Sarcocystis of rodents and marsupials in Brazil*

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INTRODUCTION

Sarcocystis species have been described in a wide variety of mammals, birds and reptiles throughout temperate and tropical countries of the world. Although early workers (Alexeieff, 1913; Wenyon, 1926) considered it impossible to differentiate species on the morphology, there are such clear-cut differences in the structure of the cyst wall, morphology of spores and other details, that there at present seems every justification for giving specific rank to these different parasites in their various hosts. Furthermore, with one or two exceptions, attempts to infect laboratory animals have met with little or no success and it would appear that at least some species of Sarcocystis may be highly host-specific.

 Whereas Sarcocystis was recorded in many animals of the Old World, there are few reports of this parasite in the New World tropics. This is almost certainly due to an uneven balance of studies in the two hemispheres, and the present observations suggest that Sarcocystis is equally prevalent in neotropical regions.

MATERIALS AND METHODS

During studies on the epidemiology of leishmaniasis in Brazil we have had the opportunity to examine a wide variety of mammals from different areas of Pará State and the Territory of Amapá (Lainson & Shaw, 1968). Our examination of muscle for Sarcocystis, however, was but supplementary to those studies and has been restricted to a macroscopic search of the superficial muscles of skinned animals and low-power examination of 'muscle-squash' preparations for cysts. A search of serial sections of skeletal and heart muscle would probably have revealed Sarcocystis in a great many more animals, and the list of mammals in our previous paper cannot be taken as a very reliable guide as to the real incidence of infection among the different species examined.

Tissues from infected animals were fixed in Carnoy's fluid or neutral formol-saline and sections prepared at 4–5 μm thickness. Sections were stained with Giemsa's stain or haematoxylin and eosin.

Individual cysts were dissected out from the muscle and crushed on slides for the examination of the freed spores. Air-dried smears were either fixed in absolute methanol and stained with Giemsa's stain in the normal way, or fixed in aqueous

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Bouin's fluid and stained by a modified Giemsa method (Wenyon, 1926; Lainson, 1959).

For study of the sectioned cysts, in particular the cyst wall, we have found phase-contrast illumination to be particularly useful, especially for demonstration of 'spores', 'villi' and 'trabeculae'.

Photomicrographs were taken on a Zeiss W.L. research microscope using Adox KB 14 film. Initial outline drawings were made by camera-lucida and fine details completed by normal or phase-contrast microscopy. For the measurement of spores, outline drawings of 100 individuals were made by camera-lucida and these measured by the technique first described by Bruce, Hamerton & Bateman (1909) for trypanosomes. The following measurements of each spore were taken: total length, width at widest point and major diameter of the nucleus.

RESULTS

Sarcocystis in rodents

Three distinctly different cysts were encountered in two rodents, Oryzomys capito and Proechimys guyannensis.

The infected Oryzomys were from forests near Belém and also from Amapá Territory, North Brazil. Infected Proechimys were found in both these areas, and in addition from forests on the Guyana–Brazil borders.

We have been unable to trace any previous record of Sarcocystis species of the same morphology in these rodents or other mammals and have assigned new specific names to them.

Sarcocystis oryzomyos *sp. nov., and Sarcocystis azevedoi *sp. nov., both from Oryzomys capito (Rodentia, Cricetidae)

Heavy infections were noted in six out of 19 adult specimens of Oryzomys capito. Macroscopically the cysts appear as prominent 'nematode-like' streaks in the muscle (Pl. 1, fig. 1). In some animals single cysts measured as much as 24.7 mm long. Squash preparations of fresh muscle showed many of the cysts to be thrown into folds, possibly owing to their excessive longitudinal growth (Pl. 1, fig. 2). It was only when stained sections were prepared that we realized that we were dealing with two distinct parasites which are, therefore, best described in comparative fashion. Their morphological differences are tabulated in Table 1.

We have gained the impression that the cysts of S. oryzomyos grow to a greater length than those of S. azevedoi and the longer sarcocysts seen in Pl. 1, fig. 1 are probably of the former parasite. Certainly the cysts of S. oryzomyos (Pl. 1, fig. 5) are much more deeply invaginated than those of S. azevedoi which most frequently presents cysts with a smooth outline (Pl. 2, fig. 7). In the larger cysts of S. oryzomyos (and rarely those of S. azevedoi) the invaginations of the cyst wall may give the

* It gives us great pleasure to name this parasite in honour of Dr Miguel Cordeiro de Azevedo, Director of the Instituto Evandro Chagas, who has offered every available facility during our work in this Institute.
<table>
<thead>
<tr>
<th>Species of Sarcocystis</th>
<th>Host</th>
<th>Gross morphology</th>
<th>Size</th>
<th>Cyst wall</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. proechimyos</em> sp.nov.</td>
<td>Spiny rat</td>
<td>Trabeculae present</td>
<td>Up to 2.3–3.9 mm × 63 μm–88.2 μm</td>
<td>3.5–4.0 μm. Striated, composed of slender spine-like villi 3.5–4.0 μm long, positioned in rows with 0.75 μm between their bases</td>
</tr>
<tr>
<td></td>
<td><em>(Proechimyos guyannensis)</em></td>
<td>Cyst wall not invaginated</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. oryzomyos</em> sp.nov.</td>
<td>Rice rat</td>
<td>Trabeculae present, Cyst wall strongly invaginated to form pseudo-loculi</td>
<td>Up to 9.4–24.7 mm × 188.0 μm–355.5 μm</td>
<td>3.0–3.2 μm. Striated composed of villi</td>
</tr>
<tr>
<td></td>
<td><em>(Oryzomyos capito)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. azevedoi</em> sp.nov.</td>
<td>Rice rat</td>
<td>No trabeculae. Cyst wall with only occasional and slight invaginations</td>
<td>At least up to 2.76 mm × 79–126 μm, probably longer</td>
<td>1.0–1.8 μm. Striated, composed of fine villi</td>
</tr>
<tr>
<td></td>
<td><em>(Oryzomyos capito)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. marmosae</em> sp.nov.</td>
<td>Murine opossum</td>
<td>Small oval cyst</td>
<td>Up to 2 mm × 800 μm</td>
<td>Spiny, composed of finger-like</td>
</tr>
<tr>
<td></td>
<td><em>(Marmosa murina)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. garnhami</em></td>
<td>‘4-eyed’ opossum</td>
<td>Trabeculae present, Cyst wall not invaginated</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Philander opossum)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. muris</em></td>
<td><em>Mus musculus</em> (laboratory mouse)</td>
<td>Trabeculae present, Cyst wall not invaginated</td>
<td>Up to 3 cm long × 66–100 μm wide</td>
<td></td>
</tr>
</tbody>
</table>
appearance of separate 'loculi' containing the spores (Pl. 1, fig. 5; Pl. 2, fig. 8): this illusion is dispelled by the study of serial sections. Sections of *S. oryzomyos* also show clearly defined trabeculae throughout the cyst, dividing the contents into small, angular packets of spores (Pl. 1, fig. 5; Pl. 2, fig. 6; Text-fig. 1). We were unable to see such trabeculae in sections of *S. azevedoi* and if they exist they

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Text-fig. 1. *S. oryzomyos* sp.nov. The tip of a cyst showing villi of the cell wall, trabeculae and proliferative layer. An enlarged drawing of a spore is shown on the right.

Text-fig. 2. *S. azevedoi* sp.nov. Portion of the cyst wall showing striation due to very fine villi, absence of trabeculae. Enlarged drawing of a spore on the right.
must be very fine indeed (Pl. 2, fig. 7; Text-fig. 2). While in gross morphology
the cysts of the two species might be confused, similarity ends with closer
examination of the cyst wall and the spores. *S. oryzomyos* has a cyst wall from
3·0 to 3·2 μm thick, showing striations (Pl. 3, fig. 14; Text-fig. 1). We interpret
these striations as homologous with the ‘villi’ described in electron-microscope
studies of *S. miescheriana* by Ludvik (1960): at times these villi are gathered
into bundles (Text-fig. 1). In contrast, the cyst wall of *S. azevedoi* is very delicate
and measures only 1·0–1·8 μm in thickness (Text-fig. 2): it is delicately striated,
and we again believe these fine lines to be villi.

The spores of *S. oryzomyos* are much larger than those of *S. azevedoi*, having an
average measurement of 9·93 μm × 3·28 μm: they are of the characteristic ‘banana-
like’ shape seen in so many other *Sarcocystis* species. The nucleus is variable in
position but is usually at one pole: at the opposite end of the spore the cytoplasm
is highly vacuolated. In air-dried/Bouin-fixed spores the cytoplasm in this region
shows numerous small vacuoles (Text-fig. 1), but if spores are air-dried and fixed
in methanol these vacuoles appear to collapse into a large, pink-staining area.
The spores of *S. azevedoi* average only 6·8 μm × 1·45 μm (Text-fig. 2). They are
much more delicate bodies, tapering to a fine point at one pole: the nucleus is
usually situated at the round end. Vacuolation of the cytoplasm in these spores
is almost imperceptible in Bouin-fixed material, while in methanol-fixed spores
there appear in the cytoplasm one or two densely staining granules. Cysts of
both species were found throughout the skeletal muscle of the whole body and
those of *S. oryzomyos* even extended to the musculature of the eye. Interestingly
enough, no parasites could be demonstrated in the heart muscle.

Infections as heavy as that shown in Pl. 1, fig. 1, prompted us to examine
sections of other organs, but liver, spleen, kidney, lungs and brain were devoid
of cysts. No host-cell reaction was seen around any of the cysts.

*Sarcocystis proechimyos* sp.nov., in Proechimys guyannensis (Rodentia,
Echimyidae)

This parasite was found in 10 out of 27 animals from Amapá forests, three out
of 22 specimens from forests on the Guyana–Brazil border and three out of four
animals from the Utinga forest, Belém, Pará. At times the infections were
remarkably heavy (Pl. 1, fig. 3), giving the skeletal muscle a peculiar greyish
colour. Cysts extended throughout the skeletal muscle of the entire body but were
not found in heart-muscle or the organs listed above.

The cysts of *S. proechimyos* are much smaller than those of both *S. oryzomyos*
and *S. azevedoi*, measuring up to 3·9 mm in length by approximately 88·0 μm
in width. They have prominent trabeculae and the cyst-wall is not invaginated
(Pl. 2, fig. 9). The cyst wall is only slightly thicker than that of *S. oryzomyos*, but
has much more prominent striations which we interpret as due to spine-like villi
which are slightly recurved at their ends (Pl. 2, fig. 9; Pl. 3, fig. 10, 12; Text-fig. 3).
The spores (Text-fig. 3) are a little smaller than those of *S. oryzomyos*, their
mean measurements being 8·67 μm × 3·35 μm. Again, the nucleus appears to be
variously located, but one pole of the spore is usually prominently vacuolated.
Sarcocystis in marsupials

Sarcocystis garnhami Mandour, 1965, in Philander opossum (Marsupialia, Didelphidae)

Sarcocystis marmosae sp.nov., in Marmosa murina (Marsupialia, Didelphidae)

The literature on Sarcocystis of marsupials has recently been reviewed by Mandour (1965), who described a new species, S. garnhami, in the opossum.
Didelphis marsupialis from British Honduras. *S. garnhami* is characterized by the presence of stout, pointed spines on the cyst wall. This feature alone is sufficient to separate it from the only other known, definite *Sarcocystis* species of New World opossums (*S. didelphidis* Scorza, Torrealba & Dagert, 1957).

We have encountered *Sarcocystis* in single specimens of two different opossums from Belém, namely *Philander opossum* and *Marmosa murina*. The first parasite is clearly *S. garnhami* (Pl. 3, fig. 16; Text-fig. 4), its morphology agreeing exactly with that of Mandour's first description. This, then, represents a new host record for this species.

The parasite from *Marmosa murina* was at first thought to be *S. garnhami*, but a closer examination of the cyst wall showed a striking difference in the spines. In contrast with the recurved, 'rose-thorn' spines of *S. garnhami*, the cysts possess blunt finger-like villi measuring 11·5–13·0 μm × 2·6 μm (as seen in smears of crushed cysts). Unfortunately, material for sectioning was lost and we have been unable to record the morphology of the cyst in section. Luckily, photographs of cysts in fresh material (Pl. 1, fig. 4) have given some idea of the size and shape of the cysts which measure approximately 2·0 mm × 800 μm and are oval in outline. The distinctive form of the spines readily differentiates the parasite from *S. garnhami* (Pl. 3, figs. 16, 17) and we propose the name *Sarcocystis marmosae* sp.nov. for this sarcosporidian of *Marmosa murina*. The pores average 7·5 × 2·36 μm (Text-fig. 4B).

**DISCUSSION**

As mentioned by Mandour (1965), taxonomy of the *Sarcosporidia* is usually based on the host in which the parasite is found, the structure of the cyst-wall, and the size of the spores. He further suggested that the size of the cyst can as a rule only indicate the age of the parasite.

We feel that care must be taken in the comparison of spores from different species of *Sarcocystis*. In the first place there is variation in the size and staining properties of spores in a given preparation from a single cyst, especially in dried, methanol-fixed smears. Secondly, we have noted that the numerous, small separate vacuoles seen in Bouin-fixed spores are coalesced into the familiar pink-staining 'vacuole', described by many authors, in dried, methanol-fixed material. We believe the former condition to be the more natural and consider methanol-fixation grossly to distort the spores. If spores are to be used at all in taxonomy, there should be standardized methods in their preparation and large numbers must be drawn to give means, standard deviations and range (Table 2). Possibly the best comparative method would be the measurement of living spores under phase-contrast illumination, combined with the Bouin-fixed smears of spores from dissected cysts.

Clearly the morphology of the cyst wall and the presence or absence of trabeculae are much more rigid features in taxonomy. As regards the size of the cysts, much depends on the quantity of material available. We were fortunate in having abundant material from *Oryzomys* and *Proechimys* and consider that the size of the cysts of *S. oryzomyos*, *S. azevedoi* and *S. proechimyos* is consistent and charac-
Characteristic. This has been borne out by the examination of material from muscle-biopsies taken from the same infected animals over intervals of several months. We were struck by the extreme length and convoluted nature of the cysts of *S. oryzomyos* and looked particularly for evidence of polar growth. A few so-called 'sporoblast' or 'proliferative' cells were seen adjacent to the cyst wall along the length of some cysts, but we felt that these alone could not account for the great length of the cysts and the vast number of spores. At one end of one cyst we encountered an extensive cap of what we interpret as 'proliferative cells' (Text-fig. 1). These polygonal-shaped cells have a clear, hyaline cytoplasm and a faint, reddish-staining nucleus. The exact process by which they give rise to the spores is not clear; presumably some of the 'proliferative cells' are also responsible for the continued production of the villi and other components of the cyst wall.

### Table 2. The measurements in microns of 100 'spores' of six species of *Sarcocystis*

(Means ± standard deviations and range)

<table>
<thead>
<tr>
<th>Species of <em>Sarcocystis</em></th>
<th>Length</th>
<th>Width</th>
<th>Diameter of nucleus</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. proechimyos</em> sp.nov. (ref. no. M 42 syntypes)</td>
<td>8.67 ± 1.020</td>
<td>3.25 ± 0.432</td>
<td>2.87 ± 0.303</td>
</tr>
<tr>
<td><em>S. oryzomyos</em> sp.nov. (ref. no. M 403 syntypes)</td>
<td>9.93 ± 0.790</td>
<td>3.28 ± 0.305</td>
<td>2.51 ± 0.377</td>
</tr>
<tr>
<td><em>S. azevedoi</em> sp.nov. (ref. no. M 403 syntypes)</td>
<td>6.80 ± 0.391</td>
<td>1.45 ± 0.241</td>
<td>1.20 ± 0.201</td>
</tr>
<tr>
<td><em>S. azevedoi</em> sp.nov. (ref. no. M 25 paratypes)</td>
<td>5.71 ± 0.589</td>
<td>1.49 ± 0.150</td>
<td>1.14 ± 0.268</td>
</tr>
<tr>
<td><em>S. marmosae</em> sp.nov. (ref. no. M 26 syntypes)</td>
<td>7.50 ± 0.415</td>
<td>2.36 ± 1.073</td>
<td>2.03 ± 0.263</td>
</tr>
<tr>
<td><em>S. garnhami</em></td>
<td>8.38 ± 1.051</td>
<td>3.11 ± 0.627</td>
<td>2.48 ± 0.509</td>
</tr>
</tbody>
</table>

Spores as seen in sections of cysts fixed in neutral formal saline

<table>
<thead>
<tr>
<th>Species of <em>Sarcocystis</em></th>
<th>Length</th>
<th>Width</th>
<th>Diameter of nucleus</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. oryzomyos</em> sp.nov. (ref. no. M 403 syntypes)</td>
<td>7.21 ± 0.696</td>
<td>2.02 ± 0.179</td>
<td>1.95 ± 0.145</td>
</tr>
<tr>
<td><em>S. marmosae</em> sp.nov. (ref. no. M 26 syntypes)</td>
<td>10.11 ± 0.62</td>
<td>2.67 ± 0.42</td>
<td>2.17 ± 0.3</td>
</tr>
</tbody>
</table>

* Only 80 'spores' measured.

We have made a direct comparison of the new *Sarcocystis* species described above with *S. marmosae* Blanchard, 1885. Our *S. marmosae* material was from a naturally infected laboratory mouse from England. *S. azevedoi* is clearly differentiated from *S. marmosae* by its tiny spores and absence of trabeculae within the cyst. *S. proechimyos* is distinguished by its short cysts and prominent, spine-like villi in the cyst wall. The cyst wall of *S. marmosae*, in the material we have examined, is extremely thin.
Sarcocystis of rodents and marsupials in Brazil

(0·5 μm) and possesses innumerable tiny protrusions, rather like the teeth of a blunt saw (Pl. 3, fig. 15). *S. oryzomyos* might be confused with *S. muris*, were it not for its thicker and highly invaginated cyst wall, and smaller spores (see Tables 1, 2).

The transmission of *Sarcocystis* remains a relative mystery and it is beyond the scope of the present paper to discuss this more than briefly. Two observations made during the present studies are worthy of note, however. Our attempts to infect laboratory mice, rats and hamsters with *S. proechimyos* have failed completely. Large numbers of these animals were fed with spores and fresh cysts, while others were inoculated with similar material by the intracardiac, intraperitoneal and intramuscular routes. Skeletal muscle from these animals has consistently remained negative up to 3 months after these inoculations.

We have bred a limited number of *Proechimys* in the laboratory in the hope of using 'clean' animals for transmission experiments. Muscle biopsies on two of the young animals, however, revealed cysts of *S. proechimyos*. As the litters and the parents had been maintained together in a single cage it is reasonable to suppose that the young acquired infection from the parents.

Two methods of transmission might be considered in this case—congenital transfer and infection per os by infective stages in faeces or urine. In the latter respect, it may be of importance that the cage of the animals in question had been deliberately left uncleaned for long periods to avoid disturbing the litters. Hutchison (1965, 1967) has established that transmission of *Toxoplasma* may be effected by way of infected nematode eggs. Possibly a similar mode of transmission exists in the case of *Sarcocystis*: it is notable that almost all the *Proechimys* we have examined have been heavily infected with nematodes, in particular *Evandroia evandroi* Travassos, 1937, and *Acanthostrongylus acanthostrongylus*, Travassos, 1937, and we are continuing to investigate this aspect.

Specific diagnosis of *Sarcocystis oryzomyos* sp. nov.

**Type Host.** *Oryzomyia capito* (Rodentia, Cricetidae).

**Geographic Area.** Utinga Forest, Belém, Pará, Brazil.

**Site of Infection.** Throughout all skeletal muscles; not seen in heart muscle.

**Cysts.** Long, slender; from 9·4 to 24·7 mm long × 158 to 355·5 μm wide. Cyst wall from 3·0–3·2 μm thick, with a striated aspect due to fine, transverse villi. Usually the cyst wall is deeply invaginated in many places, dividing the cyst into pseudo-loculi. Trabeculae are well developed and divide the contents into small, angular packets of 'spores'. Growth of cyst is largely from a cap of 'proliferative cells' at the ends of the cyst.

**Spores** (as seen in smears from ruptured cysts). Large, 'banana-shaped' type, from 8·0 to 12·2 μm long × 2·5 to 5·0 μm wide, average 9·93 × 3·28 μm. Nucleus variable in position but usually at one pole: the cytoplasm of opposite pole is highly vacuolated. (As seen in sections of cysts fixed in neutral formol saline.) Spores morphologically the same as those seen in smears except smaller, being from 5·0–8·9 μm long × 1·5–2·5 μm wide, average 7·21 × 2·02 μm.
SYNTYPES AND PARATYPES. Slides deposited with the Department of Parasitology, the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C. 1.

Specific diagnosis of Sarcocystis azevedoi sp.nov.

Type host. Oryzomya capito (Rodentia, Cricetidae).
Geographic area. Utinga Forest, Belém, Pará, Brazil.
Site of infection. Throughout all skeletal muscles; not seen in heart muscle.
Cysts. Long, slender; from up to 2.76 mm long x 79-126 μm wide, probably longer. Cyst wall from 1.0 to 1.8 μm thick, delicate, very fine striations due to minute transverse villi. Cyst wall only rarely invaginated: no trabeculae visible.
Spores (as seen in smears of ruptured cysts). Small, merozoite-like, tapering to a fine point at one pole and with nucleus situated at the rounded end. Cytoplasm usually containing one or two densely staining granules. Vacuolation of cytoplasm almost imperceptible. Syntypes from 5.0 to 8.0 μm x 1.0 to 1.9 μm, average 6.8 x 1.45 μm. Paratypes from 4.0 to 7.1 μm x 1.1 to 2.0 μm, average 5.7 x 1.49 μm.

Specific diagnosis of Sarcocystis proechimyos sp.nov.

Type host. Proechimys guyannensis (Rodentia, Echimyidae).
Geographic area. Serra do Navio, Amapá, Brazil, and Utinga Forest, Belém, Pará, Brazil.
Site of infection. Throughout all skeletal muscles; not seen in heart muscle.
Cysts. Short, spindle-like, form 2.3 to 3.9 mm long x 63 to 88.2 μm wide. Cyst wall from 3.5 to 4.0 μm thick. Transverse striations due to slender, spine-like villi which are from 3.5 to 4.0 μm long and slightly recurved at their ends. The villi are positioned in rows with 0.75 μm between their bases. Cyst wall never invaginated: trabeculae strongly developed.
Spores (as seen in smears of ruptured cysts). Of the large, 'banana-shaped' type, from 6.5 to 10.5 μm x 2.2 to 4.0 μm, average 8.67 x 3.25 μm. Nucleus variously located, but one pole of the spore is usually prominently vacuolated.

Specific diagnosis of Sarcocystis marmosae sp.nov.

Type host. Marmosa murina (Marsupialia, Didelphidae).
Geographic area. Utinga Forest, Belém, Pará, Brazil.
Site of infection. Skeletal muscle of thigh. Very scanty cysts.
Cysts. Small, oval, 2 mm x 800 μm. Cyst wall with conspicuous finger-like villi with rounded tips, measuring 11.5 to 13.0 μm x 2.6 μm (as seen in smears). No information on presence or absence of trabeculae, as no sectioned material is available.
Spores (as seen in smear of ruptured cyst). Relatively large, from 6.2 to 9.0 μm x 1.8 to 3.0 μm tapering to fine point at one end. Nucleus usually located
at opposite, rounded end. Area of delicate vacuolation in cytoplasm towards the more pointed pole.

SYNTYPES. Deposited with the Department of Parasitology, the London School of Hygiene and Tropical Medicine.

We are indebted to Professor E. E. Buckley, London School of Hygiene and Tropical Medicine, for identification of the nematodes. Dr W. T. Stearn, the British Museum (Natural History), kindly advised us on problems of nomenclature in allocating the new specific names.

REFERENCES


EXPLANATION OF PLATES

PLATE 1

Fig. 1. Sarcocystis oryzomyos sp.nov., and Sarcocystis azevedoi sp.nov. Lumbar and pelvic muscles of Oryzomya capito showing large numbers of cysts (x 1.25).

Fig. 2. S. oryzomyos sp.nov. Part of a cyst in a fresh preparation of squashed muscle: note marked invaginations of the cyst wall (x 172.5).

Fig. 3. Sarcocystis proechimyo sp.nov. Thigh muscle of Proechimys guyannensis showing massive infection (x 1.25).

Fig. 4. Sarcocystis marmosae sp.nov. Thigh muscle of Marmosa murina showing a single, superficial cyst.

Fig. 5. S. oryzomyos sp.nov. Part of a longitudinal section of a cyst showing 'pseudo-loculi' and 'trabeculae' (x 172.5).

PLATE 2

Fig. 6. S. oryzomyos sp.nov. Oblique section of part of a cyst showing well defined trabeculae (x 172.5).
Fig. 7. *S. azevedoi* sp.nov. Longitudinal section of part of a cyst showing slight invagination of the cyst wall and apparent absence of trabeculae (× 172.5).

Fig. 8. *S. azevedoi* sp.nov. Longitudinal section of the edge of part of a cyst showing pseudoloculi (× 172.5).

Fig. 9. *S. proechimyo8* sp.nov. Section of part of cyst showing trabeculae and striated appearance of cyst wall. (× 435).

Plate 3

Figs. 10–13. *S. proechimyo8* sp.nov. Figs. 10, 11. Sections of the cyst wall showing striations as seen by phase-contrast and normal illumination respectively. These striations are due to recurved, spine-like villi, more clearly seen in Fig. 12. Fig 13. A more oblique section showing the even distribution of these villi over the cyst. (Figs. 10–11, × 435; Figs. 12, 13, × 1095.

Fig. 14. *S. orzyomyo8* sp.nov. Part of a section of the cyst wall showing the fine striations (× 1095).

Fig. 15. *S. muris*. Part of a section of the cyst wall showing its delicate nature and minute teeth-like protrusions (× 1095).

Fig. 16. *Sarocystis garnhami*. The strongly recurved ‘rose-thorn’ villi of the cyst wall: smear of dissected and crushed cyst (× 1095).

Fig. 17. *S. marmorae* sp.nov. The finger-like villi of the cyst wall as seen in a crush preparation of a dissected cyst (× 1095).