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Short Communications

THE FINDING OF *PNEUMOCYSTIS CARINII* IN SHREWS (INSECTIVORA: SORICIDAE)

Z. ŠEBEK and B. ROSICKÝ

Regional Centre of Hygiene and Epidemiology, Brno—Laboratory Jihlava and Institute of Parasitology, Czechoslovak Academy of Sciences, Prague

Abstract. The authors found *Pneumocystis carinii* Delanoe, 1912 in shrews of the species *Sorex araneus* L., *S. alpinus* Schinz and *Neomys fodiens* (Schr.) (fam. Soricidae) in the Krkonoše mountains. This is the first finding of the causative agent of a group of infantile interstitial pneumonias in the evolutionally ancient group of shrews. The findings were made in biotopes slightly changed by human activities, on the upper boundary line of forest (altitude of 1200—1300 meters) and this fact is considered by the authors to be the direct evidence of the original localization of this zoonosis in natural foci.

The localization of zoonoses in nature, the inter- and intraspecific transmission of pathoergonts and their dissemination routes to man have become problems of primary interest to parasitologists and epidemiologists today. Attention has been duly focused to the causative agent of a group of infantile interstitial pneumonias, *Pneumocystis carinii* Delanoe, 1912 (Joint WHO/FAO Expert Committee on Zoonoses 1967) and we are therefore reporting about our finding of *P. carinii* in the Krkonoše mountains.

MATERIAL AND METHODS

During the systematic investigation of small terrestrial mammals on the presence of *P. carinii* in 1966 we examined 260 specimens of rodents and insectivores. During the spring expedition (from May 30 to June 9, 1966) a total of 107 specimens from the localities Prameny Bílého Labe, Stříbrná bystřina and Obří důl and during the autumn expedition (from October 10 to November 5, 1966) 153 specimens from the localities Obří důl, Pec pod Sněžkou and Velká Úpa (surroundings) were collected. The species composition and their number are given in Table 1. Lung impressions were made from all small mammals and were stained after Giemsa. Both in the spring and autumn expeditions the same methods were employed.

RESULTS

In the spring expedition we found *P. carinii* in the lung impressions of 7 specimens out of 44 shrews examined. This positivity (16 %) is surprisingly high. Out of 4 positive specimens of *Sorex araneus* the lung tissue in two specimens was slightly affected. In our preparations we found only occasional typical 8-nuclear sporogonia.

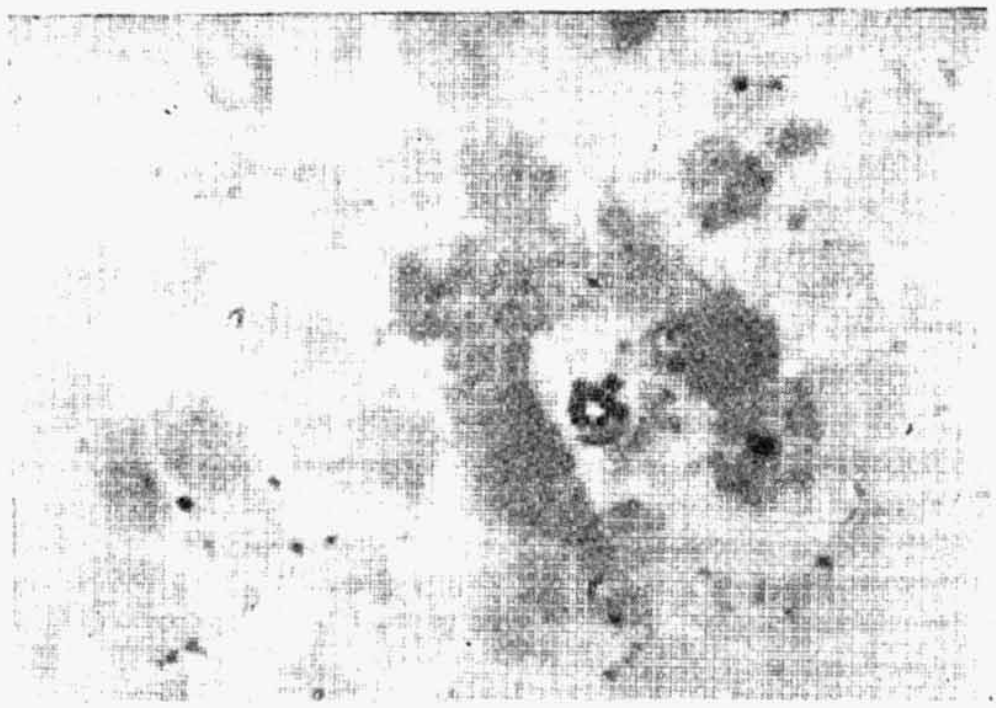

Fig. 1. Typical sporogonia of *Pneumocystis carinii* in the lung impression of the shrew *Sorex alpinus* Prep. 1089/66, enlarged. (× 1600)

In one case the infection was very low, single sporogonia were found only after the preparation had been thoroughly examined. In one specimen of *S. alpinus* the infection was found to be higher (Fig. 1), in another specimen it was very low. In all cases we found the typical 8-nuclear sporogonia. No massive infection was ascertained in either case and the infections were probably latent. No macroscopic changes were found in lungs during autopsy. The mentioned findings differ from the massive infections, as known in the lungs of infants or in our finding in *Mus musculus*.

We ascertained a high infection with *P. carinii* in a house mouse captured in winter quarters of parrots in the zoological department in Jihlava on January 13, 1966. In the lung impressions we found abundant particles of spumous matter staining pink by Giemsa's solution and including numerous developmental stages of *P. carinii*. The typical 8-nuclear sporogonia were also relatively frequent. The total picture of the impression preparation indicates (Fig. 2) that the mouse was afflicted with acute pneumocystis pneumonia similar to that which occurs in infants. It must be noted that already during autopsy the enlarged lungs were conspicuous.

The examinations of shrews and other mammals (Table 1) conducted in autumn gave negative results, although the material was treated by the same method.

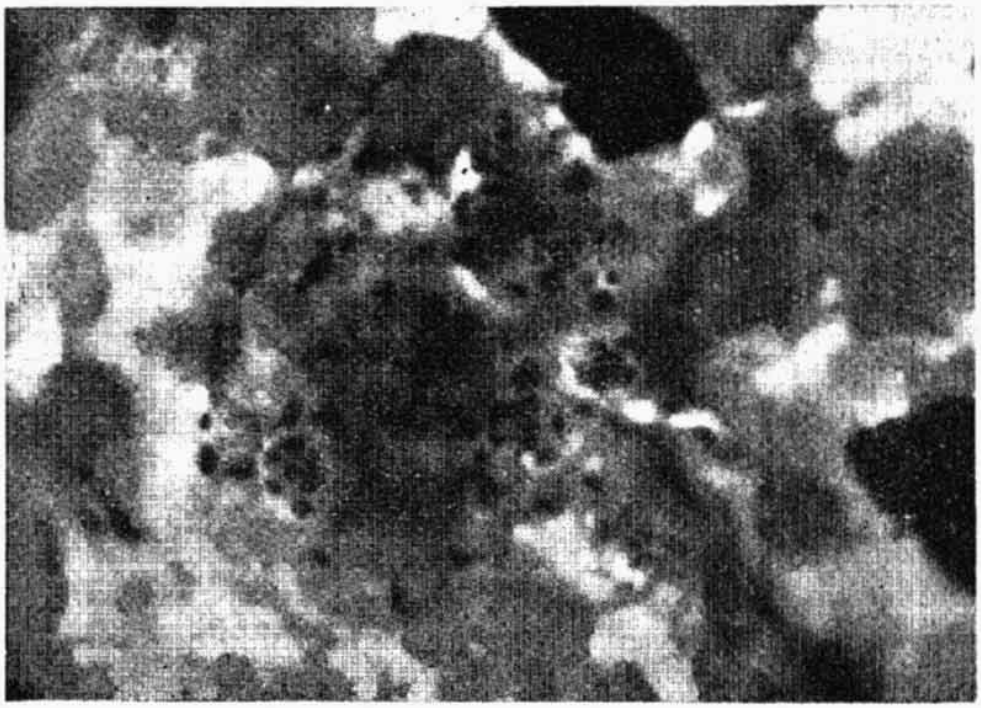

Fig. 2. Massive infection with *Pneumocystis carinii* in the lungs of house mouse *Mus musculus*. Prep. 118/66, enlarged. (× 1600)

DISCUSSION

Our finding of *P. carinii* in shrews *Sorex araneus*, *S. alpinus* and *Neomys fodiens* has revealed these species as new reservoir animals of pneumocystosis and at the same time it is the first discovery of this protozoon in insectivores ever. The present findings in free living animals, in synanthropic and domestic animals have been summarized by KUČERA (1966).

The fact that the small rodents (63 specimens) captured in the same season and in same localities were found to be negative (Table 1), is remarkable. The positive shrews were captured in biotopes practically intact by human activities and the biocenoses in them have remained in their original form. According to our previous analyses (ROSICKÝ and HEJNÝ 1959) such places are to be found in the vicinity of mountain streams at highest altitudes. The positive shrews were captured namely in places located at the very boundary line of forest in the Krkonoše mountains, at the altitude of 1200—1300 meters. At this altitude the influence of subalpine zone resembling in character the arctic tundra (HANZÁK and ROSICKÝ 1959) and occurring in Krkonoše (Bílá louka, Úpská rašelina) is distinctly manifest in the ecology of small terrestrial mammals. In our opinion the mentioned biotopes which rarely occur in our considerably cultivated landscape, except mountain regions, are of paramount importance for the determination of the phylogenetically fixed relationships between the parasite and its host. From this aspect the fact, that we

Table 1. List of small terrestrial mammals examined and positive findings of *P. carinii*

Species	Spring		Autumn	
	N	Positive on the presence of *P. carinii*	N	Positive on the presence of *P. carinii*
Sorex araneus L.	25	4**)	24	0
Sorex minutus L.	3	0	5	0
Sorex alpinus Schinz	12	2**)	3	0
Neomys fodiens (Schr.)	4	1*)	8	0
Crocidura suaveolens (Pall.)	0	0	1	0
Muscardinus avellanarius (L.)	1	0	0	0
Mus musculus L.	0	0	3	0
Apodemus sylvaticus (L.)	0	0	25	0
Apodemus flavicollis (melch.)	3	0	13	0
Clethrionomys glareolus (Schr.)	14	0	43	0
Microtus arvalis (Pall.)	0	0	5	0
Microtus agrestis (L.)	24	0	21	0
Pitymys subterraneus (S.-L.)	21	0	2	0
Total	107	7	153	0

*) Stříbrná Bystřina

**) Stříbrná Bystřina, Obří důl

ascertained in original biocenosis a high incidence of infection with *P. carinii* in shrews (which are an ancient and specific element evolutionally), appears to be very important. Especially *S. alpinus* (living in the Krkonoše mountains in the geographical ssp. *hercynicus* Miller) is generally considered to be the relict of the terciary fauna. In our opinion this is the case of the *P. carinii* occurrence in a natural focus.

We do not consider the marked difference between the spring and autumn findings (negative results) to be accidental. The fluctuation of the precentage of the incidence of infection in the population of small mammals corresponds with the data known in some other protozoan or bacterial infections.

Primarily two factors, i.e. the season and the age of animals, may be quite significant here. The first factor is in force for instance in the toxoplasmosis of hares, or in the tularemia of small mammals. The epizooties flare up towards the end of winter months and the beginning of spring months, when the animals are weakened by winter hardship. At high altitudes in the Krkonoše mountains, where positive findings of *P. carinii* in shrews were made at the beginning of June, the climatic conditions corresponded locally with the period between winter and spring. There was still a snow cover there and the period of reproduction of shrews, mice and voles was just beginning. The second factor, the age of animals, may also play a considerable role in the percentage of the incidence of infection in the populations of small mammals. This is a well known fact, for example in leptospiroses, where the percentage of the incidence of infection increases depending on the age of animals. If this factor is taken into account, the difference between the spring and autumn

populations of shrews examined is very considerable. The age average in the spring population, in which almost exclusively adult animals born in the previous year were represented, was much higher (more than double) than in the autumn population consisting mostly of young animals born between June and October. Meanwhile it is impossible to determine which of the two factors is of greater importance or whether both are equally important in pneumocystosis.

Our results obtained by the examination of small mammals from the northeast Bulgaria, where *P. carinii* was found in 5.8 % of shrews examined (including *S. minutus* L.) prove that shrews can be infected with *P. carinii* in natural foci and that our findings in the Krkonoše mountains are not accidental.

CONCLUSIONS

The first findings of *P. carinii* in insectivores of the family Soricidae may indicate the considerable age of this parasite. The remarkable localization of findings in the mountain biotopes on the very boundary line of forest proves the occurrence of *P. carinii* in natural foci. Further comprehensive investigations which we continue to carry out, will elucidate the real importance of shrews in the circulation of *P. carinii* in natural foci.

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Z. Š., OHES, Vrchlického 57, Jihlava, ČSSR.