however, the elytra still slightly overlap, the claval veins are slightly traceable, costal margin is indistinctly or not at all explanate, the apex of elytron is distinctly emarginate with outer angle angulate, and the elytra do not exceed posteriorly the abdomen which is also ventrolaterally not covered by the elytral dome. Moreover, the tarsal formula of *Chinannus* females is 2-2-2 and the labium is long, attaining the proximal third of the abdomen (China, 1946, Wygodzinsky, 1948).

Considering the coleopteroid morphs only, it seems that *Ptenidiophyes* is a valid genus. However, only the discovery of its male macropterous morph will show whether *Ptenidiophyes mirabilis* is not congeneric with species classified in some other genus in which the coleopteroid morph has not yet been found.

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Wilson E. O. a W. H. Bossert: *A primer of population biology* (Začátečník v populační biologii), Sinauer Associates, Inc. Publishers, Stamford 1971, 192 pp.

Obsah knihy je poněkud širší než naznačuje nadpis. První, nejkratší hlava se zabývá základy kvantitativního popisu variability a změny četnosti populací v čase. Druhá, nejrozsáhlejší kapitola, se zabývá základy populační genetiky. Začíná definicí evoluce, charakterizuje mechanismus mutací, včetně mutagenních činitelů a pokračuje kvantitativním hodnocením jak mutagennosti, tak stability frekvence genů během sexuálního rozmnožování. Jako činitelé evoluce jsou pak probírány na systému dvou soupeřících allel na stejném místě chromosomu mutační tlak, meiotický posun a proud genů, aby další kapitoly mohly být věnovány obecným základům, přírodního jednosměrného výběru, společnému vlivu mutability a selekci na jedné straně a proudu genů a selekci na druhé straně. Výklad je skoro vždy doprovázen kvantitativním příkladem. V dalším se zabývá vyváženým polymorfismem dvou a více allel a s tím související genetickou zátěží populace. Původně uvažované zjednodušené homogenní prostředí je v dalším výkladu nahrazeno prostředím heterogenním v prostoru a čase. Tím je připravena půda pro výklad základního teoremu přírodní selekce opět s kvantitativními příklady a výkladem jednak o genetickém driftu a jednak o náhradě neutrálních genů.

V třetí kapitole jsou probírány základy kvantitativního popisu růstu populací včetně diskuse o r a K strategii resp. selekci a demografii (včetně křivek přežití a plodnosti). Kvantifikace interakce dravce a kořisti je demonstrována na Lotka-Volterových rovnicích, přičemž je poukazováno na omezené možnosti jejich aplikace v důsledku přílišného zjednodušování skutečnosti. V přírodních podmínkách však koexistuje několik druhů dravců a kořisti, jejichž interakce tvoří vedle potravních řetězců i potravní mřížoví. Velká pozornost je věnována výkladu o měření druhové diversity, v němž autoři ukazují, že při použití Shannon Wienerova vzorce, odvozeného z teorie informace má systém dvou stejně početně zastoupených druhů větší diversitu než systém s jednácti druhy, z nichž jeden tvoří 90 % četnosti a ostatní jsou zastoupeny po jednom procentu. Třetí hlava je zakončena kapitolami o proudu energie, obměně populací a kompetici.

V poslední, poměrně krátké hlavě se autoři zabývají základy biogeografie z hlediska teorie rovnováhy druhů. Používají přitom kvantitativních příkladů McArthura a jeho školy o vztahu mezi plochou ostrovů, jejich vzdáleností od pevniny a počtem druhů. Vše pochopitelně v určité geografické oblasti. Lineární model vztahu mezi intenzitou přisunu druhů z okolí ostrova a vyhynutím druhů v důsledku nízké četnosti ukazuje dobrou shodu se zjištěnými skutečnostmi.

Knihy je určena jako úvodní zdroj informací o nejdůležitějších prvech kvantitativní ekologie. Její cenu vidím v tom, že ve většině kapitol dává ať již kvalitativní nebo převážně kvantitativní příklady ve formě otázky, která je v dalším textu zodpovězena a numerický příklad je vypočítán. Tím je čtenář nejen veden k samostatnému myšlení, ale i k ověřování, jak podrobně pochopil dosavadní výklad včetně důvěrného poznání matematického aparátu, stále důležitějšího při kvantitativním popisu populačních jevů. O užitečnosti této poměrně tenké učebnice svědčí, že v krátké době po prvním vydání byla přeložena do němčiny. Pokud by bylo možno uvažovat o dalším překladu zahraničních knih z oboru ekologie velmi bych se přimlouval za překlad této knížky.

J. Hrbáček

Hostounský Z., J. Weiser: *Nosema polygrammae* sp.n. and *Plistophora fidelis* sp.n. (Microsporidia, Nosematidae).

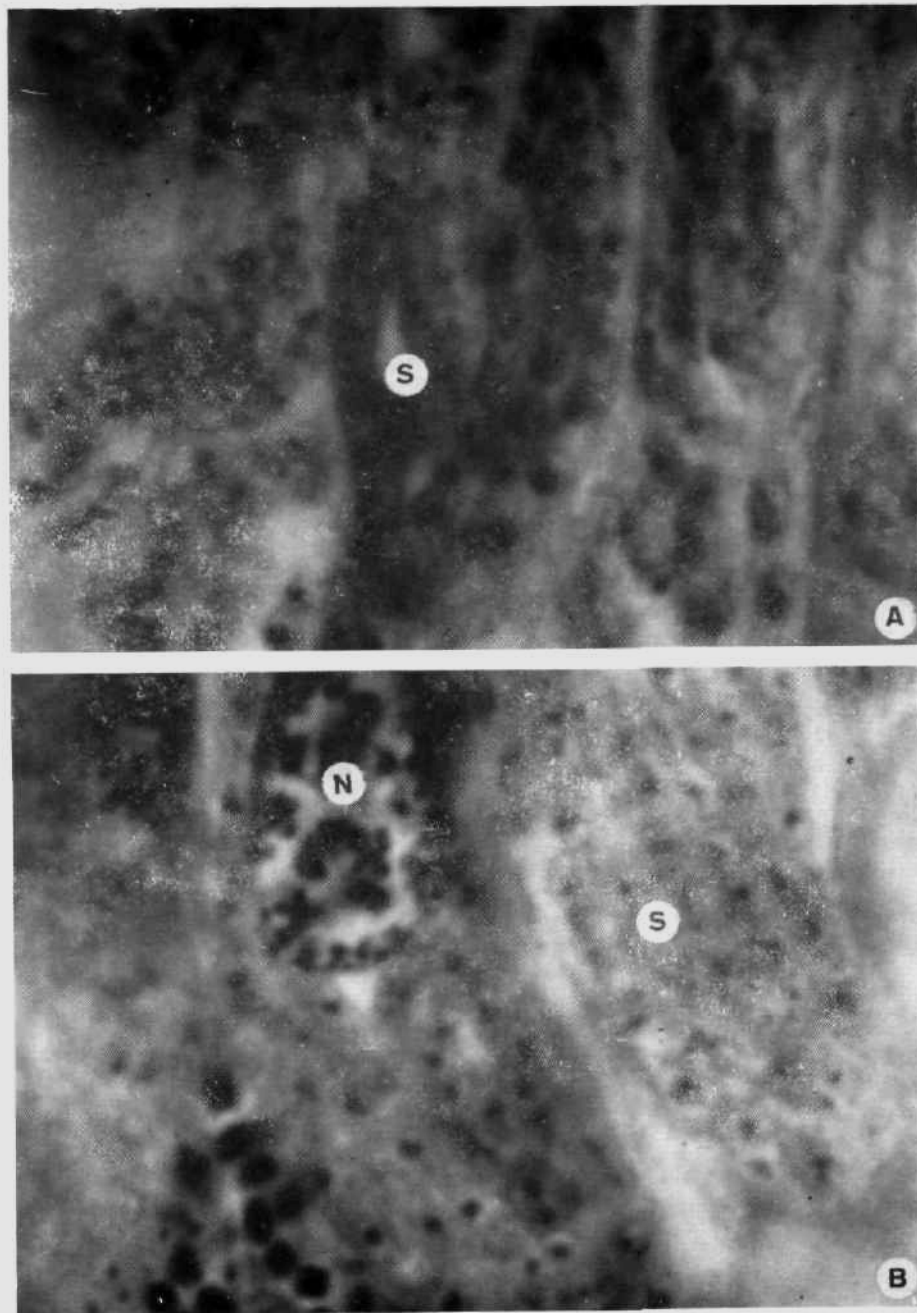


Plate 2. A-Schizonts of *Nosema polygrammae* sp.n., pear-shaped, (S) with twins of nuclei in the broad end. Bouin-Heidenhain, 2000 $\times$. B-Ribbons of schizonts with central nucleus in *Plistophora fidelis* sp.n. (S). N-Nucleus of the epithelial cell. Bouin, Heidenhain, Magn. 2000 $\times$.

Hostouňský Z., J. Weiser: *Nosema polygramae* sp. n. and *Plistophora fidelis* sp. n. (Microsporidia, Nosematidae).

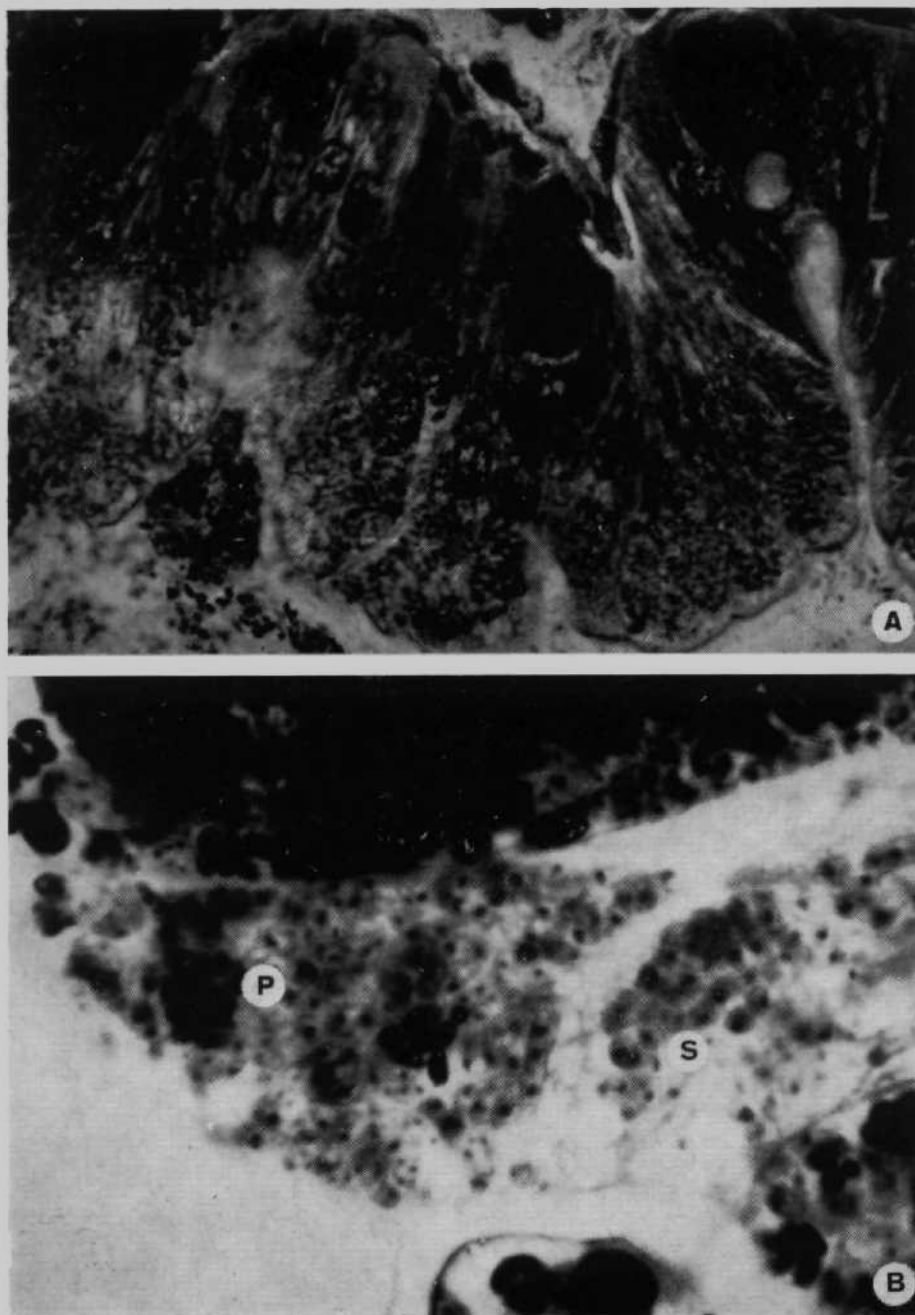


Plate 1. A-Gut of *Polygramma undecimlineata* with *Nosema polygramae* sp. n., spores and vegetative stages. Bouin-Heidenhain, Magn. 500 $\times$. B — Epithelial cells of the midgut of *P. undecimlineata* with *Plistophora fidelis* sp. n. S-schizonts, P, spores in pansporoblasts. Bouin-Heidenhain, Magn. 2000 $\times$.