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Seven new coccidian species from marine fishes in Australia

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Abstract

One hundred and thirty fish of 15 species from the coast of northern New South Wales, Australia, were examined for coccidia. Seven new species, *Eimeria cheilodactyli* n. sp. and *E. dykovae* n. sp. from *Cheilodactylus fuscus; E. pleurostici* n. sp. from *Sphaeroides pleurosticus; E. sillaginis* n. sp., *E. ciliatae* n. sp. and *Goussia arrawarra* n. sp. from *Sillago ciliata; G. microcanthi* n. sp. from *Microcanthus strigatus* as parasites of the intestine; and a *Goussia* sp. from the liver of *Rhabdosargus sarba* are described.

Introduction

In a checklist of fish coccidia, Dyková & Lom (1983) recorded 128 species belonging to the genera *Eimeria, Epieimeria, Goussia, Crytallospora* and *Cryptosporidium.* More recently, Overstreet, Hawkins & Fournie (1984) established a new genus *Callyptospora.* An intensive study of marine fish coccidia has commenced in recent years and several authors in Europe, Africa and North America have studied the prevalence of the known species and described new ones (Duszynski *et al.*, 1979; Solangi & Overstreet, 1980; Lom & Dyková, 1981, 1982; MacKenzie, 1981; Daoudi *et al.*, 1984; Kalfa-Papaioannou & Athanassopoulou-Raptopoulou, 1984; Morrison & Hawkins, 1984; Obikezie, 1986). No coccidia have been described from Australian marine fishes prior to this study.

The present paper gives an account of a survey of marine fishes from the coast of New South Wales, Australia. Seven new coccidia belonging to the genera *Eimeria* and *Goussia* are described.

Materials and methods

One hundred and thirty fish belonging to 15 species were examined for coccidia (Table I). Fish were obtained from three different sources. Live specimens of smaller fishes were collected at the Arrawarra Research Station, north of Coffs Harbour, and larger specimens were bought from commercial fishermen at Coffs Harbour or collected in the estuarine waters of the Richmond River.

Only the intestine and the inner organs (liver, kidney, spleen, swimbladder, seroseous membranes) were examined for coccidia. From the intestine small drops of mucus and scrapings of the epithelium were checked microscopically under a coverslip, and from the inner organs pieces were squashed and examined in fresh preparations.

Sporulated oöcysts were measured and drawings were made of them. Non-sporulated oöcysts were placed in 0.65% or 2.5% saline to which a small drop of penicillin was added in order to bring about sporulation.

Histological preparations were made only from two hosts, namely from the intestine of the stripey and from the liver of the tarwhine. For histological examination organs were fixed in 10% formalin or

Bouin's solution, embedded in paraffin wax, sectioned at 4–6 μm and stained with haematoxylin and eosin.

For electron microscopy samples were fixed in 3% gluraraldehyde in 0.13 M sodium cacodylate for two hours at room temperature, washed four times for 20 minutes each time in 0.13 M sodium cacodylate, and postfixed in 1% $0s0_4$ for one hour. Subsequently the samples were dehydrated in an alcohol series and embedded in Spurr-resin. Sections were examined under a Philips E.M. 300 at 60 kV.

Results

Eight of the 15 species of fish examined proved to be infected with coccidia (Table I). Most of the coccidia were found in the gut, and only three fishes had oöcysts in the liver. The majority of oöcysts in the intestine left the fish unsporulated, some of them, however, completed sporulation in tap-water within 48 hours. Unsporulated oöcysts of 9–11 μm from the gut of *Acanthopagrus australis, Rhabdorsargus sarba* and *Chelidonichthys kumu* failed to sporulate. Morphologically four *Eimeria* and three *Goussia* species were differentiated, all of which proved to be new species. Descriptions follow (Table II).

Genus *Eimeria* Schneider, 1881

Eimeria cheilodactyli n. sp.

Host: Red morwong, *Cheilodactylus fuscus.*
Site of infection: Mucosa of the intestine and pyloric caeca.
Locality: Coffs Harbour, northern New South Wales.

Description of sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 1a) round with diameter of 11.2 (10.5–11.5) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent. One polar granule of irregular shape present, measuring 1.6 (1.3–1.8) μm. Sporocyst elongated ellipsoidal, with small Stieda body-like thickenings at one end. Length of the sporocysts 9.6 (8.6–10.4) μm, width 4.2 (4.0–4.4) μm. Sporocyst wall very thin. Sporocysts relatively

Table I. Coccidian infection of fishes in northern New South Wales.

Fishes	No. examined	No. infected	Locality
Acanthopagrus australis (Günther)	11	5	CH
Caranx georgianus (Cuvier & Valenciennes)	1	1	CH
Cheilodactylus fuscus Castelnau	2	2	CH
Chelidonichthys kumu (Lesson & Garnot)	12	12	CH
Centropogodon australis Fortesque	1	0	A
Gerres ovatus (Günther)	10	0	CH
Liza argentea (Quoy & Gaimard)	6	0	R
Microcanthus strigatus (Cuvier & Valenciennes)	1	1	A
Mugil cephalus L.	19	0	R; A
Myxus elongatus (Waite)	18	0	R; A
Scorpis lineatus Kner	2	0	CH
Sillago ciliata (Cuvier & Valenciennes)	10	10	A
Sphaeroides pleurosticus Günther	4	2	CH; A
Rhabdosargus sarba (Forskal)	19	11	CH; R
Therapon jarbua Day	4	0	A

Localities: A, Arrawarra Research Station north of Coffs Harbour. CH, Coffs Harbour. R, Richmond River.

Table II. A comparison of key features of coccidians found in Australian marine fishes (measurements in μm).

	Eimeria cheilodactyli	*Eimeria dykovae*	*Eimeria sillaginis*	*Eimeria ciliatae*	*Eimeria pleurostici*	*Goussia arrawarra*	*Goussia microcanthi*	*Goussia* sp.
Oöcysts:								
form	round	round	round	round	round	ellipsoidal	short oval	round
length	11.2 (10.5–11.5)	7.8 (7.2–8.4)	8.9 (8.4–9.2)	14.0 (13.4–14.2)	9.3 (9.1–9.6)	14.5 (14.7–15.1)	12.2 (11.7–13.5)	19.0 (18.5–19.7)
width	–	–	–	–	–	10.7 (10.1–10.9)	10.9 (10.1–11.7)	–
Sporocysts:								
form	elongated ellipsoidal	oval	oval	oval	short ellipsoidal or oval	elongated ellipsoidal	elongated ellipsoidal	short ellipsoidal
length	9.6 (8.6–10.4)	5.6 (5.1–5.9)	6.8 (5.9–7.6)	11.2 (10.9–11.7)	6.7 (6.3–7.0)	9.4 (9.3–9.6)	11.0 (10.9–11.2)	10.2 (9.6–11.3)
width	4.2 (4.0–4.4)	3.3 (3.2–3.5)	4.3 (3.8–5.0)	7.3 (6.7–7.6)	4.4 (4.2–4.6)	4.8 (4.6–5.0)	4.6 (4.5–4.7)	9.4 (9.2–10.3)
Sporozoites:								
length	7.0 (6.8–7.3)	4.4 (4.3–4.5)	4.2 (4.1–4.4)	9.2 (9.1–9.3)	3.8 (3.7–3.9)	8.8 (8.4–9.2)	9.6 (9.2–10.0)	8.4 (8.0–8.6)
width	1.2 (1.1–1.3)	0.8 (0.7–0.9)	1.8 (1.6–2.0)	2.6 (2.5–2.8)	1.6 (1.5–1.7)	2.4 (2.2–2.5)	2.5 (2.4–2.6)	1.6 (1.5–1.8)
Polar granule	1.6 (1.3–1.8)	0.7 (0.6–0.8)	1.0	(1.7–2.0)	0.7 (0.6–0.8)	absent	0.8	absent
Sporocyst residuum	coarse granules	round	round	round	round or ellipsoidal	lentiform	scattered	large granules
	1.2 (0.8–1.6)	1.1 /0.8–1.5/	1.8 /1.6–2.3/	2.8 (2.5–3.0)	1.5 × 2.5 or 2.5 × 2.5	4.2 × 1.5	–	2.0 (1.6–2.2)
Host	*Cheilodactylus fuscus*	*Cheilodactylus fuscus*	*Sillago ciliata*	*Sillago ciliata*	*Sphaeroides pleurosticus*	*Sillago ciliata*	*Microcanthus strigatus*	*Rhabdosargus sarba*

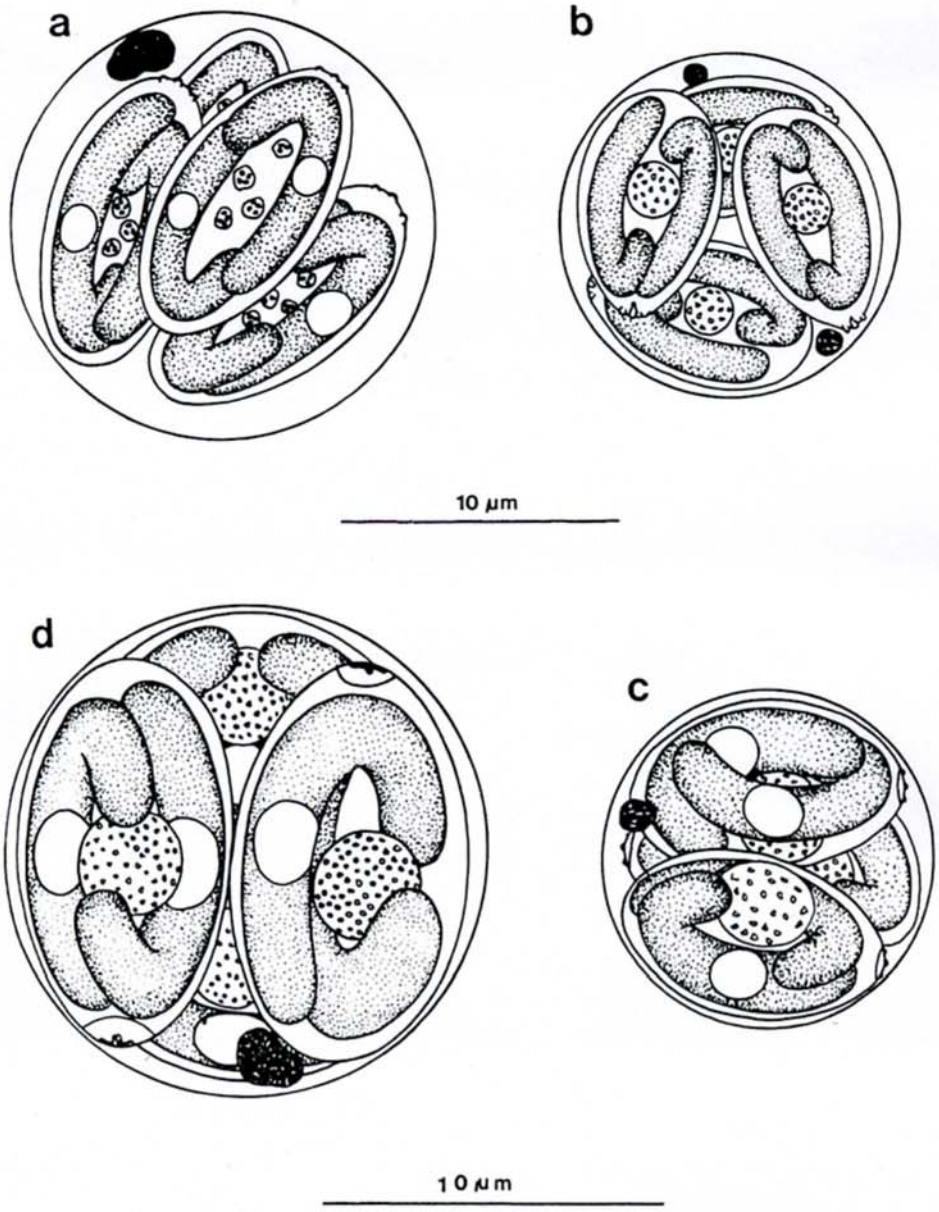


Fig. 1. Oöcysts of *Eimeria* spp. found in red morvong and sand whiting: a, *E. cheilodactyli* n. sp.; b, *E. dykovae* n. sp.; c, *E. sillaginis* n. sp.; d, *E. ciliatae* n. sp.

compact, but do not fill oöcysts completely, so may be arranged in oöcyst in different positions. Each sporocyst contains 2 vermiform sporozoites, with one end reflexed, arranged head to tail in sporocyst. Length of sporozoites without reflexed portion 7.0 (6.8–7.3) µm, width 1.2 (1.1–1.3) µm. Sporocyst residua composed of some scattered coarse granules measuring 1.2 (0.8–1.6) µm. Merogonic and gamogonic stages were not studied.

The oöcysts were found in the sporulated stage in the faeces and mucosal scrapings.

Number of hosts examined/infected: 2/2.

Comment

This species resembles *Epieimeria anguillae,* but differs from it in the shape of the sporocysts, i.e., they are round in cross section and not hexagonal.

***Eimeria dykovae* n. sp.**

Host: Red morwong, *Cheilodactylus fuscus*
Site of infection: Mucosa of the intestine and pyloric caeca.
Locality: Coffs Harbour, northern New South Wales.

Description of the sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 1b) round with diameter of 7.8 (7.2–8.4) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent. Two polar granules of 0.7 (0.6–0.8) μm present. Sporocyst oval with small thickenings on tapered end representing Stieda body. Length of sporocysts 5.6 (5.1–5.9) μm, width 3.3 (3.2–3.5) μm. Sporocyst wall very thin. Sporocysts compact filling completely space within oöcyst; usually arranged 3 in one plane. Each sporocyst contains 2 vermiform sporozoites with one end reflexed, arranged head to tail in sporocyst. Length of sporozoites without the reflexed portion 4.4 (4.3–4.5) μm, width 0.8 (0.7–0.9) μm. Sporocyst residuum round finely granular, measuring 1.1 (0.8–1.5) μm. Merogonic and gamogonic stages were not studied.

The oöcysts were found in the sporulated stage in the faeces and mucosal scrapings.

Number of hosts examined/infected: 2/2.

Comment

This species resembles *E. cheilodactyli* n. sp., but differs from it in having two polar granules in the oöcysts and in its smaller and shorter sporocysts. The two species occurred in about equal number in the faeces.

***Eimeria sillaginis* n. sp.**

Host: Sand whiting, *Sillago ciliata.*
Site of infection: Mucosa of the intestine and pyloric caeca.
Locality: Arrawarra Research Station near Coffs Harbour, northern New South Wales.

Description of sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 1c) round, with diameter of 8.9 (8.4–9.2) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent; 1–4 polar granula of 1 μm present. Sporocysts oval, with small thickenings on tapered end. Length of sporocysts 6.8 (5.9–7.6) μm, width 4.3 (3.8–5.0) μm. Sporocyst wall very thin. Sporocysts compact filling completely space within oöcyst; usually arranged 2 or 3 in one plane. Each sporocyst contains 2 vermiform sporozoites with one end reflexed. Sporozoites arranged head to tail in sporocyst. Length of sporozoites without reflexed portion 4.2 (4.1–4.4) μm, width 1.8 (1.6–2.0) μm. Sporocyst residuum round, finely granular, measuring 1.8 (1.6–2.3) μm.

About half of the oöcysts were found completely sporulated in the faeces and mucosal scrapings. Merogonic and gamogonic stages were not studied.

Number of hosts examined/infected: 10/10.

Comment

Oöcysts of about the same size were recorded by Setna & Bana (1936) in *Sillago sihana,* but no description was given by these authors.

***Eimeria ciliatae* n. sp.**

Host: Sandwhiting, *Sillago ciliata.*
Site of infection: Mucosa of the intestine and pyloric caeca.
Locality: Arrawarra Research Station near Coffs Harbour, northern New South Wales.

Description of sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 1d) round, with diameter of 14.0 (13.4–14.2) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent: 1–4 polar granules measuring 1.7–2.0 μm present. Sporocyst oval with small thickenings and cap on tapered end. Length of sporocyst 11.2 (10.9–11.7) μm, width 7.3 (6.7–7.6) μm. Sporocyst wall very thin. Sporocysts compact filling space within oöcyst; usually arranged 2 in one plane. Each sporocyst contains 2 vermiform sporozoites with one end reflexed. Sporozoites are arranged head to tail in sporocyst. Length of sporozoites without reflexed portion 9.2 (9.1–9.3) μm, width 2.6 (2.5–2.8) μm. Sporocyst residuum round, finely granular, measuring 2.8 (2.5–3.0) μm.

About half of the oöcysts were found fully sporulated in the faeces and mucosal scrapings. Merogonic and gamogonic stages were not studied.

Number of hosts examined/infected: 10/10.

Comment

This species morphologically resembles *E. sillaginis* n. sp., but differs from it in its significantly larger size. The oöcysts of the two species were found in mixed infections, but oöcysts of intermediate sizes were never found.

***Eimeria pleurostici* n. sp**

Host: Toad fish, *Sphaeroides pleurosticus.*
Site of infection: Mucosa of the intestine.
Locality: Coffs Harbour, northern New South Wales.

Description of sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 2a) round with diameter of 9.3 (9.1–9.6) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent. One polar granule 0.7 (0.6–0.8) μm present. Sporocysts short ellipsoidal or oval with characteristic plug-like Stieda body on more tapered end. Length of sporocysts 6.7 (6.3–7.0) μm, width 4.4 (4.2–4.6) μm. Sporocysts compact, filling entire space within oöcyst. Sporocysts are usually arranged 3 in one plane in oöcysts. Sporocyst wall very thin. Each sporocyst contains 2 vermiform sporozoites with one end reflexed; latter arranged head to tail in sporocyst. Length of sporozoites without reflexed portion 3.8 (3.7–3.9) μm, with 1.6 (1.5–1.7) μm. Sporocyst residuum round or ellipsoidal, finely granular, measuring 1.5 × 2.5 or 2.5 × 2.5 μm.

The oöcysts leave the fish unsporulated. Oöcysts kept in 0.65% saline completed sporulation within 72 hours. Merogonic and gamogonic stages were not studied.

Number of hosts examined/infected: 4/2.

Comments

This species resembles *E. cotti,* a species parasitizing an unrelated host, but it differs from it in its smaller size and in having a bright polar granule in the oöcyst. It also resembles *E. catalana,* which, however, has no polar granule but several refractile granules in the oöcyst.

Genus *Goussia* Labbe, 1896

***Goussia arrawarra* n. sp.**

Host: Sand Whiting, *Sillago ciliata.*
Site of infection: Mucosa of the intestine.
Locality: Arrawarra Research Station near Coffs Harbour, northern New South Wales.

Description of the sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 2b) ellipsoidal, 14.5 (14.3–15.1) μm long and 10.7 (10.1–10.9) μm wide. Cyst wall

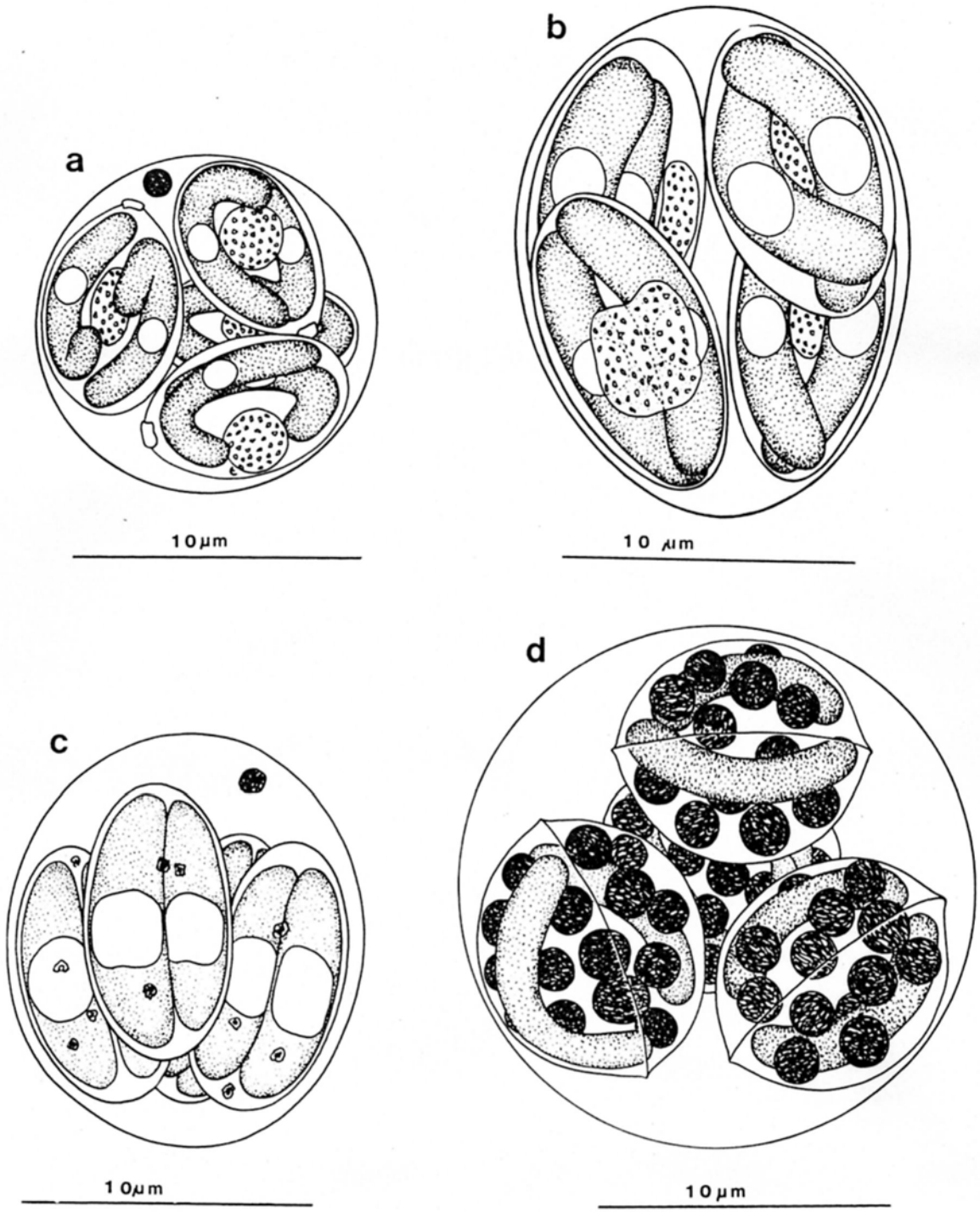


Fig. 2. Oöcysts of *Eimeria* and *Gousia* spp. found in banded toad, sand whiting, stripey and tarwhine: a, *E. pleurostici* n. sp.; b, *G. arrawarra* n. sp.; c, *G. microcanthi* n. sp.; d, *Goussia* sp.

smooth colourless, composed of very thin layer. Oöcyst residuum, micropyle and polar granule absent. Sporocysts elongated ellipsoidal, 9.4 (9.3–9.6) μm long and 4.8 (4.6–5.0) μm wide. Sporocysts longitudinally arranged in oöcyst; compact filling space in oöcyst. Each sporocyst with 2 banana-shaped sporozoites, arranged head to tail in sporocyst. Length of sporozoites 8.8 (8.4–9.2) μm, width 2.4 (2.2–2.5) μm. Sporocyst residuum finely granular, lentiform or scattered within sporocyst. Lentiform residua measure 4.2 μm in diameter and 1.5 μm in thickness.

The oöcysts were found unsporulated in the faeces and mucosal scrapings. Unsporulated oöcysts were ellipsoidal, consisting of one round, finely granular sporont. They completed sporulation in 0.65% saline within 24 hours. Merogonic and gamogonic stages were not studied.

Number of hosts examined/infected: 10/10.

Comments

This species was found in a mixed infection with *E. sillaginis* and *E. ciliatae,* but the intensity of infection never exceeded that of the previous species. In having ellipsoidal oöcysts and sporocysts and no polar granule, this species differs from all *Goussia* species known from marine fishes.

Goussia microcanthi n. sp.

Host: Stripey, *Microcanthus strigatus.*
Site of infection: Mucosa of the intestine.
Locality: Arrawarra Research Station near Coffs Harbour, northern New South Wales.

Description of the species (based on 5 sporulated and 50 unsporulated oöcysts)

Oöcysts (Fig. 2c) short oval measuring 12.2 (11.7–13.5) by 10.9 (10.1–11.7) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum and micropyle absent; one small polar granule of 0.8 μm present. In non-sporulated oöcysts there is single round sporont filled by coarse granules with diameter of 11.2 (10.8–11.6) μm. Sporocysts elongated ellipsoidal, measuring 11.0 (10.9–11.2) μm in length and 4.6 (4.5–4.7) μm in width. Four sporocysts are longitudinally arranged in oöcyst. Sporocyst wall very thin. Each sporocyst with 2 banana-shaped sporozoites with large, refractile nuclei. Length of sporozoites 9.6 (9.2–10.0) μm, width 2.5 (2.4–2.6) μm. Sporocyst residuum scattered, forming small pieces.

The oöcysts were found unsporulated in the faeces and intestinal scrapings. The mucosa showed a high level of infection with developmental stages (merozoites, macro- and microgamonts) and oöcysts: nevertheless, only 5 oöcysts became sporulated after keeping the faeces for 48 hours in 2.5% saline solution. Despite high infection with developmental stages, in histological sections only unsporulated oöcysts were found in the epithelium of the foregut.

Number of hosts examined/infected: 1/1.

Comment

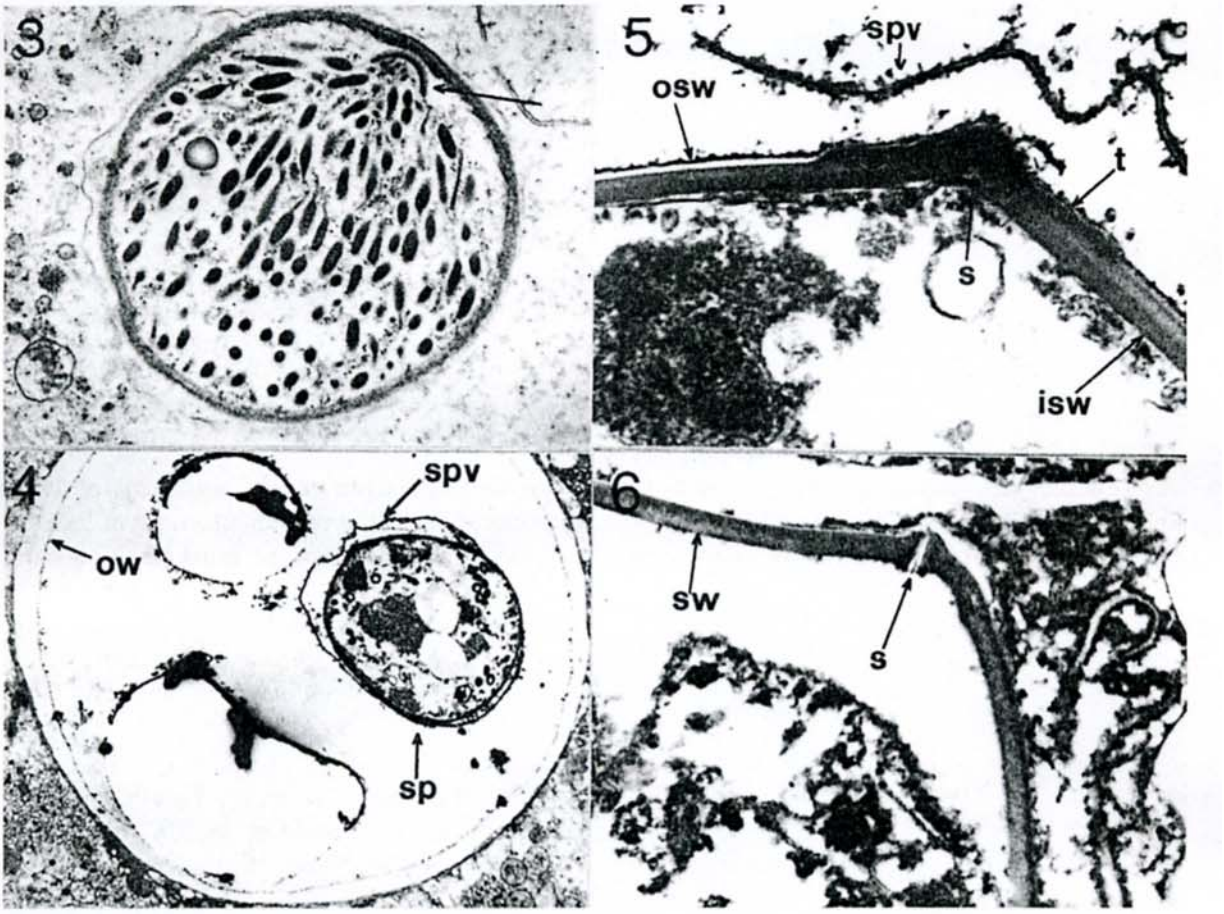
This species differs from most of the known *Goussia* in having very large sporozoites in the sporocyst.

Goussia sp.

Host: Tarwhine, *Rhabdosargus sarba.*
Site of infection: Parenchyma of the liver.
Locality: Coffs Harbour, northern New South Wales.

Description of sporulated oöcysts (50 specimens measured)

Oöcysts (Fig. 2d) round with a diameter of 19 (18.5–19.7) μm. Cyst wall smooth, colourless, composed of very thin layer. Oöcyst residuum, micropyle and polar granule absent. Sporocysts short ellipsoidal, almost round and composed of 2 equal valves. Suture of sporocysts is visible, pro-



Figs. 3–6. Transmission electron microscopy on a *Goussia* sp. from the liver of tarwhine. 3. Cross-sectioned merozoite. Note the conoid apparatus (arrow). (× 20,000). 4. Part of a cross-sectioned oöcyst. Oöcyst wall (ow); sporocyst (sp); sporocyst veil (spv). (× 36,000). 5. Part of the sporocyst wall of a young sporocyst. Suture (s); outer layer of the sporocyst wall (osw); inner layer of the sporocyst wall (isw); thickening of the sporocyst wall (t); sporocyst veil (spv). (× 40,000). 6. Part of the sporocyst wall (sw) of a more mature oöcyst with suture (s). (× 30,000).

ducing small protrusion at ends. Sporocyst wall relatively thick. Length of sporocysts 10.2 (9.6–11.3) μm, width 9.4 (9.2–10.3) μm. Three of sporocysts arranged in one plane in oöcyst; fill oöcyst relatively loosely. Each sporocyst with 2 banana-shaped sporozoites of 8.4 (8.0–8.6) μm length and 1.6 (1.5–1.8) μm width. Sporocyst filled by coarsely granulated residua; each sporocyst with 16–20 granules of 2 (1.6–2.2) μm diameter. In old oöcysts number of sporocyst residual granules is reduced to 2 or 3.

In histological slides of liver parenchyma 5–10 oöcysts surrounded by melano-macrophages were found in small islets.

For technical reasons only cross-sectioned merozoites and young oöcysts were examined electron-microscopically. From the older oöcysts the mature sporocysts dropped out during the sectioning process. In merozoites of 250 nm in diameter found in hepatic cells a typical conoid apparatus was clearly seen (Fig. 3). The single layered wall of the oöcyst, 20 μm in diameter, proved to be 20 nm thick (Fig. 4). The wall of the sporocysts was composed of two layers, a thin outer one of 30 nm and a thicker inner one of 160 nm. The sporocysts were loosely surrounded by a membraneous veil 40 nm in thickness (Figs 4, 5). In young oöcysts the suture surrounding

the sporocysts was covered by a thick layer (Fig. 5); in the more mature oöcysts, however, the opening of the suture was clearly seen (Fig. 6).

Number of hosts examined/infected: 13/11.

Comments

No infection with this species was found in six tharwine collected from the estuarine waters of the Richmond River. On the other hand, morphologically identical or similar coccidium oöcysts were found in two other unrelated fish species. The liver of a *Caranx georgianus* specimen harboured oöcysts morphologically completely identical with the ones described from tharwine. A relatively frequent infection with oöcysts was found in red gurnard (*Chelidonichthys kumu*). Seven of 12 specimens examined harboured oöcysts in the liver. These oöcysts were morphologically identical with those found in tarwhine, but both the oöcysts and the sporocysts were smaller. The oöcysts measured 15.8 (15.0–16.6) μm in diameter, whereas the sporocysts were 8.2 (7.9–8.4) μm in length and 6.2 (6.0–6.4) μm in width.

The question arises whether this *Goussia* species has an unusually wide host range or whether several morphologically similar species exist.

Two species of *Goussia* are known from the liver of marine perciforms. *G. cruciata* was described by Thelohan (1892) from *Trachurus trachurus*. A second species, found in *Labrus festivus* by Thelohan (1894), was described and named by Labbé (1896) as *G. thelohani*. Unfortunately the relatively detailed description given by the above authors is not fully adequate to identify the two species because of the poor-quality drawings. Although Yakimoff (1929), Dogiel (1948) and Kalfa-Papaioannou & Athanassopoulou-Rhaptopoulou (1984) have increased our knowledge of these coccidia, they did not give a redescription of the species. Both species are characterized by oöcysts of about 25 μm in diameter.

With regard to its measurements, the *Goussia* found in *Rhabdosargus sarba* is somewhat smaller than *G. cruciata* and *G. thelohani*, but morphologically they are very similar. Although we have examined our *Goussia* thoroughly, because of the above facts, we cannot identify it. We are of the opinion that the validity of the species can be decided only after the redescription of *G. cruciata* and *G. thelohani* from the original hosts.

Also, we cannot decide at this stage whether the oöcysts found in the liver of *Caranx georgianus* and *Chelidonichthys kumu*, which are perciform hosts but taxonomically rather distant, represent the same species as that in *Rhabdosargus sarba*.

Discussion

Our findings made on 130 specimens of 15 fish species show that coccidian infections of fishes are common on the coast of northern New South Wales. Eight of the 15 fish species proved to be infected and in the case of some species, i.e. *Acanthopagrus australis, Rhabdosargus sarba, Cheilodactylus fuscus, Chelidonichthys kumu* and *Sillago ciliata*, both the extensity and intensity of infection were high. According to the morphological variations of oöcysts, the species parasitic in the intestine can be regarded as specific ones, among which members of both the genera *Eimeria* and *Goussia* could be found. At the same time, further studies are required to determine the host specificity of the *Goussia* sp. found in the liver, a species with relatively large oöcysts, since in fish belonging to different genera oöcysts similar in morphology but differing in size were found. Some of the oöcysts leave the fish in the sporulated stage. To examine and describe this type of oöcyst presents no difficulty. However, species which do not finish sporulation in the gut, can only be examined if the oöcysts obtained from freshly killed fish finish sporulation outside the fish. Sporulation is successful if theoöcysts are collected from clean mucus containing only traces of faecal elements.

If we regard the high number of marine fish species not yet studied, our study can only be regarded as that of a small random sample, indicating that, after a systematic investigation of the coccidia of marine fishes, large numbers of species could be expected.

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