THE GENUS *MICROTETRAMERES* TRAVASSOS (NEMATODA, SPIRURIDA) IN AUSTRALIAN BIRDS

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ABSTRACT

MAWSON, PATRICIA M. The genus *Microtetrameres* Travassos (Nematoda, Spirurida) in Australian birds. *Rec. S.A. Mus.* **71** (14): 239-259.

Australian *Microtetrameres* species were taken only from birds of the orders Accipitriformes, Cuculiformes, Strigiformes, Caprimulgiformes and Passeriformes. Considerable host specificity was noted. Fifteen new species are proposed, named after the host group or genus: *M. meliphagidae*, *M. philemon*, *M. mirafrae*, *M. gymnorhinae*, *M. streperae*, *M. cractici*, *M. coracinae*, *M. sphecotheres*, *M. eopsaltriae*, *M. aegotheles*, *M. paraccipiter*, *M. cerci*, *M. raptoris*, *M. ninoctis* and *M. tytonis*. *M. helix* Cram (syn. *M. corax* Schell) was identified from Australian corvids, and *M. oriolus* Petrov and Tschertkova from an Australian oriole. The shape and size of the hilt of the left spicule are regarded as of taxonomic value. A key is given based on male characters and a partial key based on female characters.

INTRODUCTION

No species of the genus *Microtetrameres* has ever been recorded from Australian birds. This is surprising, since in dissections made in this Department the incidence of species of this genus has been relatively high in some bird groups (Table 1). In honeyeaters, *Microtetrameres* spp. are the most common nematode parasites. In water birds (waders, gulls, grebes, cormorants, petrels) the same niche in the body is occupied by species of *Tetrameres*. Species of *Microtetrameres* have, however, been recorded from water birds in other countries—*M. canadensis* Mawson, 1956 (♂ only), *M. egretes* Rasheed, 1960, *M. pelecani* Skrjabin, 1949 (♂ only), and *M. spiralis* Seurat, 1915. In our dissections both *Microtetrameres* and *Tetrameres* have been taken from an owl and from falcons—in two cases both parasite genera were represented in the same host animal. *Microtetrameres* is a relatively homogenous genus in which the species have many characters in common. Ellis (1970) considers the female specimens as the type of a species; because of the dissimilarity in the appearance of the sexes, he allows the allocation of a male to a species only when this has been proved by breeding from the eggs of the female. In the present work, it is considered that the form of males belonging to the genus *Microtetrameres* is characteristic of the genus, and that in general the occurrence of male and female specimens in the same host specimen is evidence of conspecificity. The characters considered to be of the greatest taxonomic use are discussed below in the section "Characters of specific importance".

The division of the genus into two subgenera, as proposed by Rasheed (1960), has not been followed, because of the sporadic occurrence of a poorly developed gubernaculum in some specimens of some species in the Australian material.

Most of the *Microtetrameres* spp. recognised show a marked degree of host specificity among cuculiform and passeriform birds, and less among birds of prey. Almost all the species found in Australian birds are regarded as new. Exceptions are *M. helix* Cram from crows, and *M. oriolus* Petrov and Tschertkova from an oriole. *M. mirafrae* n.sp. from a lark and a flycatcher is very close to *M. jakutensis* Kontrimevichus from related birds in U.S.S.R., and *M. paraccipiter* n.sp. from an Australian *Accipiter* sp. is very close to *M. accipiter* Schell from an American *Accipiter* sp. It is noteworthy that *Corvus*, *Mirafra*, *Oriolus*, and *Accipiter* are regarded as relatively recent arrivals in Australia (late Pliocene or Pleistocene).

METHODS

Adult female *Microtetrameres* were taken from the proventricular glands of the host. Infected glands are readily recognisable by their dark colour, and pressure on the adjoining proventricular wall causes the worm to pop out of the gland. The female lies in the gland with the tail end nearest the opening and often protruding through it (Fig. 61). Males and very young females are usually in the mucus on the surface of the proventriculus, but in two or three cases a male has apparently come out of a gland with a female. The greatest numbers of females present in one individual host were 40 in *Tyto alba* and 30 in *Corvus mellori*. This compares poorly with 250 females from a Golden Eagle and 102 from a Great Horned Owl recorded by Schell (1953, p. 227).

1st February, 1977.

The worms were fixed in 70% alcohol. The measurements of all species described are given in Tables 2-7. In all cases the length of the whole oesophagus and of the muscular part of the oesophagus has been taken from the anterior end of the body to the posterior end of the organ in question. Measurements of the spicules have been taken along their whole length.

In giving the locality of specimens the State is abbreviated as follows: SA, South Australia; NT, Northern Territory; Qld, Queensland; NSW, New South Wales; ACT, Australian Capital Territory; Tas, Tasmania; Vic, Victoria.

Types of new species will be deposited in the South Australian Museum, and other material in the Helminthological Collection of the Zoology Department, University of Adelaide.

GENERAL DESCRIPTION OF THE AUSTRALIAN SPECIES

The head (Plate 1; Figs. 1, 2, 3 and 4) bears two lateral lips each with three swellings—a lateral one bearing the amphid, and a dorsal and a ventral with the submedian cephalic papillae. The mouth opening is more or less hexagonal. The inner circle of papillae around the mouth, described by Ali (1970), were not seen.

The buccal capsule is well-developed. In the male it is laterally compressed, in the female barrel- or urn-shaped. In both sexes the anterior part is connected by a relatively thin cuticular sleeve to a chitinised basal ring lying just above the anterior end of the oesophagus.

The oesophagus consists of an anterior narrower muscular and a longer glandular section. The nerve ring surrounds the anterior section at about $\frac{2}{3}$ to $\frac{3}{4}$ its length; the excretory pore is shortly behind this and the small cervical papillae at or behind the level of the excretory pore. The cervical papillae are seldom distinguishable in the gravid female, as the cuticle becomes inflated and folded in this region. In the female there is sometimes an apparent intestinal diverticulum, as the oesophagus joins the intestine obliquely; in one case (*M. raptoris*) two distinct diverticula are formed at this junction.

Female: The shape of the coil of the female varies to some extent among individuals, but the general form is more or less constant in one species. There are three types of coil, the spiral, the reversed spiral, and the irregular (Figs. 61, 72, 51). There is some evidence that the form is influenced by the shape of the gland which in some birds (e.g. honeyeaters) is shallow, in other (e.g. falcons and hawks), deep and narrow. It seems impossible that the form of the coil can change, or be assumed as the worm emerges from the gland, as suggested by Ellis (1969, p. 716). In fact, if the whole infested gland be dissected out and cleared, the contained worm, in its typical coil, can be seen inside (Fig. 61).

It appears that whether fertilised or not, the female enters the gland at an early stage (its body somewhat twisted and only slightly swollen). Young female worms have been found to thicken and coil before any eggs are visible (Fig. 72), so the swelling is not caused by pressure of eggs. Eggs are produced in great numbers even in unfertilised females. The shape of the female with infertile eggs is similar to that of the female with fertile eggs although on closer inspection it is seen that the unembryonated eggs are thin-shelled, often mis-shapen, and smaller than fertile eggs of the same species. Both fertile and infertile eggs may be present in one female.

The posterior end of the female is often surrounded by a prepuce formed by overgrowth of the prevulvar cuticle; this is not seen in young females.

Male: The tip of the tail ends in a small ball point. In all the Australian specimens there are two pairs of pre-anal papillae shortly in front of the cloaca, two pairs of post-anal papillae on the first half of the tail and a pair of phasmids laterally at $\frac{1}{2}$-$\frac{2}{3}$ of the tail length from the anus. In most specimens the papillae are not exactly symmetrical; in a very few, one papilla is missing or one extra is present. The odd one is always aligned longitudinally with the others, and is never medial. The position of the papillae with relation to the tail length varies within the limits noted above; this variation is, however, as great among individuals from one host as among all the specimens examined from any host. The phasmids are usually small and often hard to see. It is presumed that they are present in all specimens.

The left, and longer spicule has a relatively short cylindrical hilt proximally and ends in a small terminal ala. The tip of the spicule within the ala is usually cleft or otherwise imperfectly chitinised. The shorter right spicule is simple and acicular or rounded at the tip. There is some thickening of the dorsal wall of the cloaca in some specimens, but this appears to be a variable feature, apparent in one or two specimens

of a number of species. In one species (*M. raptoris*) it is well-developed in all the males (16), and in another it is present but only lightly chitinised in the three males available.

CHARACTERS OF SPECIFIC IMPORTANCE

Females: The form of the coil is not a specific character, as even among females from the same bird there are variations, some a simple coil, some reversed once or twice.

The length of the oesophagus and of its component parts, the position of the nerve ring, the cervical papillae (seen only in young specimens) and the excretory pore are very similar in all specimens examined. The presence or absence of an intestinal diverticulum at the point of junction with the oesophagus is cited by some authors as a specific character; however, in the gravid female its absence can only be ascertained by dissection.

Ellis (1969) considered that the size and shape of the buccal capsule and of the eggs, and the presence or absence of cuticular ridges and flanges, is sufficient to differentiate the females of the various species of *Microtetrameres*, and he gave (p. 718) a key to species from the western hemisphere based on these characters in the female. In the Australian specimens, only a single worm was seen with cuticular flanges, and this was among and in other respects similar to, unflanged females taken from the same specimen of *Corvus bennetti*. Most of the measurements of female worms are subject to error because of cuticular inflation to which the specimens are subject and because of the many curves of the intact worm. In the present work the measurements of the female considered to be most reliable are those cited by Ellis, i.e. those of the largest fertile egg and of the buccal capsule. However, these characters are not sufficiently varied throughout the genus to form the sole basis for the identification of the species. The difficulties of identification of species from females only is apparent in the key given below in which only female characters are used. As some species are represented only by females, this key is given here, although the species are by no means fully segregated.

Males: In the male as in the female the position of the nerve ring, cervical papillae and excretory pore in relation to each other and to the end of the muscular oesophagus is similar in all specimens examined. The same situation is found with the positions of pre- and post-cloacal papillae. Judging from figures given by authors, there is a marked similarity between the arrangement of the caudal papillae in all *Microtetrameres* species, except where a larger number of papillae have been described. From some descriptions it seems likely that a third pair of post-anal papillae are in fact the phasmids.

Schell (1953) suggested that the position of the constriction in the male reproductive tube between the testis and the vas deferens, might be a constant character within a species. This feature, however, is not clear in all of the Australian specimens and has not been used by other workers. Schell also used as a specific character the presence or absence of a "ball point" on the tip of the tail. Such a point is present on all the Australian males.

Another character used by Schell as a distinguishing feature, is the shape of the tip of the left spicule. However, this character must be used with discretion as the tip may appear bifurcate in one view and rounded in another. The tip in almost all the Australian specimens is more or less cleft, or is imperfectly chitinised.

In the present study, the characters of the spicules have been considered most useful in diagnosis. The length of the longer spicule in relation to the body length, the ratio of the lengths of the two spicules and the shape and proportions of the hilt (proximal end) of the left spicule, appear to be of value in separating species. The spicule ratio has been used by many authors. In the present study both the spicule ratio and the shape and size of the hilt of the left spicule were found to be similar in specimens from the same host bird, and this similarity extends to those from the same host species and often to those from related species, from the same and different localities. At the same time, the spicule ratio and the shape and size of the hilt differ, often markedly, from those of specimens from hosts belonging to a different group even from the same locality. The shape of the hilt (tapering, or slightly bulbous, etc.) as well as the actual length:width ratio has been considered. To obtain this ratio, referred to in Tables 1-7 as the Hilt Factor, the width is measured across the base of the cylindrical part of the spicule in lateral view, just anterior to the longitudinal groove, in the position indicated in Fig. 6 by line *ab*; the length is the distance from this level to the proximal end of the spicule. The chief limitation to the use of the hilt of the left spicule as a specific character is that in a few specimens it is damaged or folded over so

that the shape, or at least the measurements, are not clear. As the hilt has seldom been noted by other workers, it cannot be used to compare the Australian specimens with many of the species already described. However, through the kindness of the Beltsville Parasitological Laboratory (U.S. Department of Agriculture), and of Dr. Schell (University of Idaho), male specimens of *M. helix* Cram, *M. aquila* Schell, *M. bubo* Schell, *M. accipiter* Schell and *M. corax* Schell, have been examined, and some comparisons have been made. In particular it was noted (1) that the hilt has a different shape in each of Schell's species (Figs. 5, 55, 56 and 57) and (2) that the shape is similar in *M. helix* (Cram's specimens), *M. corax* (Schell's specimen) and specimens from Australian corvids.

The characters which have emerged as most indicative of the species among male worms are the body length, the spicule lengths, the length and breadth of the hilt of the left, or longer, spicule, and the length of the buccal capsule.

TABLE 1

Incidence of *Microtetrameres* spp. and *Tetrameres* spp. in "land" birds dissected. Numbers refer to specimens, not species.

Bird Group	Number Dissected	Number with Nematodes	Number with *Microtetrameres* sp.	Number with *Tetrameres* spp.	Number with Other spp.
Passeriformes—					
Alaudidae	2	1	1	—	1
Motacillidae	11	1	1	—	—
Campephagidae	16	11	5	—	8
Muscicapidae	50	11	6	—	10
Pachycephalidae	37	16	7	—	4
Falcunculidae	7	7	1	—	6
Meliphagidae	199	45	38	—	18
Oriolidae	6	2	2	—	—
Grallinidae	34	11	2	—	10
Cracticidae	100	51	27	—	40
Corvidae	77	69	24	—	61
Other families	385	42	—	—	42
Caprimulgiformes	21	11	1	—	11
Coraciiformes	28	14	—	1	13
Strigeiformes	25	17	8	2	12
Accipitriformes	59	38	19	2	29
Cuculiformes	21	5	4	—	2
Columbiformes	43	1	—	—	1
Psittaciformes	157	4	1	—	3
Gruiformes	56	17	—	7	12
Galliformes	7	2	—	—	2

LIST OF AUSTRALIAN SPECIES ARRANGED UNDER THEIR HOSTS

The following is a list of hosts from which *Microtetrameres* spp. have been taken. The numbers after each species indicates the number of host specimens in which *Microtetrameres* were found/the number of specimens examined. *Microtetrameres* is shown as *M.* throughout.

PASSERIFORMES

ALAUDIDAE

Mirafra javanica Horsfield. *M. mirafrae* n.sp.; 1/2, NT.

CAMPEPHAGIDAE

Coracina novaehollandiae (Gmelin). *M. coracinae* n.sp.; 1/2 SA, 0/1 Tas, 0/2 NT.

Coracina hypoleuca Gould. *M. coracinae* n.sp.; 1/1 NT.

Lalage sueuri tricolor (Swainson) *M.* sp.; 2/3 SA.

MUSCICAPIDAE

Microeca leucophaea (Latham). *M. mirafrae* n.sp.; 2/9 SA; 1/2 NT.

Eopsaltria australis (Shaw). *M. eopsaltriae* n.sp.; 2/2 SA.

FALCUNCULIDAE

Oreoica gutturalis (Vig. & Horsf.) *M.* sp.; 1/1 SA; 1/5 NT.

Ptiloris sp. *M.* sp.; 1/1.

MELIPHAGIDAE

Meliphaga virescens (Vieillot) *M. meliphagidae* n.sp.; 4/15 SA; O/5 NT.

Meliphaga leucotis (Latham) *M. meliphagidae* n.sp.; 2/10 SA.

Manorina melanocephala (Latham) *M. meliphagidae n.*sp.; 2/7 SA; 1/1 ACT.

Manorina flavigula Gould. *M. meliphagidae* n.sp.; 1/5 SA; 0/1 NT.

Entomyzon cyanotis (Latham). *M. philemon* n.sp.; 2/4 NT.

Philemon citreogularis (Gould). *M. philemon* n.sp.; 3/3 NT.

Philemon argenticeps (Gould). *M. philemon* n.sp.; 3/11 NT.

Anthochoera chrysoptera (Latham). *M. meliphagidae* n.sp.; 3/11 SA.

Anthochoera carunculata (Shaw) *M. meliphagidae* n.sp.; 5/10 SA.

Acanthocephala rufogularis Gould. *M. meliphagidae* n.sp.; 10/18 SA; 0/5 NT.

ORIOLIDAE

Oriolus sagittatus (Latham) *M. oriolus oriolus* Petrov & Tschertchova. 1/3 NT.

Sphecotheres flaviventris Gould. *M. sphecotheres* n.sp.; 1/2 NT.

GRALLINIDAE

Corcorax melanorhamphus (Vieillot) *M. helix* Cram 2/9 SA.

CRACTICIDAE

Strepera versicolor (Latham) *M. streperae* n.sp.; 1/7 SA; 0/1 NT.

Cracticus torquatus (Latham). *M. cractici* n.sp.; 1/5 SA.

Gymnorhina tibicen tibicen (Latham) *M. gymnorhinae* n.sp.; 0/4 SA; 0/2 NT, 8/16 ACT.

Gymnorhina tibicen leuconota Gould. *M. gymnorhinae* n.sp.; 9/58 SA.

CORVIDAE

Corvus mellori Mathews. *M. helix* Cam. 8/9 SA; 11/48 Tas.

Corvus bennetti North. *M. helix* Cram 3/3 NT.

Corvus orru Bonaparte. *M. helix* Cram. 0.2 SA; 4/7 NT.

Corvus coronoides Vig. & Horsf. *M. helix* Cram. 4/5 SA.

CAPRIMULGIFORMES

Aegotheles cristata Shaw. *M. aegotheles* n.sp.; 0/2 SA; 0/1 Tas; 1/3 NT.

CUCULIFORMES

Cuculus pallidus (Latham) *M. coracinae* n.sp.; 1/4 NT; 0/1 Tas.

Cacomantis variolosus Vig. & Horsf. *M. cacomantis* n.sp.; 1/1 NT.

Cacomantis pyrrhophanus Vieillot. *M.* sp.; 1/9 SA; 1/1 Tas.

ACCIPITRIFORMES

Accipiter fasciatus Vig. & Horsf. *M. paraccipiter* n.sp.; 3/5 SA; 1/1 Tas; 3/3 NT.

Accipiter cirrhocephalus Vieillot. *M.* sp.; 2/2 SA; 1/1 Tas; 0/2 NT.

Circus assimilis Jard. & Selby. *M. circi* n.sp.

Falco berigora Vig. & Horsf. *M. raptoris* n.sp.; 2/4 SA; 0/1 Tas; 3/7 NT.

F. longipennis Swainson *M. raptoris* n.sp.; 0/2 Tas; 1/3 NT.

F. cenchroides Vig. & Horsf. *M. raptoris* n.sp; 1/5 SA; 0/1 NT.

F. peregrinus Tunstall. *M. raptoris* n.sp.; 2/4 SA.

STRIGIFORMES

Ninox novaeseelandiae (Gmelin) *M. raptoris* n.sp.; *M. ninoctis* n.sp.; 4/12 SA; 0/1 Tas; 3/4 NT.

Tyto alba (Scopoli) *M. tytonis* n.sp.; 0/6 SA; 1/1 NT.

Keys to *Microtetrameres* spp.

Two keys are offered. The first has been compiled from male characters. The second key, based only on the females, is necessarily restricted, but is included as the information conveyed may help other workers.

In some cases the ratios used were not given by the authors but have been calculated from data provided. Abbreviations have been used to assist in the lay-out of the keys, as follows: HF, hilt factor; L, left; pap, papillae; R, right; spic, spicule; sp. rat, spicule ratio. All measurements are in μm.

1. Key to male *Microtetrameres* spp.

1. Gubernaculum absent or weakly developed . 2
   Gubernaculum present 42
2. (1) Median preanal pap. present 3
   Median preanal pap. absent 4
3. (2) Sp. rat. 6·2; median preanal pap. on lip of cloaca .. .. *M. calabocencis* Diaz-Ungria
   Sp. ratio 15·8; median preanal pap. anterior to cloacal lip .. .. *M. inermis* (Linstow)
4. (2) Fewer than two preanal papillae 5
   Two or more pre pairs of preanal papillae 6
5. (4) No preanal papillae .. *M. xiphidiopici* Barus
   One pair of preanal papillae .. .. *M. cruzi* (Travassos)
6. (4) Three pairs of preanal papillae 7
   Two pairs of preanal papillae 9
7. (6) Sp. rat. 32 .. .. *M. papillocephala* Oshmarin
   Sp. rat. 25-26 8
8. (7) R. spic. 85-88 .. .. *M. erythrorhynchi* Ali
   R. spic. 150 .. .. .. *M. canadensis* Mawson
9. (6) L. spic. longer than body 10
   L. spic. not longer than body 11
10. (9) Sp. rat. 16-22 .. .. *M. spiculata* Boyd
    Sp. rat. 37 .. .. *M. helix asiaticus* Oshmarin
11. (9) Four pairs of post-cloacal pap. *M. oshmarini* Sobolev
    Not more than three pairs of post-cloacal pap. 12

12. (11) Adanal pap. present 13
Adanal pap. absent 14

13. (12) One pair of adanal pap. *M. pusilla* Travassos
Two pairs of adanal pap.
M. travassosi Rasheed

14. (12) R. spic longer than tail 15
R. spic. shorter than tail 22

15. (14) L. spic. less than 1200 16
L. spic. more than 1300 17

16. (15) Vestibule length 25 *M. cloacitectus* Oshmarin
Vestibule length 19 .. .. *M. singhi* Sultana

17. (15) Sp. rat. over 18 .. .. .. *M. centuri* Barus
Spicule ratio not more than 17 18

18. (17) Sp. rat. less than 9 19
Sp. rat. between 10-17 20

19. (18) Junction of vas deferens and testis 500-600 from cloaca .. .. *M. bubo* Schell
Junction of vas deferens and cloaca 800-900 from cloaca .. .. *M. aquila* Schell

20. (18) Vestibule about 10 long .. *M. eopsaltriae* n.sp.
Vestibule at least 13 long 21

21. (20) Hilt of L. spic. very long: HF 6-8·1
M. cacomantis n.sp.
Hilt of L. spic. shorter; HF 2·5-3·3
M. cerci n.sp.

22. (14) L. spic. 3200 long or more 23
L. spic. not longer than 3100 25

23. (22) Spicule ratio not more than 30; parasitic in crows .. .. *M. helix helix* Cram
Spicule ratio more than 34 24

24. (23) Spicule ratio 36; parasitic in hornbills
M. contorta (Wiedman)
Spicule ratio 40-45; parasitic in hornbills
M. bucerotidae Ortlepp

25 (22) Vestibule 30 long .. .. *M. spiralis* (Seurat)
Vestibule not longer than 25 26

26. (25) Sp. rat. 11 or less 27
Sp. rat. 12 or more 31

27. (26) L. spic. not more than half body length 28
L. spic. more than half body length .. 29

28. (27) Hilt of L. spic. long, slender; HF 4·7-5·6
M. sphecotheres n.sp.
Hilt of L. spic. shorter; HF 1·6-1·9
M. tytonis n.sp.

29. (27) R. spic. 120 long
M. oriolus orientalis Oshmarin
R. spic. 80-100 long 30

30. (29) From *Tachyphonus* sp., Brazil
M. minima (Travassos)
From *Cracticus* sp., Australia
M. cracticus n.sp.

31. (26) L. spic. not longer than 1050; egg longer than 75 32
L. spic. not shorter than 1060; egg shorter than 60 33

32. (31) R. spic. 66; vestibule 19 long
M. longiovatus Barus
R. spic. 100; vestibule 14 long
M. asymmetrica Oshmarin

33. (31) Vestibule 21 or more long 34
Vestibule not longer than 20 35

34. (33) L. spic. over 2500 long: 1/1·1 of body length .. .. *M. o. oriolus* Oshmarin
L. spic. less than 2500 long; 1/1·7-1·8 of body length .. .. .. *M. accipiter* Schell

35. (33) Tail more than 1·5 times length of R. spic 36
Tail not more than 1·5 times length of R. spic 37

36. (35) L. spic. 2032-2270; vestibule 16 long
M. oriolus rasheedae Skrjabin et al.
L. spic. 1250; vestibule 11 long
M. aegotheles n.sp.

37. (35) Vestibule 18-20 long .. *M. paraccipiter* n.sp.
Vestibule not more than 16·5 long 38

38. (37) L. spic. over 2200 long .. *M. philemon* n.sp.
L. spic. not longer than 2200 39

39. (38) Sp. rat. 21 .. .. *M. streperae* n.sp.
Sp. rat. not more than 20 40

40. (39) R. spic. almost equal to tail length .. 41
R. spic. distinctly less than tail length .. 42

41. (40) Vestibule elongate in shape .. .. *M. saguei*
Vestibule almost as wide as long
M. meliphagidae n.sp.

42. (40) Vestibule not more than 11 long 43
Vestibule not less than 12 long 44

43. (42) HF 6·1-7·9 .. .. *M. coracinae* n.sp.
HF 3-4 .. .. *M. mirafrae* n.sp.

44. (42) From small passerines in Russia
M. jakutensis Kontrimavichus
From Australian birds 45

45. (44) HF 2·2-3·3; hilt more or less cylindrical
M. raptoris n.sp.
HF 3·3-4·4; hilt tapering towards extremity
M. gymnorhinae n.sp.

46. (1) Spic. rat. under 11 47
Sp. rat. over 13 49

47. (46) Length of oesophagus less than ⅓ that of body
M. tubocloacis Oshmarin
Length of oesophagus ⅓-½ that of body 48

48. (47) L. spic. 1125; R. spic. 220-260
M. rasheedae Sultana
L. spic. 1950-2120; R. spic. 142
M. cephalatus Sultana

49. (46) L. spic. over 2200 long 50
L. spic. not longer than 2000 52

50. (49) R. spic. less than half tail length; vestibule 23
M. egretes Rasheed
R. spic. more than half tail length; vestibule 17 or less 51

51. (50) R. spic. 100-110 .. .. .. *M. ninoctis* n.sp.
R. spic. 190-230 .. .. *M. malabari* Ali

52. (49) Gubernaculum 20-21 long
{ *M. creplini* (Vavilova)
{ *M. raptoris* n.sp.
Gubernaculum 28 long 53

53. (52) R. spic. 50-80; tail 100-120
M. osmaniae Rasheed
R. spic. 80-90; tail 140-180
M. mirzae Rasheed

2. Key to female *Microtetrameres* spp.

M. contorta Wiedman is not included, as the length of the vestibule is not known; the eggs are 40-45 x 20-25 μm.

1. Eggs very long, 70 at least 2
Eggs very short, under 40 3
Egg length between 40-60 4

2. Eggs 80-82 x 36-39; from *Lanius* sp.
M. asymmetrica Ashmarin
Eggs 70-73 x 20-23; from *Glaucidium* sp.
M. longiovata Barus

3. Eggs 39 x 26; vestibule 39 long
M. erythrorhynchi Ali
Egg 36 x 21; vestibule 24 long
M. travassosi Rasheed
Egg 36 x 20; vestibule 20 long
M. inermis (Linstow)
Egg 35 x 15; vestibule 24 long
M. egretes Rasheed

4. Vestibule not more than 12 long 5
Vestibule more than 12 long 6

5. Vestibule 12 long; egg 45 x 24; from *Tachyphonus* sp. .. .. *M. minima* (Travassos)
Vestibule 9 long; eggs 42-49 x 28; from *Turdus* sp. .. .. *M. pusilla* Travassos
Vestibule 12 long; eggs 45 x 25-26; from *Aegotheles* sp. .. .. *M. aegotheles* n.sp.

6. Vestibule not longer than 20 7
Vestibule longer than 20 13

7. Body with two longitudinal flanges
M. accipiter Schell
Body without flanges 8

8. Breadth of egg not more than 28 9
Breadth of egg more than 28 12

9. Vestibule twice or more, as long as wide .. 10
Vestibule less than twice as long as wide .. 11

10. Egg length 40 .. .. .. *M. canadensis* Mawson
Egg length 45-49 .. .. *M. oshmarini* Sobolev
Egg length 50-60 .. .. .. *M. cruzii* Travassos

11. Vestibule 17-19; egg 44-46 x 23-26
M. paraccipiter n.sp.
Vestibule 17-19; egg 43-50 x 26-28
M. raptoris n.sp.
Vestibule 19; egg 46 x 26 .. .. *M. ninoctis* n.sp.
Vestibule 15-17; egg 42-44 x 24-27
M. tytonis n.sp.
Vestibule 17-19; egg 45 x 25-26
M. cacomantis n.sp.
Vestibule 18-20; egg 44-48 x 24-26
M. osmaniae Rasheed

12. From Passeriformes:
Vestibule 15; egg 46-49 x 29-31 . *M. saguei* Barus
Vestibule 17; egg 49-53 x 32
M. jakutensis Kontrimavichus
Vestibule 16; egg 44 x 31 .. *M. eopsaltriae* n.sp.
Vestibule 13; egg 44 x 29 .. *M. coracinae* n.sp.
Vestibule 13-16; egg 45-50 x 31-35
M. meliphagidae n.sp.
Vestibule 16-19; egg 47-50 x 31-33
M. philemon n.sp.
Vestibule 14-17; egg 51-55 x 33-34
M. streperae n.sp.
Vestibule 17-20; egg 49-51 x 31-33
M. gymnorhinae n.sp.
From Piciformes:
Vestibule 19; egg 49-53 x 33-38
M. centuri Barus
From Coraciiformes:
Vestibule 18; egg 42-45 x 30-32
M. bucirotidae Ortlepp

13. From birds of prey 14
From other groups of birds 17

14. Vestibule not longer than 23 15
Vestibule over 25 16

15. Eggs 44-48 x 24-16 .. .. .. *M. osmaniae* Rasheed
Egg 44 x 28 .. .. *M. bubo* Schell

16. Egg 48 x 28 .. .. *M. mirzai* Rasheed
Egg 44-50 x 23-26 .. .. *M. aquila* Schell

17. Egg at least 32 wide 18
Egg at most 31 wide 19

18. Length of vestibule less than twice its width
M. xiphidiopici Barus
Length of vestibule at least twice its width
M. helix Cram

19. Vestibule 30 long .. .. *M. spiralis* (Seurat)
Vestibule less than 25 long 20

20. Egg length 48-50 .. .. .. *M. spiculata* Boyd
Egg length less than 47 21

21. Vestibule length 21; egg (34)-43 x (17)-30
M. oriolus oriolus Oshmarin
Vestibule length 23; egg 40-46 x 25-29
M. oriolus rasheedae Skrjabin *et al*

Microtetrameres helix Cram

Plate 1; Figs. 1-9; Table 2

Microtetrameres helix Cram 1926, p. 355.

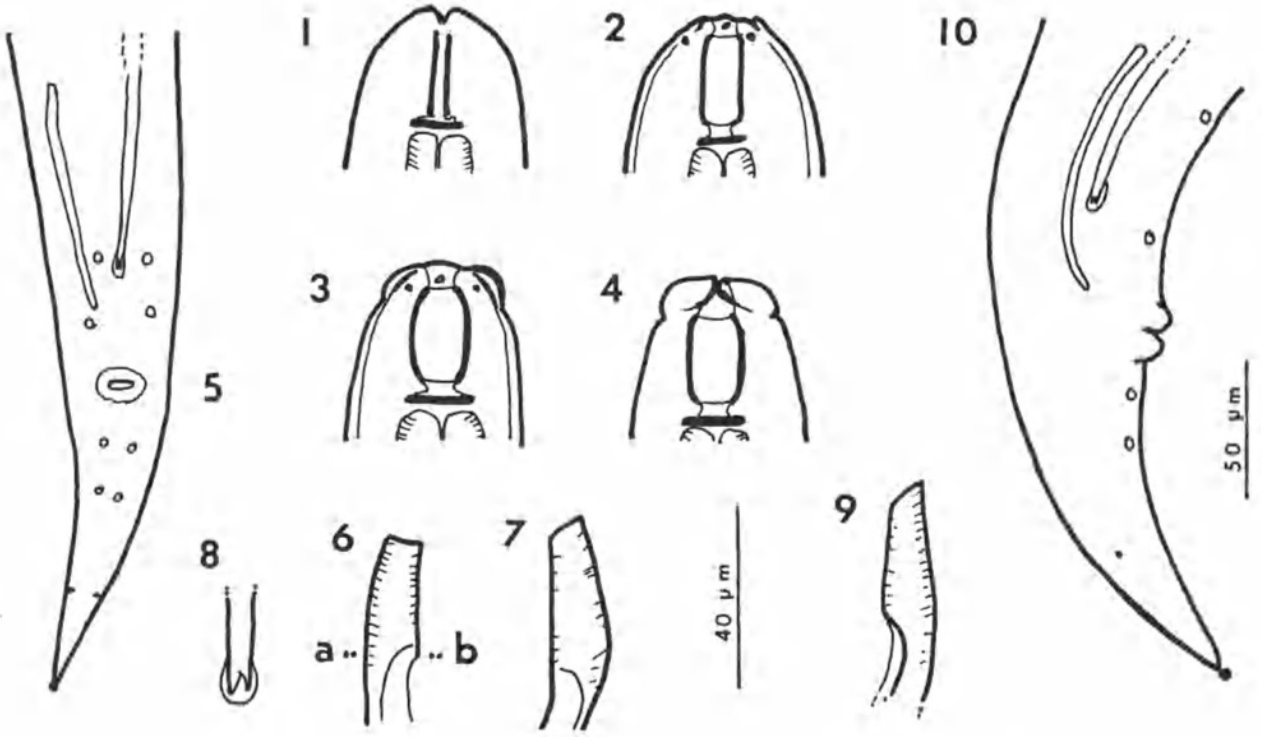
Microtetrameres corax Schell, 1953, p. 234.

Hosts and localities: *Corvus mellori*, Launceston, Tas; Balgowan, Ardrossan, Williamstown, Adelaide, SA; *C. bennetti* (♀s only) Ayers Rock, Erldunda, NT; *C. coronoides*, Adelaide, Heatherleigh, Lock, Oodnadatta, SA; *C. orru* (♀s only) Ayers Rock, Alice Springs, Death Adder Creek, NT; *Corcorax melanorhamphus*, Mt. Crawford, Mantung, SA; Inverleigh, Vic.

The numerous Australian specimens have been compared with *M. corax* (one male specimen lent by Dr. Schell) and with *M. helix* (male specimens from Dr. Lichtenfels) and it has been concluded that all belong to the same species.

Schell differentiates *M. corax* from *M. helix* in the male by the length of the body and of the left spicule, the bifid tip of the left spicule in *M. helix*, the absence of a ball point on the tip of the tail in *M. helix*, and by the distance of the vulva from the tip of the tail.

Examination of the single loaned male specimen of *M. corax* shows that the tip of the left spicule is slightly incised, resembling that of the Australian specimens (Fig. 7). The four male specimens of *M. helix* (Cram's material) are mounted and are in a poor condition, because of air bubbles on the slides. The tips of the tails are not very clear, but in one there is definite



Figs. 1-8, *M. helix*. 1 and 2, head of male, median and lateral views respectively; 3 and 4, head of female, median and lateral views respectively; 5, posterior end of male; 6 and 7, hilt of left spicule in Australian and U.S.A. (*M. corax* Schell) specimens respectively; 8, tip of left spicule. Figs. 9-10, *M. oriolus*. 9, posterior end of male; 10, hilt of left spicule. Figs. 1, 2, 3, 4, 6, 7, 8 and 9 to same scale; Figs. 5 and 10 to same scale.

indication of the presence of a ball point; the hilt of the left spicule is similar to those of the Australian specimens and to that of *M. corax*.

The measurements of all three sets of specimens are very close, except those of the eggs which in Cram's and Schell's descriptions are smaller than those of the Australian specimens. As it is easy to measure infertile eggs in *Microtetrameres* spp. this difference is not considered significant. Bethel (1973) recorded *M. corax* Schell from *Pica pica hudsoni* in Colorado and studied its life cycle. His young adult males agree in general appearance and in measurements with those of *M. helix*. Sultana (1962, 336) described *M. helix* from a hornbill, *Tockus birostris*, from India. The measurements of her specimens fall within, or close to, those of the Australian ones, except for those of the eggs which are smaller. Morgan and Waller (1941, 16) recorded *M. helix* from *Corvus brachyrhynchos brachyrhynchos* from eastern U.S.A. This work has not been seen by the present author.

Oshmarin (1956, 303) described *M. helix asiaticus* from four corvid species from Turkestan. This is a large worm known only from the male. Only one set of measurements is given. It differs from Cram's specimens chiefly in the greater length of the left spicule which is longer than the body.

Other records of *M. helix* and of *M. corax* are by Ellis (1972, p. 31 *et seq*). It appears that the species has a wide distribution, and that it is apparently restricted to corvids and hornbills, apart from the two records from an Australian chough, not now regarded as a corvid. It is possible that closer examination of the specimens from hornbills may show some differences not indicated in published measurements and drawings. *M. malabari* Ali, 1970, from a hornbill, is very similar to Sultana's specimens of *M. helix* in many points, but differs in the presence of a gubernaculum.

Microtetrameres oriolus Petrov and Tschertkova
Figs. 9-10; Table 4

Microtetrameres oriolus Petrov and Tschertkova, 1950, 78. From *Oriolus oriolus*.

Host and locality: *Oriolus sagittatus*, Katherine Gorge, NT.

Only a single male worm was collected. It agrees with the description and measurements of *M. oriolus*. In *M. oriolus rasheedae* Skrj. (syn. *M. orioles* Rasheed, 1960, 60) the spicules are shorter. The subspecies *M. oriolus orientalis* Oshmarin, 1956, is a much smaller worm. The hilt of the left spicules of these species cannot at present be compared.

TABLE 2

Males of *Microtetrameres helix* from Australian birds and from U.S.A.

Unless otherwise indicated, measurements are in μm.

Host species	*Corvus mellori*				*C. coronoides*		*C.* spp.	*C. americanus*	*C. corax*		*Corcorax* spp.
Locality	Tasmania		South Australia		South Australia		All Aust. Species	U.S.A.	U.S.A.		South Australia
Number of specimens	19		16		5						
	Range	Mean	Range	Mean	Range	Mean	Mean	(Ram)	Schell	PMM	PMM
Male:											
Length (mm)	3·7–5·8	5·0	4·1–5·3	4·7	4·0–5·4	4·4	4·4	4·9	3·7–4·7	3·6	3·8–4·3
Oesophagus—											
Total	860–1 200	1 076	900–1 200	1 070	900–1 200	1 022	1 058	826	885–1 051	—	950–1 250
Musc.	260–350	309	230–330	298	225–300	265	28·9	274	244–266	—	270–350
Buccal capsule Length	19–23	21	19–23	16·7	24–26	21	20	21†	21–25†	20	16–20
Ant. end—											
Nerve ring	175–260	187	140–190	179	150–190	163	174	191	151–187	—	160–185
Cerv. pap	212–280	225	180–235	210	190–235	208	210	—	194–237	—	200–230
Excr. pore	175–280	214	150–245	202	180–225	198	201	—	154–194	—	200–215
Spicule—Left	2 800–4 200	3 625	3 600–4 450	3 922	3 650–4 510	4 042	3 950	3 600	3 200–3 800	2 650	3 000–3 950
Right	120–162	140	130–160	144	125–145	133	141	135	120–140	—	110–140
Ratio	20·7–32·3	27·6	23·1–30·7	27·5	25·2–34·7	30·5	28·2	26·6	26·6–27·1*	22·1	27·3–29·0
Left spicule—											
Hilt L	23–32	26	20–27	24	21–30	27	25	—	—	17	26–30
Hilt factor	1·7–2·8	2·3	1·7–2·7	2·2	2·0–2·7	2·3	2·2	—	—	1·9	2·0–2·5
Body L/left spicule L	1·1–1·5	1·3	1·0–1·3	1·2	1·1–1·2	1·1	1·2	1·3	1·1–1·2*	1·4	1·1–1·3
Tail	135–200	172	140–180	152	160–180	172	1 164·5	183	160–207	—	165–170
Female:							From *Corvus orru*				
Oesophagus—											
Total	1 760–1 900	—	1 640–1 900	—	1 800–2 000	—	1 400	—	1 625–1 709	—	—
Musc.	340–360	—	340–380	—	360–420	—	250	225–250	241–284	—	—
Vestibule—											
Length	20–25	—	22–26	—	23–26	—	22–23	22·5	24–25†	—	—
Ext. diameter	11·0–12·1	—	11·0–12·1	—	8·8–12·1	—	11·0	—	—	—	—
Ant. end, Nerve ring	190–200	—	185–250	—	190–210	—	180	—	126–129	—	—
Tail	200–220	—	190–220	—	190–310	—	180	141	129–187	—	—
Post. end vulva	340–350	—	300–330	—	320–450	—	290	216	237–240	—	—
Egg—Length	50–52	—	50–55	—	50–55	—	57–53	42	47	—	—
Breadth	33	—	33	—	33	—	33	33	32	—	—

*As these proportions are taken from the largest and smallest measurements given by Schell they may be inexact.

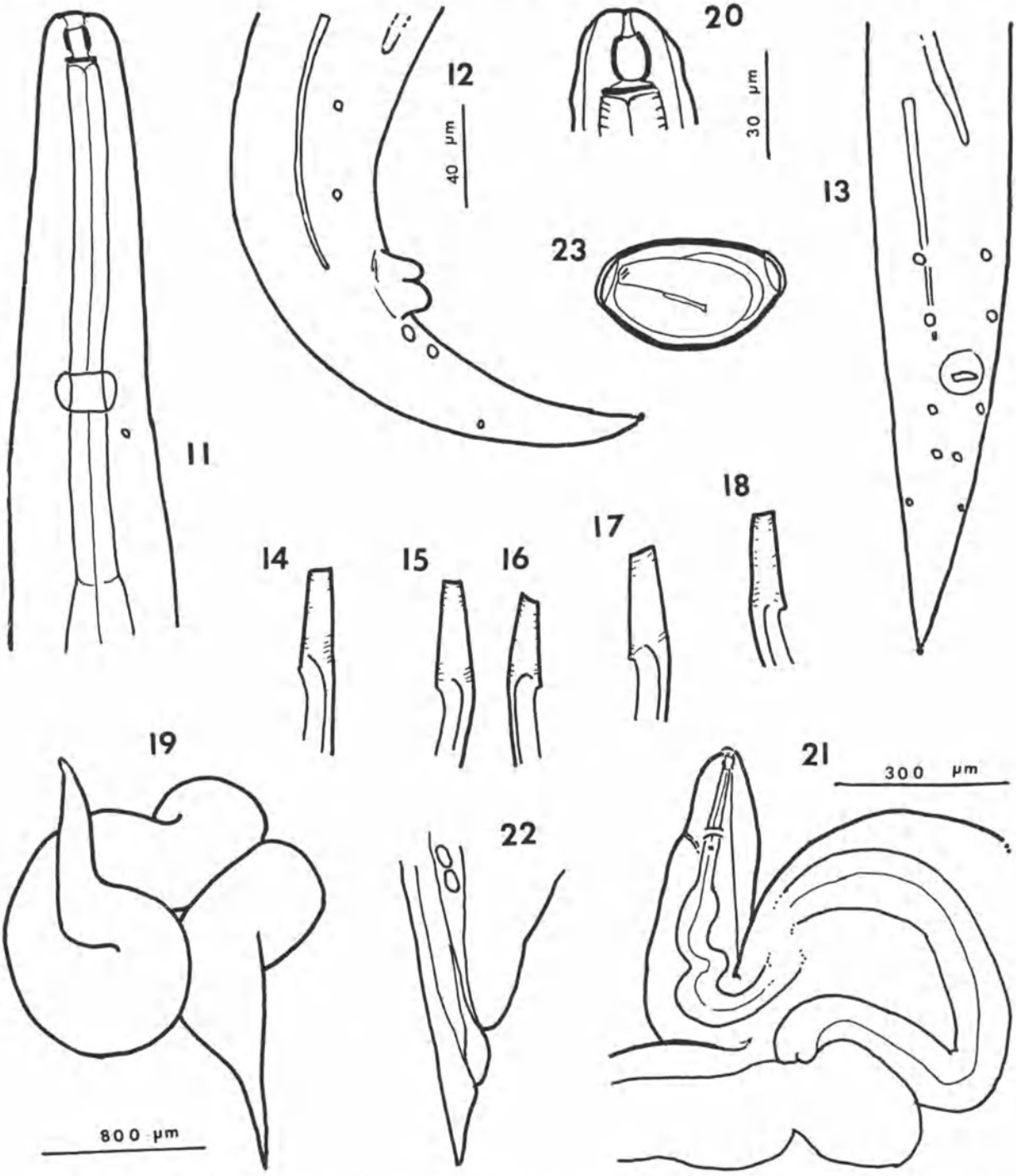
†Measured by the authors.

TABLE 3

Measurements of *Microtetrameres meliphagidae* and *M. philemon*.

Unless otherwise noted measurements are in μm.

Host species	*Microtetrameres meliphagidae*								*M. philemon*	
	Acanthogenys sp.		*Manorina* spp.		*Meliphaga* spp.		*Anthochoera* spp.		*Philemon* spp.	
Number of specimens	13		10		16		17		18	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Male:										
Length (mm)	2·0–3·3	2·7	1·9–2·2	2·1	1·9–2·7	2·2	1·8–2·8	2·3	2·8–4·3	3·4
Oesophagus—Total	550–680	6·4	450–600	552	490–650	562	500–730	587	600–850	736
Musc.	190–245	218	190 (1x)	—	170–240	193	180–240	202	205–250	230
Vestibule length	11–14	13	12–13	13	12–14	13	11–14	12	13–17	15
Ant. end—Nerve ring	130–170	152	135 (1x)	—	120–150	132	120–150	133	120–165	144
Cerv. pap.	160–210	194	170 (1x)	—	150–200	170	145–204	173	150–225	181
Excr. pore	155–205	182	—	—	125–180	152	130–177	152	140–205	166
Left Spicule—Left	1 450–2 200	1 910	1 550–1 770	1 642	1 400–1 850	1 644	1 500–2 050	1 737	2 200–3 000	2 571
Right	90–130	114	90–110	98	85–110	96	80–120	103	95–125	109
Ratio	14·1–20·7	16·9	14·3–18·3	16·8	14·7–19·6	17·4	15·9–19·8	16·7	20–28	23·4
Body L/left spicule	1·2–1·6	1·4	1·2–1·3	1·2	1·2–1·4	1·3	1·1–1·5	1·3	1·2–1·4	1·3
Left spicule—Hilt L	17–26	24	18–27	23	17–30	22	17–30	22	19–26	23
Hilt factor	2·0–3·2	2·5	2·2–3·3	2·8	2·2–3·3	2·6	2·3–3·2	2·6	1·9–2·5	2·3
Tail	110–140	112	100–130	115	100–140	115	95–130	112	120–150	131
Female:										
Oesophagus—Total	1 600	—	850–1 200	—	1 200	—	980–1 400	—	900–1 450	—
Musc.	260	—	220–320	—	270–280	—	200–300	—	280–300	—
Vestibule—Length	13–15	—	14–16	—	16	—	14–16	—	16–19	—
Ext. Breadth	10–12	—	10–11	—	10–11	—	10–11	—	10–12	—
Ant. end Nerve ring	140	—	150–175	—	160–170	—	130–160	—	140–160	—
Tail	80–120	—	120–140	—	150	—	120	—	130	—
Post. end vulva	130–220	—	220–270	—	240	—	230	—	230	—
Egg—Length	49–50	—	48–50	—	50	—	50	—	46–50	—
Breadth	31–35	—	31–33	—	30	—	31–33	—	31–33	—



Figs. 11-23, *M. meliphagidae;* unless otherwise stated, all from type host. 11, anterior end of male; 12 and 13, lateral and ventral views of posterior end of male; 14, 15, 16, 17, and 18, hilt of left spicule; 14, from type host; 15 and 16, from *Anthochoera* sp.; 17, from *Myzantha* sp.; 18, from *Meliphaga* sp.; 19, entire female; 20, head of female; 21 anterior end of female; 22, posterior end of female; 23, egg. Figs. 11, 12 and 13 to same scale; Figs. 14, 15, 16, 17, 18, 20 and 23 to same scale; Figs. 21 and 22 to same scale.

Microtetrameres meliphagidae n.sp.

Figs. 11-23; Table 4

Hosts and localities: *Acanthogenys rufogularis*, Pt. Augusta, Flinders Ranges, Blanchetown, Meningie, SA; *Meliphaga virescens*, Blanchetown, Eyre Peninsula and the Flinders Ranges, SA; *M. leucotis*, Eyre Peninsula, SA; *M. melanocephala*, Canberra, ACT, Naracoorte, SA; *M. flavigula*, Flinders Ranges, SA; *Anthochoera chrysoptera*, Naracoorte, and Mt. Barker, SA; *A. carunculata*, Adelaide, Eyre Peninsula and Yorke Peninsula, SA.

The male of this species is of medium size, with a short buccal capsule almost as wide as long. The left spicule is rounded, with a small cleft at the tip. The right spicule is simple, rounded at the tip. There is no gubernaculum.

The body of the female is twisted into a reversed spiral, sometimes twice reversed. The buccal capsule is barrel-shaped. There is a short intestinal caecum. This species is closest to *M. philemon* n.sp., in which the left spicule is longer and the spicule ratio greater; to *M. saguei Barus* (1966) from *Myadestes* sp. (Turdidae) from Cuba, and to *M. gymnorhinae* n.sp. in both of which however the buccal capsule is elongate.

Microtetrameres philemon n.sp.

Figs. 26-28; Table 4

Hosts and localities: Philemon argenticeps, Coomalie Creek and Berrimah, NT; *P. citreogularis,* (♀s), Coomalie Creek, NT; *Entymyzon cyanotis,* (immature ♀s), Edith R, and Yam Creek, NT.

All the specimens of *Microtetrameres* taken from honeyeaters in the Northern Territory are distinctly larger than those from South Australia. The specimens from *Entomyzon,* though immature, are larger and have a larger buccal capsule than those of a similar stage from *Acanthogenys rufogularis* from South Australia, and are similar to some from *Philemon* sp. The distinction between the two groups is not only of size, as the spicule ratio is quite different. The hilt of the left spicule is similar to that of *M. meliphagidae,* and the ratio between the lengths of the left spicule and the body, the egg size, and the shape of the female body (though not its size) are similar in the two species. The size of the body and spicules are somewhat similar to those of *M. oriolus oriolus* but the buccal capsule and eggs are smaller.

Microtetrameres mirafrae n.sp.

Figs. 26-28; Table 4

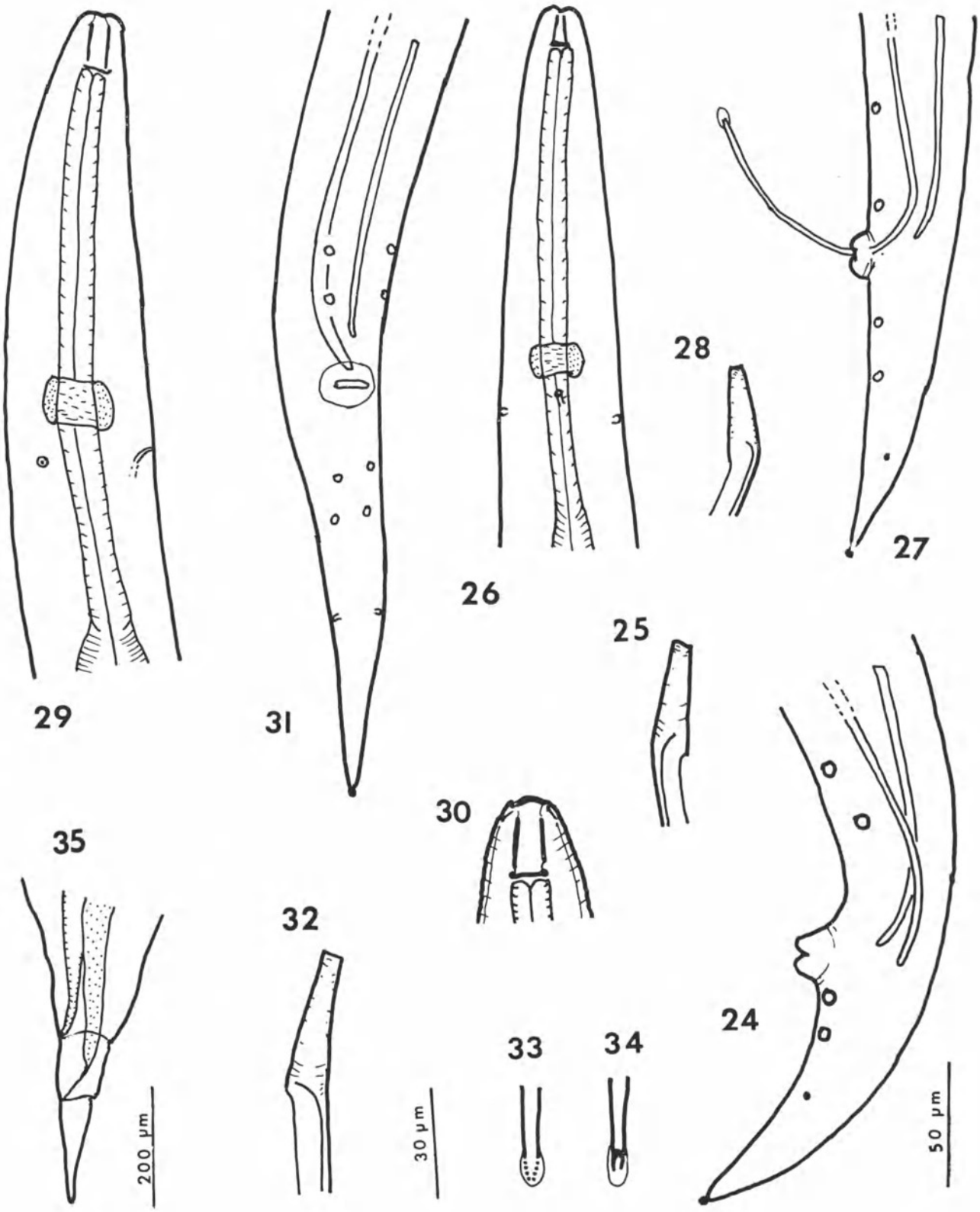
Host and locality: Mirafra javanica, ? loc., NT (6 ♂s, 1 imm. ♀); *Microeca leucophaea,* Newcastle Waters, NT (1 ♂); Blanchetown, SA (1 ♀), Waikerie, SA (3 young ♀s).

These are small worms, in some ways resembling *M. meliphagidae* but the buccal capsule is more elongate and the left spicule shorter with a more slender hilt. The only females in the collections are immature. The male specimen from *Microeca* is very similar in shape and proportions to those from *Mirafra.* The females from *Microeca* from SA are placed in this species because they are from the same host species.

TABLE 4

Measurements of *Microtetrameres mirafrae, M. gymnorhinae, M. streperae* and *M. cractici*
Unless otherwise indicated, measurements are in μm.

Species	*M. mirafrae*		*M. gymnorhinae*			*M. streperae*	*M. cractici*
Host species	*Mirafra javanica*	*Microeca leucophaea*	*Gymnorhina t. tibicen*	*G. tibicen leuconota*	Mean of all from *Gymnorhina* sp.	*Strepera versicolor*	*Cracticus torquatus*
Number of specimens	6	1	6	16		1	3
Male:							
Length (mm)	1·8–2·0	1·4	2·3–2·9	2·2–3·2	2·6	3·1	1·3–1·7
Oesophagus—Total	480–560	470	750–1 080	620–800	751	900	530–580
Musc.	170–210	190	230–290	215–300	245	260	195–210
Buccal capsule length	12–13	12	14–19	14–17	16	14	13–16
Ant. end—Nerve ring	125–140	100	130–190	130–165	151	150	135–150
Cerv. pap.	145–170	120	155–230	155–190	168	—	150–170
Excr. pore	148–160	120	150–180	145–200	171	—	150–165
Spicule—Left	1 100–1 200	1 060	1 500–1 830	1 400–1 960	1 685	2 100	860–1 000
Right	80–92	80	90–124	100–120	113	100	80–100
Ratio	13·1–15·0	13·3	15·2–17·0	14·2–18·2	14·2	21·0	8·6–11·2
Left spicule—Length	1·3–1·7	1·3	1·3–1·7	1·4–1·8	1·6	1·5	1·5–1·7
Hilt	19–27	14	32–36	26–38	34	45	26–32
Factor	3·0–4·0	3·0	3·3–4·2	3·3–4·4	3·7	5·0	4·1–4·6
Tail	115–130	120	130–180	130–160	—	150	110
Female:							
Oesophagus—Total	—	650	1 300–1 320	1 150	—	1 600–1 800	—
Musc.	—	190	280–310	250	—	330–400	—
Buccal capsule—Length	—	19	17–20	17–20	—	14–17	—
Breadth	—	8·0	11–12	11	—	12–13	—
Tail	—	90	120–130	190	—	190–200	—
Post. end vulva	—	140	280–290	300	—	340–350	—
Egg—Length	—	—	49·5–50·6	49·5	—	50·6–55·0	—
Breadth	—	—	30·8–33·0	30·8–33·0	—	33–34·1	—



Figs. 24-25, *M. philemon*. 24, posterior end of male; 25, hilt of left spicule. Figs. 26-28, *M. mirafrae*. 26, anterior end of male; 27, posterior end of male; 28, hilt of left spicule. Figs. 29-35, *M. gymnorhinae*. 29, anterior end of male; 30, head of male; 31, posterior end of male; 32, hilt of left spicule; 33 and 34, tips of two left spicules; 35, posterior end of female. Figs. 25, 28, 30, 32, 33 and 34 to same scale; Figs. 24, 26, 27, 29 and 31 to same scale.

In the spicule ratio and the ratio of the lengths of the left spicule and the body, this species is very close to *M. jakutensis* Kontrimavichus, 1958, from species of *Alauda, Motacilla, Anthus* and *Prunella*, but as it is impossible to compare the hilt of the left spicule and as females are not present in the Australian species, it is considered wiser to regard the Australian species as distinct, pending further information.

Microtetrameres gymnorhinae n.sp.

Figs. 29-35; Table 4

Hosts and localities: *Gymnorhina tibicen tibicen*, Canberra, ACT; *G. tibicen leuconota*, Clarendon, Victor Harbor, One Tree Hill, Ashbourne, Blackwood, Naracoorte, SA.

Microtetrameres specimens from *Gymnorhina* spp. are about the same overall size as those from honeyeaters. They are differentiated in the male mainly by the characters of the left spicule, which is rather shorter and has a more elongate hilt and in both sexes by the more elongate buccal capsule.

In many specimens the tip of the left spicule, which as in all the Australian species is enclosed in a small ala, is incompletely chitinised so that it appears bifid or broken.

The female body forms a complex coil, often twice reversed and sometimes with the tail end passing between the coils. The whole coil is about the same size as that of *M. meliphagidae*.

Microtetrameres streperae n.sp.

Figs. 36-40; Table 4

Host and locality: *Strepera versicolor*, Waikerie, SA (1 ♂, 4 ♀s).

The tip of the left spicule is bifid, within the terminal ala. The female body forms an irregular coil reversed two or three times. No intestinal diverticulum was seen. The egg is larger than that of most other Australian species.

In most measurements it resembles *M. paraccipiter* but the buccal capsule is shorter and the shape of the hilt of the left spicule is different. It differs from *M. gymnorhinae* (from a host species closely related to *Strepera*) chiefly in the spicule ratio and the shape of the hilt of the left spicule.

Microtetrameres cractici n.sp.

Figs. 41-42; Table 5

Host and locality: *Cracticus torquatus*, Eyre Peninsula, SA (3 ♂s).

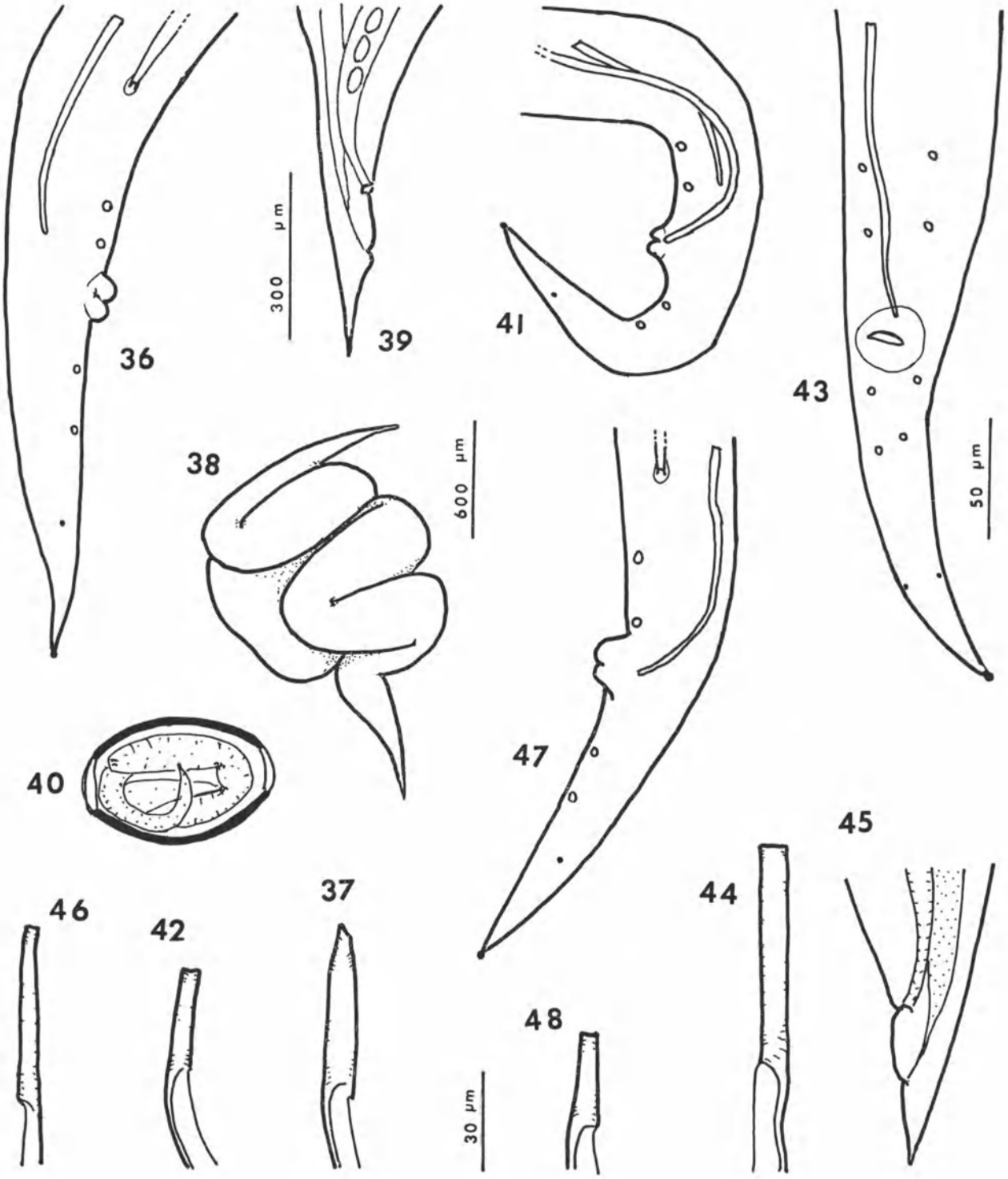
The tip of the left spicule is entire and rounded, lying within the terminal ala.

The species is close to *M. asymmetrica* Oshmarin, 1956, from *Lanis* sp., USSR, and to *M. minima* (Travassos, 1914) from *Tachyphonus* sp., Brazil. These three species are very similar in such measurements as are available. The male of *M. minima* is briefly described and poorly figured. *M. asymetrica* differs from *M. cractici* in having the tail longer in comparison with the length of the right spicule and in the shape of the hilt of the left spicule.

TABLE 5

Measurements of *Microtetrameres oriolus*, *M. cacomantis*, *M. aegotheles*, *M. coracinae*, *M. sphecotheres*, and *M. eopsaltriae*. Unless otherwise indicated, all measurements are in μm.

	M. oriolus	*M. cacomantis*	*M. aegotheles*	*M. coracinae*			*M. sphecotheres*	*M. eopsaltriae*
Host species	*Oriolus sagittatus*	*Cacomantis variolosus*	*Aegotheles cristata*	*Coracina hypoleuca*	*C. novae-hollandiae*	*Cuculus pallidus*	*Sphecotheres flaviventris*	*Eopsaltria australis*
Number of specimens	1	7	1	1	1	1	2	1
Male:								
Length (mm)	3·4	3·1–4·3	2·0	2·1	1·7	2·6	2·0–2·3	2·6
Oesophagus—Total	710	600–900	—	—	480	—	700 (1x)	690
Musc.	300	270 (2x)	310	—	—	—	190–200	220
Buccal capsule	16	16–22	13	13	11	13	16–17	11
Ant. end—Nerve ring	180	140–200	200	—	—	—	130–132	140
Cerv. pap.	—	160 (1x)	240	—	—	—	132–135	170
Excr. pore	180	155 (1x)	—	—	—	—	142 (1x)	170
Spicule—Left	3 000	1 900–2 250	1 250	1 400	1 200	1 350	1 000–1 100	1 420
Right	110	130–150	75	100	90	115	95–115	130
Ratio	27·3	14·2–16·1	16·6	14·0	13·3	11·7	9–11	10·1
Left Spicule—Length	1·1	1·6–1·9	1·6	1·5	1·4	1·9	2·0–2·3	1·8
Hilt L.	26	55–78	27	37	47	50	36–40	27
Hilt factor	2·5	6·0–8·1	3·5	7·9	6·3	6·1	4·7–5·6	3·7
Tail	155	120–145	130	130	100	—	130–150	120
Female:								
Oesophagus—Total	—	1 150	850–1 000	(1x)	—	—	—	—
Musc.	—	330	310	—	—	—	—	295
Buccal capsule—Length	—	19–20	13	14	—	—	—	17
Breadth	—	11	9	11	—	—	—	10
Tail	—	160	190	—	—	—	—	160
Post. end vulva	—	300	320–330	—	—	—	—	220
Egg—Length	—	44	45	44	—	—	—	44
Breadth	—	28	25–26	29	—	—	—	31



Figs. 36-40, *M. streperae*. 36, posterior end of male; 37, hilt of left spicule; 38, entire female; 39, posterior end of female; 40, egg. Figs. 41-42, *M. cracticis*. 41, posterior end of male; 42, hilt of left spicule. Figs. 43-45, *M. cacomantis*. 43, posterior end of male; 44, hilt of left spicule; 45, posterior end of female. Fig. 46, *M. coracina*, hilt of left spicule. Figs. 47-48, *M. sphecotheres*. 47, posterior end of male; 48, hilt of left spicule. Figs. 36, 41, 43 and 47 to same scale; Figs. 37, 40, 42, 44, 46 and 48 to same scale; Figs. 39 and 45 to same scale.

Microtetrameres cacomantis n.sp.

Figs. 43-45; Table 5

Host and locality: *Cacomantis variolosus*, Tobermory, NT (7 ♂s, 2 ♀s).

The males are distinguished by a combination and a low spicule ratio. The body of the female forms a more or less spherical knot from which of a short left spicule with a long slender hilt, head and tail protrude; one is a simple and one a reversed spiral.

The species is perhaps nearest to *M. centuri* Barus, 1966, from a Cuban piciforme bird, and *M. cerci* n.sp. from an Australian harrier. It is distinguished from both of these by the spicule ratio and actual spicule lengths, and from *M. cerci* by the shape of the hilt of the left spicule.

Microtetrameres coracinae n.sp.

Fig. 46; Table 5

Hosts and localities: *Coracina novaehollandiae* (1 ♂, 3 juv. ♀s) from Culburra, SA; *C. hypoleuca* (1 ♂, 1 broken ♀) Katherine, NT; *Cuculus pallidus* (1 ♂), Casuarina Beach, NT.

Although the three male specimens come from very different localities they are very similar in general morphology and in measurements. They resemble *M. cacomantis* but are distinguished by the shorter spicules, and the fact that the right spicule is shorter than the tail. The specimens are not in good condition, but the chitinous parts are unimpaired. The shape of the hilt of the left spicule (Fig. 46) distinguishes this from all other Australian species.

Microtetrameres sphecotheres n.sp.

Figs. 47-48; Table 5

Host and locality: *Sphecotheres flaviventris*, Katherine Gorge, NT (3 ♂s).

The tip of the left spicule is indented and alate. The species is nearest to *M. tytonis* (described below) and *M. oriolus oriolus*. It is distinguished from the former by the length of the buccal capsule, from the latter by the length of the left spicule in relation to the body length, and from both by the shape of the hilt of the left spicule.

Microtetrameres aegotheles n.sp.

Figs. 49-52; Table 5

Host and locality: *Aegotheles cristata*, Markaranka, NT (1 ♂, 2 ♀s).

In the male the hilt of the left spicule is distinctly narrower than the shaft, a circumstance not seen in any other Australian specimen. The female forms a reversed spiral. There is a bulge, probably a diverticulum, at the anterior end of the intestine. The species is similar in many features to *M. saguei* Barus, differing in the shorter left spicule and in the ratio of tail length to that of the right spicule.

Microtetrameres eopsaltriae n.sp.

Figs. 53-54; Table 5

Host and locality: *Eopsaltria australis*, Heatherleigh, SA (1 ♂, 1 ♀).

The tip of the left spicule is not fully chitinised. The right spicule is longer than the tail.

The female body forms a spiral reversed about its mid-length.

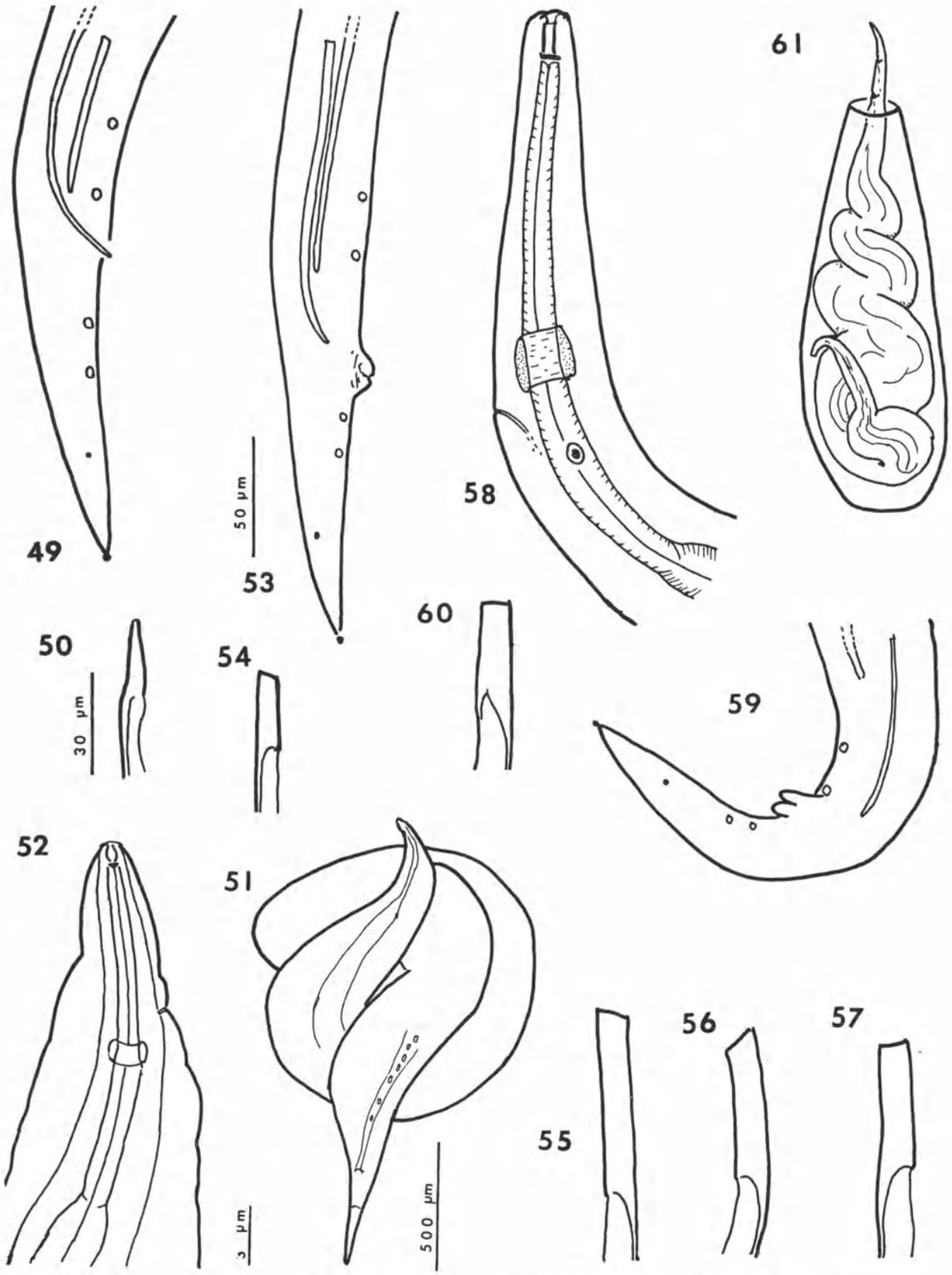
The measurements of this species are closest to those of *M. cerci* n.sp.; the buccal capsule however, is much shorter.

Microtetrameres paraccipiter n.sp.

Figs 58-61; Tables 6 and 7

Hosts and localities: *Accipiter fasciatus* from Darwin (♀). (Type host and locality), Kunoth Wells (♂), and Petermann Range (♀) NT; Happy Valley (♀) and Mallala (♀) SA; Longford, Tas (♀); Brisbane, Qld (♀).

The male and female specimens listed above are placed together here only because they occur in the same host species, but in no case were both males and females in the same host specimen. The female body forms an elongate simple spiral (Fig. 61); the morphology and the measurements of the eggs and buccal capsule are similar in all the females present. No intestinal caecum was observed. The male worms are very similar to those of *M. accipiter* Schell in measurements and appearance, and the species are separated on characters of the females, which in *M. paraccipiter* lack the longitudinal flange on the body, and the intestinal caecum described for *M. accipiter*. It seems more likely that the male worms from *A. fasciatus* in Australia belong to the same species as the female worms from the same host species than that they belong to *M. accipiter* Schell from an American host.



Figs. 49-52, *M. aegotheles*. 49, posterior end of male; 50 hilt of left spicule; 51, entire female; 52, anterior end of female. Figs. 53-54, *M. eopsaltriae*. 53, posterior end of male; 54, hilt of left spicule. Fig. 55, *M. bubo*, hilt of left spicule. Fig. 56, *M. aquila*, hilt of left spicule. Fig. 57, *M. accipiter*, hilt of left spicule. Figs. 58-61, *M. paraccipiter*. 58, anterior end of male; 59, posterior end of male; 60, hilt of left spicule; 61, entire female in proventricular gland of host. Figs. 49, 53 and 58 to same scale; Figs. 50, 54, 55, 56 and 57 to same scale; Figs. 51 and 61 to same scale.

TABLE 6

Measurements of male specimens of *Microtetrameres paraccipiter*, *M. cerci*, *M. raptoris*, *M. ninoctis*, *M. tytonis* and *M.* sp. from *Tyto alba*. Unless otherwise indicated, measurements are in μm.

Species	*M. paraccipiter*	*M. cerci*	*M. raptoris*			*M. ninoctis*		*M. tytonis*	*M.* sp.
Host Species	*Accipiter fasciatus*	*Circus assimilis*	*Falco peregrinus*	*F. berigora*	*Ninox* sp.	*Ninox* sp.		*Tyto alba*	*Tyto alba*
Locality	Kuneth Wells, Northern Territory	Petermann Ra., Northern Territory	South Australia	Northern Territory and South Australia	Northern Territory	Northern Territory	South Australia	Northern Territory	Northern Territory
Number of specimens	2	10	6	7	3	1	2	4	1
Lenth	3·4, 3·7	2·1–3·3	3·3–3·8	2·2–2·6	2·1–3·0	3·4	2·6, 3·2	2·9–3·3	3·9
Oesophagus—Total	900, 950	530–800	1 200–1 400	600–750	810–1 200	1 250	?, 1 130	850–950	850
Ant.	250, 260	—	230–290	165	—	300	?, 310	240–250	250
Buccal capsule	16, 20	21–25	19–20	16–20	19–20	20	17, 21	20–22	26
Ant. end—Nerve ring	140, 150	—	130–160	105	—	170	?, 160	140	180
Cerv. pap.	190, 200	—	180–210	110	—	200	?, 210	170–185	220
Excr. pore	180, 180	—	155–180	110	—	205	?, 185	150–170	—
Spicule—Left	2 000, 2 400	1 400–1 920	1 750–2 000	1 250–1 490	1 510–1 630	2 250	2 490, 2 500	1 200–1 250	1 900
Right	110, 120	115–150	100–150	80–105	90–130	100	100, 110	115–135	160
Ratio	18·2, 20·0	10·4–16·0	13–20	13·5–17·0	12·5–16·8	22·5	22·7, 24·9	9·3–10·4	11·9
L/left spicule—Length	1·7, 1·5	1·5–1·8	1·7–2·1	1·5–1·9	1·4–1·8	1·5	1·1, 1·3	2·4–2·8	2·1
Hilt L	27, 31	20–32	29–36	18–27	20–24	20	18, 13	15–21	43
Hilt factor	3·0, 3·3	2·5–3·3	3·0–4·0	2·5–2·9	2·5–3·3	1·8	1·4, 2·5	1·6–1·9	4·2
Tail	120, 140	110–130	100–150	130–170	150–190	160	160, 160	150–155	170

TABLE 7

Measurements of females of *Microtetrameres paraccipiter*, *M. raptoris*, *M. ninoctis*, *M. tytonis*, and *M.* sp. from *A. cirrhocephalus*. All measurements are in μm.

Species	*M. paraccipiter*			*M.* sp.		*M. raptoris*			*M. ninoctis*	*M. tytonis*
Host Species	*Accipiter fasciatus*			*A. cirrhocephalus*		*Falco peregrinus*	*F. berigora*	*F. longipennis*	*Ninox novae-seelandiae*	*Tyto alba*
Locality	Northern Territory	South Australia	Tasmania	Tasmania	South Australia	South Australia	South Australia	Northern Territory	Northern Territory	Northern Territory
Oesophagus—Total	1 400	2 000	1 800	1 300	1 300	1 100–2 140	1 300–1 400	1 050–1 400	1 500	1 300–1 400
Ant.	260	240	270	230	200	210–290	200–240	230–270	250	140
Ant. end nerve ring	130	140	120	100	100	140–170	110–120	—	—	260–290
Buccal capsule—Length	15	19	17	15	13	17–20	19	17–20	21	15–17
Breadth	10	11	10	10	10	10–12	10	10–11	11	9–10
Tail	250	—	200	180	140	150–190	100–210	150–170	—	200–280
Post. end vulva	400	—	300	310	280	250–330	230–320	250–290	—	340–380
Egg—Length	44–45	44–46	—	46–49	44	50	—	43	46	42–44
Breadth	23–24	24–26	—	23–24	24	28	—	26–27	26	24–27

Microtetrameres cerci n.sp.

Figs 62-65; Tables 6 and 7

Host and locality: *Circus assimilis*, Petermann Ranges, NT (12 ♂s, no ♀s).

Some of these specimens, all collected from a single host were found actually in the wall of the proventriculus between the glands. The buccal capsule is relatively long, the cloacal lips are outstanding. The tip of the left spicule is not divided, but there is an annular groove shortly before the tip (Fig. 65). In some specimens there is a definite chitinisation of the dorsal wall of the gubernaculum, but this is not present in all. The lips of the cloaca are more prominent in this than in any other Australian species.

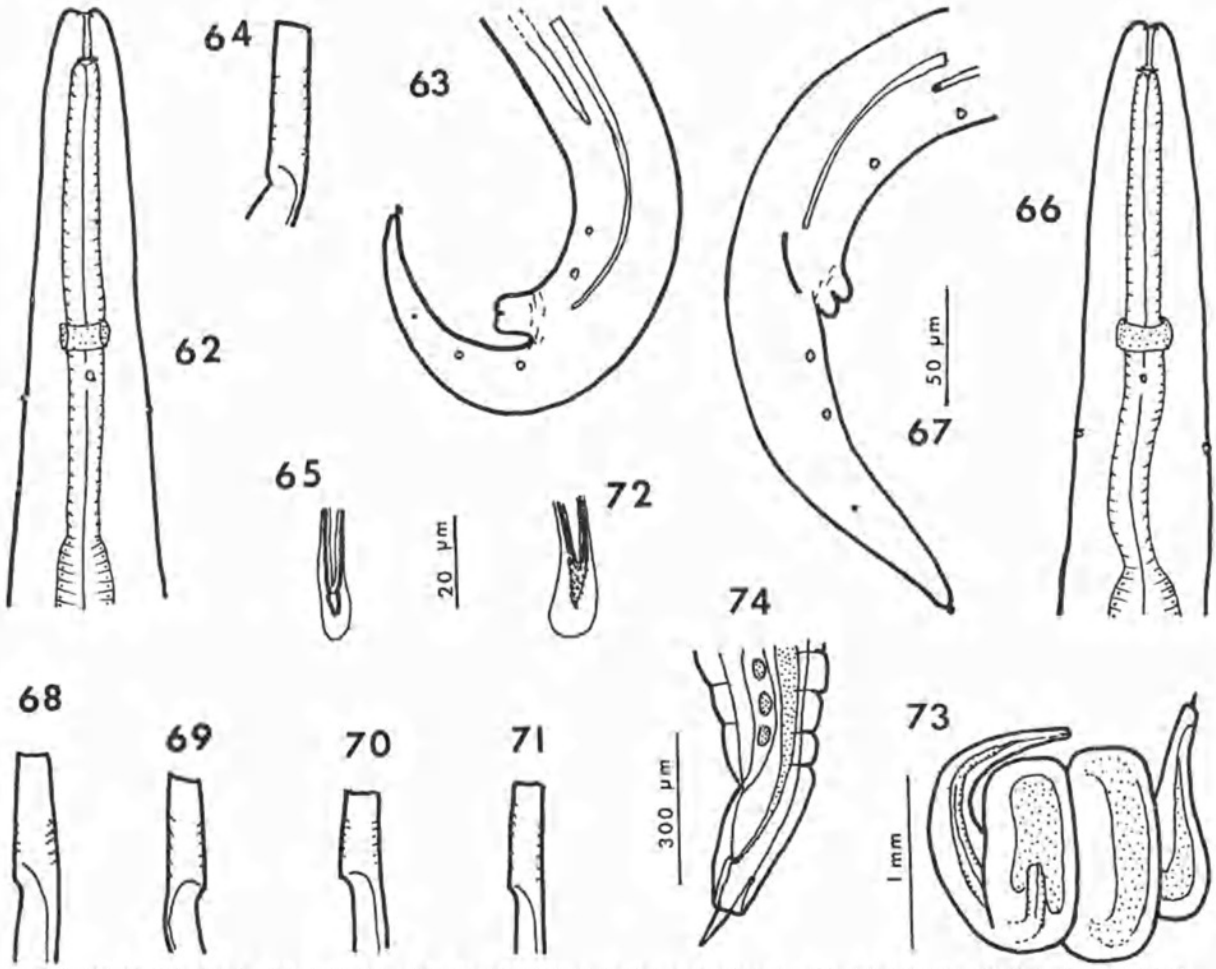
The species is distinguished from *M. aquila* and *M. bubo* by the greater spicule ratio; in measurements and proportions it is perhaps closest to *M. centuri* Barus and *M. cacomantis* n.sp., but is distinguished from the former by the very prominent cloacal lips from the latter by the shape of the hilt of the left spicule, and from both by the rather different, though overlapping, range of measurements. Among Australian species, the measurements are closest to those of *M. gymnorhinae*, but the species are distinguished by the length of the tail compared to that of the right spicule.

Microtetrameres raptoris n.sp.

Figs. 66-74; Tables 6 and 7

Hosts and localities: *Falco peregrinus*, Pt. Augusta, SA (5 ♂s, 14 ♀s) (type host and locality), Mallala, SA (1 ♂, 1 ♀); *F. berigora*, Blanchetown, SA, Robe, SA (♀s), Petermann Ranges, NT; *F. cenchroides*, Meningie, SA (2 ♂s, 1 ♀); *F. longipennis*, Humpty Doo, NT (♀s); *Ninox novae-seelandiae*, Petermann Ranges, NT (4 ♂s, juv. ♀).

The buccal capsule is elongate. The tip of the left spicule is bifid (within the terminal ala) and the hilt is stoutly built, tapering very slightly. It is slightly shorter, but similar in general shape,



Figs. 62-65, *M. cerci*. 62, anterior end of male; 63, posterior end of male; 64, hilt of left spicule; 65, tip of left spicule. Figs. 66-73, *M. raptoris*. 66, anterior end of male; 67, posterior end of male; 68, 69, 70 and 71, hilts of left spicules from *Falco peregrinus*, *F. berigora*, *F. cenchroides*, and *Ninox novaeseelandiae*, respectively; 72, tip of left spicule; 73, female worm; 74, posterior end of female. Figs. 62, 63, 66 and 67 to same scale; Figs. 64, 65, 68, 69, 70, 71 and 72 to same scale.

in the specimens from *F. berigora* (Fig. 69) and *F. cenchroides* (Fig. 70) than in those from the other hosts (Figs. 68, 71). The right spicule is not more than two-thirds the length of the tail. In all specimens there is a distinct gubernaculum, most heavily chitinised in the type specimens.

The body of the female forms a spiral, usually simple, in a few cases reversed. The intestine forms two short caeca at its junction with the oesophagus. There were no females with fertilised eggs in any specimen from *F. berigora*.

Two male and one female specimens from *Falco cenchroides* were broken, so measurements are not given. Their general appearance, the hilts of the left spicules and the egg size agreed with those of the other specimens from *Falco* spp. The females from *F. longipennis* and those from *F. berigora* from Robe agree with those from the Blanchetown, but the identification is not certain.

Of the species in which a distinct gubernaculum has been described, the males of these Australian specimens fall closest to *M. mirzae* Rasheed, 1960, *M. osmaniae* Rasheed, 1960 and *M. creplini* Vavilova, 1926. They differ in the shorter gubernaculum and the shorter buccal capsule from the first two of these. *M. creplini* was described from *Accipiter niseus* from the U.S.S.R., from male specimens only; as the females cannot be compared it is safer to describe the Australian specimens as a separate species.

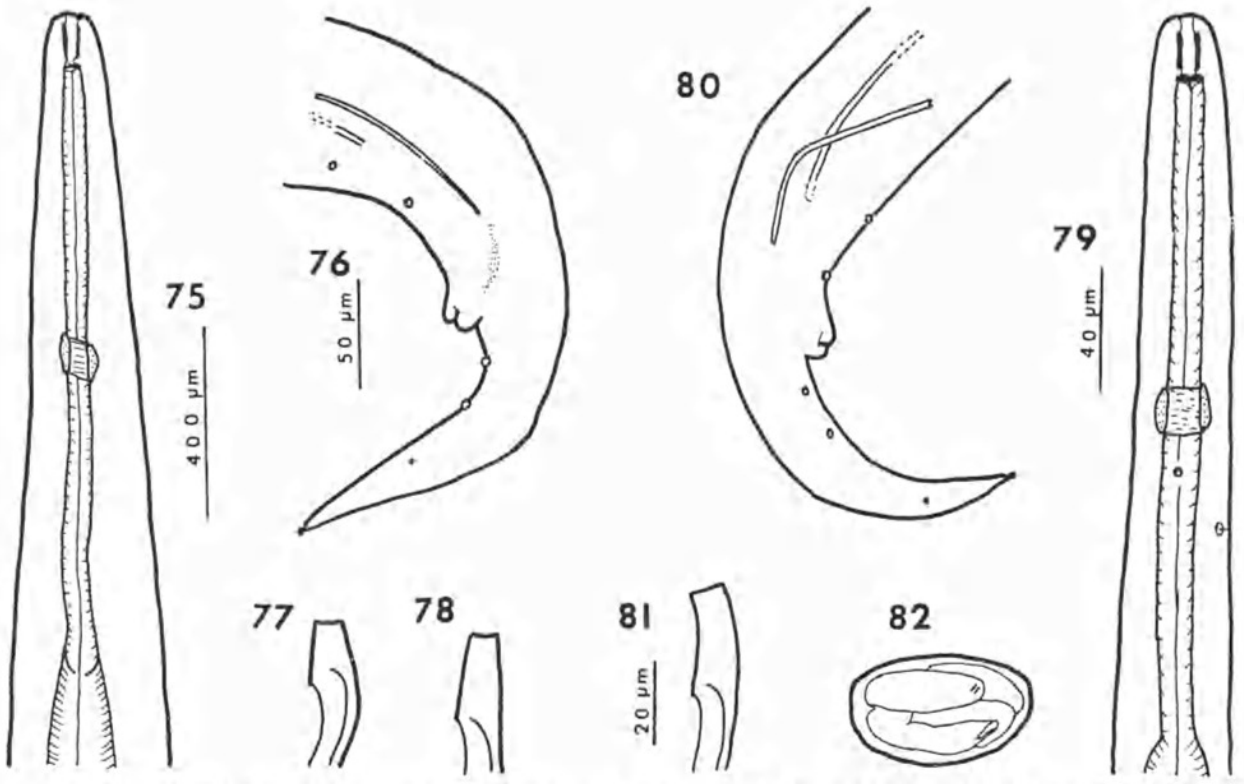
Microtetrameres ninoctis n.sp

Figs. 75-78, Tables 6 and 7

Host and localities: *Ninox novaeseelandiae*, Berrimah, NT (1♂, 4♀s); Adelaide, SA (2♂s, 2♀s).

The three male worms are similar in measurements, but in those from South Australia the hilt of the left spicule is rather longer.

The tips of the left spicules are different in the three specimens—one bifid, one rounded and one truncated. A very slight chitinisation, 30μm long, of the dorsal wall of the cloaca, which



Figs. 75-78, *M. ninoctis*. 75, anterior end of male; 76, posterior end of male; 77 and 78, hilts of left spicules from specimens from Berrimah and Adelaide, respectively. Figs. 79-82, *M. tytonis*. 79, anterior end of male; 80, posterior end of male; 81, hilt of left spicule; 82, egg. Figs. 75 and 79 to same scale; Figs. 76 and 80 to same scale; Figs. 77, 78, 81 and 81 to same scale.

could be called a small thin gubernaculum, is present in two specimens, one of them from Berrimah.

The female specimens are broken and the form of the spiral is uncertain. Only one contained fertile eggs.

These specimens differ from *M. raptoris* recorded from the same host species chiefly in the very much longer left spicule and the different spicule ratio. Among specimens in which a gubernaculum is present, the length of the left spicule brings it closest to *M. egretes* Rasheed, 1960 (from an egret) but the gubernaculum of the male, the buccal capsule of both sexes, and the length of the eggs, are all shorter than those of *M. egretes*.

Microtetrameres tytonis n.sp.

Figs. 77-80, Tables 6 and 7

Host and locality: *Tyto alba*, Banka Banka, NT (4 ♂s, 5 ♀s).

Of the six male *Microtetrameres* found in the only host specimen, four (the type material for *M. tytonis*) were similar, the fifth was without any spicules, and the sixth was very different, in relative length of the left spicule, in the longer hilt of the left spicule, and in the length of the buccal capsule. The measurements of this sixth specimen are given separately in Table 6 as it may belong to another species, or may be another aberrant form.

The left spicule in the four similar males is short, considerably less than half the body length; as in some other species the tip is not well chitinised, looking like a collection of refractile pieces in the terminal ala.

The body of the female forms a long spiral, reversed in the most posterior coil. The eggs, which contain a spiny-headed larva (Fig. 80), are more strongly curved on one side than the other, and the operculum, presumably present, is not distinct.

The species is closest to *M. sphecotheres* in which the hilt of the left spicule is longer, and to *M. raptoris*—in which the left spicule ranges from just less than $\frac{1}{2}$ to $\frac{2}{3}$ the body length—but in which the spicule ratio is very different.

Microtetrameres spp.

Female worms only were taken from the following hosts:—

Accipiter cirrhocephalus, from Koonamore, SA, and Flinders Island, Tas. The measurements of five females from SA and 1 from Flinders Island showed a small difference in the size of the buccal capsule and in the shape of the eggs, from

those of *M. paraccipiter*. Because of this and because no male is present, the specimens from *A. cirrhocephalus* have not been allotted to a species. In other respects the specimens from the two host species are similar.

Lalage sueuri tricolor, Mt Barker, SA (2 ♀s); Sandy Creek, SA (2 ♀s). All without embryonated eggs. The buccal capsule is 14 x 10 μm.

Oreoica gutturalis, Waikerie, SA (1 ♀), Petermann Ranges, NT, (1 juvenile ♀). The buccal capsule of the specimen from Waikerie is 12 x 10 μm, the eggs 44 x 22 μm.

Ptiloris sp., two females, without fertile eggs. Buccal capsule 10 x 11 μm.

Anthus australis, Reynella, SA, one female only, without fertile eggs.

Cacomantis pyrrhophanus, Gravelly Beach, Tas (1 ♀) with infertile eggs and Hamley Bridge, SA (3 immature ♀s). The adult female is coiled in a reversed spiral. The barrel-shaped buccal capsule is 16·5 μm long, 11 μm wide. The specimen is very similar to the female of *M. cacomantis* n.sp., but is impossible to identify positively on the material available.

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LIST OF SPECIES

FAMILY TETRAMERIDAE

Microtetrameres Travassos

M. helix Cram. syn. *M. corax* Schell
M. oriolus Petrov and Tschertkova
M. meliphagidae n.sp.
M. philemon n.sp.
M. mirafrae n.sp.
M. gymnorhinae n.sp.
M. streperae n.sp.
M. cacomantis n.sp.
M. coracinae n.sp.
M. sphecotheres n.sp.
M. aegotheles n.sp.
M. eopsaltriae n.sp.
M. paraccipiter n.sp.
M. cerci n.sp.
M. raptoris n.sp.
M. ninoctis n.sp.
M. tytonis n.sp.
M. accipiter Schell
M. bubo Schell
M. aquila Schell

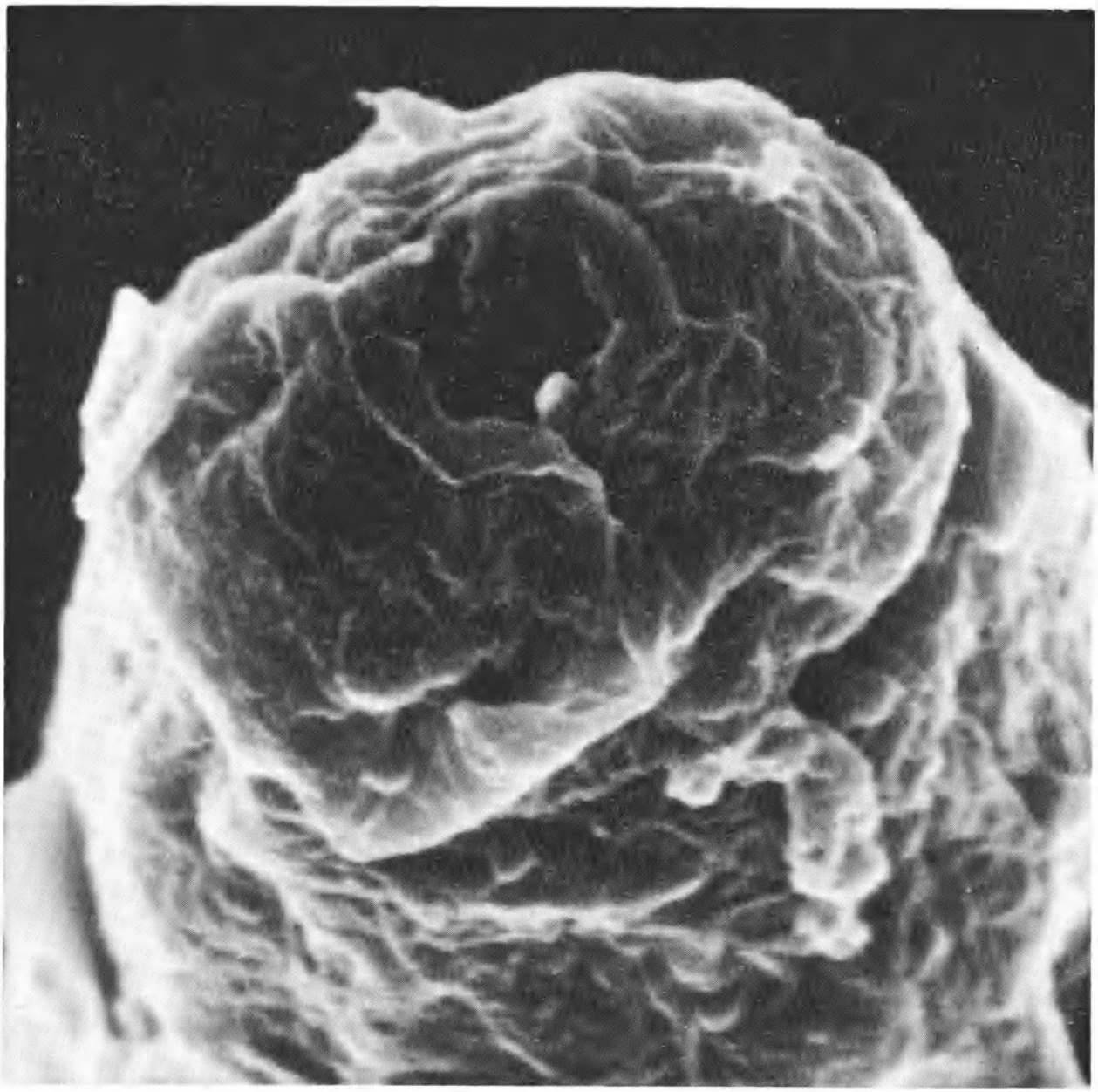

Plate 1. Head of *Microtetrameres helix*, female, S.E. micrograph. X 8000. The lateral lobes of the lips became wrinkled and shrunken in drying the specimen, but the median lobes, with the amphids, are clear.