

***Calicotyle australiensis* n. sp. and *Calicotyle* sp. (Monogenea, Monopisthocotylea) from the rectum and rectal glands, and *Rugogaster hydrolagi* Schell, 1973 (Trematoda, Aspidogastrea) from the rectal glands of holocephalans off the coast of southeastern Australia**

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Abstract

Calicotyle australiensis n. sp. from *Chimaera* sp., caught off the coast of New South Wales, is described. It differs from the other species of the genus in the combination of the following characteristics: length of the penis-tube, absence of medial diverticula of the caeca and presence of hamuli. *Calicotyle* sp. from *Rhinochimaera pacifica* and *Rugogaster hydrolagi* from *Chimaera* sp. caught at the same locality are reported and illustrated.

Introduction

Rohde (1984) has reviewed the geographical distribution of marine parasites. The review shows that little attention has been paid to “bipolar” distributions of parasites in northern and southern seas since the classical studies of marine trematodes by Manter (1955). “Bipolar” distributions, according to Manter, usually involve genera and paired species rather than identical species, and some of the species known from both southern and northern cold waters have also been found in deep waters at low latitudes, e.g. *Derogenes varicus* (Müller). In this paper, we report for the first time the occurrence in Australian chimaeriform fishes of one species of platyhelminth previously known only from the northern hemisphere, and of two species similar to one from the northern Atlantic.

Materials and methods

The following holocephalan specimens were examined: 12 *Chimaera* sp. I, 29 *Chimaera* sp.

II, 18 *Rhinochimaera pacifica* (Mitsukuri, 1895), three *Hydrolagus* sp., one *Hydrolagus ogilbyi* (Waite, 1889) and two *Harriotta raleighana* (Goode & Bean, 1895). *H. ogilbyi* was caught at a depth of 200–265 m; the other species are from deeper waters (700–1225 m). Fish were caught by demersal trawl during cruises of the research vessel “Kapala” of the Fisheries Research Institute, NSW Department of Agriculture & Fisheries, off the coast of New South Wales (31°45' S–35°44' S, 150°42' E–153°19' E, April to September 1989) and identified by Ken Graham. The digestive tracts were dissected out of the fish and fixed in 10% formalin. They were transferred to 70% alcohol, opened and examined in the laboratory under a dissecting microscope. Specimens of *Rugogaster* and *Calicotyle* were stained with Grenacher's carmine alum and, after dehydration, mounted in Canada balsam. For comparison, slides of *Calicotyle affinis* Scott, 1911 from *Chimaera monstrosa* caught in the Northern Atlantic (The Natural History Museum, London BM(NH) No. 1988.10.14.11–16, 1988.8.31.7–12, 1959.10.14.9, 1989.8.31.21), and of *Calicotyle ramsayi* Robinson, 1961 from *Squalus lebruni*

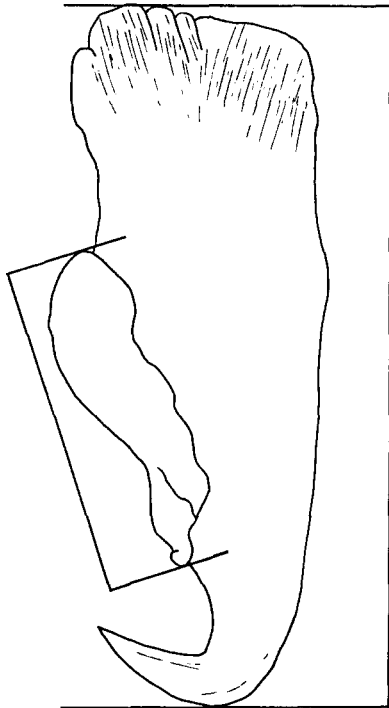


Fig. 1. Hamulus of *Calicotyle* sp. from *Rhinochimaera pacifica* to show method of measuring total length of hamulus and length of guard.

caught in Cook Strait, New Zealand (US National Helminthological Collection 39429), were examined. Also examined were seven specimens of *Rugogaster hydrolagi* Schell, 1973 from *Hydrolagus colliei* caught in Hecate Strait, Pacific Canada (130°45.6' W–130°54.7' W, 53°17.3' N–53°19.3' N, 12.9.1982), stained as above, for comparison with *R. hydrolagi* (three whole-mounts, two cross-sections, two "frontal" sections, one sagittal section) lent by Prof. S.C. Schell, University of Idaho.

Total length of hamulus and length of guard were measured as shown in Fig 1. Length of penis-tube was measured from drawings made with the aid of a camera lucida.

***Calicotyle australiensis* n. sp.** (Fig. 2, based on several specimens, Figs 3, 4: Table I)

Host: *Chimaera* sp. II.

Locality: Off coast of southeastern Australia.

Site: Rectum, some juvenile specimens also in rectal glands.

Type-material: Holotype deposited in the Natural History Museum, London: BM(NH) No. 1991.1.2.1, one paratype in Australian Museum No. W20385.

Description

Based on 20 specimens (including holotype and one paratype). Opisthaptor with one central and 7 peripheral loculi. Single pair of hamuli, increasing in size with size of worm: tip of blade formed first. Fourteen marginal hooks: complete set seen only in small immature specimens. Mouth ventral, subterminal. Pharynx followed by short oesophagus. Caeca bent inwards at end of third quarter of body proper and outwards again, terminate close to posterior end. Vitelline follicles occupy region on each side between body margin and caecum from level of oesophagus to posterior end of body proper. Transverse vitelline ducts at end of anterior third of body proper, join vitelline reservoir between ovary and oötype. Ovary elongate, embracing right caecum: blind end of ovary lobed. Oviduct in mid-line, opens into thick-walled oötype with triangular lumen: 2 corners of triangle directed antero-laterally, one corner medio-posteriorly. Two vaginae at level just posterior to bifurcation of intestine, open on surface ventral to caeca: distal parts of vaginal canals surrounded by (apparently glandular) cells; seminal receptacle close to junction of vaginal canals. Testicular mass intercaecal, between ovary and inward turn of caeca. Penis-tube length increases at least until body (length + width/2) reaches 1–2 mm (Fig. 3): fully-developed penis-tube with $3\frac{1}{2}$ – $4\frac{1}{2}$ coils ($3\frac{1}{2}$ in 4 and $4\frac{1}{2}$ in one specimen). Egg triangular: short filament at pointed posterior end.

Differential diagnosis

C. australiensis differs from *C. inermis* Woolcock, 1936 in the presence of hamuli, from *C. palombi* Euzet & Williams, 1960, *C. stossichi* Braun, 1899, *C. kroyeri* Diesing, 1850, *C. australis* Johnston,

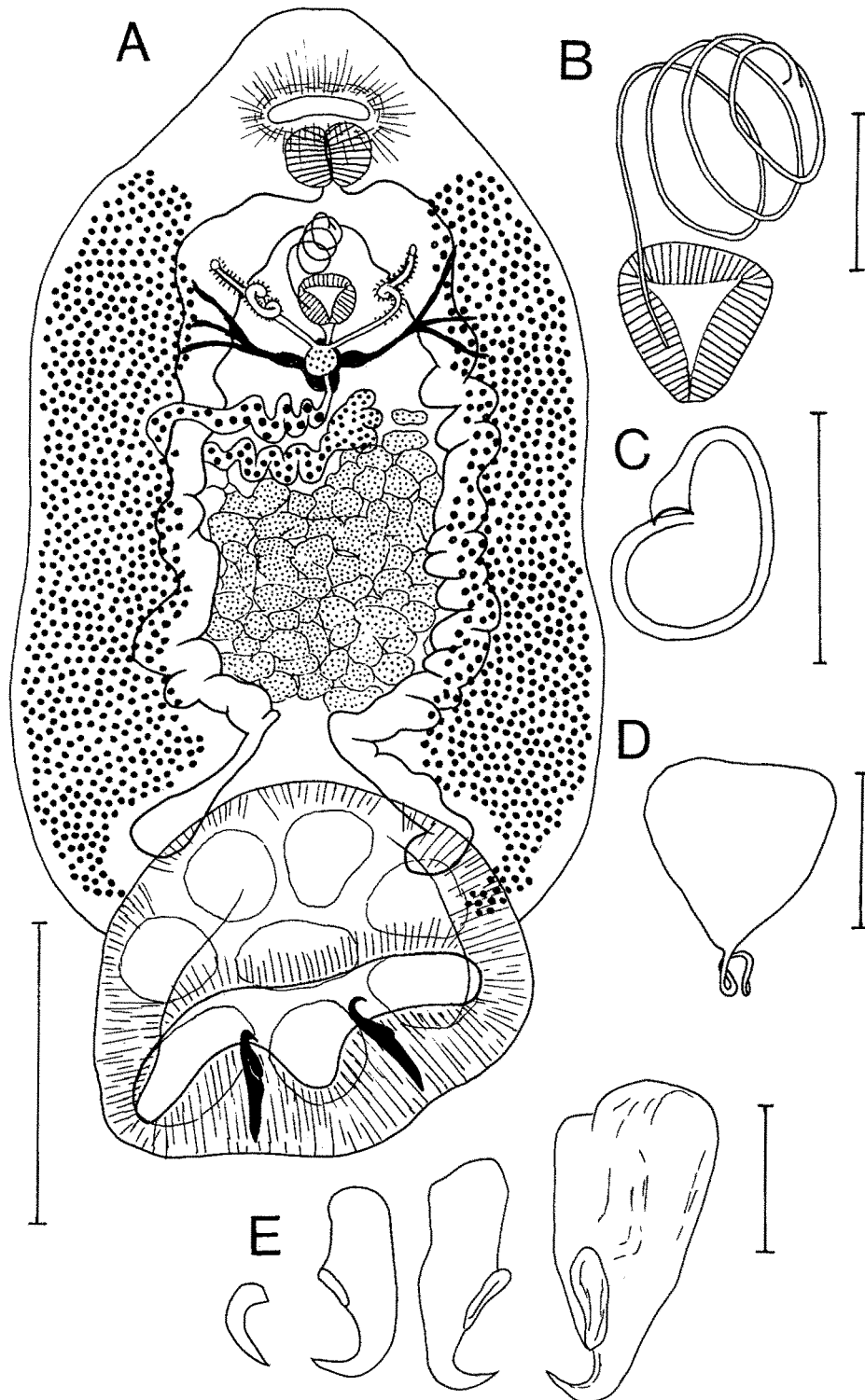


Fig. 2. *Calicotyle australiensis* n. sp. from *Chimaera* sp. II. A. Whole-mount, ventral view. B. Oötype and fully-developed penis-tube. C. Penis-tube, not fully developed from a specimen 0.8×0.47 mm large. D. Egg. E. Hamuli from specimens with a length of 0.44, 1.8, 1.04 and 3.2 mm. Scale-bars: A, 1 mm; B,E, 0.2 mm; C,D, 0.1 mm.

Table 1. Measurements of *Calicotyle australiensis* and *C. sp.* from *Rhinochimaera pacifica* and *C. affinis* (length \times width, micrometres).

<i>Calicotyle australiensis</i>									
Specimen	1	2	3	4	5	6	7	8-13	
Body proper	630 \times 467	1,220 \times 720	1,400 \times 1,100	1,720 \times 1,000	2,200 \times 1,680	3,200 \times 2,800	5,000 \times 3,200	-	
Haptor	293 \times 538	522 \times 672	577 \times 920	760 \times 672	-	1,020 \times 1,280	1,160 \times 1,740	-	
Pharynx	96 \times 98	120 \times 132	180 \times 180	214 \times 222	237 \times 237	-	-	-	
Penis-tube length	240	-	1,726	1,798	-	2,140	2,413	-	
Hamulus	178, 178	148, 178	245	250, 260	245	340	395, 395	-	
Ratio guard to hook length	-	0.22	0.24	0.26, 0.27	-	0.40	-	0.23, 0.24, 0.29, 0.29, 0.29, 0.32	
Egg	-	-	-	-	121 \times 121	-	-	-	
<i>Calicotyle sp.</i>									
<i>Calicotyle affinis</i>									
Specimen	1	2	3	Specimen		1	2		
Body proper	4,300 \times 2,340	4,440 \times 2,140	3,245 \times 1,805	Body proper		3,367 \times 2,429	2,071 \times 1,122		
Haptor	- \times 1,680	1,460 \times 943	857 \times 1,061	Haptor		1,000 \times 1,225	-		
Pharynx	-	- \times 316	-	Pharynx		287 \times 426	185 \times 203		
Penis-tube	1,067	1,250	1,470	Penis-tube		1,620	1,680		
Large hamulus	-	337	270	Large hamulus		324	316		
Ratio guard to hook length	approx. 0.38	0.47	0.40	Ratio guard to hook length		0.35, 0.32	0.28		
Egg	-	-	-	Egg		137 \times 117	-		

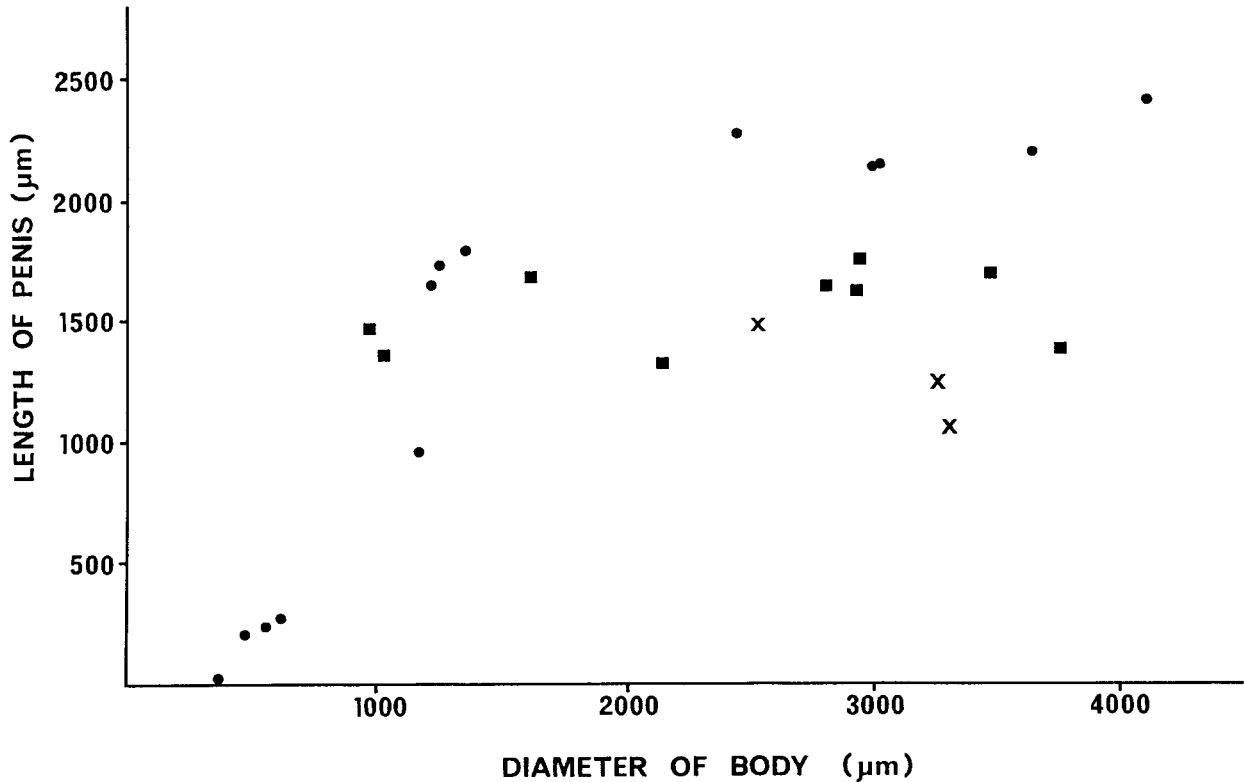


Fig. 3. Length of penis tubes of *Calicotyle australiensis* (●), *C. affinis* from Scotland (■), and *C. sp.* from *Rhinochimaera pacifica* (X). Diameter of body = (body length + maximum body width/2).

1934, *C. mitsukurii* Goto, 1895, *C. affinis* Scott, 1911, *C. urolopi* Chisholm & Beverley-Burton, 1991, *C. similis* (Szidat, 1972), Timofeeva, 1985, *C. quequeni* (Szidat, 1972) Timofeeva, 1985, *C. splendens* (Szidat, 1972) Timofeeva, 1985, *C. asterii* Szidat, 1970, and *C. sp.* from *Rhinochimaera pacifica* (this paper) in the greater length (>2 mm) of the fully-developed penis-tube, and from *C. ramsayi* Robinson, 1961 in the absence of well-developed medial diverticula of the caeca.

***Calicotyle* sp.** (Fig. 5; Table I)

Host: *Rhinochimaera pacifica*.
Locality: Off coast of southeastern Australia.
Site: Rectum.
Material: Specimen deposited in the Natural History Museum, London: BM(NH) No. 1991.1.2.2.

Description

Based on 3 specimens.
 Similar in all respects to *C. australiensis*, but fully-developed penis-tube shorter ($2\frac{1}{2}$ coils), and ratio of guard/length of hamulus usually greater.
 Since only 3 specimens are available, a new species is not established in spite of the distinct difference in penis-tube length from that of other described species.

***Rugogaster hydrolagi* Schell, 1973** (Fig. 6: Table II)

Host: *Chimaera* sp. II.
Locality: Off coast of southeastern Australia.
Site: Rectal glands, mouth end sometimes protruding into the rectal cavity.
Material: Specimens deposited in the National

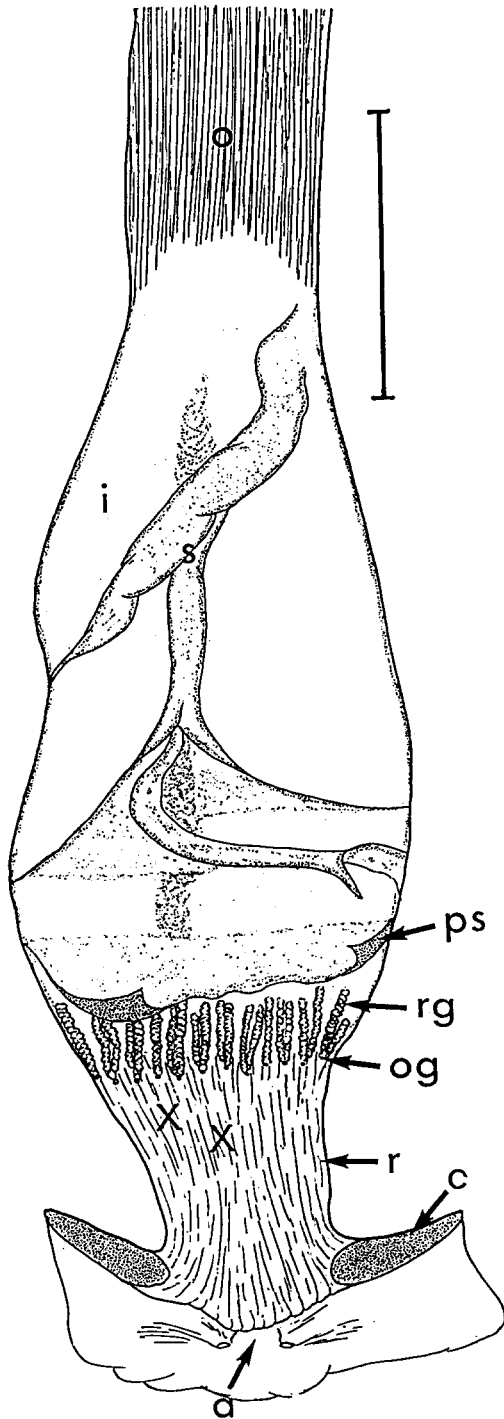


Fig. 4. Digestive tract of *Chimaera* sp. II opened dorsally. Crosses indicate sites at which two *Calicotyle* were firmly attached. Abbreviations: a, anus; c, cut surface; i, intestine; o, oesophagus; og, opening of rectal gland; ps, cut posterior lining of spiral valve; r, rectum; rg, rectal gland; s, spiral valve. Scale-bar: 5cm.

History Museum, London: BM(NH) No. 1991.1.2.3.

Description

Based on 3 complete and several (at least 18) incomplete specimens.

The specimens agree in all details with *R. hydrolagi* described by Schell (1973) from *Hydrolagus colliei* collected in the north Pacific off San Juan Island, Washington State. Measurements are similar (Table II) except for the size of the testes (which could be due to the different degree of maturity) and the number of transverse ridges (rugae). However, specimens of *R. hydrolagi* from *H. colliei* caught in Hecate Strait, BC, Canada, had a number of rugae intermediate between that of the American and Australian specimens and, thus, geographical variation of this feature appears to be likely.

Discussion

Calicotyle australiensis and *C. sp.* are most similar to *C. affinis* in the length of the penis-tube and the size of the hamuli but differ from it in the greater length of the fully-developed penis-tube (Fig. 3). *C. affinis* was originally described by Scott (1911) from the gills of *Chimaera monstrosa* from Scottish waters. According to Dieneske (1968a), this microhabitat may be erroneous, and the species has since been collected from the cloaca and sometimes from the posterior part of the rectum of *Chimaera monstrosa* off Norway and in the Barents Sea (Brinkmann, 1940, 1952; Dieneske, 1968a,b). Brinkmann (1940, 1952) also recorded the species once from *Raja fullonica*, according to Dieneske (1968a) an 'incidental' host. In contrast to most species of holocephalans, *C. monstrosa* lives in relatively shallow water, at a depth of 200–600 m in the Norwegian fjords (Dieneske, 1968a). A detailed description of the species of *Calicotyle* was given by Brinkmann (1940), who gave a key to the species then known. A more recent key was provided by Euzet & Williams (1960). Descriptions of *C. rosinae* and *C.*

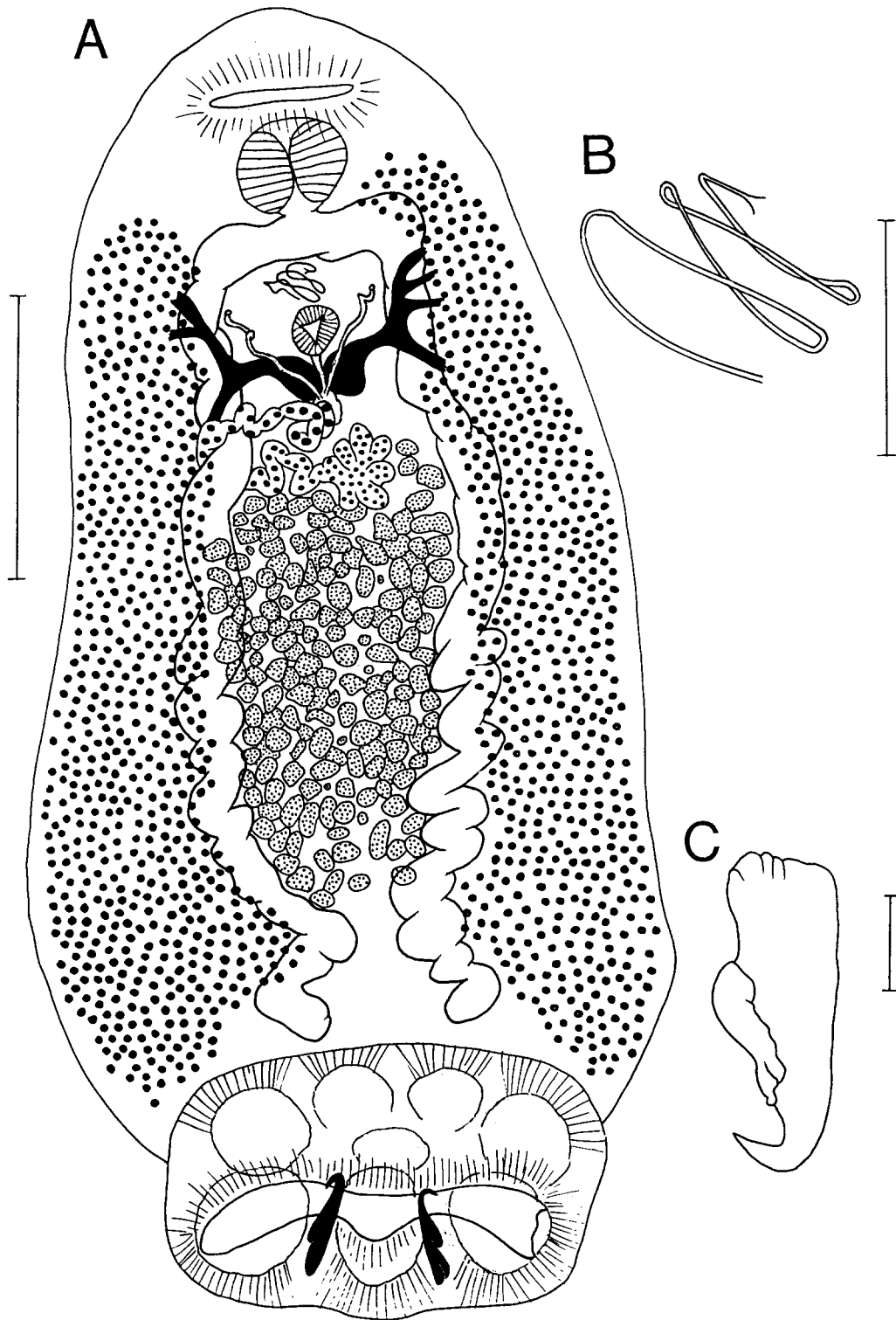


Fig. 5. *Calicotyle* sp. from *Rhinochimaera pacifica*. A. Whole-month ventral view. B. Penis-tube. C. Hamulus. Scale-bars: A, 1 mm; B, 0.2 mm; C, 0.1 mm.

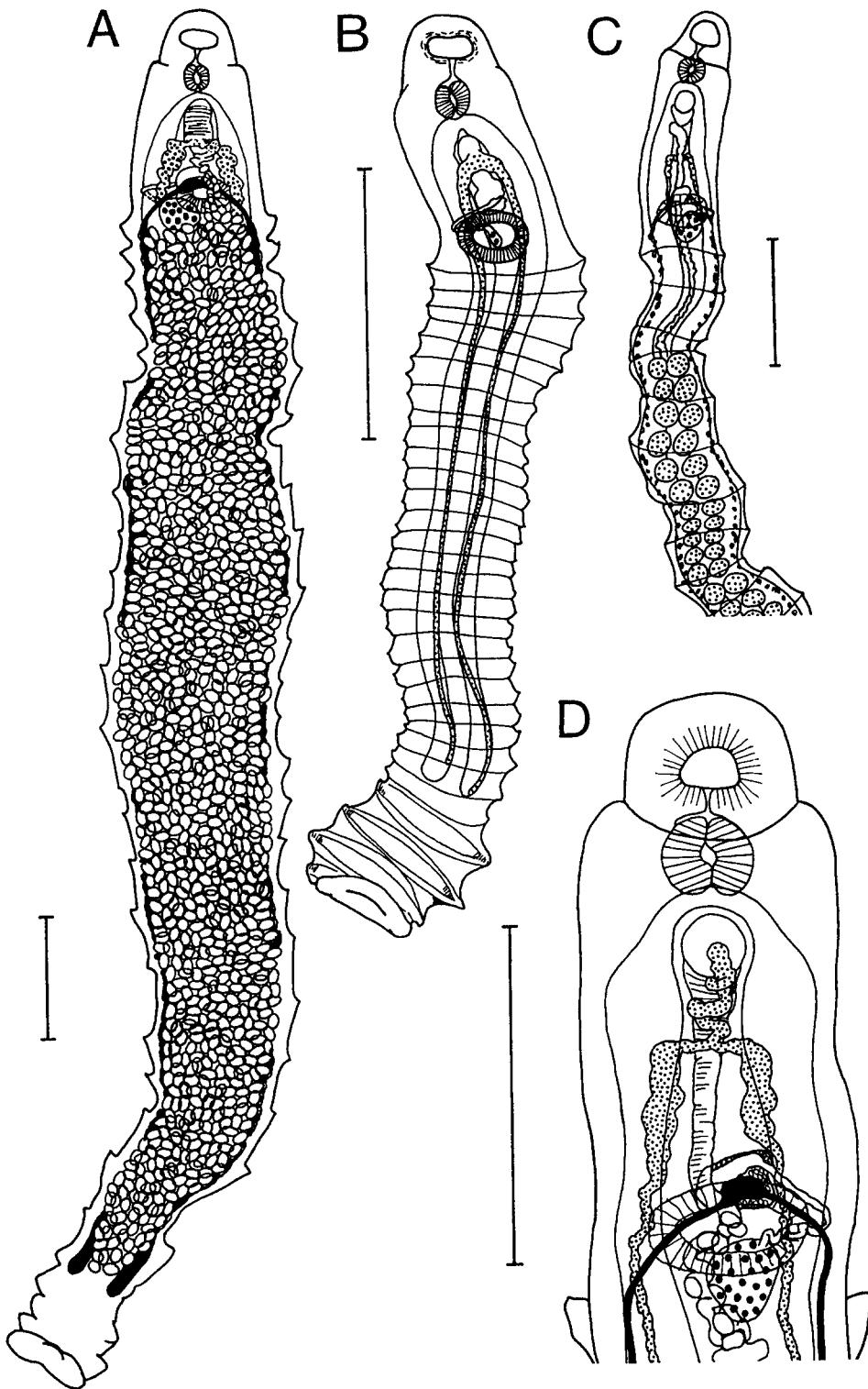


Fig. 6. Rugogaster hydrolagi. A. Mature specimen. B. Juvenile specimen. C, D. Anterior parts of mature specimens. Scale-bars: 1 mm.

Table II. Measurements of *Rugogaster hydrolagi* from *Hydrolagus colliei* in the northern Pacific and from *Chimaera* sp. II in southeastern Australia (length × width, micrometers).

	Washington State (acc. to Schell, 1973)	Hecate Strait, Pacific Canada	N.S.W.
Host	<i>Hydrolagus colliei</i>	<i>Hydrolagus colliei</i>	<i>Chimaera</i> sp. II
Site	Rectal glands	Rectal glands	Rectal glands
Number of rugae	18–25 (<i>n</i> = 12)	24–28 (<i>n</i> = 4)	27–32 (<i>n</i> = 4)
Size of body	7,000–15,000 × 1,000–2,000	8,000–11,500 × 1,800–2,200 (<i>n</i> = 3)	3,500–11,500 × 600–1,500 (<i>n</i> = 2)
Size of mouth opening	124–187 × 205–265	113–155 × 261–367 (<i>n</i> = 6)	76–317 × 171–374 (<i>n</i> = 8)
Diameter of pharynx	156–234	–	137–245 (<i>n</i> = 6)
Ventral sucker	–	–	220–465 × 195–301 (<i>n</i> = 8)
Cirrus sac	187–234 × 156–187	195–223 × 159–174 (<i>n</i> = 5)	187–285 × 167–260 (<i>n</i> = 3)
No. testes	46–58	–	–
Size of testes	218–312 × 312–421	–	68–196 × 80–260 (<i>n</i> = 3)
Ovary	187–327 × 140–249	–	230–350 × 140–265 (<i>n</i> = 9)
Eggs in whole-mounts	117–127 × 65–72	109–134 × 61–76 (<i>n</i> = 7)	121–133 × 48–64 (<i>n</i> = 6)

sjegi were given by Kuznetzova (1970), of *C. macrocotyle*, *C. similis*, *C. quequeni*, *C. splendens* and *C. asterii* by Suriano (1977).

Calicotyle australiensis differs from the other species of the genus in the greater length of the penis-tube (*C. australiensis* > 2 mm; *C. affinis* 1.0–1.50 mm (maximum 1.80 mm, this paper), *C. palombi* approx. 0.5 mm, *C. stossichi* approx. 0.48 mm, *C. kroyeri* approx. 0.38 mm, *C. australis* 0.32–0.50 mm, *C. mitsukurii* 0.56 mm, *C. urolophi* 0.17–0.24 mm, *C. macrocotyle* 0.85–1.1 mm, *C. similis* 0.5–0.56 mm, *C. quequeni* 0.14–0.16 mm, *C. splendens* 0.11–0.12 mm and *C. asterii* 0.79 mm. Drawings in Kuznetzova (1970) show that *C. rosinae* and *C. sjegi* also have a much shorter penis-tube. *C. inermis* Woolcock, 1936 has a penis-tube of 1.0–1.8 mm length and lacks hamuli on the opisthaptor. *C. ramsayi*, described by Robinson (1961) on the basis of a single specimen from the dogfish *Squalus acanthias* in New Zealand, differs from *C. affinis* and *C. australiensis* in its short hamuli (0.17 mm long in a specimen 7.5 × 5.3 mm large) and the presence of at least six very large medial diverticula of the caeca. The related genus *Dictyocotyle* has an opisthaptor with many irregularly distributed shallow loculi (Nybelin, 1941; Euzet & Williams, 1960). There is no evidence that this genus is the coelomic form of *Calicotyle* as has been suggested (see Dawes & Griffiths, 1958, 1959; Llewellyn, 1959).

Several species of *Calicotyle* have been shown

to infect several species of one or more genera. Thus, Llewellyn *et al.* (1984) list five species of the genus *Raja* as hosts of *Calicotyle kroyeri* at Plymouth, England. *Calicotyle australis* has been reported from *Trygonorhina fasciata* (see Johnston, 1934), *Aptychotrema rostrata* (see Young, 1970) and *Rhinobatos batillum* (see Whittington *et al.*, 1989), all belonging to the family Rhinobatidae; *C. palombi* and *C. stossichi* are both known from two species of *Mustelus* (see Euzet & Williams, 1960); and *C. urolophi* is known from three species of *Urolophus* (see Chisholm & Beverley-Burton, 1991). *C. affinis* has previously been described from *Chimaera monstrosa* in the North and Barents Sea, and once from *Raja fullonica* (see above). It appears that species of *Calicotyle*, generally, are not strictly restricted to a single host species.

Nybelin (1941) established three subgenera for the species of *Calicotyle*, *i.e.* *Calicotyle* for *C. kroyeri*, *C. mitsukurii* and *C. australis*; *Calicotylides* for *C. affinis* and *C. stossichi*; and *Gymnocalicotyle* from *C. inermis*. With the exception of the last subgenus, which differs from all the others in the lack of hamuli, differences between the other two subgenera appear to be minor (shape of body and caeca, length of penis-tube and vaginae) and not sufficient for distinguishing subgenera.

The genera *Hydrolagus* and *Chimaera* belong to the family Chimaeridae, and the genera *Harriotta* and *Rhinochimaera* to the family Rhinochi-

maeridae (see Paxton *et al.*, 1989). At least nine species of the first family have been recorded from Australian waters, but the taxonomy of most has not been elucidated. Two species of the second family are known from Australian waters. Our knowledge of the geographical distribution of chimaerids and rhinochimaerids is insufficient. In particular, not many studies of the group have been made at low latitudes. However, *Harriotta raleighana* is known from the western, north and eastern Atlantic, the north Pacific, the south Pacific, (New Zealand and Australian waters), while *Rhinochimaera pacifica* occurs in the Pacific (Japan, New Zealand, Peru), as well as in the north and southeastern Atlantic. It is likely that the parasites of these hosts (and other chimaeriform fishes) are widespread and that parasites in the northern and southern hemisphere may belong to the same species, showing geographical variation. The detailed studies of geographical variation of some Monogenea from the mackerel *Scomber* spp. by Rohde (1987, 1991) and Rohde & Watson (1985a,b) have shown that such variation is common at least in the Monogenea. Hence, although our specimens of *Calicotyle* spp. distinctly differ from *C. affinis*, it cannot be excluded that further studies in geographical regions between the northern Atlantic and the southern oceans will find forms intermediate between *C. affinis* and both *C. australiensis* and *C. sp.* In that case, the species from *Chimaera* sp. II and/or *Rhinochimaera pacifica* would be synonyms of *C. affinis*, perhaps with the status of subspecies.

Geographical variation is more difficult to quantify in plathyhelminths lacking hard sclerites. In *Rugogaster*, it can be documented by counting the number of rugae. Geographical variation appears to exist in this character. Differences are too insignificant to justify establishment of a new species for the Australian specimens. Gibson (1987) did not illustrate a ventral sucker in *Rugogaster*, but such a sucker was clearly visible in most of our specimens. It is clearly separated from the most anterior rugae.

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