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Protrellus dalei n. sp., *Blatticola barryi* n. sp., and *Suifunema mackenziei* n. sp., thelastomatid nematodes from New Zealand cockroaches

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Abstract Three new species of thelastomatid nematodes from the hind guts of New Zealand cockroaches are described. They are *Protrellus dalei* n. sp. from *Celatoblatta vulgaris* Johns, 1966, *C. peninsularis* Johns, 1966, and *C. brunni* (Afken, 1901) Johns, 1966; *Blatticola barryi* n. sp. from *C. quinquemaculata* Johns, 1966; and *Suifunema mackenziei* n. sp. from *C. undulivita* (Walker, 1868) Johns, 1966. This is the first record of *Suifunema* in New Zealand. The diagnoses of the genera *Blatticola* and *Suifunema* are emended to accommodate the new species. Keys to species of *Protrellus* and *Blatticola* are given and the larval development of *P. dalei* is discussed. Aspects of the biology and distribution of the new species are noted.

Keywords *Protrellus; Blatticola; Suifunema;* Thelastomatidae; new species; nematodes; parasites; cockroaches; hosts

INTRODUCTION

Thelastomatids (Nematoda: Thelastomatidae) live in the alimentary canals of a variety of detritivorous, coprophagous, and saprohagous arthropods. Most of the nearly 200 nominal species are from cockroaches. Of these, only four are from New Zealand. *Blatticola tuapakae* Dale, 1966 and *Protrellus gurri* (Dale, 1966) Zervos, 1987 occur in *Platyzosteria novaeseelandia* Brunner, 1856 (but not together); *Blatticola monandros* Zervos, 1983 occurs in *Parellipsidion pachycercum* Johns, 1966; and *Protrellus dixoni* Zervos, 1987 occurs in the introduced Australian cockroach *Drymaplaneta variegata* (Shelford, 1909). Recently, three undescribed species of thelastomatid were found in several species of native cockroach from numerous collection sites. These thelastomatids are described here and belong in *Protrellus, Blatticola,* and *Suifunema.* The diagnoses of the genera *Blatticola* and *Suifunema* are emended to accommodate the new species, and keys to species of *Protrellus* and *Blatticola* are given.

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MATERIAL AND METHODS

Cockroaches were collected during 1981–1984 from habitats at the locations indicated after appropriate descriptions. They were killed by crushing the nerve cord behind the head; individuals were then dissected in cockroach saline. Some drawings and observations were made of live nematodes in saline in wax-sealed preparations (Doncaster 1962). Most nematodes were eventually heat-killed, fixed in TAF (Courtney et al. 1955), processed using Seinhorst's (1959) glycerol/ethanol method, and mounted in anhydrous glycerine. Measurements of fixed specimens are given in μm in Tables 1–3 and in the text. Adult nematodes are described from adult hosts only. Some differential comparisons of the new species are based on my own calculations of dimensions from figures or tables accompanying descriptions of existing species.

SYSTEMATICS

Subfamily PROTRELLOIDINAE Chitwood, 1932

Genus PROTRELLUS Cobb, 1920

Synonym *Protrellina* Chitwood, 1932

Emended diagnosis. Thelastomatidae; body diameter fairly uniform but tapering anteriorly and posteriorly; cuticle annulated.

FEMALES: cuticular annuli often wide anterior to vulva, then flattening out to disappear posterior to oesophageal region. Mouth opening circular or triangular; 8 papillae or labiopapillae; pair of small lateral amphids. Oesophagus tripartite, distinct anterior corpus with more or less swollen base separated from posterior valvular bulb by less distinct isthmus. Nerve ring around oesophageal corpus. Intestine expanded anteriorly; glands between

Table 1 Dimensions (μm) of the type specimens of *Protrellus dalei* (ranges in parentheses, — = no measurement).

	Holotype female	Allotype male	Paratype females (n = 12)	Paratype males (n = 12)
Length	4400	1148	4166 ± 135 (2980–4900)	1007 ± 27 (840–1148)
Width (maximum)	250	56	213 ± 14 (130–310)	49 ± 2 (40–68)
Width at bulb	180	40	177 ± 8 (110–220)	38 ± 1 (30–52)
Width at anus	60	24	77 ± 4 (60–100)	22 ± 1 (16–30)
Length of oesophagus	440	180	414 ± 5 (360–440)	155 ± 3 (124–180)
Length of corpus	340	—	309 ± 5 (260–340)	—
Length of isthmus	24	—	25 ± 1 (20–32)	—
Length of bulb	76	36	79 ± 2 (68–90)	31 ± 2 (20–56)
Width of bulb	80	—	75 ± 2 (64–88)	
Head to nerve ring	190	110	169 ± 4 (140–188)	85 ± 9 (84–120)
Head to excretory pore	290	200	244 ± 6 (220–290)	188 ± 5 (168–220)
Length intestinal/rectal gland junction to anus	200	—	163 ± 7 (120–200)	—
Head to anterior extremity of anterior ovary	770	—	734 ± 43 (500–1200)	—
Tail to posterior extremity of posterior ovary	1200	—	996 ± 59 (780–1560)	—
Head to vulva	300	—	273 ± 5 (260–320)	—
Tail to anus	100	60	106 ± 3 (90–128)	71 ± 2 (56–110)
Length tail to posterior-most papillae	—	42	—	42 ± 2 (36–50)
Head to anterior extremity of testis	—	570	—	498 ± 24 (360–750)
Length of spicule	—	24	—	26 ± 6 (20–28)
Egg	98 ! 45			

intestine and rectum sometimes distinct. Excretory pore anterior to vulva. Vulva anterior to base of oesophagus. Monodelphic or didelphic. Ovijector sometimes present. Eggs oval or ellipsoidal, colourless, yellow, yellow green or yellow brown, often bearing a polar or lateral cuticular crest or boss, or with a lateral groove. Tail short, conical, or acutely pointed, or short cone with long filiform projection. MALES: much smaller than females. Excretory pore at or posterior to base of oesophagus. Testis single, reflexed or outstretched. Tail variable in shape but never plainly filiform; 2–4 pairs of tail papillae; one spicule.

Females, males, and juveniles found in hind gut of cockroaches.

Geographical distribution. New South Wales, Australia; New Zealand; North Carolina, Maryland, U.S.A.; Island of Madagascar; Brazil; Aligarh, India.

Type species. *Protrellus aureus* Cobb, 1920.

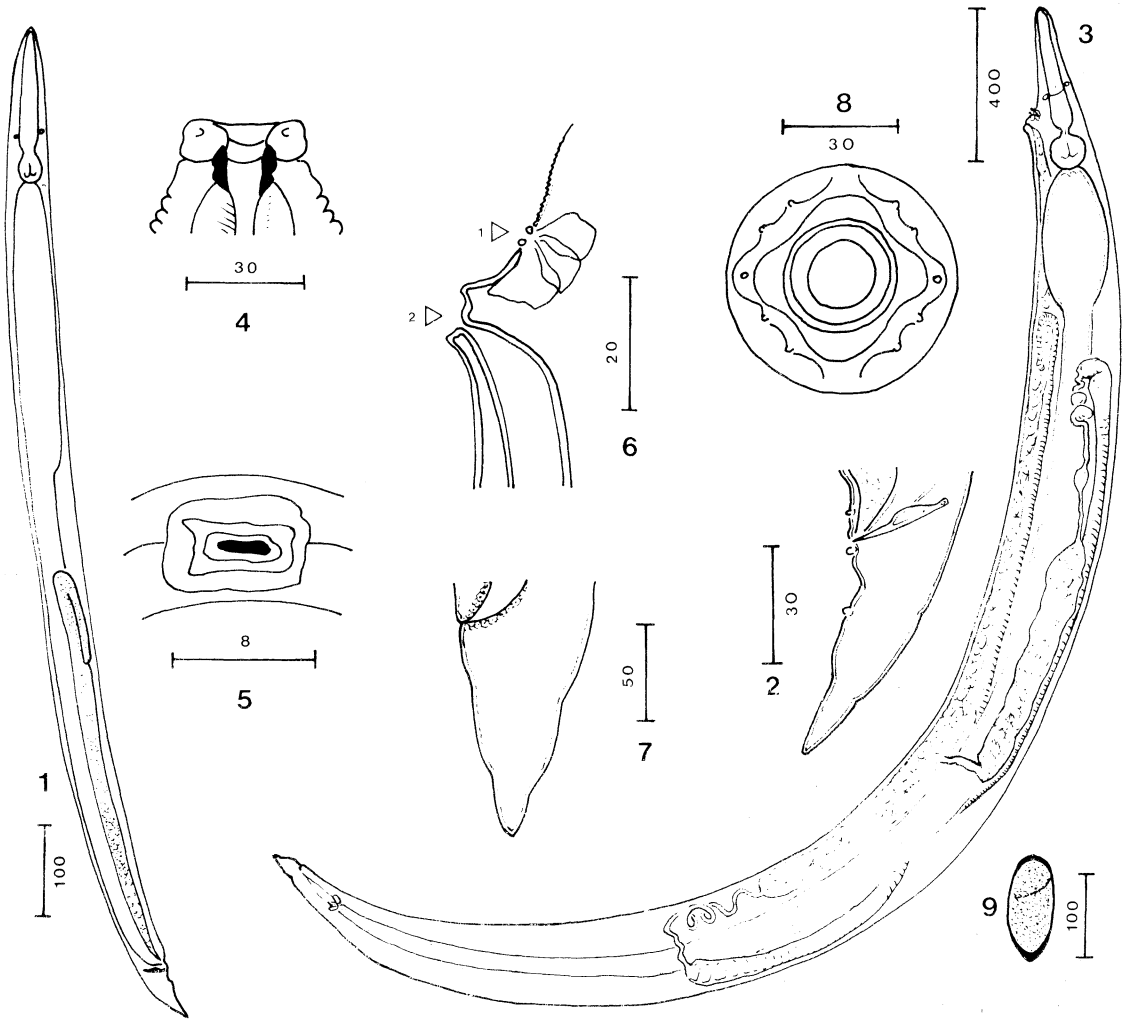

Fig. 1–9 *Protrellus dalei* from *Celatoblatta vulgaris, C. peninsularis* and *C. brunni.* **1–2, male:** (1) entire; (2) tail. **3–8, female:** (3) entire; (4) head; (5) excretory pore lip; (6) excretory sinus, excretory pore (arrow 1), vulva (arrow 2), lateral view; (7) tail; (8) *en face.* **9** egg. (Scale lines in μm)

Protrellus dalei n. sp.

(Fig. 1–9, Table 1).

Description. FEMALES (Fig. 3–8) Cuticle strongly annulated only anterior to vulva; first annule 12 μm, subsequent annules 6 μm wide. Lip region offset (Fig. 4). Head with circular oral opening surrounded by circular lip, then 8 very small papillae and 2 small, oval amphidial apertures (Fig. 8). Buccal capsule small, distinctly sclerotised, width 6–8. Oesophageal corpus sub-parallel sided, slightly expanded posteriad; isthmus distinct from corpus but merging with bulb; bulb valve plates indistinctly sculptured. Nerve ring just over half way along corpus. Intestine broadest slightly behind oesophagus, decreasing in diameter at level of anterior extremity of anterior ovary, then subparallel sided to rectum. Rectal glands distinct at junction of intestine and rectum. Excretory ampulla or sinus leads to excretory pore just anterior to vulva (Fig. 6); pore surrounded by broad, flat, circular lip (Fig. 5). Vulva in anterior tenth of body, just anterior to corpus-isthmus junction, leading to thin-walled vagina then poorly developed muscular ovijector in region of anterior extremity of ovary. Repro-

ductive system amphidelphic. Anterior and posterior branches of uterus join to form anteriorly directed common uterus near middle of body; this common uterus with ovijector. Posterior branch arising from an oviduct coiled several times in posterior quarter of body; this arising from an anterior ovary reflexed in region of narrowing of intestine to pass posteriad for a short distance. Anterior branch arising from a coiled oviduct which arises in turn from an ovary reflexed in region of narrowing of intestine, this ovary originating posteriorly, near junction of uteri. Eggs (Fig. 9) oval; slightly broader at one end, shell thickened slightly at both ends, more so at pointed end; surface punctate; with operculum; colourless. Tail very short, conical, formed of 2 or 3 indistinct convex conoids of diminishing size, cuticle of tail tip not thickened.

MALES (Fig. 1–2). Cuticle not distinctly annulated. Lip slightly offset; amphidial apertures and labial papillae not seen. Oesophageal regions barely distinguishable. Nerve ring just anterior to corpus-isthmus junction. Intestine subparallel sided, constricted somewhat near middle in live specimens. Excretory pore just posterior to oesophagus (not seen in all specimens). Glands between intestine and cloaca conspicuous in live specimens. Testis extends anteriad, then reflected posteriad posterior to mid body point. Spicule small, rounded proximally, broadest at the middle, tapering to a point distally; without capitulum. No gubernaculum. Three pairs of latero-ventral papillae; 1 pair preanal, 2 pairs post-anal. Tail a tapering cone with ventral constriction.

JUVENILES IN EGGS. Embryos in eggs developed into active juveniles with bodies longer than the egg shell; such juveniles were reflected. Juveniles then shrank to about ⅔ the length of the shell. They remained in this state thereafter.

JUVENILE FEMALES. L2 (n=15). Length (L)= 226 +/−5 (Range (R) = 215–312); maximum width (W. max.)= 23 +/−2 (R= 21–25). Cuticle not distinctly annulated. Lips indistinct. Oesophagus (L= 100 +/−9, R= 87–112) as in adult female but extending 44% of body length. Oesophageal bulb valvate, with indistinctly sculptured plates. Intestine as in adults. Excretory pore not evident. Tail short, conical.

L3 (n= 11). L= 520 +/−15 (R= 440–590); W.max.= 43+/−5 (R= 39–59). Cuticle distinctly annulated. Lips distinct, offset. Oesophagus (L= 160+/−11; R= 149–168) as in adult female but extending 33% of body length. Intestine broad anterior to distinct intestinal constriction, then subparallel sided to rectum. Excretory pore and small excretory sinus evident just anterior to oesophageal bulb. Nerve ring distinct, encircles corpus. Tail (L= 40 +/−5; R= 38–45) short, conical.

L4 (n= 6). L= 1570 +/−98 (R= 970–2014); W. max.= 98 +/−14 (R= 84–113). Cuticle distinctly annulated; lips distinctly offset. Oesophagus (L= 370 +/−47; R= 250–393) as in adult female but extending 24% of body length. Intestine as in L3. Excretory pore and well developed sinus at level of isthmus; developing vulva just posterior to this. Developing reproductive system evident. Tail (L= 90 +/−10; R= 78–111) conical.

JUVENILE MALES. Juvenile males were rare, but could be distinguished from juvenile females and adult males by their small size, by their possession of a spicule and adult-like tail, but absence of gonad.

Type data. Holotype female and 19 **paratypes** (9 ♀♀, 10 ♂♂) in New Zealand National Nematode Collection, Entomology Division, Department of Scientific and Industrial Research, Auckland (holotype female, NZNNC holotype no. 125; paratypes NZNNC 22118–22137).

Type host: *Celatoblatta vulgaris* Johns, 1966, Site in host: anterior end of colon of hind gut. Other hosts: *C. peninsularis, C. brunni.*

Type locality: Castle Hill, Canterbury, South Island, New Zealand (43°13′20″S,171°42′40″E); elevation 500 m; 9/10/1983. Other localities: Mount White, Craigieburn, Maruia Springs, Reefton, Cass, Klondyke Corner, Charming Creek, Kaituna Valley (South Island, New Zealand); Tuku Valley (Chatham Island Group, New Zealand).

Etymology. The species is named for the New Zealand nematologist and entomologist, Mr Pat Dale.

Differential diagnosis of *Protrellus dalei*

FEMALES: *P. dalei* are unique in possessing a suite of characters that include: anterior annules (excluding the first) of almost uniform width (as have others except *P. galebi* Schwenck, 1926, *P. aureus* Cobb, 1920, *P. dixoni* Zervos, 1987, and *P. manni* (Chitwood, 1932) Chitwood, 1933, which have broad and narrow anterior annules); a distinct oesophageal isthmus (merging in others); a lipped excretory pore (as have *P. dixoni, P. rasolofi* Van Waerebeke, 1969 and *P. behorefi* Van Waerebeke, 1969, but not others); a posterior ovary reflexed anterior to the rectum (as have others except *P. rasolofi* and *P. aurifluus* (Chitwood, 1932) Chitwood, 1933 and *P. australasiae* (Pessoa & Correa, 1926) Travassos, 1929, which have a posterior ovary reflexed in the region of the rectum); a short tail composed of diminishing convex conoids (as has *P. behorefi* but not others, in which the tail is plainly conical, or subulate — *P. ituana* (Kloss, 1966) Zervos, 1987 — or with constrictions (*P. manni*, or filiform projections — *P. gurri, P. dixoni* and *P. rasolofi*); an ovijector (as have *P. dixoni, P.*

ituana, P. eurycotesi (Kloss, 1961) Zervos, 1987, *P. galebi* and *P. ischnopterae* (Kloss, 1966) Zervos 1987, but not others); this ovijector not well developed and apparently lacking a sphincter (ovijector muscular, with sphincter in *P. dixoni*, sphincter not noted in others).

P. dalei eggs are quite large (137 × 51), but not as large (150 × 85) as those of *P. kunckeli* (Galeb, 1878), Travassos, 1929 and are colourless, plainly oval, and without the bumps, grooves, or crests of others.

MALES: comparison of *Protrellus* species males is hindered because for half of the species, males are unknown. Of those known, *P. dalei* have greatest body length, the longest tail, and 3 pairs of tail papillae (as have others except *P. dixoni* and *P. gurri,* which have 4 pairs).

LARVAL *P. DALEI*: Although larval females increase in overall length and width with each successive stage, the ratio of oesophageal length to total body length decreases. Total female body length (from L2 to adult) increases 17 fold while oesophageal length increases only 4 fold. Such allometric growth is common amongst nematodes (for example, see Yeates 1973).

The confused taxonomic history of the genus *Protrellus* was clarified in Zervos 1987. As a key to the species in the genus *Protrellus* has not appeared since 1956 (Basir 1956), and as over half the known species in the genus have been described since then, a new key is provided.

KEY TO SPECIES IN THE GENUS *PROTRELLUS*

1. Female tail conical, with long filiform projection 2
   Female tail short, no filiform projection 4
2. Female: excretory pore without lip; posterior ovary reflexed anterior to rectum, about one third of a body length from posterior end; egg ovoid with crest; male: tail shorter than spicule .....*P. gurri* (Dale, 1966) Zervos, 1987
   Female: excretory pore with lip; posterior ovary reflexed at or posterior to rectum; egg ovoid without crest; male: tail longer than spicule 3
3. Female: 2964–4758 long; cuticular annulations broad and narrow anterior to vulva; excretory pore with thin circular or oval lip; mouth circular; muscular ovijector; egg 98 × 45; male: 4 pairs of tail papillae ....*P. dixoni* Zervos, 1987
   Female: 5600–7660 long; cuticular annulations more or less uniform anterior to vulva; excretory pore covered by flap; mouth subtriangular; no ovijector; egg 65–73 × 38–45; males: 3 pairs of tail papillae .....*P. rasolofi* Van Waerebeke 1969
4. Egg with crest or bosses 5
   Egg without crest or bosses 10
5. Female oesophagus >600; vulva in region of oesophageal bulb; egg 130–180 × 70–100; male: > 800; spicule 50 .....*P. kunckeli* (Galeb, 1878) Travassos, 1929
   Female: oesophagus <510; vulva anterior to oesophageal bulb; egg <100 × 50; male (where known: <300), spicule <20 6
6. Female: 8585–10370; excretory pore not evident; vulva not salient; with ovijector .....*P. eurycotesi* (Kloss, 1961) Zervos, 1987
   Female: <4500; excretory pore evident or not; vulva salient; with or without ovijector 7
7. Female: 3400–5200; tail plainly conical 8
   Female: <2750; tail with small appendix or pronounced constriction 9
8. Female: 4120 long; tail 54; vulva about half way along oesophageal corpus; excretory pore not evident; posterior ovary reflexed twice anterior to rectum; egg crest reduced .....*P. ischnopterae* (Kloss, 1966) Zervos, 1987
   Female: 3400–5200 long; tail 100–290; vulva near base of oesophageal corpus; excretory pore evident; posterior ovary reflexed once in region of rectum; egg crest prominent .*P. aurifluus* (Chitwood, 1932) Chitwood, 1933
9. Female: 2620 long; tail with medial constriction; excretory pore evident; oesophageal corpus bent before union with isthmus; vulva near posterior end of corpus; two ovaries; lateral crest of egg with cuticular bosses .... *P. manni* (Chitwood, 1932) Chitwood, 1933
   Female: 2700–2750 long; tail with short appendix excretory pore not evident; oesophageal corpus linear; vulva about half way along corpus; one ovary; lateral crest of egg without bosses ... *P. australasiae* (Pessoa & Correa, 1926) Travassos, 1929
10. Female: length of head to vulva >270; eggs >100 long, without lateral groove 11
    Female: length head to vulva <230; eggs <85 long, with or without lateral groove 12
11. Female: 6000 long; 100 wide; cuticular annulations up to 20 wide; without ovijector; tail (188) acutely pointed; mouth opening triangular; excretory pore without lip; male: 610 long; spicule linear and acute *P. aureus* Cobb, 1920
    Female: 2980–4900 long, 130–310 wide; cuticular annulations 6–12 wide; with ovijector; tail (90–128) conical composed of diminishing conoids; mouth opening circular; excretory pore with lip; male: 840–1148; spicule round proxi-

Table 2 Dimensions (μm) of the type specimens of *Blatticola barryi* (ranges in parentheses, — = no measurement).

	Holotype female	Allotype male	Paratype females (n = 11)	Paratype males (n = 3)
Length	3180	1112	2995±10 (2430–3480)	1030,1080,1100
Width (maximum)	320	92	316±13 (230–360)	73,80,84
Width at bulb	168	56	167±17 (110–210)	52,60,70
Width at anus	72	24	78±2 (70–81)	30,30,30
Length of oesophagus	388	193	385±9 (360–450)	192,194,200
Length of corpus	272	124	267±7 (230–330)	124,124,130
Length of isthmus	32	36	35±2 (20–40)	30,32,36
Length of bulb	84	36	82±3 (70–100)	40,40,44
Width of bulb	88	—	94±3 (80—100)	—
Head to nerve ring	252	116	231±6 (200–260)	96,100,120
Head to excretory pore	84	—	77±5 (72–84)	—
Length intestinal/rectal gland junction to anus	144	—	120±6 (100–144)	—
Head to anterior extremity of anterior ovary	1000	—	1068±40 (940–1190)	—
Tail to posterior extremity of posterior ovary	—	—	428±26 (330–480)	—
Head to vulva	2572	—	2381±15 (1760–2920)	—
Tail to anus	72	44	78±2 (70–80)	40,48,60
Length tail to posterior-most papillae	—	28	—	20,30,40
Head to anterior extremity of testis	—	524	—	510,600,610
Length of spicule	—	20	—	20,20,20
Egg	175 × 66			

mally, wide medially, pointed distally, linear but not acute ..... *P. dalei*

12. Female: 5500–7800 long; cuticular annulations anterior to vulva broad, salient; egg with lateral groove ..... *P. galebi* Schwenck, 1926
Female: <5650 long; cuticular annulations anterior to vulva narrow, smooth; egg with or without lateral groove 13

13. Female: 2300 long; vulva 6.5% of body length from anterior end; nerve ring 5.6% of body length from anterior end; tail plainly conical, egg with 2 lateral grooves ..... *P. phyllodromi* Basir, 1942
Female: 3440–5650 long; vulva 3.2–5.5% of body length from anterior end; nerve ring 2.2–4.3% of body length from anterior end; tail subulate or composed of diminishing convex conoids; egg without lateral grooves 14

14. Female: 5029–5147 long; posterior uterus reflexed about one sixth of a body length from

posterior end; tail subulate; excretory pore without lip; egg oval
.....*P. ituana* (Kloss, 1966) Zervos, 1987
Female 3440–5650 long; posterior uterus reflexed about one third of a body length from anterior end; tail not subulate, composed of diminishing convex conoids; excretory pore with lip; egg cresentrically ovoid
..... *P. behorefi* Van Waerebeke, 1969

Subfamily THELASTOMINAE Travassos, 1920
Genus BLATTICOLA Schwenck, 1926

Emended diagnosis. Thelastomatidae; body of fairly uniform diameter but tapering anteriorly and posteriorly. FEMALES: mouth opening circular or subtriangular; surrounded by 8 sub-median papillae or labiopapillae and pair of small lateral amphids. Oesophagus tripartite, consisting of anterior subcylindrical corpus followed by an isthmus (often short) and posterior valvular bulb. Nerve ring around corpus. Intestine wide anteriad, then parallel or subparallel sided to rectum or wide posteriad. Rectal glands between rectum and anus sometimes distinct. Excretory pore in anterior third of body. Vulva in posterior quarter of body. Reproductive system monodelphic and prodelphic. Uterus may lead to well developed muscular vagina which forms an ovijector. Eggs oval or ellipsoidal, colourless, surface often punctate. Tail short, conical. MALES: much smaller than females. Oesophagus tripartite. Nerve ring around oesophageal corpus or isthmus. Intestine sub-parallel sided to cloaca. Excretory pore posterior to base of oesophagus. Testis single, reflexed or outstretched. Tail conical, with or without constrictions, 3–4 pairs of tail papillae. Spicule single, without capitulum. No gubernaculum.

Females, males, and juveniles found in hind gut of cockroaches.

Geographical distribution: The type species *Oxyuris blattae* Graeffe, 1860 = *Blatticola blattae* (Graeffe, 1860) Chitwood, 1932 is probably as widespread as its cosmopolitan host, *Blattella germanica* Linn. Other species of *Blatticola* occur in Andhra Pradesh, India; Karachi, Pakistan; Banks Peninsula and Tararua Ranges, New Zealand.

Blatticola barryi n. sp.
(Fig. 10–14, Table 2).

Description. FEMALES (Fig. 10–12). Cuticle annules only evident anterior to oesophageal isthmus annules 3–4 μm wide. Lip region slightly offset. Amphidial apertures not seen. Buccal capsule small (width = 8–12 μm), indistinctly sclerotised. Oesophagus tripartite, anterior corpus sub-parallel sided, expanded slightly posteriad; isthmus distinct, expanded anteriad; posterior bulb with sculptured plates. Nerve ring in region of posterior swelling of corpus or just anterior to it. Intestine broadest slightly behind oesophagus, decreasing in width in region of excretory pore, then sub parallel sided to rectum. Rectal glands at junction of intestine and rectum distinct. Excretory pore near anterior extremity of ovary, not seen in all specimens. Vulva within 20% of a body length from posterior end, leading to very muscular vagina which forms an ovijector. Ovary originates in anterior third of body, passes posteriad for a short distance, reflexed to pass anteriad, then reflexed again in region of narrowing of intestine to pass posteriad beneath intestine. Ovary leads to a reflexed oviduct between anus and vulva, oviduct leads to anteriorly directed uterus. Uterus single, reflexed in region of anterior flexure of ovary, passes posteriad to join vagina. Eggs asymetrically ovoid; slightly broader at one end, surface punctate, shell of uniform thickness throughout, operculum not seen. Tail very short, conical, formed of 2 indistinct convex conoids of diminishing size, cuticle of tail tip variously thickened to form pattern of internal body wall in optical section.

MALE (Fig. 13–14). Cuticle indistinctly annulated anterior to oesophageal isthmus, smooth posteriad. Lips slightly offset. Amphidial apertures and labial papillae, not seen. Oesophagus tripartite, corpus cylindrical, isthmus long, distinct from corpus but merging with bulb, bulb valve plates indistinctly sculptured. Nerve ring about ⅔ along corpus from anterior end. Intestine sub-parallel sided to cloaca. Excretory pore not seen. Testis extends anteriad, then reflexed posteriad at about mid body point to originate in posterior third of body. Spicule small, unornamented, linear, tapering to a point proximally and distally, broadest at middle, without capitulum. No gubernaculum. Tail tapering cone, with 2 shallow constrictions. Three pairs of ventrolateral papillae; 1 pair pre-anal, 2 pairs post-anal.

Type data. Holotype female (12 ♀♀, 4 ♂♂) and 16 **paratypes** in the New Zealand National Nematode Collection, Entomology Division, Department of Scientific and Industrial Research, Auckland (holotype female, NZNNC holotype no. 126; paratypes NZNNC 22138–22154).

Type host: *Celatoblatta quinquemaculata* Johns, 1966. Site in host: anterior end of colon of hind gut.

Type locality: Rock and Pillar Ranges, central

Otago, South Island, New Zealand (45°25′0″S, 170°5′0″E); elevation 1000 m; 21/3/1981.

Etymology. The species is named for the New Zealand neurophysiologist Dr Barry O'Brien, who collected the hosts.

TAXONOMY AND DIFFERENTIAL DIAGNOSIS

Some characteristics used in differential diagnosis are from redescriptions or dimensions given by authors (Ahmed & Jabin 1966; Bozeman 1942; Chitwood 1930; Groschaft 1956) other than those who initially described the species.

FEMALES: *B. barryi* females have a suite of characters that distinguish them from other species of *Blatticola* that include: an intestine subparallel sided to rectum (as have others except *B. opisthoplatia* Ahmed & Jabin, 1966 and *B. blattae*, which have an expanded posterior intestine); distinct rectal glands (as have others except *B. supellaimae* Rao & Rao, 1956 and *B. tuapakae*); thickened, patterned tail cuticle (as has *B. monandros,* but not others); vulva more than 16% of body length from the anus (as has *B. opisthoplatia* but not others, in which the vulva is less than 13% of a body length from the anus); a doubly reflexed ovary (as have *B. blattae* and *B. tuapakae* but not others, which have a singly reflexed ovary); and a linear tail (as have others except *B. tuapakae*, which has a subulate tail, and *B. opisthoplatia* in which the tail is bluntly then sharply conical).

MALES: *B. barryi* males have a suite of characters that distinguish them from other species of *Blatticola* that include: cuticular annuli only obvious anteriad (as have others except *B. opisthoplatia* and *B. supellaimae*, which have annules over the entire body); a nerve ring near the posterior end of the oesophageal corpus (anterior or posterior to this in others); a cylindrical corpus (as have *B. opisthoplatia* and *B. blattae* but not others, which have a corpus of uneven width); a reflexed testis (as have others except *B. opisthoplatia* and *B. blattae*, which have an outstretched testis); 3 pairs of tail papillae (as have *B. tuapakae* and *B. monandros*, but not others, which have 4 pairs); and a tapering conoid tail with 2 constrictions (as have *B. monandros*, but not others). *B. barryi* males are the longest in the genus.

The confused taxonomic history of the genus *Blatticola* and of the type species *B. blattae* was clarified by Dale 1966. The emended diagnosis of the genus given earlier was modified to accommodate *B. barryi* and species described since Chitwood's (1932) revision of the thelastomatids. As no key exists from species in this genus, one is given here.

KEY TO SPECIES IN THE GENUS *BLATTICOLA*

1. Female: intestine tapering posteriorly; male: reflexed testis; nerve ring around corpus 2
   Female: posterior intestine broader than medial intestine; male: outstretched testis; nerve ring around isthmus 5
2. Female: distance vulva to anus about 5% of body length; ovary singly reflexed; male: 4 pairs tail papillae; cuticle annulated throughout; tail conical, with sharp linear point; nerve ring around first half of corpus; corpus broadest medially ..... *B. supellaimae* Rao & Rao, 1965
   Female: distance vulva to anus 7–17% of body length; ovary singly or doubly reflexed; male: 3 pairs of tail papillae; cuticle annulated only anteriad; tail without sharply linear point; nerve ring around second half of corpus; corpus not broadest medially 3
3. Female: 1440–2740; ovary singly reflexed; egg with operculum; male: corpus flask shaped; spicule <15. ..... *B. monandros* Zervos, 1983
   Female: 2430–4470; ovary doubly reflexed; egg with or without operculum; male: corpus cylindrical or broadest anteriad; spicule 17–22 4
4. Female: tail <3% of body length; distinct rectal glands; distance vulva to anus about 17% of body length; egg with operculum; male: tail tapering cone with 2 shallow constrictions; corpus cylindrical ..... *B. barryi*
   Female: tail >7% of body length; rectal glands apparently absent; distance vulva to anus about 7% of body length; egg without operculum; male: tail convex conoid then elongate, tending subulate near tip; corpus broadest anteriad ..... *B. tuapakae* Dale, 1966
5. Female: nerve ring about two thirds along corpus from anterior end; ovary not doubly reflexed; tail about 4% of body length; egg 259 × 75; male: spicule 34–50; tail about 35 ..... *B. opisthoplatia* Ahmed & Jabin, 1966
   Female: tail about 8% of body length; nerve ring near base of corpus; ovary doubly reflexed; egg 120 × 40; male: spicule about 20; tail about 62–80 .... *B. blattae* (Graeffe, 1860) Chitwood, 1932

Subfamily THELASTOMINAE Travassos, 1920

Genus SUIFUNEMA Chitwood, 1932

Emended diagnosis. Thelastomatidae; body of fairly uniform diameter but tapering anteriorly and posteriorly. FEMALE: mouth opening prismoidal, lips offset, 8 submedian labiopapillae; amphids

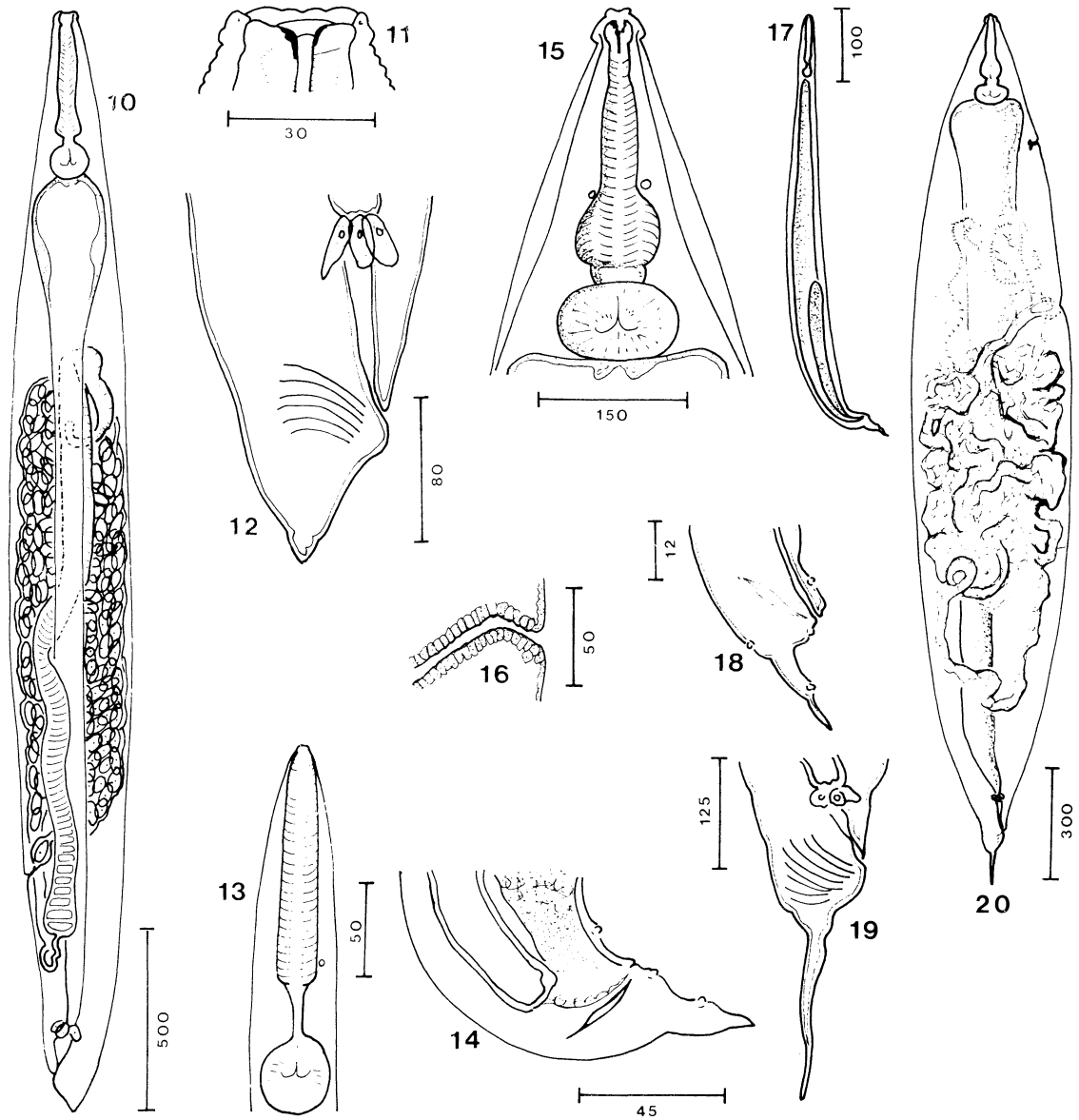

Fig. 10–20 *Blatticola barryi* from *Celatoblatta quinquemaculata* and *Suifunema mackenziei* from *Celatoblatta undulivitta*. **10–14, *B. barryi*: 10–12, female:** (10) entire; (11) head, lateral view; (12) tail. **13–14, male:** (13) anterior end; (14) tail. **15–20, *S. mackenziei*:** (15) female, anterior end; (16) female, vulva, vagina; (17) male, entire; (18) male, tail; (19) female, tail; (20) female, entire. (Scale lines in μm)

present. Oesophagus tripartite, consisting of a simple cylindrical or posteriorly swollen distinct anterior corpus, an isthmus set off from corpus and distinctly or not distinctly set off from posterior valvular bulb. Nerve ring encircles corpus or isthmus. Intestine sub-parallel sided to rectum. Rectal glands sometimes distinct at junction of intestine and rectum. Excretory pore between base of oesophagus and anterior extremity of ovary. Vulva anteriad, approximately 25–40% of body length from anterior end, leading to muscular ovijector. Reproductive system didelphic, both ovaries originate in anterior part of body. Eggs oval, or ovoid with one side flattened, with operculum. Tail short,

Table 3 Dimensions (μm) of the type specimens of *Suifunema mackenziei* (ranges in parentheses, — = no measurement).

	Holotype female	Allotype male	Paratype females (n = 6)	Paratype males (n = 2)
Length	3772	604	2720±17 (2200–3772)	520,560
Width (maximum)	468	44	378±5 (260–560)	36,44
Width at bulb	248	20	208±15 (160–250)	20,24
Width at anus	108	16	85±7 (72–108)	12,20
Length of oesophagus	376	80	335±8 (320–376)	68,84
Length of corpus	264	—	232±7 (220–270)	—
Length of isthmus	28	—	20±2 (20–30)	—
Length of bulb	84	—	80±4 (70–90)	14,16
Width of bulb	120	—	105±3 (100–120)	—
Head to nerve ring	140	—	—	—
Head to excretory pore	580	—	460±34 (400–580)	—
Length intestinal/rectal gland junction to anus	140	—	—	—
Head to anterior extremity of anterior ovary	656	—	513±34 (400–640)	—
Head to vulva	1240	—	865±13 (780–1240)	—
Tail to anus	288	24	268±8 (250–290)	28,28
Length tail to posterior-most papillae	—	16	—	16,18
Head to anterior extremity of testis	—	320	—	360,368
Length of spicule	—	18	—	18
Egg	80 × 28			

bluntly rounded or slightly conical, bearing a filiform projection. MALES: much smaller than females. Body broadest about three quarters of a body length from anterior end. Oesophagus indistinct. Testis single, outstretched. Tail round, with short filiform projection, 4 pairs of tail papillae (3 pairs ventro-lateral, 1 pair dorso-lateral). Single spicule. Males, females, and juveniles in the anterior hind gut (colon) of cockroaches.

Geographical distribution. China, Turkey, New Zealand.

Type species. *Suifunema caudelli* Chitwood, 1932.

Suifunema mackenziei n. sp.

(Fig. 15–20; Table 3).

Description. FEMALE (Fig. 15–16, 19–20). Cuticle annulated, first annule 20 μm wide, subsequent annules about 4 μm wide; annules flatten out and become indistinguishable in posterior quarter of body. Lip region offset (Fig. 15); amphids small. Buccal capsule small (width 7–8), distinctly sclerotised. Oesophagus tripartite, corpus expanded posteriorly into a pseudobulb almost the width of the bulb; isthmus distinct from corpus and bulb,

expanded slightly at anterior end or in the middle; bulb broader than long, plates distinctly sculptured. Nerve ring about half way along corpus. Rectal glands distinct between intestine and rectum. Vulva about one third of a body length from anterior end. Vagina muscular, forming an ovijector (Fig. 16). Reproductive system didelphic. Ovaries originate in anterior third of body; in some females, one ovary originates posteriad, passes anteriad, then reflexed posteriad; the other originates anteriad, passes posteriad, is reflexed anteriad, then reflexed again to pass posteriad; in other (possibly older) females, both ovaries much coiled and reflexed just posterior to oesophagus. Ovaries both pass to much coiled uteri packed with numerous eggs; uteri unite to form a common uterus which leads to the ovijector. Eggs oval, flattened on one side, slightly broader at one end, surface punctate. Tail (Fig. 19) very short, bluntly rounded, with a short, filiform projection.

MALE (Fig. 17–18). Cuticle minutely annulated, annules more obvious posteriad. Lips minute, offset. Amphidial apertures and labial papillae not seen. Oesophageal regions indistinct. Nerve ring and excretory pore, not seen. Intestine parallel sided. Spicule very small, parallel sided except tapering to a point proximally and distally, without capitulum. No gubernaculum. Tail (Fig. 18) round, with short, filiform projection. Four pairs of tail papillae; 3 pairs ventro-lateral (1 pair pre-anal, 2 pairs post-anal), 1 pair dorso-lateral.

Type data. Holotype female 10 **paratypes** (5 ♀♀, 5 ♂♂) in New Zealand National Nematode Collection, Entomology Division, Department of Scientific and Industrial Research, Auckland (holotype female, NZNNC holotype no. 127; paratypes, NZNNC 22155–22165.

Type host: *Celatoblatta undulivitta* (Walker, 1868) Johns, 1966. Site in host: anterior end of colon of hind gut.

Type locality: Lower Hutt, North Island, New Zealand (41°12′0″S, 174°58′0″E); elevation 100 m; 27/5/1982.

Etymology. The species is named for the New Zealand nematologist, Ms. Jan McKenzie.

TAXONOMY AND DIFFERENTIAL DIAGNOSIS

Only one species has been described in the genus *Suifunema* so far. *S. caudelli* Chitwood, 1932 occurs in the cockroach *Stelopyga sinensis* Walker in China (Chitwood 1932) and Turkey (Mimioglu & Sahin 1976). This is the first record of a *Suifunema* in a New Zealand host. *S. mackenziei* females posses a suite of characters that distinguish them from *S. caudelli* females. These include: dimensions larger overall; a corpus pseudobulb (no pseudobulb in *S. caudelli*); a nerve ring around the corpus (around isthmus in *S. caudelli*); longer, narrower eggs which lack a conspicuous opercular cap (cap present in *S. caudelli*); a longer tail with longer filiform projection; and prominent rectal glands (not described in *S. caudelli*). Comparison of males can not be made because *S. caudelli* males are unknown. The emended diagnosis of the genus given earlier was modified to accommodate the new species and include a description of the male.

GENERAL REMARKS

All nematodes described here were found in the anterior part of the colon of the hind gut. The much smaller male lay anterior to the female or near her anterior end. The majority of females lay outstretched with the head directed anteriorly; in only a few cases were females reflexed so that the tail was also directed anteriorly. In all but one case, there was no visible evidence of damage to the host. Thus these thelastomatids are probably benign, as are other thelastomatids (Poinar 1975).

PARASITE DISTRIBUTIONS

Protrellus dalei, like its type host *Celatoblatta vulgaris,* is widespread. This nematode is also found in *C. peninsularis,* which is restricted to Banks Peninsula, Canterbury, and *C. brunni,* which is restricted to the Chatham Island Group. *C. vulgaris* is unknown on Banks Peninsula or the Chatham Islands (Johns 1966), but as the three cockroach species host the same parasite species, it is likely that they were once sympatric. *C. vulgaris, C. brunni* and *C. peninsularis* are certainly very closely related species (P. M. Johns, Department of Zoology, University of Canterbury, New Zealand, pers. comm.). The only other cockroach on Banks Peninsula is *Parellipsidion pachycercum,* which, although sympatric with *C. peninsularis,* never contains *P. dalei.* Instead, it contains a thelastomatid (*Blatticola monandros*) which is apparently specific to it (Zervos 1983). *C. brunni* is the only cockroach species on the Chatham Islands. Comment cannot be made on the relationships of the other nematodes described in this paper because of lack of data, but further work may show taxonomic and/or ecological relationships within the host-parasite groups.

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