

# *Austromermis* n. gen. and *Blepharomermis* n. gen. (Mermithidae : Nematoda) from New Zealand Simuliidae and Blepharoceridae (Diptera)

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## SUMMARY

Two new genera of Mermithidae are described from New Zealand aquatic Diptera. *Austromermis namis* n. gen., n. sp. is described from *Austrosimulium m. multicornis* Tonnoir (Simuliidae) from the South Island. The genus *Austromermis* n. gen. is characterized by wide wave-like amphids and fused spicules. *Blepharomermis craigi* n. gen., n. sp. is described from *Neocurupira hudsoni* (Lamb) (Blepharoceridae) from the South Island. The genus *Blepharomermis* n. gen. is characterized by circular amphids with small openings and the absence of a scar or appendage on the postparasitic juveniles. The backfly host of *Austromermis namis* does occasionally bite man, however not as severely as *Austrosimulium unguatum* in the South Island. If the latter species was also susceptible to the mermithid, then *A. namis* n. sp. could possibly be used as a biological control agent against this painful human pest.

## RÉSUMÉ

*Austromermis* n. gen. *Blepharomermis* n. gen. (Mermithidae : Nematoda) provenant de simulies et *Blépharocérides* (Diptères) de Nouvelle-Zélande

Deux nouveaux genres de Mermithidae sont décrits chez des Diptères aquatiques de Nouvelle-Zélande. *Austromermis namis* n. gen., n. sp. provient d'*Austrosimulium m. multicornis* Tonnoir (Simuliidae) de l'Île du Sud. Le genre *Austromermis* n. gen. est caractérisé par des amphides ondulées et la fusion des spicules. *Blepharomermis craigi* n. gen., n. sp. provient de *Neocurupira hudsoni* (Lamb) (Blepharoceridae), de l'Île du Sud également. Le genre *Blepharomermis* n. gen. est caractérisé par les amphides circulaires à petite ouverture et l'absence d'incisure ou d'appendice chez les juvéniles post-parasitaires. La simulie hôte d'*Austromermis namis* n. sp. pique occasionnellement l'homme; elle est toutefois moins agressive dans l'Île du Sud qu'*Austrosimulium unguatum*. Si cette dernière espèce s'avérait hôte du Mermithide, celui-ci pourrait éventuellement être utilisé comme agent de lutte biologique contre cet insecte dont les agressions sont douloureuses pour l'homme.

While sampling for larval stages of aquatic Diptera in the South Island, New Zealand, the author collected mermithid parasites from representatives of the Simuliidae and Blepharoceridae. Both species of nematode parasites could not be placed in existing genera and are described here as new taxa. This study reports the first mermithids described from New Zealand, the first mermithid parasite of a member of the simuliid genus *Austrosimulium* Tonnoir and the first described mermithid found in a member of the Blepharoceridae.

Mermithid infected larvae and pupae of *Neocurupira hudsoni* Lamb and *Peritheates turrifer* Lamb (Blepharoceridae) were collected from Bealey Chasm in Arthur's Pass in the South Island, New Zealand on January 19, 1989.

The infected insects were held in the laboratory until the nematodes emerged. The postparasites were transferred to separate containers with a layer of sand in the bottom and held at 10-15 °C. After molting, the adult nematodes were heat killed (60 °C), fixed in TAF and processed to glycerin.

## Materials and methods

Mermithid infected larvae and pupae of *Austrosimulium m. multicornis* Tonnoir (Simuliidae) were collected on January 3, 7, 15 and 19, 1989 from Cave Stream in Craigieburn Forest in the South Island, New Zealand.

## *Austromermis* n. gen. (Mermithidae Braun)

### DIAGNOSIS

Small nematodes; postparasitic juvenile and adult cuticles lacking cross-fibres under light microscope; six cephalic papillae arranged in one plane; mouth papillae

absent; six hypodermal cords at midbody; amphidial openings large, wider than long, located posterior to the ring of cephalic papillae; vagina elongate, S-shaped; spicules fused; length of spicules less than two times male body width at cloacal opening; post-parasitic juveniles with a short, thick tail appendage.

#### TYPE SPECIES

*A. namis* n. sp.

***Austromermis namis*\* n. sp.**  
(Figs 1 A-D, F-K; 3 C, D)

#### MEASUREMENTS

*Female* (n = 8) : L = 11.9 (9.4-15.0) mm; greatest width 185 (164-214)  $\mu\text{m}$ ; distance from head to nerve ring = 222 (199-254)  $\mu\text{m}$ ; length of vagina = 203 (179-227)  $\mu\text{m}$ ; V = 51 (47-54); length of amphidial pouch = 7.9 (4.2-10.6)  $\mu\text{m}$ ; width of amphidial pouch = 12.7 (8.5-15.9)  $\mu\text{m}$ ; eggs spherical, 69 (64-72)  $\mu\text{m}$  in diameter.

*Male* (n = 10) : L = 7.7 (4.5-11.2) mm; greatest width = 116 (95-139)  $\mu\text{m}$ ; distance from head to nerve ring = 207 (165-254)  $\mu\text{m}$ ; spicules = 84 (59-112)  $\mu\text{m}$ ; width of spicule shaft = 10 (8-11)  $\mu\text{m}$ ; fusion of spicules = 17 (10-37)  $\mu\text{m}$ ; tail length = 132 (98-155)  $\mu\text{m}$ ; cloaca diameter = 88 (69-101)  $\mu\text{m}$ ; length of amphidial pouch = 11 (9-14)  $\mu\text{m}$ ; width of amphidial pouch = 22 (17-28)  $\mu\text{m}$ .

#### DESCRIPTION

*Adults* : Small, slender; postparasites light pinkish (females) or white (males) in color; cuticle smooth; mouth opening shifted slightly to ventral side of head; six cephalic papillae arranged in a single circle, located in lateral, subventral and subdorsal positions; anterior portion of hypodermis usually forms a cushion or crown at the tip of the head; mouth opening passes through this protrusion; amphids large, anterior border of amphidial pouch contains four projections separated by depressions (these projections may be less conspicuous or modified in some specimens); sexual dimorphism expressed with larger amphids in males than females; amphids located in lateral or slight dorsal-lateral position; six muscle fields and six hypodermal cords present at midbody; lateral hypodermal cords broad with two centrally located rows of cells. Vagina S-shaped, second bend forming attachment with uterus at right angles to vaginal canal; posterior vulva lip swollen in most specimens; eggs spherical; proximal portion of spicules paired but distal portion fused for a varying degree

(from 13-45 %); proximal portion of shaft often slightly expanded; tips acutely rounded, roughened; fused portion of spicules indicated by a lateral elliptical fusion area; genital papillae in three single rows, middle row may show some doubling in region of cloacal opening; body cavity contains circular coelomic cells; tail tip of female bluntly rounded, that of male slightly less rounded; postparasitic juveniles with short tail appendage.

*Postparasitic juvenile* (n = 20) : Cephalic papillae and amphids not conspicuous; tail tip with a short appendage approximately 9-16  $\mu\text{m}$  long; final molt consists of a thick outer (3rd stage) cuticle and very thin, fine inner (4th stage) cuticle; these cuticles lack cross fibers.

#### TYPE HOST

*Austrosimulium multicornis multicornis* Tonnoir (Simuliidae : Diptera).

#### TYPE LOCALITY

Cave Stream in Craigieburn Forest (elevation 770 m) on the road to Arthur's Pass, South Island, New Zealand.

#### TYPE SPECIMENS

Holotype (male) and allotype (female) deposited at the National Museum, Wellington, N.Z. Paratypes deposited in the Division of Nematology, University of California, Davis, California.

#### DIAGNOSIS AND RELATIONSHIPS

Small mermithids with both adult and postparasitic juvenile cuticles lacking cross-fibers. There are six cephalic papillae, six hypodermal cords and large amphidial openings. The vagina is elongate S-shaped and the spicules are short and fused. The structure of the spicules and amphids, together with six hypodermal cords and an S-shaped vagina separate the new genus *Austromermis* n. gen. from previously described genera in the family Mermithidae.

Since fusion of the spicules in *A. namis* is always less than 50 %, it might appear that the species was derived from a separate spiculed form. The genus *Strelkovimermis* Rubtsov as redefined by Poinar and Camino (1986) includes forms which possess paired short spicules, an S-shaped vagina, six hypodermal cords and cuticle lacking cross fibers. One species, *S. spiculatus* Poinar & Camino also shows the rare condition of spicular fusion at the tips. However, members of the genus *Strelkovimermis* possess small to medium sized amphids, whereas *Austromermis* n. gen. has uniquely shaped large amphids. Also members of *Strelkovimermis* have been recorded only from midges (Chironomidae) and mosquitoes (Culicidae).

\* From *namu*, the Maori name for simuliid.

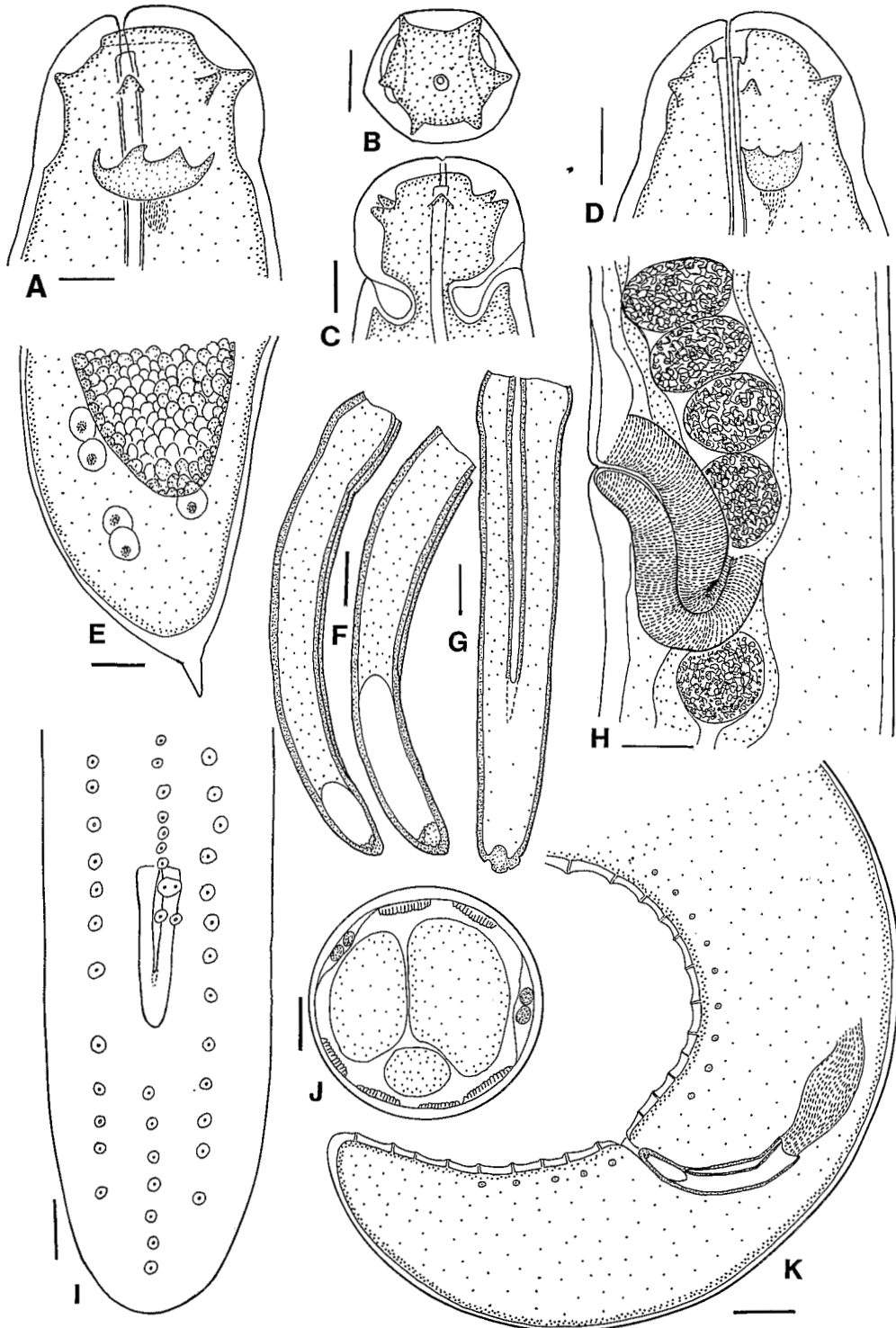


Fig. 1. *Austromermis namis* n. gen., n. sp. A : Lateral view of male head; B : "En face" view of male; C : Dorsal view of male head; D : Lateral view of female head; E : Lateral view of postparasitic juvenile tail; F : Lateral view of spicules showing variation in amount of fusion (enclosed area at tip); G : Ventral view of spicules showing fused region; H : Lateral view of vulvar area; I : Ventral view of male tail; J : Cross section of male at mid-body; K : Lateral view of male tail. (Bars equivalent : A = 10  $\mu$ m; B = 30  $\mu$ m; C = 10  $\mu$ m; D = 20  $\mu$ m; E = 30  $\mu$ m; F = 10  $\mu$ m; G = 10  $\mu$ m; H = 50  $\mu$ m; I = 30  $\mu$ m; J = 30  $\mu$ m; K = 30  $\mu$ m).

If *Austromermis* n. gen. was to be considered as derived from a single spiculed form (less probability than the former supposition because of the greater portion of the spicules being separated), then it would resemble representatives of the genus *Limnomermis*. However no *Limnomermis* species shows any indication of separate or fused spicules, nor do any species have amphids similar to those found in *Austromermis* n. gen. (Rubtsov, 1974). The mosquito parasite, *Hydromermis churchillensis* Welch, 1960 represents the first reported case in the family Mermithidae where the spicules are fused (in this case for more than half of their length). However, *H. churchillensis*, a mosquito parasite, possesses eight hypodermal cords and small amphids.

#### BIOLOGICAL OBSERVATIONS

*Austrosimulium m. multicornis* occurs throughout the northern two-thirds of the South Island and in at least one locality in the North Island (Dumbleton, 1972). The recorded upper altitudinal limit is 1200 m on Mt. Balloon. The collection site at Craigieburn Forest (770 m) is a new locality for this subspecies.

The host's habitat, Cave stream, is a fast flowing, shallow, small stream which passes through a forest of southern beech, *Nothofagus solandri* var. *cliffortioides*. In November, small infective stage mermithids (presumed to be *A. namis*) were found in the malpighian tubules of young larvae of *A. m. multicornis*. This suggests that a "per os" infection route may be occurring with the insect larvae catching the infective stages in their mouth brushes and passing them into their alimentary canal. By mid-January, the mermithids had completed their parasitic development and were ready to emerge. At that time, water temperature varied from 10-12 °C and air temperature from 12-16 °C.

The larvae and pupae of *A. m. multicornis* were typically found on stones, both angular and rounded. During warm periods, algal growths on the rock surfaces would appear but these were normally avoided by the larvae. Gut contents of the larvae revealed that they were ingesting microscopic algae (including desmids) and fungi.

Mermithid infected larvae of *A. m. multicornis* could be recognized in the stream by their white abdomens (sometimes confused with the white expanded malpighian tubules in individuals ready to pupate) and the infection rate in mid-January varied from 3-30 % depending on the location of the population sampled. Although some mature parasitic mermithids were found in quite small simuliid larvae in mid-January, there is probably only a single parasitic generation per year.

The postparasitic juvenile female mermithids were slightly pinkish at the time of emergence from the host but became white during the final molt. The smaller postparasitic juvenile males were white to transparent at the time of emergence. A reduction in the size of the fat

body, adult histoblasts and malpighian tubules was noted in infected host.

The nematodes molted approximately 23 days after emergence from host larvae when held at 15 °C. Mating occurred immediately after molting and eggs were deposited approximately 20 days later. The eggs were laid in a packet of 20-30 enclosed in a frothy sticky mass that would probably be attached to the rock surface in the stream.

While collecting larvae of *A. m. multicornis*, the author was bitten by adults of *A. unguatum* Tonnoir. However, no larvae of the latter species were collected from the stream.

#### *Blepharomermis* n.g.

##### DIAGNOSIS

Medium sized nematodes; postparasitic juvenile and adult cuticles lacking cross-fibers under the light microscope; six cephalic papillae arranged in one plane; mouth papillae absent; six hypodermal cords at mid-body; amphidial openings small, located posterior to the ring of cephalic papillae; vagina short, S-shaped; spicules paired, separate, length less than three times male body width at cloacal opening; post-parasitic juveniles lacking tail appendage or scar.

##### TYPE SPECIES

*B. craigi* n. sp.

*Blepharomermis craigi*\* n. sp.  
(Figs 2 A-I)

##### MEASUREMENTS

*Females* (n = 4) : L = 28.4 (24.1-31.1) mm; greatest width = 253 (220-284) µm; distance from head to nerve ring = 345 (302-391) µm; length of vagina = 232 (160-304) µm; vulva = 55 (50-57); length of amphidial pouch = 17 (16-21) µm; width of amphidial pouch = 16 (14-19) µm; diameter of amphidial opening = 2.4 (1.7-4.2) µm.

*Males* (n = 10) : L = 19 (11-26) µm; greatest width = 191 (158-246) µm; distance from head to nerve ring = 319 (284-359) µm; spicules = 278 (216-352) µm; width of spicule shaft = 16 (14-18) µm; length of tail = 208 (190-238) µm; cloaca diameter = 162 (130-187) µm; length of amphidial pouch = 18 (15-20) µm; width of amphidial pouch = 16 (14-18) µm; diameter of amphidial opening = 3.3 (1.6-5.3) µm.

\* In honor of D. A. Craig who first reported the occurrence of mermithids in New Zealand Blepharoceridae (Craig, 1963).

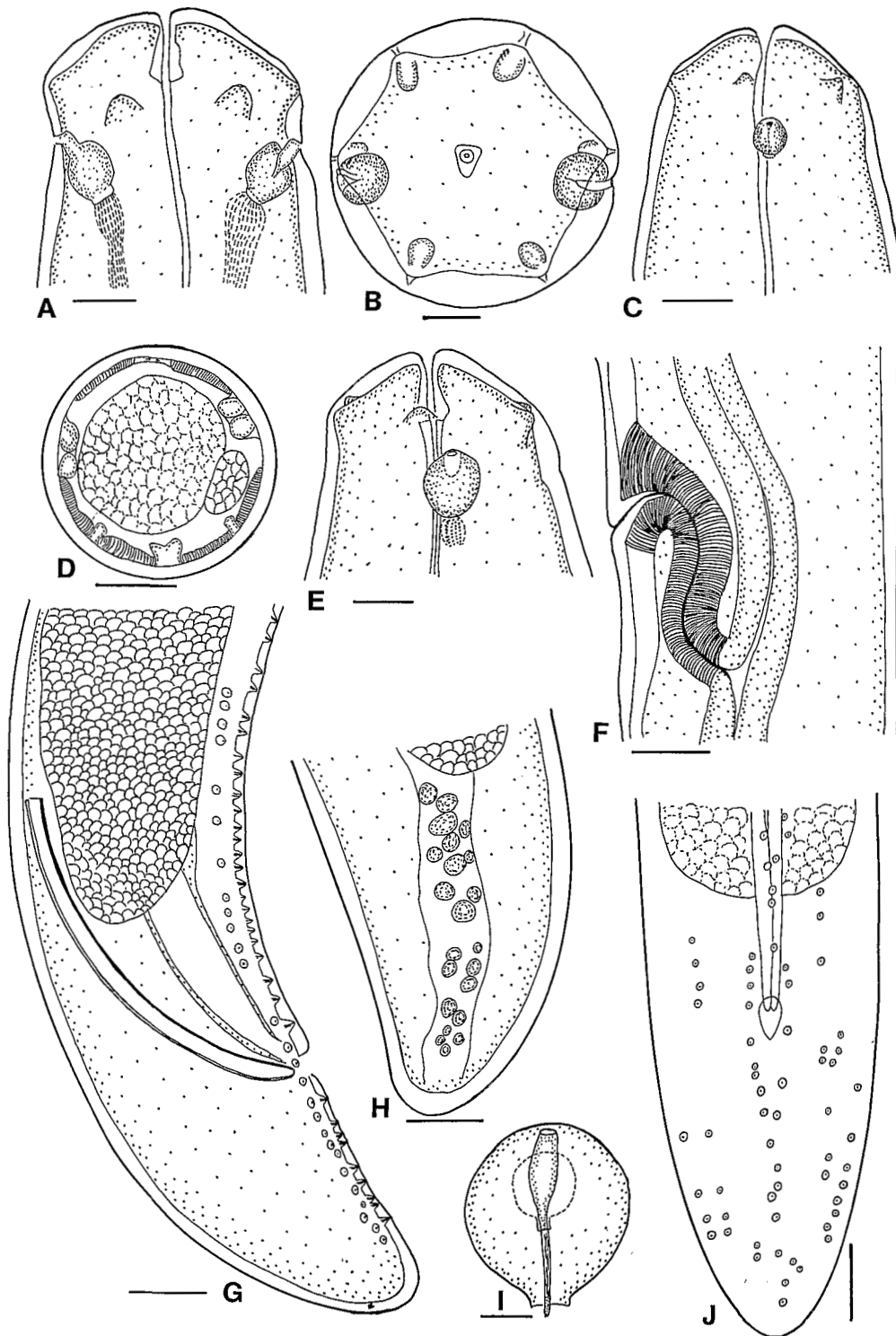


Fig. 2. *Blepharomermis craigi* n. gen., n. sp. A : Dorsal view of male head; B : "En face" view of male; C : Lateral view of female head; D : Cross section of male at mid-body; E : Lateral view of male head; F : Lateral view of vulvar area; G : Lateral view of male tail; H : Lateral view of tail of postparasitic juvenile female; I : Lateral view of male amphid; J : Ventral view of male tail. (Bars equivalent : A = 20  $\mu$ m; B = 20  $\mu$ m; C = 30  $\mu$ m; D = 60  $\mu$ m; E = 20  $\mu$ m; F = 60  $\mu$ m; G = 60  $\mu$ m; H = 60  $\mu$ m; I = 5  $\mu$ m; J = 60  $\mu$ m).

## DESCRIPTION

*Adults* : Medium sized, robust forms; postparasites are yellowish in color; cuticle smooth, mouth opening terminal or occasionally subterminal; six cephalic papillae arranged in a single circle, located in lateral, subventral and subdorsal positions; anterior portion of pharyngeal tube in mouth region thickened, set off from remainder of tube; amphids located in lateral position; amphidial openings small, circular; amphidial vesicles circular or nearly so; amphidial structure and size similar in both sexes although proportionally larger in the males; six muscle fields and six hypodermal cords present at midbody; lateral hypodermal cords widest with two rows of cells; ventral cord prominent with two rows of cells; vagina relatively short, S-shaped; spicules paired, separate for their entire length, uniformly wide throughout their length, tips acutely rounded; genital papillae scattered over ventral portion of tail in three vague disarrayed rows; tail tips of adults and postparasitic juveniles rounded; postparasitic juveniles without any tail appendage or scar.

*Postparasitic juveniles* (n = 40) : Cephalic papillae and amphids not conspicuous; tail tip lacking an appendage or scar; cuticle lacking cross fibers.

## TYPE HOST

*Neocurupira hudsoni* Lamb (Blepharoceridae : Diptera).

## TYPE LOCALITY

Bealey chasm (elevation 900 m) Arthur's Pass, South Island, New Zealand.

## TYPE SPECIMENS

Holotype (male) and allotype (female) deposited at the National Museum, Wellington, N.Z. Paratypes deposited in the Division of Nematology, University of California, Davis, California.

## DIAGNOSIS AND RELATIONSHIPS

*Blepharomermis* n. gen. can be distinguished from existing mermithid genera by the following combination of characters; six head papillae, S-shaped vagina, six hypodermal cords, two short parallel separate spicules (less than three times body width at cloaca) absence of cross fibers in the adult and postparasitic juvenile cuticles and the absence of a scar or tail appendage on the postparasitic juvenile.

The new genus shares several characters with the genus *Strelkovimermis* as redefined by Poinar and Camino (1986), however the circular structure of the amphidial pouches with their minute openings, the lack

of sexual dimorphism regarding these structures, and the absence of a tail appendage in the postparasitic juveniles separates *Blepharomermis* from the latter genus.

## BIOLOGICAL OBSERVATIONS

Mermithids emerged from late stage larvae and pupae of infected blepharocerids collected from the stream. The infection rate on January 19th was approximately 25 % (n = 200). However this rate could be due to a prolongation of the developmental period in infected individuals. On rocks containing hundreds of pupae of *Neocurupira hudsoni*, it was noted that approximately 75 % of the pupae were empty (adults had emerged) and of those remaining, almost all (90 %) were parasitized. In his original report, Craig (1963) mentioned finding nematodes in adults as well as pupae of *N. campbelli* (Dumbleton) and *Peritheates turriifer* (Lamb). Later, Craig (1966) extended the host range to *N. hudsoni* and *N. tonnoiri* Dumbleton. Although he never collected nematodes from the larval stage, Craig (1966) mentioned that parasitized *N. campbelli* males exhibited the female number of twelve antennal segments and parasitized females, while showing no apparent external morphological effects, fail to develop eggs.

At the time of collecting, the water temperature was 8.5 °C and the air temperature 15.5 °C. The nematodes that emerged from infected larvae and pupae were held at 10 °C in the laboratory. Molting was initiated 33 days later.

## Discussion

The genus *Austrosimulium* occurs in Australia, New Zealand and South America. It is the only genus of Simuliidae represented in New Zealand and all of the species are considered endemic (Dumbleton, 1972).

The bite of the females of some New Zealand *Austrosimulium* species can be quite painful and Captain James Cook entered the following into his journal for May 11, 1773 at Dusky Sound : " The most mischievous animal here is the small black sand fly which are exceeding numerous and are so troublesome that they exceed anything of the kind I ever met with, wherever they bite they cause a swelling and such an intolerable itching that it is not possible to refrain from scratching and at last ends in ulcers like the small pox " (Beaglehole, 1961). The present author can confirm the above description based on his own personal experience. In regards Cook's description, even today, the common name for Simuliidae in New Zealand is sand fly rather than black fly. In other parts of the world, sand flies normally refer to biting members (Phlebotominae) of the dipterous family Psychodidae.

This first report of a mermithid parasite of *Austrosimulium* is also interesting from the practical standpoint

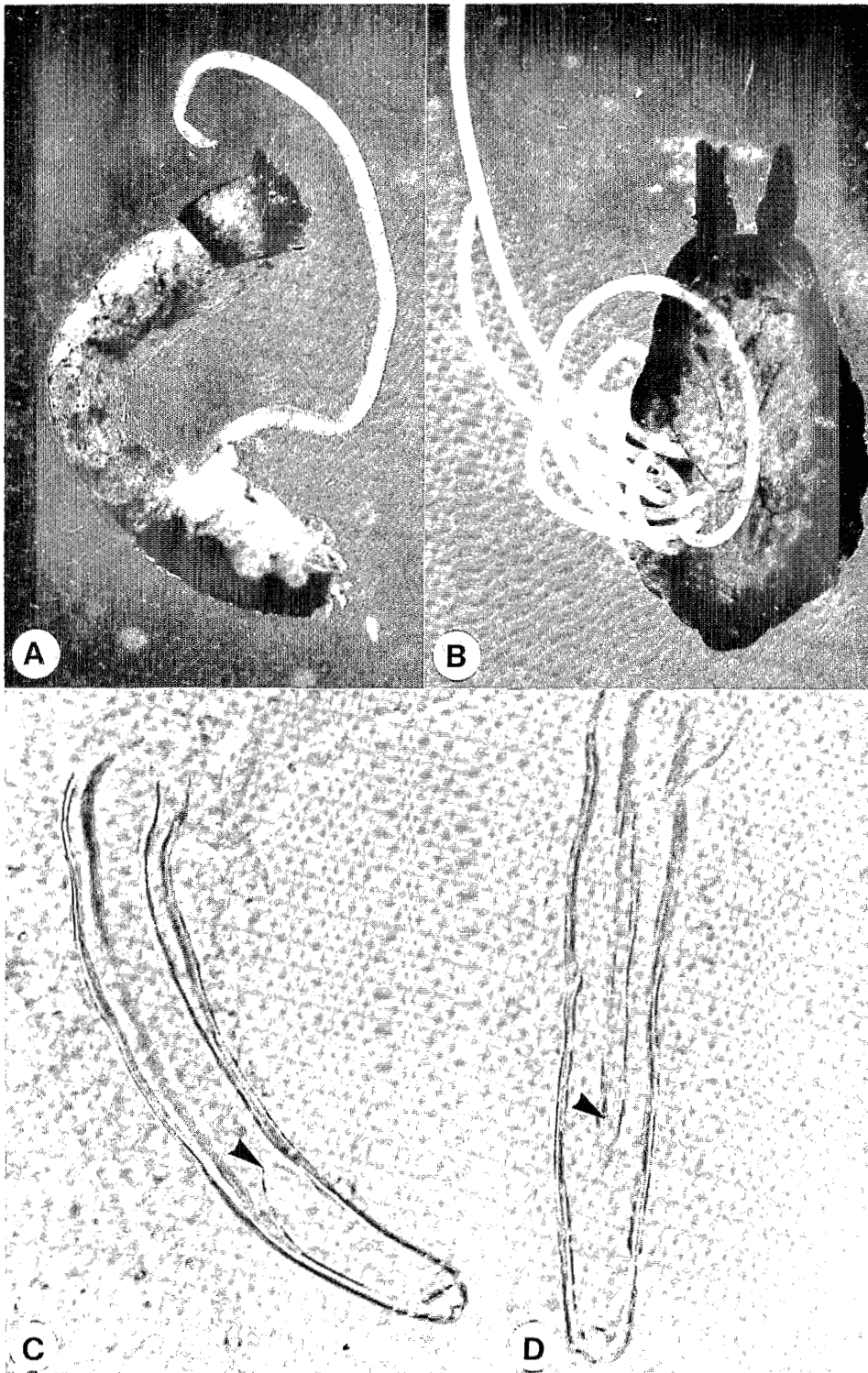


Fig. 3. A : Postparasitic juvenile of *Austromermis namis* emerging from *Austrosimulium m. multicornis*; B : Postparasitic juveniles of *Blepharomermis craigi* emerging from a blepharocerid pupa; C : Lateral view of fused spicules of *A. namis* (arrow shows point of fusion); D : Ventral view of spicules shown in 3A (arrow shows point of fusion).



of biological control. *Simulium unguatum* Tonnoir is the main human biter in South Island, New Zealand, however *S. m. multicornis* will also occasionally bite humans (T. Crosby, pers. comm.). It is not known whether *Austromermis* n. gen. also attacks *S. unguatum* in nature but this could be determined in the laboratory. If successful, introductions of *A. namis* n. sp. could be made into the breeding habitats of *S. unguatum* in attempts to biologically control this human pest.

Blepharocerids do not bite man. The larvae feed on algae and other organic deposits growing on rocks in swift flowing streams and the adults are predaceous on other insects (in some species). Members of the genus *Neocurupira* Lamb have been divided into three subgenera, two of which occur only in New Zealand and a third which occurs in Australia. The type host of *Blepharomermis* n. gen., *N. hudsoni* Lamb, is confined to the South Island of New Zealand, although it has a wider distribution there than the remaining *Neocurupira* species and is the largest species (Dumbleton, 1963). In the Arthur's Pass area of the South Island, blepharocerids are probably more abundant than in many places of the world. If a mermithid parasite of this family did exist, it would not be surprising to find it in this locality. *Blepharomermis* n. gen. could well be a remnant population of parasites which due to habitat damage and host extinction, was eliminated from blepharocerid populations throughout much of the world.

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#### REFERENCES

- BEAGLEHOLE, J. C. (1961). *The Journal of Captain James Cook. II. The Voyage of the Resolution and Adventure, 1772-1775.* London, Cambridge University Press., 1021 p.
- CRAIG, D. A. (1963). The occurrence of nematodes in the family Blepharoceridae (Diptera). *N. Z. Entomologist*, 3 : 25.
- CRAIG, D. A. (1966). *The biology of some New Zealand Blepharoceridae (Diptera : Nematocera).* Ph. D. Thesis, Univ. Canterbury, Christchurch, N. Z., 230 p.
- DUMBLETON, L. J. (1963). New Zealand Blepharoceridae (Diptera : Nematocera). *N. Z. J. Sci.*, 6 : 234-258.
- DUMBLETON, L. J. (1972). The genus *Austrosimulium* Tonnoir (Diptera : Simuliidae) with particular reference to the New Zealand fauna. *N. Z. J. Sci.*, 15 : 480-584.
- POINAR, JR. G. O. & CAMINO, N. B. (1986). *Strelkovimermis spiculatus* n. sp. (Mermithidae : Nematoda) parasitizing *Aedes albifasciatus* Mac. (Culicidae : Diptera) in Argentina. *J. Nematol.*, 18 : 317-319.
- RUBTSOV, I. A. (1974). [*Aquatic Mermithidae of the fauna of the USSR. Vol. 2*], Leningrad, U.S.S.R., Nauka Pub., 222 p.
- WELCH, H. E. (1960). *Hydromermis churchillensis* n. sp. (Nematoda : Mermithidae) a parasite of *Aedes communis* (De G.) from Churchill, Manitoba, with observations of its incidence and bionomics. *Can. J. Zool.*, 38 : 465-474.