

HOST AND TISSUE SPECIFICITY OF SPIRIOPSIS ADIPOPHILA (ARVY ET DELAGE) (PROTOZOA, COCCIDIA) AND ITS DISTRIBUTION IN THE ELBE BASIN OF CZECHOSLOVAKIA

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Abstract. The host specificity, tissue specificity, intensity of infection and distribution of *Spiriopsis adipophila* (Arvy et Delage) were studied. This microorganism found at 12 localities evenly distributed in the Elbe basin is recorded from Czechoslovakia for the first time. The following species of mayflies (Ephemeroptera) were infected: *Ephemera danica* Müll. (preferred host in Bohemia), *E. vulgata* L., and *E. lineata* Etn. (recorded for the first time). Intensity of infection was 13.6—100 %. Coiled stages of *S. adipophila* which are the only stages known are contained in fat body (100 % of specimens infected), somatic muscles (15—27 %), and gonads (7.5—12.3 %). Practically all host instars (mayflies are considered only as phoretic or intermediate hosts) are infected all year round.

According to Arvy and Peters (1972, 1973) *Spiriopsis adipophila* is a microorganism of unclear systematic position. Its structure shows close affinities to the coccidian or hemogregarinan sporozoites. Desportes and Delage-Darchen (1975), while describing its ultrastructure, place this species to the family Barrouxiidae (Coccidia). *S. adipophila* consists of a few small isolated cells deposited in a narrow coiled ribbon (about 600—700 μ m in length) (Figs. 1—3). However, the coiled acellular ribbon resembles much more the swellable, anchor-shaped spores of Actinomyxidina than the cauda of Barrouxia-like coccidia. These stages of *S. adipophila* originally known only from France occur in the body cavity of some mayfly larvae (Insecta, Ephemeroptera).

Although *S. adipophila* is a relatively abundant and morphologically well defined species, no detailed data are known about the origin and fate of stages occurring in mayfly larvae tissues. *S. adipophila* has recently been found in Czechoslovakia as well. This material enables us to study its tissue and host specificity, distribution in the Elbe basin and intensity of infection at some localities.

MATERIAL AND METHODS

Mayfly larvae from 15 localities evenly distributed in the Elbe basin in Czechoslovakia were investigated (for localities and number of specimens dissected see Table 3). Fresh material was dissected whenever available. Some larvae were preserved in Carnoy or 75% alcohol. Squashes of fat body, alimentary canal, gonads, somatic and visceral muscles, malpighial tubules, and nerve system were examined under phase (anoptal) and interference phase contrast. Photomicrographs were taken with a Zetopan camera.

RESULTS

THE HOST AND TISSUE SPECIFICITY

Host species of *Spiriopsis adipophila* in Czechoslovakia are shown in Table 1. Although at least 15 species of mayflies from different families were examined, the coiled stages of this microorganism were found only in larvae of the genus *Ephemera* (family Ephemeridae). At most localities *S. adipophila* occurs in tissues of widespread and abundant larvae of *Ephemera danica* (Table 3) but it was found in larvae of *E. vulgata* as well. At a single Czechoslovak locality (Table 3) *S. adipophila* occurs also in larvae of *E. lineata*. The coiled stages found in tissues of this species (Figs. 1—3) are morphologically identical with those found in the tissues of *E. danica* and *E. vulgata*.

The infected tissues of mayfly larvae are shown in Table 2. The fat body (and especially its parietal layer) is infected in all cases. Other tissues (Table 2) are probably infected only incidentally. Muscles of head and thorax were not infected, *S. adipophila* was found only in muscles or peritoneal membranes of the abdominal cavity. The gonads (both testes and ovaries) contain *S. adipophila* not only in their peritoneal cover but also rarely in germarium of testicular follicles and in germarium and vitellarium of ovarioles. No parasites were found in the growing oocytes suggesting that the trans-ovarial transmission probably does not take place.

The infected larvae show no abnormalities in appearance or behaviour, the infection is spread evenly throughout the fat body. No histopathological effects of infected tissues or mortality of infected larvae were observed.

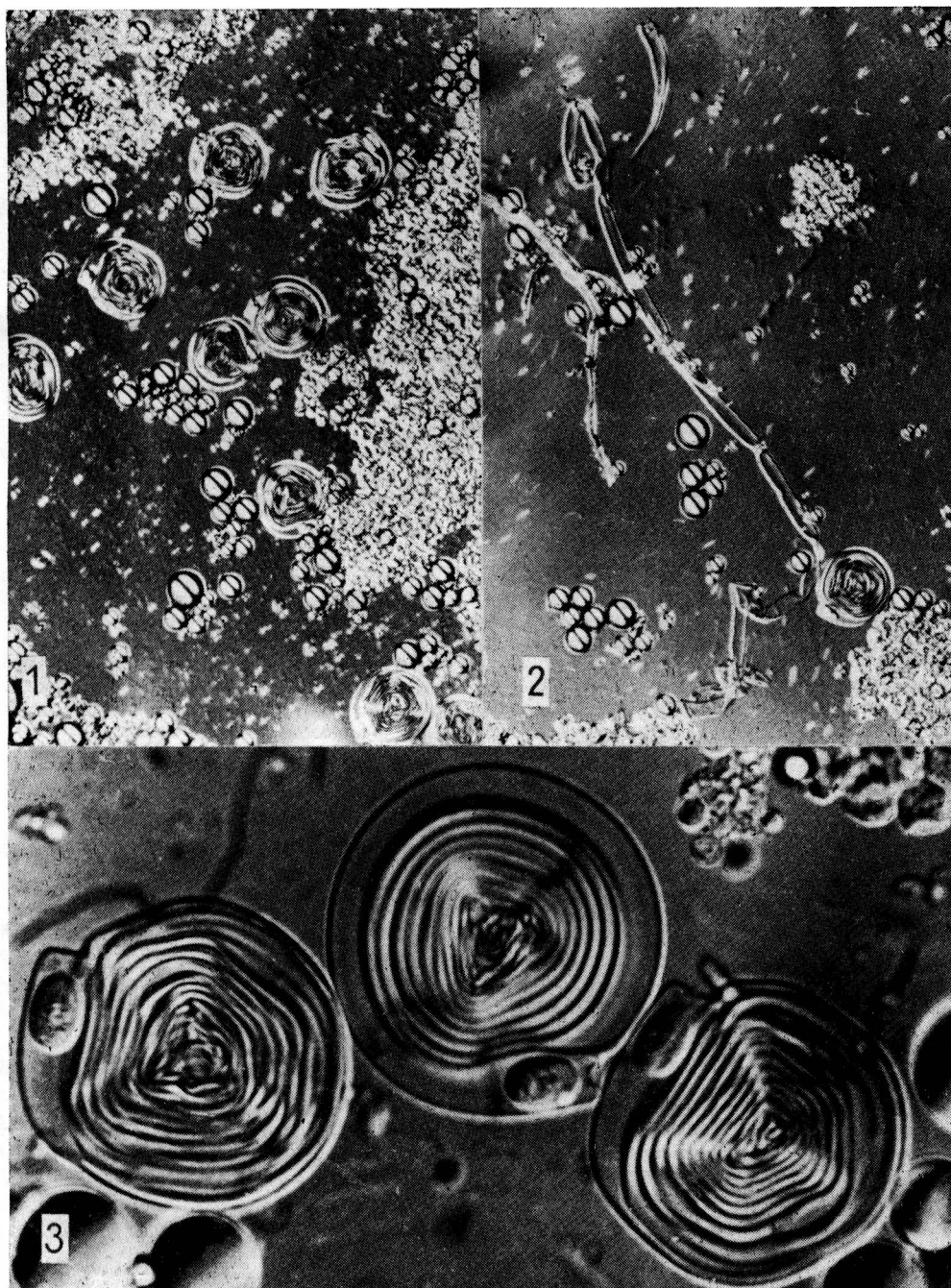
THE DISTRIBUTION AND INTENSITY OF INFECTION

According to the distribution of host species, *S. adipophila* occurs only in highland brooks, small rivers, ponds and lakes. It is missing at mountain localities; most of the localities investigated lie at altitudes of about 200—400 m a.s.l. With the exception of four localities, *S. adipophila* was found (in Czechoslovakia for the first time) at all localities investigated in the Elbe basin in Bohemia. This microorganism is therefore supposed to be relatively abundant and evenly distributed in Central European water biotopes.

The intensity of infection (13.6—100 %) at localities investigated is shown in Table 3. As already pointed out by Arvy and Delage (1973), it is extremely variable even within the same river basin. With the exception of newly hatched and very young larvae (approximately up to the 5th instar), all instars of host larvae are infected. Only slight differences in the intensity of infection were observed between larvae from different habitats within one locality. At two localities (Nos. 2, 7), *S. adipophila* was found also in the fat body of adults suggesting the possible way of spreading. Larvae of the genus *Ephemera* have a two-year development so that half-grown larvae and older ones occur all year round. Infected larvae were collected from January until December, no seasonal occurrence was observed.

DISCUSSION AND CONCLUSIONS

Spiriopsis adipophila was originally found in the fat body of larvae of *Oligoneuriella rhenana* by Vayssière (1882). Later authors (Table 1) recorded *S. adipophila* only from larvae of the genus *Ephemera* L. In Southern Europe (where *E. danica* is solitary or rare), *S. adipophila* occurs mainly in larvae of *E. vulgata*. *E. danica* is very abundant in brooks and small rivers in Central Europe so that *S. adipophila* prefers this species to



Figs. 1—3. *Spiroopsis adipophila* (Arvy et Delage). **Fig. 1.** Squash of the fat body of *Ephemera lineata* with coiled stages of the parasite ($\times 200$). **Fig. 2.** Uncoiled ribbon fo *S. adipophila* ($\times 200$). **Fig. 3.** Detail of coiled ribbon and nucleus ($\times 800$), interference phase contrast.

Table 1. Host specificity and distribution of *Spiriopsis adipophila*

Host	Country	Reference
A. Family Oligoneuriidae 1. <i>Oligoneuriella rhenana</i> (Imhoff)	France	Vayssière 1882
B. Family Ephemeridae 1. <i>Ephemera vulgata</i> L.	France Czechoslovakia	Arvy and Delage 1966, 1973 present paper
2. <i>Ephemera danica</i> (Müll.)	Poland Czechoslovakia	Arvy and Sowa 1976 present paper
3. <i>Ephemera lineata</i> Eaton	Czechoslovakia	present paper

Table 2. Tissue specificity of *Spiriopsis adipophila*

Tissue infected	<i>E. danica</i>	<i>E. vulgata</i>	<i>E. lineata</i>
parietal fat body	445 (100 %)	40 (100 %)	15 (100 %)
visceral fat body	429 (94.1 %)	40 (100 %)	12 (80 %)
somatic muscles	121 (27.1 %)	6 (15 %)	3 (20 %)
gonads	54 (12.3 %)	3 (7.5 %)	—
visceral muscles	9 (2 %)	2 (5.0 %)	1 (6.6 %)
malpighian tubes	1 (0.23 %)	—	—
digestive canal	2 (0.45 %)	—	—

Table 3. List of Czechoslovak localities and intensity of infection of mayflies with *Spiriopsis adipophila*

Host species	Locality	No. of specimens investigated	No. of specimens infected
<i>E. danica</i>	(1) Zahořanský brook, Central Bohemia	105	105 (100 %)
	(2) Židova strouha brook, South Bohemia	62	62 (100 %)
	(3) Lužnice river, South Bohemia	34	34 (100 %)
	(4) Jelenka brook, West Bohemia	87	72 (85.1 %)
	(5) Kačák brook, Central Bohemia	120	81 (67.5 %)
	(6) Blanice river, South Bohemia	53	29 (54.7 %)
	(7) Trusovický stream, North Moravia	8	4 (50 %)
	(8) Oslava river, South Moravia	41	19 (48.7 %)
	(9) Radotínský brook, Central Bohemia	38	15 (37.3 %)
	(10) Divišovský brook, West Bohemia	22	3 (13.6 %)
	(11) Chválkovický brook, East Bohemia	109	—
	(12) Travná brook, North Bohemia	67	—
<i>E. vulgata</i>	(13) Zvůle pond, South Bohemia	11	11 (100 %)
	(14) Pšovka brook, Central Bohemia	55	39 (70.8 %)
	(9) Radotínský brook, Central Bohemia	32	4 (12.5 %)
<i>E. lineata</i>	(15) Plzinský brook, South Bohemia	114	—
	(3) Lužnice river, South Bohemia	35	15 (42.8 %)
	(16) Sázava river, East Bohemia	18	—

E. vulgata at Central European localities. There are no reports of occurrence of this microorganism in larvae of the Mediterranean species *E. glaucops* Pictet or in larvae of other species of *Ephemera*. The host specificity of *S. adipophila* is apparently connected with the bionomy of host larvae. Larvae of the genus *Ephemera* are burrowing, living in u-shaped tubes in sandy or muddy bottoms. They inhabit lenitic (occasionally *E. vulgata*) or lotic-erosional habitats. Contrary to most of mayfly larvae, they feed on detritus. The mayfly larvae are probably only phoretic or intermediate hosts conserving the coiled stages of the parasite for the definitive host (mayfly larvae predators). According to Arvy and Delage (1973) the ingestion of infected larvae had no effect on some predators, fish (*Phoxinus*) and amphibians (*Rana*, *Salamandra*).

Contrary to other common pathogens of mayflies (e.g., microsporidia) *S. adipophila* does not produce any conspicuous mass of spores concentrated in the tissue infected. This is probably the reason why the infection escaped our attention although it is relatively very abundant. Moreover, no histopathological effects of infected tissues were observed and infected larvae are able to finish their development. Since the transovarial transmission does not probably take place, the larvae could be infected by ingestion of free stages of *S. adipophila* (unknown so far) which may occur in bottom detritus. The tissues seem to be infected because of their accessibility and phagocytic activity but further study of the mechanism of infection is needed.

The distribution of *S. adipophila* is closely related with the distribution of its hosts *E. danica* (preferred in Central Europe) and *E. vulgata* (preferred in Southern Europe). *S. adipophila* is abundant in the Elbe basin. It is possible to suppose that similar distribution exists at least also in Southern and Eastern Europe (the Danube basin) (cf. Arvy and Delage 1973, Arvy and Sowa 1976).

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СПЕЦИФИЧНОСТЬ *SPIRIOPSIS ADIPOPHILA* (ARVY ET DELAGE) (PROTOZOA, COCCIDIA) ПО ОТНОШЕНИЮ К ХОЗЯИНУ И ТКАНЯМ И ЕГО РАСПРОСТРАНЕНИЕ В БАСЕЙНЕ РЕКИ ЭЛЬБЫ В ЧЕХОСЛОВАКИИ

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Резюме. Изучены специфичность по отношению к хозяину и тканям, интенсивность заражения и распространение *Spiriopsis adipophila* (Arvy et Delage). Это первая находка *S. adipophila* в Чехословакии. Микроорганизмы были равномерно распространены в бассейне реки Эльбы в 12 местах нахождения. Были заражены следующие виды поденок (Ephemeroptera): *Ephemera danica* Müll. (предпочитаемый хозяин в Чехии), *E. vulgata* L. и *E. lineata* Etn. (зарегистрированные в первый раз). Интенсивность заражения была 13,6 — 100 %. Свернутые стадии *S. adipophila*, которые являются единственными известными стадиями этого микроорганизма, найдены в жировом теле (100 % зараженных экземпляров), соматических мышцах (15—27 %) и гонадах (7,5—12,3 %). Практически все стадии хозяина (поденки считаются только форетическими или промежуточными хозяевами) были заражены круглый год.

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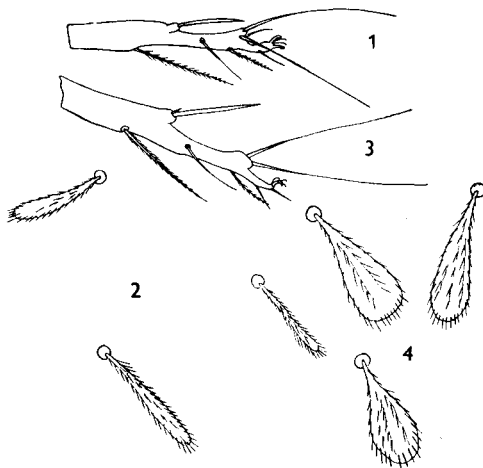
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TO THE SYSTEMATIC POSITION OF THE SPECIES ACAROPSELLA SCHMIDTMANNI PRINCE, 1972

Acaropsella schmidtmani, a predatory mite species collected from the nest of the turkey vulture (*Cathartes aura* (L.)) was described by Prince (Proc. Ent. Soc. Wash. 74: 45—49, 1972). Later Summers erected the genus



Acaropsellina sollers (Rohdendorf, 1940). Fig. 1. Tarsus I. Fig. 2. First three opisthosomal setae. *Acaropsellina schmidtmani* (Prince, 1972). Paratypes. Fig. 3. Tarsus I. Fig. 4. First three opisthosomal setae.

Acaropsellina (Proc. Ent. Soc. Wash. 78: 190—194, 1976) listing in it three species: *A. sollers* (Rohdendorf, 1940) as a type species, *A. docta* (Berlese 1886) and *A. azarsia* Summers, 1976. The first two species had been previously included in the genus *Acaropsis* Moquin-Tandon, 1863, with the type species *Tyroglyphus mericourti* Laboulbène, 1851, which Summers' revision (1976) proved as representative of the genus *Cheyletus* Latreille, 1796 and the name *Acaropsis* a synonym of this genus. The examination of paratypes of *Acaropsella schmidtmani* showed that this species undisputedly was a representative of the genus *Acaropsellina*, closely related to the species *A. sollers*, from which it differs in wider dorsal setae and in the presence of a minute solenidion ω_1 on tarsus I. (The author is grateful to Dr. D. W. Prince for making available the paratypes mentioned). As pointed out previously (Haragšim O. et al., Z. Angew. Entomol. 87: 52—67, 1968), typical of the genus *Acaropsellina* is the presence of "ocelli" on propodosomal plate, already mentioned by Volgin (Mites of the family Cheyletidae of the world fauna, Nauka, Leningrad, 432 pp., 1969, in Russian), and unexpanded humeral setae.

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