

The subgenus *Nothocriconemella* Ebsary, 1981 (Nematoda: Criconematidae), with the description of four new species from New Zealand

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Summary. In the genus *Criconema*, the subgenus *Nothocriconemella* is discussed and redefined. The following species are recorded for New Zealand: *C. (N.) acuticaudatum*, *C. (N.) alpinum*, *C. (N.) californicum*, *C. (N.) graminicola*, *C. (N.) macilentum*, *C. (N.) mutable*, *C. (N.) pasticum* and *C. (N.) sphagni*. A short description of each of these is given. *Criconema (N.) macilentum* is redescribed from a population from Auckland Island. Four new species are described and illustrated: *C. (N.) crosbyi* sp. n. from Campbell Island; *C. (N.) farrelli* sp. n. from Auckland Islands, and *C. (N.) dugdalei* sp. n. from high altitude, and *C. (N.) ramsayi* sp. n. from sea level, in the South Island. The basal part of the stylet, the lip and postvulval regions of these species are illustrated and compared, and a key to the species is presented.

Key words: *Criconema*, nematodes, new species, New Zealand, *Nothocriconemella*.

The genus *Nothocriconemella*

The genus *Nothocriconemella* (Nematoda: Criconematidae) was proposed by Ebsary (1981) for species of *Nothocriconema* characterised by two lip annules of unequal diameter (diameter of first smaller than of second), slightly separated from each other, narrower than, or almost as wide as adjacent body annules which are retrorse, and 4-6 µm wide. Species with the first lip annule distinctly separated from, and wider than, the second lip annule, with rounded body annules 8-12 µm wide, were retained in the genus *Nothocriconema*, or transferred to the genus *Paracriconema*.

Raski & Luc (1985) synonymised *Nothocriconemella* with *Criconema*. Siddiqi (1986), Raski & Luc (1987) and Loof (1989) accepted the synonymy. Siddiqi (1986) recognised *Nothocriconemella* as a subgenus of *Criconema*.

New Zealand species of the subgenus *Nothocriconemella*

The species in this taxon are very similar morphologically, with only the length of the stylet and the number of body annules separating the species. This high degree of similarity suggests common ancestry. Therefore, *Nothocriconemella* is here rec-

ognised as a monophyletic group of subgeneric rank, following Siddiqi (1986). The ranges of the values for stylet length and number of body annules of the New Zealand *C. (N.) macilentum* (Raski & Pinochet, 1976) Raski & Luc, 1985 overlap those of the cosmopolitan *C. (N.) sphagni* Micoletzky, 1925. Consequently, some populations can not be distinguished (Yeates *et al.*, 1997).

To determine new diagnostic characters for the identification of *C. (N.) macilentum*, all *Nothocriconemella* specimens present in the National Nematode Collection, Mount Albert, New Zealand, were studied. This study revealed that the taxon *Nothocriconemella* is well represented in New Zealand. Many populations have been studied and five have been described as separate species, two of them recently (Raski & Pinochet, 1976; Loof *et al.*, 1997).

The study further showed that *C. (N.) sphagni* and *C. (N.) macilentum* are not the only species in the taxon that are difficult to distinguish from each other. Because of similarity in stylet lengths, *C. (N.) mutable* (Taylor, 1936) Raski & Luc, 1985 is difficult to distinguish from *C. (N.) californicum* (Diab & Jenkins, 1966) Siddiqi 1986; *C. (N.) californicum* from *C. (N.) pasticum* (Raski & Pinochet, 1976) Raski & Luc, 1985; and *C. (N.) graminicola* Loof, Wouts & Yeates, 1997 from *C. (N.) acuticaudatum*

Loof, Wouts & Yeates, 1997. When large numbers of specimens are available the average stylet length remains a valid character to distinguish the species. When only a few specimens are available, especially when their stylet lengths vary greatly, identification is difficult. Additional study revealed further characters for the diagnosis of these species and these are reported here.

The taxon *Nothocriconemella*

Ebsary (1981) based *Nothocriconemella* on the species *Criconema sphagni*, which is characterised by retrose body annules of up to 6 µm wide, and two undifferentiated lip annules that fit in the contour of the body outline, the second lip annule being slightly wider than the first. The lip annules are not separated from each other, or from the body annules, by cuticular outgrowths or collars. The first annule, the lip annule, is dish-shaped with its outer edge flexible, generally directed laterally or anteriorly surrounding the lips, but in some species it is retrose. The outer edge of the second lip annule may be directed anteriorly, but generally it is retrose, similar to the body annules. The second lip annule differs from the body annules in that it is located over the cephalic framework and consequently is part of the lip region. In some specimens the diameter of the second lip annule may not be perfectly intermediate between the lip annule and the first body annule, it may be closer in size to the lip annule and may make the lip region look somewhat set off. In some New Zealand populations of *C. (N.) sphagni*, specimens with three lip annules over the cephalic framework have been observed. The vulva is closed and has a distinctly overlapping anterior vulval lip, which gives the vagina an S-shaped appearance.

Species traditionally recognised in the subgenus *Nothocriconemella*

Of the 17 species originally included in *Nothocriconemella* by Ebsary (1981), Siddiqi (1986) synonymised *Criconemoides grassator* Adams & Lapp, 1967, with *C. (N.) sphagni* and similarly *C. kovasci* Andrassy, 1963, with *C. (N.) mutabile*. He transferred to the subgenus: *Discocriconemella ananas* Heyns, 1970, *Nothocriconema bellatulum* Minagawa, 1981, *N. lanxifrons* Orton Williams, 1982, *N. miscauthi* Minagawa, 1985, *N. montanum* Razjivin, 1974, *N. neopacificum* Mehta, Raski & Valenzuela, 1983, *N. polynesianum* Orton Williams 1982, *N. varicaudatum* Eroshenko, 1980, *Nothocriconemella ina* Skwiercz, 1983, *N. sulcata* Van den Berg, 1984, *Nothocriconemoides justus* Eroshenko, 1982, and

Criconemella meridiana Mehta, Raski & Valenzuela, 1983.

Species rejected from the subgenus *Nothocriconemella*

Of the 27 species recognised by Siddiqi (1986) 19 are excluded from the subgenus for the following reasons:

- *D. ananas* and *Nothocriconema coorgi* Khan & Nanjappa, 1972, because the lip annules are differentiated, extending only slightly outside the body contour, making the lip region look like a corrugated tube distinctly set off from the rest of the body.

- *N. lanxifrons*, *N. neopacificum*, *N. sulcata*, *Nothocriconema paraguayensis* Andrassy, 1968, and *Criconemoides permistus* Raski & Golden, 1966 (Fig. 1A), because they have a single lip annule.

- *Criconema longulum* Gunhold, 1953, *C. demani* Micoletzky, 1925, *N. ina* (Fig. 1B) and *Criconemoides calvus* Raski & Golden, 1966 (Fig. 1C), because their lip annules are not retrose and are of equal width and several microns narrower than the first body annule, giving the lip region a cubical, distinctly set off appearance. Furthermore, *C. longulum*, *C. demani* and *C. calvus* have wide (6-7 µm), weakly retrose body annules, and in *C. calvus* the first body annule appears to be subdivided into four parts, and the body rings are ornamented with a continuous string of minute regular platelets on their outer edge.

- *N. polynesianum* (Fig. 1D), *N. psammophilum* Krnjaic & Loof, 1973, and *N. varicaudatum* because the diameter of the second lip annule is smaller than that of the first and appears somewhat like a collar, and in *N. polynesianum* and *N. psammophilum* the body annules are not distinctly retrose.

- *N. aciculum* Raski & Pinochet, 1976 (Fig. 1E), and *N. orientale* Andrassy, 1979 (Fig. 1F) because the lip annules are much smaller than the body annules and are directed anteriorly so that the lip region appears set off, and in *N. aciculum* in the region of the lateral field the body annules have irregular thickenings on their upper or lower surface.

- *N. degrissei* Baqri, 1979, because the first body annule is distinctly narrower than the adjacent lip annule.

- *N. montanum*, a species from an apple orchard in Kazakhstan, has a very high number of body annules (206-210) and a very short stylet (39-42 µm) and very closely resembles *Criconemella parva* (Raski, 1952) de Grisse & Loof, 1965, both in these characters and in its habitat, and clearly does not belong in the subgenus *Nothocriconemella*.

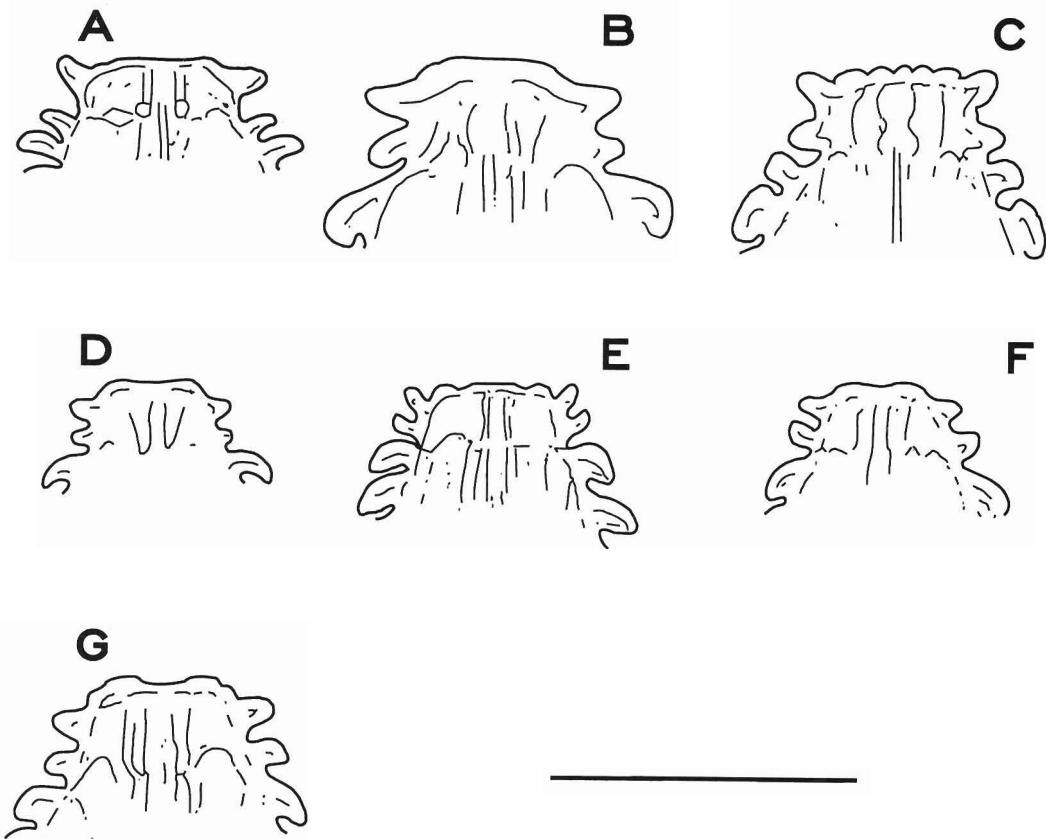


Fig. 1. *Criconema* female lip regions. A: *C. permistus*; B: *C. ina*; C: *C. calvus*; D: *C. polynesianum*; E: *C. acriculum*; F: *C. orientale*; G: *C. californicum*. Scale bar - 20 µm.

- *Criconemoides pacificus* Andrassy, 1965, because it has a single lip annule. Type material of this species was not illustrated in the original description (Andrassy, 1965), and is no longer available (Andrassy pers. com.). However, an illustration in a subsequent paper (Andrassy, 1967) clearly shows that the species has a single, set off lip annule; with the cephalic framework confined to this annule. It is similarly illustrated by Loof *et al.* (1997).

Additional species accepted in the subgenus *Nothocriconemella*

Besides the eight species recognised above, included in the subgenus are the following species:

- *C. (N.) californicum* (Fig 1G), a synonym of *C. (N.) mutable* according to Siddiqi (1986) but reinstated by Loof *et al.* (1997).

- *C. (N.) acuticaudatum*, *C. (N.) graminicola*, and *C. (N.) alpinum* described by Loof *et al.* (1997).

- *C. meridiana*. Type material of *C. meridiana* was not examined, but in the illustration of the female in the original description of this species two lip annules are drawn. The juveniles of this species are exceptional in that they have annules with rounded

scales rather than the pointed spines typical for *Nothocriconemella* juveniles.

These species, together with the four species described in this paper, bring to 16 the number of species recognised in the subgenus *Nothocriconemella*. Twelve of these are present in New Zealand, ten of them being described from New Zealand, where this group of nematodes seems to be endemic (Raski & Pinochet, 1976; Loof *et al.*, 1997). The four species not present in New Zealand seem to be restricted to the Pacific Rim in their type localities in Southern Chile, Japan, and the Vladivostok region.

The subgenus *Nothocriconemella* is redefined, the species recognised in the subgenus are listed and the species present in New Zealand are compared and their diagnostic characters briefly discussed. Divergent populations within these species, and their distinctive characters, are discussed. *C. (N.) macilentum* is redescribed and four *Nothocriconemella* populations with unique distinguishing characters are described as new species. The anterior and posterior ends and the stylet bases of the females of New Zealand species are illustrated and compared. A key to the species currently recognised in the subgenus *Nothocriconemella* is presented.

MATERIAL AND METHODS

Specimens were isolated from soil by a modified combination of Cobb's sieving method and sugar flotation, and fixed by adding 5 ml of boiling 8% formalin to 5 ml of an aqueous suspension of nematodes. After at least one month in fixative the specimens were processed to glycerine through a modified "slow glycerine" method in which the cuticles were punctured with a fine needle to allow the glycerine to enter (Wouts & Sher, 1971). The scanning electron micrographs were obtained using a Philips 505 SEM and Emscope SP 2000 sputter cryo unit. Formalin fixed specimens were placed in osmium tetroxide + 0.1M phosphate buffer for 2 h, then passed through a graded ethanol series (70-90-100%), critical point dried, mounted on stubs and sputtered with gold. The conventions used in reporting body dimensions of females and their ratios are as defined in Loof *et al.* (1997). In Table 1, L = total body length in mm; VB = diameter at level of vulva; PV = length of postvulval part of body; St%L = length of the stylet as a percentage of the total length; R = total number of body annules, in this paper a clear distinction is made between the two lip annules characteristic for the subgenus, and the remaining body annules, all R values represent the number of body annules, they do not include lip annules; L/R = average width of body annules; RV = number of the annule on which the vulva lies, counting from the tail end; Ran = number of the annule on which the anus lies, counting from the tail end; RVan = number of annules between vulva and anus. The widths of body parts were measured from the outside of the annules and therefore more strictly indicate the diameter of the annule, rather than the width of the body. For synonymies of the species see Siddiqi (1986).

DESCRIPTIONS

In the genus *Criconema*, the subgenera *Criconema*, *Notholetus* Ebsary, 1981 and *Paracriconema* Ebsary, 1981 are recognised as defined by Siddiqi (1986). The subgenus *Nothocriconemella* is redefined. The *Nothocriconemella* species recognised by Siddiqi (1986), but not recognised here, are transferred to *Paracriconema*. The *Nothocriconemella* species present in New Zealand are presented in the sequence of their stylet length followed by the descriptions of the new species.

Subgenus *Criconema* (*Nothocriconemella*) Ebsary, 1981

Diagnosis. Body annules 60-135, 4-6 µm wide, retrorse. Lip region not distinctly set off. Lip

annules 2, rarely 3, not differentiated, not separated from each other or from the body annules by body outgrowth or collar. Anterior lip annule equal to or narrower than posterior lip annule. Posterior annule intermediate between anterior annule and first body annule. It is usually not perfectly intermediate but slightly narrower, which may give the impression that the lip region is slightly set off. Stylet 50-160 µm long, flexible if long. Vulval lips conical, 5-21 annules from tail tip. The anterior lip generally overlapping the posterior lip to form a S-shaped vagina (in *C. (N.) mutable* the vagina is straight). Tail varying in shape from narrowly drawn out to conically pointed, or blunt and rounded, depending if the last tail annules are extended, regular in shape or retracted. Juveniles with smooth or minutely spined rows of scales.

Type species:

Criconema (Nothocriconemella) sphagni Micoletzky, 1925
for synonymy see Siddiqi (1986).

Other species:

- C. (*N.*) *acuticaudatum* Loof, Wouts & Yeates, 1997
- C. (*N.*) *alpinum* Loof, Wouts & Yeates, 1997
- C. (*N.*) *bellatulum* (Minagawa, 1981) Raski & Luc, 1985
- C. (*N.*) *californicum* Diab & Jenkins, 1966
- C. (*N.*) *graminicola* Loof, Wouts & Yeates, 1997
- C. (*N.*) *justum* (Eroshenko, 1982) Siddiqi, 1986
- C. (*N.*) *macilentum* (Raski & Pinochet, 1976) Raski & Luc, 1985
- C. (*N.*) *meridiana* (Mehta, Raski & Valenzuela, 1983) Siddiqi, 1986
- C. (*N.*) *misanthi* (Minagawa, 1982) Raski & Luc, 1985
- C. (*N.*) *mutable* (Taylor, 1936) Raski & Luc, 1985
- C. (*N.*) *pasticum* (Raski & Pinochet, 1976) Raski & Luc, 1985
- C. (*N.*) *crosbyi* sp. n.
- C. (*N.*) *dugdalei* sp. n.
- C. (*N.*) *farrelli* sp. n.
- C. (*N.*) *ramsayi* sp. n.

Criconema (Nothocriconemella) mutable (Taylor, 1936) Raski & Luc, 1985 (Figs. 2A-C, 3A-B & 4A)

Criconema (N.) mutable has not been previously reported from New Zealand. It is here reported from soil collected in a citrus orchard at Hawke's Bay. It is not known from native habitats and is therefore considered an adventive species. Dimensions and descriptions can be found in the original description, in the descriptions of populations now considered

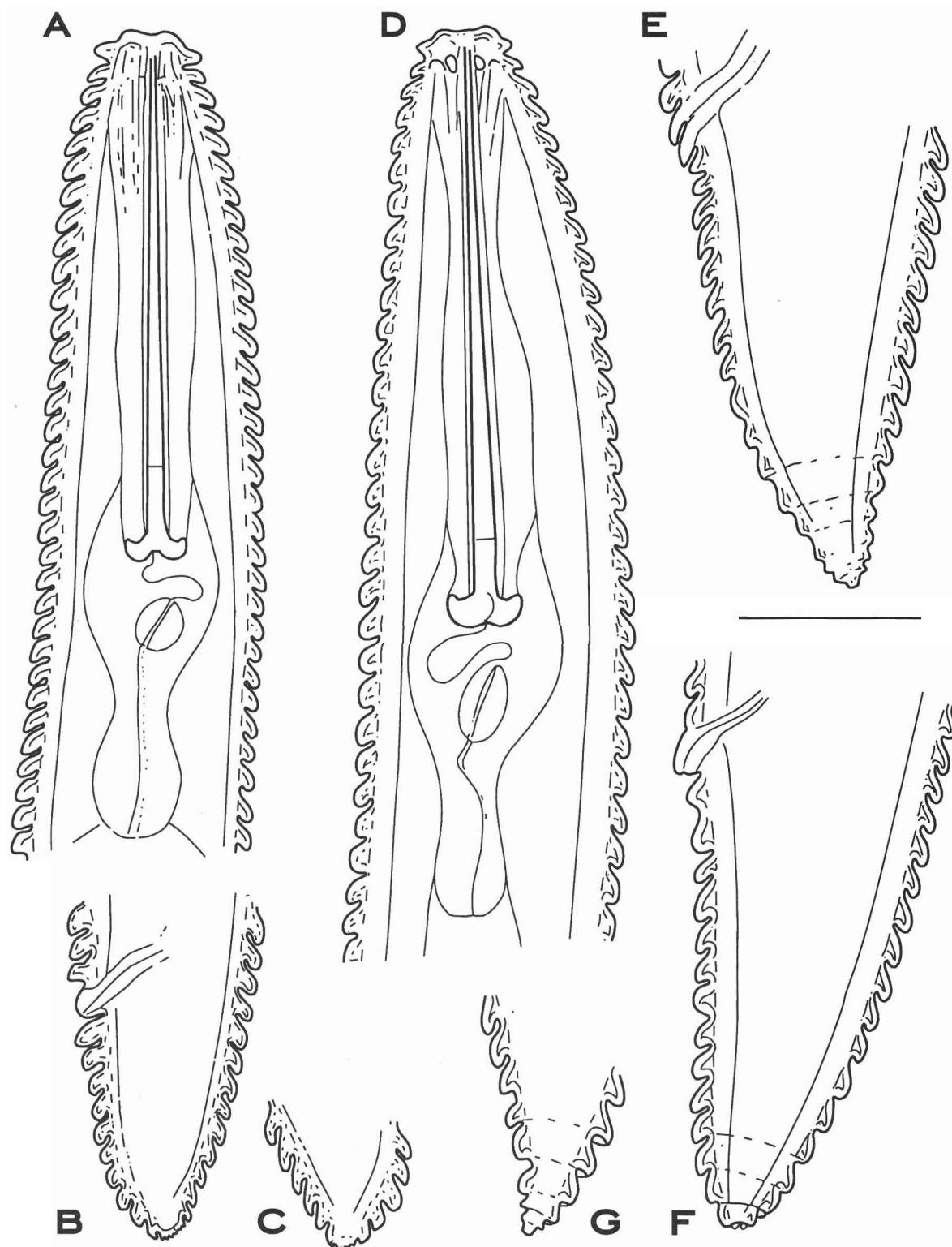


Fig. 2. *Criconema (Nothocriconemella)* females. A-C, *C. (N.) mutabile*. A: Anterior region; B: Postvulval region; C: Tail terminus variant. D-G, *C. (N.) californicum*. D: Anterior region; E - F: Postvulval regions with different tail terminus; G: Tail terminus variant. Scale bar - 20 μm .

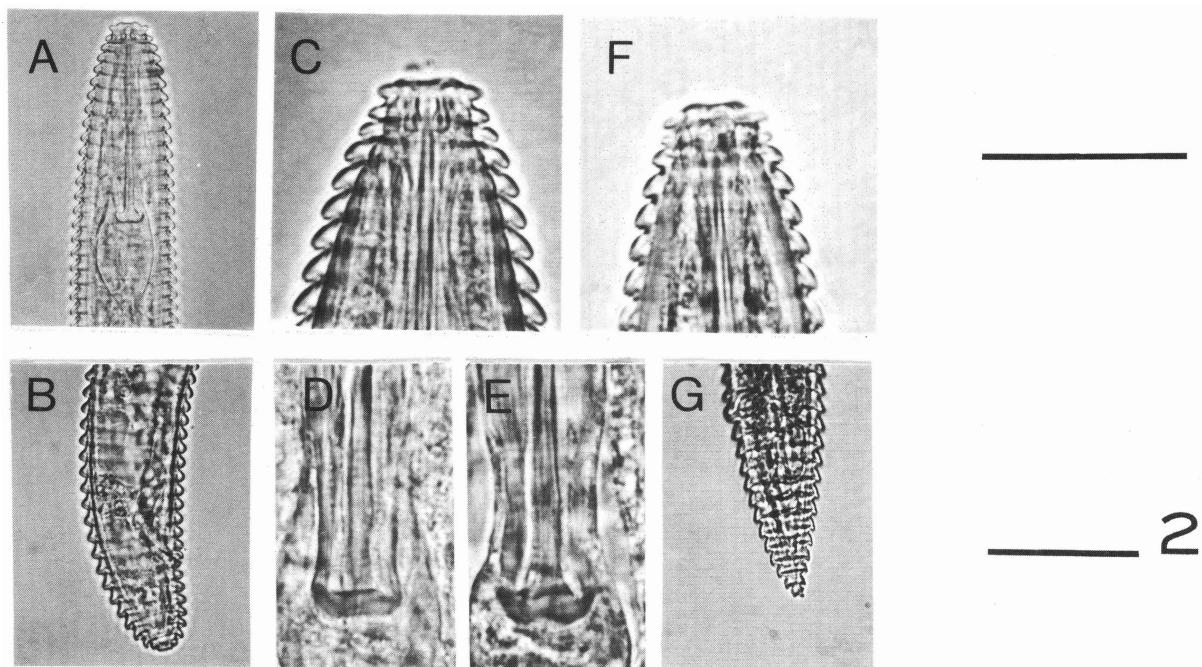


Fig. 3. *Criconema (Nothocriconemella)* females. A - B, C. (*N.*) *mutable*. A: Anterior region; B: Posterior region; C - D, C. (*N.*) *graminicola*. C: Anterior region; D: Stylet base. E: C. (*N.*) *acuticaudatum* stylet base. F - G, C. (*N.*) *californicum* population from Lyell with low, flat lip region. F: Anterior region; G: Postvulval region. Scale bar 1 - 50 μm for B, G. Scale bar 2 - 50 μm for A, 20 μm for C-F.

synonyms and in revisions (Taylor, 1936; Raski, 1952; Andrássy, 1963; Edward & Misra, 1964; Khan, 1964; Raski & Golden, 1966; Van den Berg, 1984; Yeates *et al.*, 1997). The species is unique in the subgenus in that in fresh and heat-killed females and juveniles the last two tail annules are fully retracted within the contour of the body giving these stages a short postvulval area and rounded posterior end that in the female is generally directed somewhat dorsally. In the New Zealand population the spermatheca is empty, but elsewhere many populations have been reported with sperm present (Yeates *et al.*, 1997). These characteristics in combination with a flexible first lip annule, generally directing anteriorly or laterally, more than 86 body annules, no lateral line on the postvulval region, a non-overlapping anterior vulval lip, and a 45-62 μm long stylet with a shaft less than 11 μm long and a base less than 11 μm wide, easily distinguish the species.

Criconema (Nothocriconemella) californicum Diab & Jenkins, 1966 (Figs. 2D-G & 3F-G)

Criconema (N.) californicum closely resembles *C. (N.) mutable* in the length of the stylet and the shaft of the stylet, the width of the stylet base, the number of body annules being more than 86, and the absence

of a lateral line on the postvulval region. It was synonymised with *C. (N.) mutable* by de Grisse (1967) but was recently re-established by Yeates *et al.* (1997), as a valid species with a conically pointed tail, a stylet more than 55 μm long and sperm in the spermatheca. Together with its S-shaped vagina, this combination of characters clearly distinguishes *C. (N.) californicum* from *C. (N.) mutable*. *Criconema (N.) californicum* is also similar to *C. (N.) pasticum*, the next species discussed. It shares with *C. (N.) pasticum* all the characters that separate it from *C. (N.) mutable*. According to the original descriptions, the only difference between *C. (N.) californicum* and *C. (N.) pasticum* is the length of the stylet, 55-74 μm and 73-82 μm , respectively. Comparison of material of the *C. (N.) californicum* and *C. (N.) pasticum* populations from New Zealand listed by Loof *et al.* (1997), revealed that the separation of these two species on the basis of their stylet lengths is somewhat arbitrary. Stylet lengths between populations varied from 56 to 90 μm . Within populations, however, stylet length was generally remarkably stable, varying within most populations by less than 6 μm , and populations could be subdivided according to stylet lengths of 56-65 μm , 60-65 μm , 65-74 μm (the majority), 75-83 μm and 80-90 μm . No additional characters, however, could be established to separate the first three groups with stylets

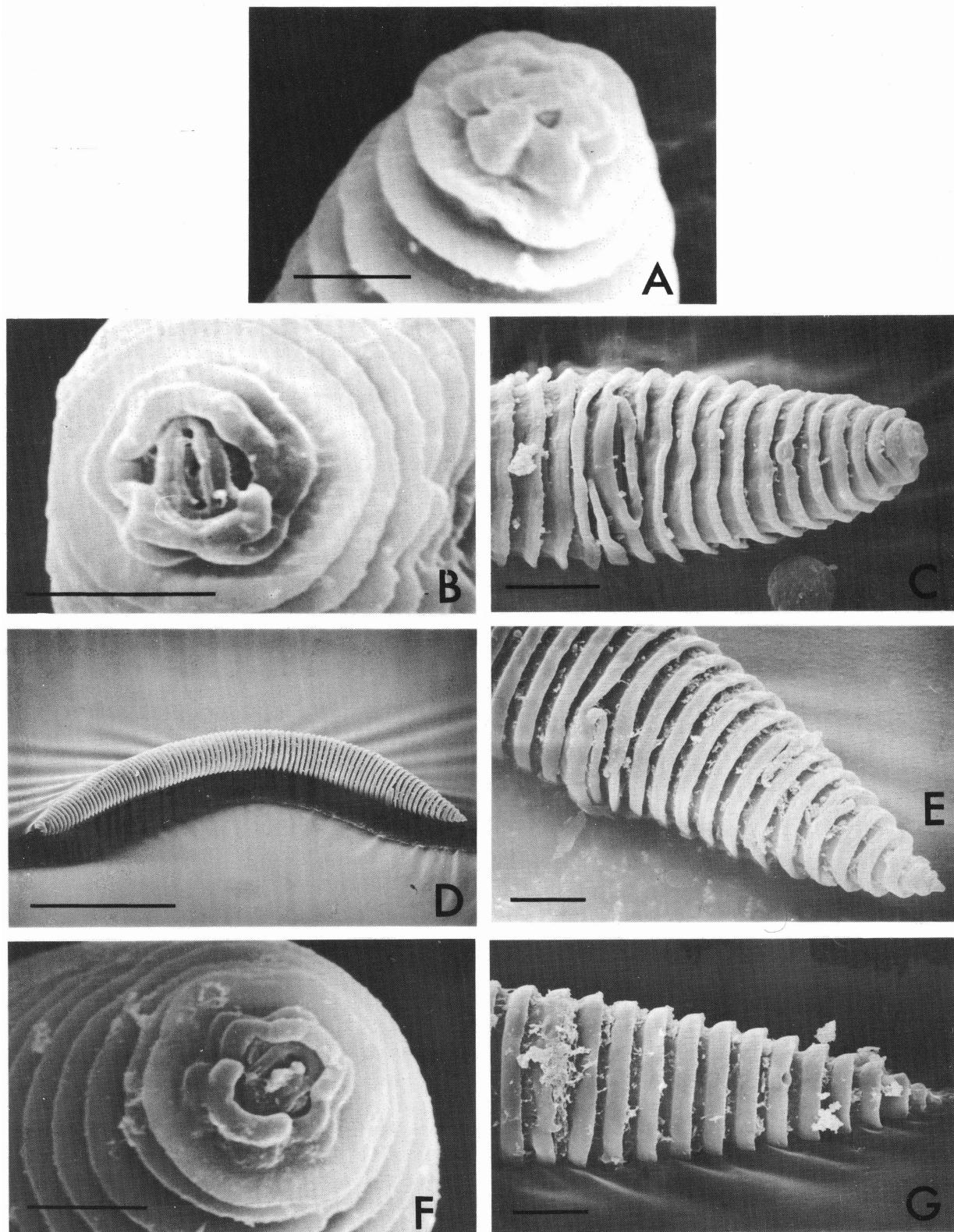


Fig. 4. Scanning electron micrographs *Criconema (Nothocriconemella)* females. A: *C. (N.) mutabile* face view. B-G, *C. (N.) alpinum*. B-C, Porters Pass population. B: Face view; C: Postvulval region. D-E, Haast Pass population. D: Entire; E: Postvulval region. F-G, Mt Lodestone population. F: Face view; G: Postvulval region. Scale bar - 5 µm for A, B, F; 10 µm for C, E, G, 0.1 mm for D.

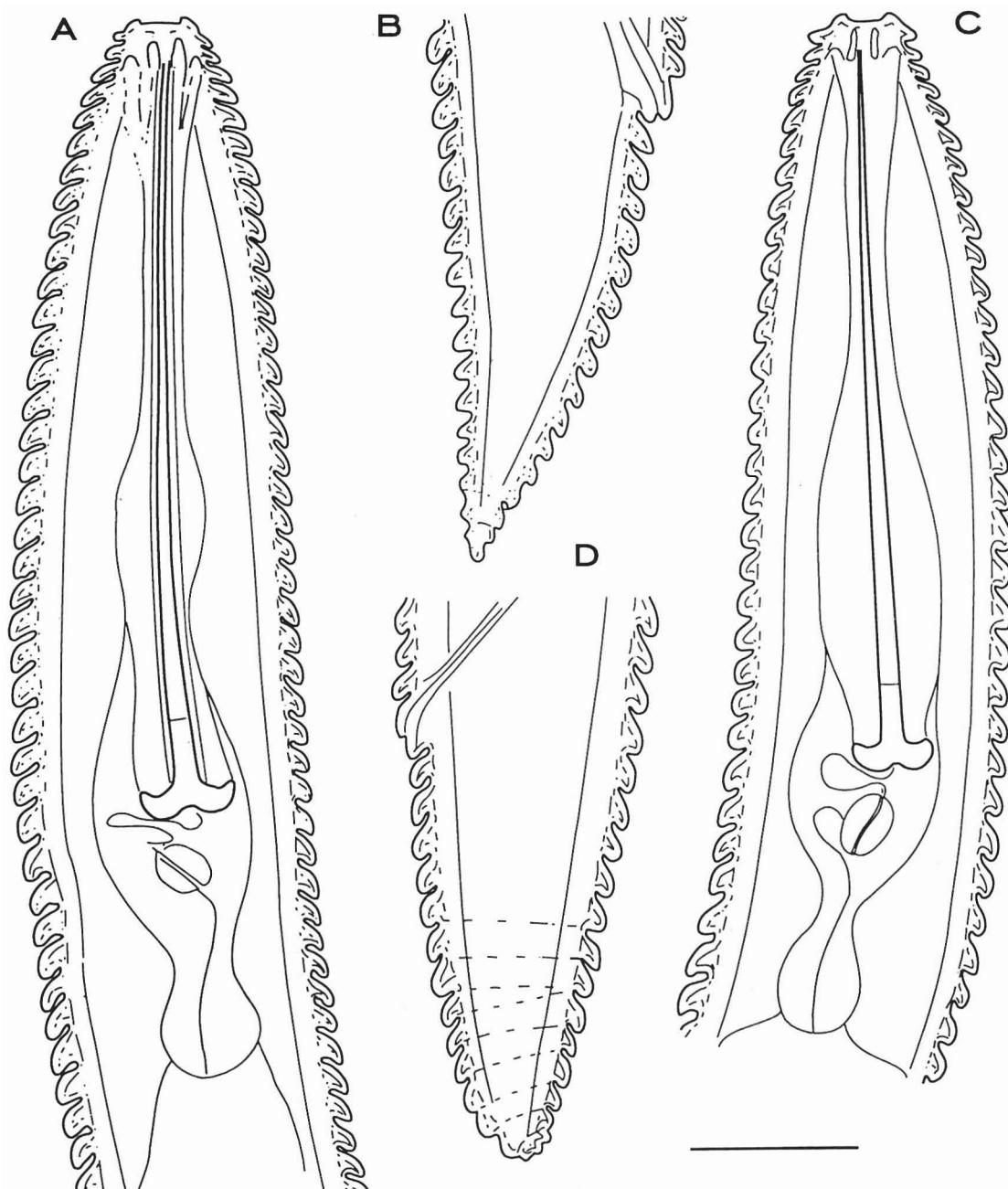


Fig. 5. *Criconema (Nothocriconemella)* females. A - B, C. (*N.*) *pasticum*. A: Anterior region; B: Postvulval region. C - D, C. (*N.*) *alpinum*. C: Anterior region; D: Postvulval region. Scale bar - 20 μm .

less than 74 μm (*C. (N.) californicum*), from the last two groups with stylets more than 74 μm long (*C. (N.) pasticum*). Differences in the size of the stylet bases, the edges of the body annules and the shape of the tail were observed between some populations, and occasionally a lateral groove was present, but these characters were inconsistent. It seemed that either *C. (N.) californicum* is a very variable species or it represents a group of closely related species. The only consistent difference between some popu-

lations was the width of the first lip annule. The lip region of *C. (N.) californicum* is narrow, being 10-12 μm (Loof *et al.*, 1997). In populations from the West Coast of the South Island at Lyell (NZMS 260 L29/277316), Greymouth (NZMS 260 J32/575467), and Haast (NZMS 260 F37/928933), and in individual specimens in a population from Rai Valley (NZMS 260 O27/584998), the first lip annule is 12.5-14 μm wide and is directed laterally or anteriorly as in *C. (N.) graminicola* but they differ from

the latter by the less robust stylet base. They also have a slightly sharper tail terminus, generally somewhat thicker lip annules and fewer (*c.* 90) and more angular body annules than typical *C. (N.) californicum*. Especially because of the low number of body annules, it was considered that they should belong to a new species until a population from Campbell Island was found with these characteristics but with 105 body annules, a number high even for *C. (N.) californicum*. Further examination of material from these populations may reveal characters that would identify them as separate species. Until then the *status quo* is maintained and populations with a stylet shorter than 74 µm are considered to be *C. (N.) californicum*, and those with a stylet of 74-90 µm, *C. (N.) pasticum*.

***Criconema (Nothocriconemella) pasticum*
(Raski & Pinochet, 1976) Raski & Luc, 1985
(Fig. 5A-B)**

Criconema (N.) pasticum most closely resembles *C. (N.) californicum*. These two species each have more than 86 body annules, the absence of a lateral line on the postvulval region, a conically pointed tail, and an S-shaped vagina.

Criconema (N.) pasticum can be distinguished from *C. (N.) californicum* by its longer stylet of more than 73 µm (73-82). Populations with the characteristics of these two species are common in New Zealand. In these populations the length of the stylet varies from 56-90 µm. With no other characters available to distinguish populations with a short stylet from populations with a longer stylet, all populations could be considered a single species. The stylet length within populations, however, is fairly stable, generally varying not more than 10 µm, indicating that probably more than one species is represented. Populations with an average stylet length of 74-90 µm are here considered *C. pasticum*.

***Criconema (Nothocriconemella) alpinum*
Loof, Wouts & Yeates, 1997
(Figs. 4B-G & 5C-D)**

Criconema (N.) alpinum females are about 0.33 mm long, stylet=85-99 µm, R=84-91, V=87-90% and PV=31-44 µm. The stylet with a base less than 11 µm wide and a shaft less than 11 µm long is not heavy. The lip region is high and seems to have a distinct basal ring on which the pseudolips are located and the first lip annule is directed sideways or somewhat posteriorly. The last tail annules are somewhat retracted, forming a blunt tail. There is no lateral line in the postvulval region. Populations differing from this description by having almost

pointed female tails and slightly higher numbers of body annules were obtained from soil under manuka (*Leptospermum scoparium*), Governors Bay, Havelock, Marlborough (NZMS 260 P27/913927); *Pentachondra pumila*, Makahu Spur, Kaweka Range (NZMS 260 U20/042077); black beech (*Nothofagus solandri*), Kaiteriteri, Nelson (NZMS 260 N26/113195); *Cassinia leptophylla* in mixed native forest, Redwood Pass Road, Blenheim, Marlborough (NZMS 260 P28/988581); whiteywood (*Melicrytus ramiflorus*), Lee Valley, Nelson (NZMS 260 N28/233777); *Dracophyllum* sp., Porters Pass, Canterbury (NZMS 260 K35/055673); and *Hebe* sp., Lake Wanaka, Southland (NZMS 260 F39/056425).

Populations from *Celmisia* species from the Mt Arthur/Mt Lodestone area (NZMS 260 M27/830987), native vegetation near Winton, Southland (NZMS 260 E45/491495), and *Hebe* sp. at Bluff, Southland (NZMS 260 E47/527892), and Beeman Point, Campbell Island (52°33'S, 169°08'E), have normally extended, pointed tails and if further characters are found that distinguish them from blunt tailed *C. (N.) alpinum* they could be recognised as a separate species.

Because of its stylet length of more than 85 µm, *C. (N.) alpinum* most closely resembles *C. (N.) pasticum*, but can be distinguished from this species by its lower number of body annules and generally less pointed tail terminus.

***Criconema (Nothocriconemella) graminicola*
Loof, Wouts & Yeates, 1997
(Figs. 3 C-D & 6A-B)**

Criconema (N.) graminicola females have a stylet length of 62-81 µm, overlapping the ranges of *C. (N.) californicum* and *C. (N.) pasticum*. *Criconema (N.) graminicola* can be distinguished from these two species by the lower number of body annules (73-86 vs 86-111) (Yeates *et al.*, 1997). It shares this character with *C. (N.) justum*, a species not known to be present in New Zealand, from which it can be distinguished by the greater number of annules on the postvulval region (11-14 vs 6). The number of body annules can vary considerably with some populations having very wide ranges, making identification difficult. An obvious supporting character for the identification of *C. (N.) graminicola* is the robust stylet with heavy stylet base relative to its length. Also, the rather flat, wide lip region with sideways or anteriorly directed first lip annule and distinctly retrose second lip annule distinguish *C. (N.) graminicola* from its closest relatives, *C. (N.) californicum* and *C. (N.) pasticum*. *Criconema (N.) graminicola* shares these characters with *C. (N.) acuticaudatum*, from which it can be distinguished

by a low lip region and less extended postvulval annules and smaller PV. *Criconema (N.) graminicola* has a sharp tail and no lateral line in the postvulval region.

***Criconema (Nothocriconemella) acuticaudatum* Loof, Wouts & Yeates, 1997
(Figs. 3E & 6C-D)**

Criconema (N.) acuticaudatum closely resembles *C. (N.) graminicola* in the size and shape of the stylet, the stylet base, the configuration of the lip region and the sharp tail and its general habitat (sub-alpine) and host (tussock grass; *Chionochloa* sp.). In general appearance these two species look identical. According to the original description *C. (N.) acuticaudatum* females are longer than *C. (N.) graminicola* females, the pseudolips are higher, there are more body annules (89-95 vs 73-86), and annules on the postvulval area are more extended making PV longer. Except for the size of the pseudolips and the extended postvulval annules, these characters are related to body length, and since *C. (N.) acuticaudatum* is generally larger than *C. (N.) graminicola* a greater number of annules on individual body parts and on the body overall, may be expected. Although the lip region of both these species is very similar, the first lip annule of *C. (N.) acuticaudatum* is not as distinctly anteriorly directed as in *C. (N.) graminicola*, and the resulting lip region, in side view, is less surrounded by the lip and is higher. The high pseudolips, together with the greater number of body annules ($R > 86$) and the more extended postvulval annules ($PV > 61$), reliably separate *C. (N.) acuticaudatum* from *C. (N.) graminicola*. *Criconema (N.) acuticaudatum* has so far been obtained only from Campbell Island and Auckland Islands.

Criconema (N.) acuticaudatum differs from *C. (N.) californicum* and *C. (N.) pasticum* by the wider, lower lip region, the robust stylet base of more than 11 μm width, the sharp and longer postvulval area (62-78 μm vs 33-62 μm), the extended but not fused tail annules and resulting more anterior position of the vulva, and the sharper tail terminus. There is no lateral line in the postvulval region.

***Criconema (Nothocriconemella) sphagni* Micoletzky, 1925
(Figs. 7A-B, 8H & 9A-B)**

Criconema (N.) sphagni is a rather long species reaching 0.6 mm in some specimens. It differs from *C. (N.) mutabile*, *C. (N.) californicum*, *C. (N.) pasticum*, *(N.) alpinum*, *C. (N.) graminicola* and *C. (N.)*

acuticaudatum by its long stylet of $> 102 \mu\text{m}$ with somewhat larger stylet base (9-11 μm wide) and longer shaft (11-14 μm). In general morphology, *C. (N.) sphagni* closely resembles *C. (N.) macilentum* but differs from it in the morphology of the lip region and the shape of the tail. The lip region generally resembles that of *C. (N.) mutabile* and is presented in a SEM photograph by Ebsary (1981). It consists of an elongated lip cap surrounded by six almost symmetrical pseudolips. The subdorsal and subventral lips are somewhat elevated and in lateral view slightly project from the lip region, but are not located on a basal ring. The first lip annule may be directed anteriorly, the second is directed laterally or is retrorse. The postvulval region is without a lateral line and is conical in shape and generally tapering regularly initially but more progressively posterior to the anus, making its ventral outline convex. This may be accentuated by a slight dorsal upturn of the tail terminus. In heat-killed material the annules of the postvulval region, like the body annules, are generally not extended.

***Criconema (Nothocriconemella) macilentum* (Raski & Pinochet, 1976)
Raski & Luc, 1985
(Figs. 7C-F, 8A-G & 9C-D)**

The measurements of 20 females of *C. (N.) macilentum* are presented in Table 1.

Criconema (N.) macilentum resembles *C. (N.) sphagni*. Their characters are so similar that until now not all populations could be confidently identified (Yeates *et al.* 1997). A detailed study of the type material was, therefore, carried out. Three paratypes were obtained from the University of California, Davis. In these specimens the cuticle has lifted from the body surface in the anterior and posterior region, seriously affecting the general appearance of these areas and the accuracy of their description and illustration in the original description.

The type material originated from a soil sample from Campbell Island. The original extraction from this sample is held by Landcare Research NZ. A search for further and better material from this sample led to the recovery of seven females and a juvenile. These specimens have a stylet but no body contents. In some of the specimens the anterior and posterior ends are almost completely intact. In these specimens the pseudolips are located on a basal ring, making them rather high, much higher than in *C. (N.) sphagni*, the stylet base is moderately heavy and the annules posterior to the vulva are more or less equally extended without being fused, causing the last four or five tail annules, and the tail generally,

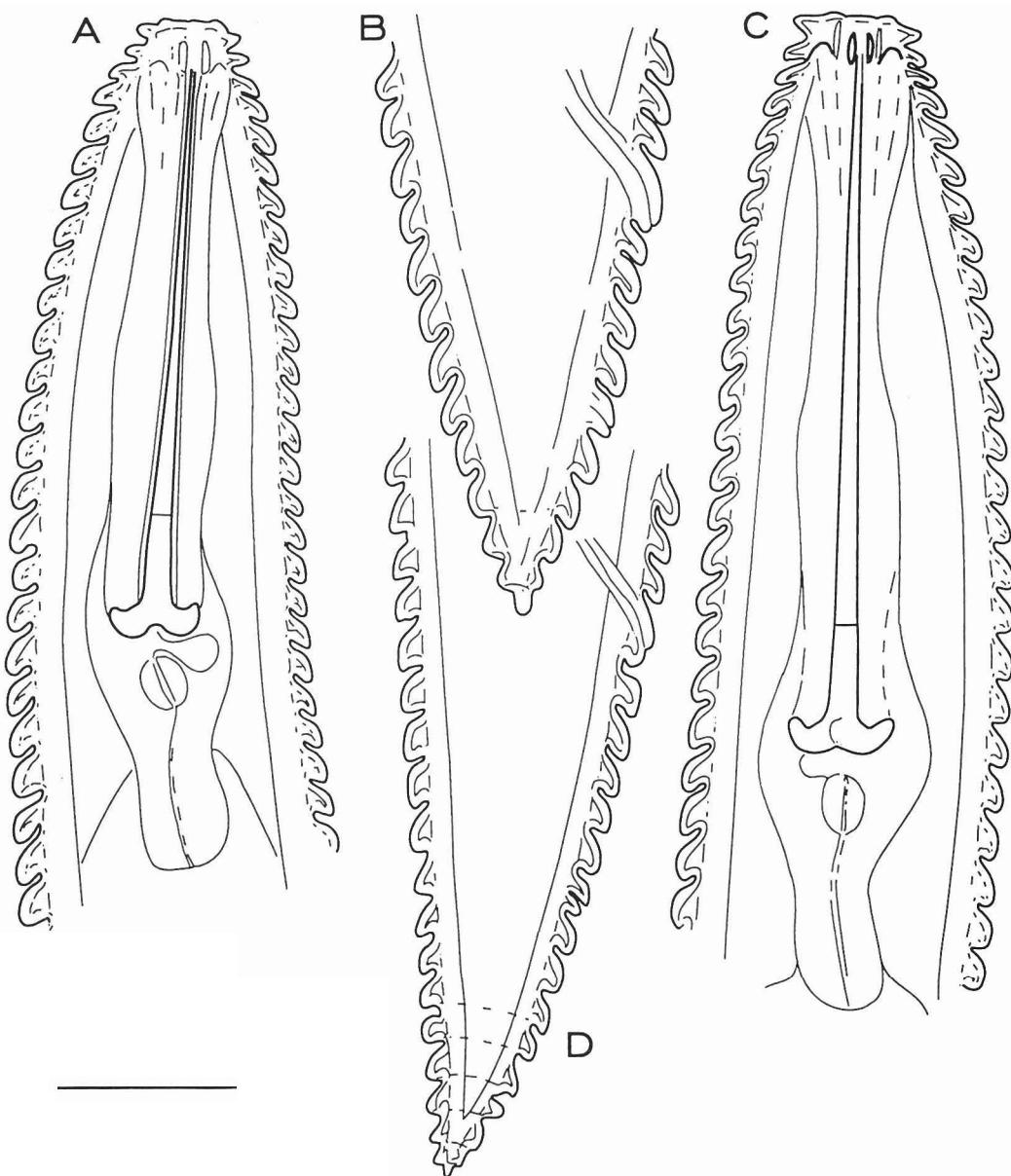


Fig. 6. *Criconema (Nothocriconemella)* females. A - B, *C. (N.) graminicola*. A: Anterior region; B: Postvulval region. C - D, *C. (N.) acuticaudatum*. C: Anterior region; D: Postvulval region. Scale bar - 20 μm .

to look distinctly more drawn out than in *C. (N.) sphagni*. The tail annules of the juvenile are even more extended and the tail more drawn out than in the females. There is no lateral line in the postvulval region.

Specimens from Auckland Island, another New Zealand subantarctic island, and from Fox Glacier, South Island, distinctly display both the high lip region and the typical, somewhat extended tail terminus with the last few annules protruding less than the body annules generally. The Fox Glacier material consists of four long females in which the number of body annules is about 120, the same as

reported for the type material of *C. (N.) macilentum*. The material from Auckland Island is more abundant but the specimens are shorter and the number of body annules is only about 105. Although this number is low it falls within the range of the seven empty specimens from the Campbell Island type locality. The Auckland Island specimens were therefore identified as *C. (N.) macilentum*. They are in excellent condition and their measurements are presented in Table 1. These specimens are clearly distinct from *C. (N.) sphagni* because of their narrow somewhat drawn out tail terminus and the retrose first lip annule in most specimens, which accentuates the

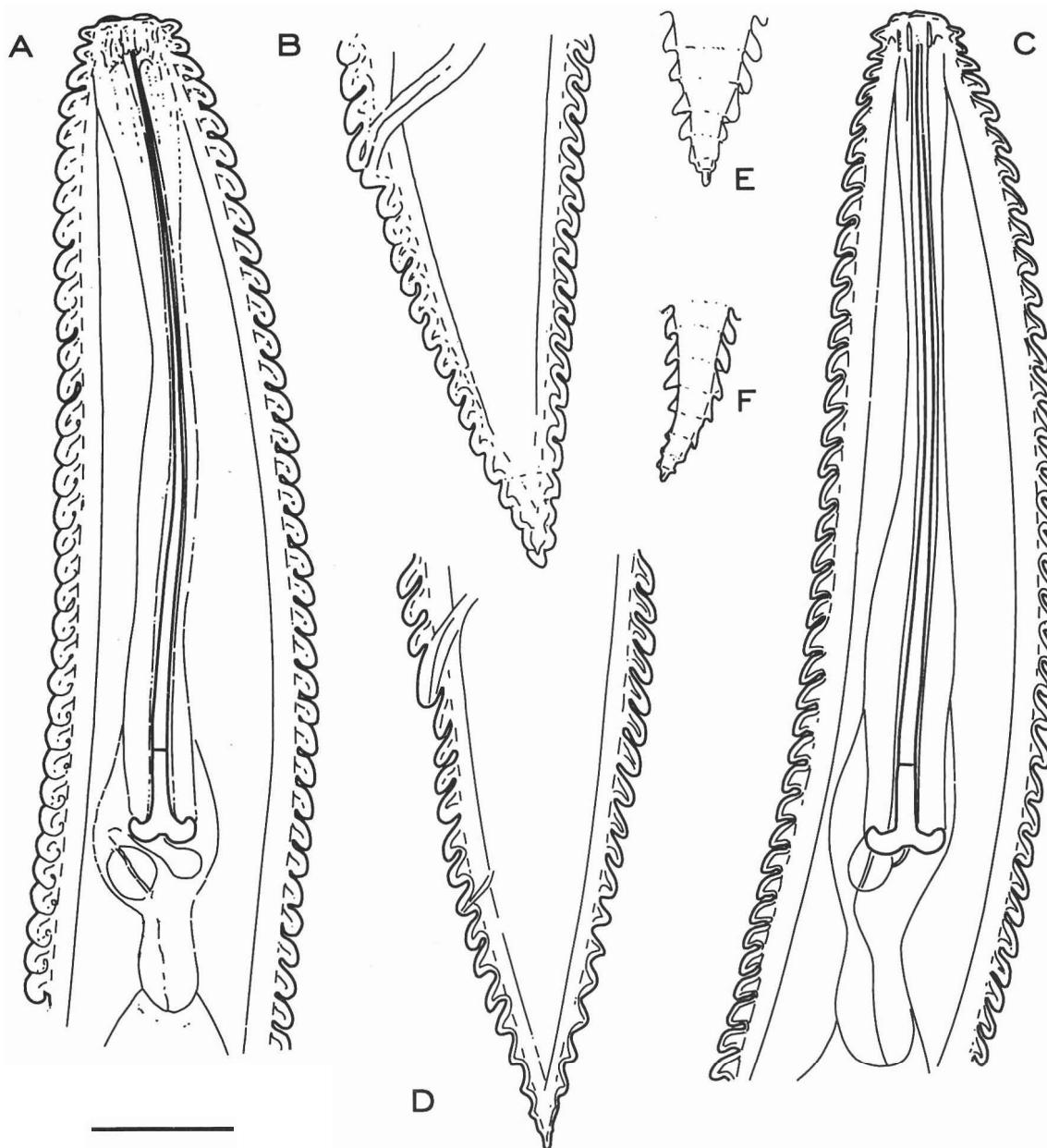


Fig. 7. *Criconema (Nothocriconemella)* females. A - B, *C. (N.) sphagni*. A: Anterior region; B: Postvulval region. C-F, *C. (N.) macilentum*. C: Anterior region; D: Postvulval region; E - F: Tail terminus variants. Scale bar - 20 μm .

high lip region with the pseudolips located on a basal ring which can be observed even with light microscopy. In some specimens, a slight indentation in the postvulval region is present, indicating the position of the lateral field, with the third or fourth annule from the terminus at times showing a deep groove. If further study reveals that this material differs from the Fox Glacier material, it will be likely that the Fox Glacier material is true *C. (N.) macilentum* and that the subantarctic population described here represents a new species.

Voucher specimens of this population have been distributed as in Table 2.

Origin of the voucher specimens: Native vegetation, Mt D'Urville and Mt Raynalt, Auckland Islands. Coll. J.A.K. Farrell, 4 Jan. 1973.

***Criconema (Nothocriconemella) crosbyi* sp. n.
(Figs. 8I-J, 10A-B & 11A-B)**

The measurements of the holotype and female paratypes of *C. (N.) crosbyi* sp. n. are presented in Table 1.

Body gently curved ventrad, tapering anteriorly from base of stylet and posteriorly from about 1 body width anterior to vulva. Occasionally, the anterior

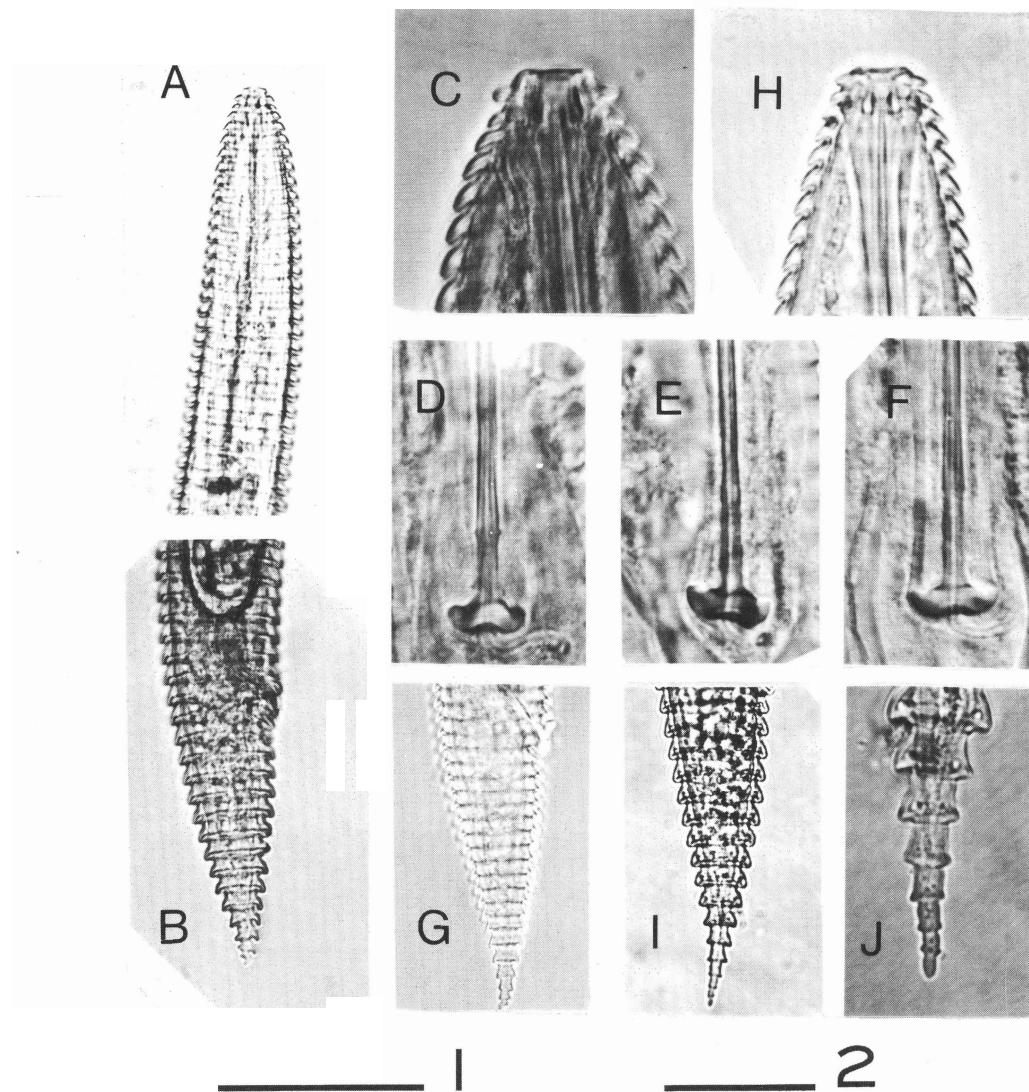


Fig. 8. *Criconema (Nothocriconemella)* females. A-G, *C. (N.) macilentum*. A: Anterior region; B: Posterior region; C: Anterior region, close up; D-F, Posterior parts of stylets. D: Fox Glacier population; E: Campbell Island population; F: Auckland Islands population. G: Postvulval region. H: *C. (N.) sphagni*, anterior region. Note the low labial region of *C. (N.) sphagni* (H) relative to *C. (N.) macilentum* (C). I - J, *C. (N.) crosbyi* sp. n. I: Postvulval region; J: Tail terminus. Scale bar 1 - 50 µm for B, G, I, 20 µm for C. Scale bar 2 - 50 µm for A, 20 µm for D-F, H, J.

tapering starts nearer to the lip region. Lateral lines or lateral field not observed. Lip region wide, compact. Lip cap low, with four distinct submedian pseudolips, not supported by hexagonal base-ring but seemingly resting immediately on anterior lip ring. Two lip annules of almost equal size, giving the lip region a somewhat cylindrical appearance. Lip annules narrower than first body annule. First lip annule retrorse or directing sideways, second lip annule retrorse. Except for last 4-6 tail annules, body annules retrorse, outer edge smooth with minute hairs or particulate matter adhering to it, in some specimens one or two anastomoses present. Last 4-6 tail annules extended, cylindrical and fused to form narrow, digital terminus, through absence of protrusions set off from rest of the tail. Head sclerotisation

prominent. Stylet straight, apparently rigid. Ovaries straight, sometimes reflexed, not reaching base of oesophagus. Vulval slit wide, closed, anterior vulval lip overlapping posterior lip, slightly extending outside body contour of the animal. Spermatheca oval to rounded, offset, ventrad, filled with small sperm c. 1 µm in diameter. Anus distinct.

Males. Not observed.

Type locality and host. *Bulbinella* sp., South side top of small island off Ramp Point, Campbell Island (52°32'S, 169°02'E), New Zealand.

Type material. Holotype and 113 paratypes from the type locality, coll. T. K. Crosby, 4 December 1975. Holotype on slide 167, National Nematode

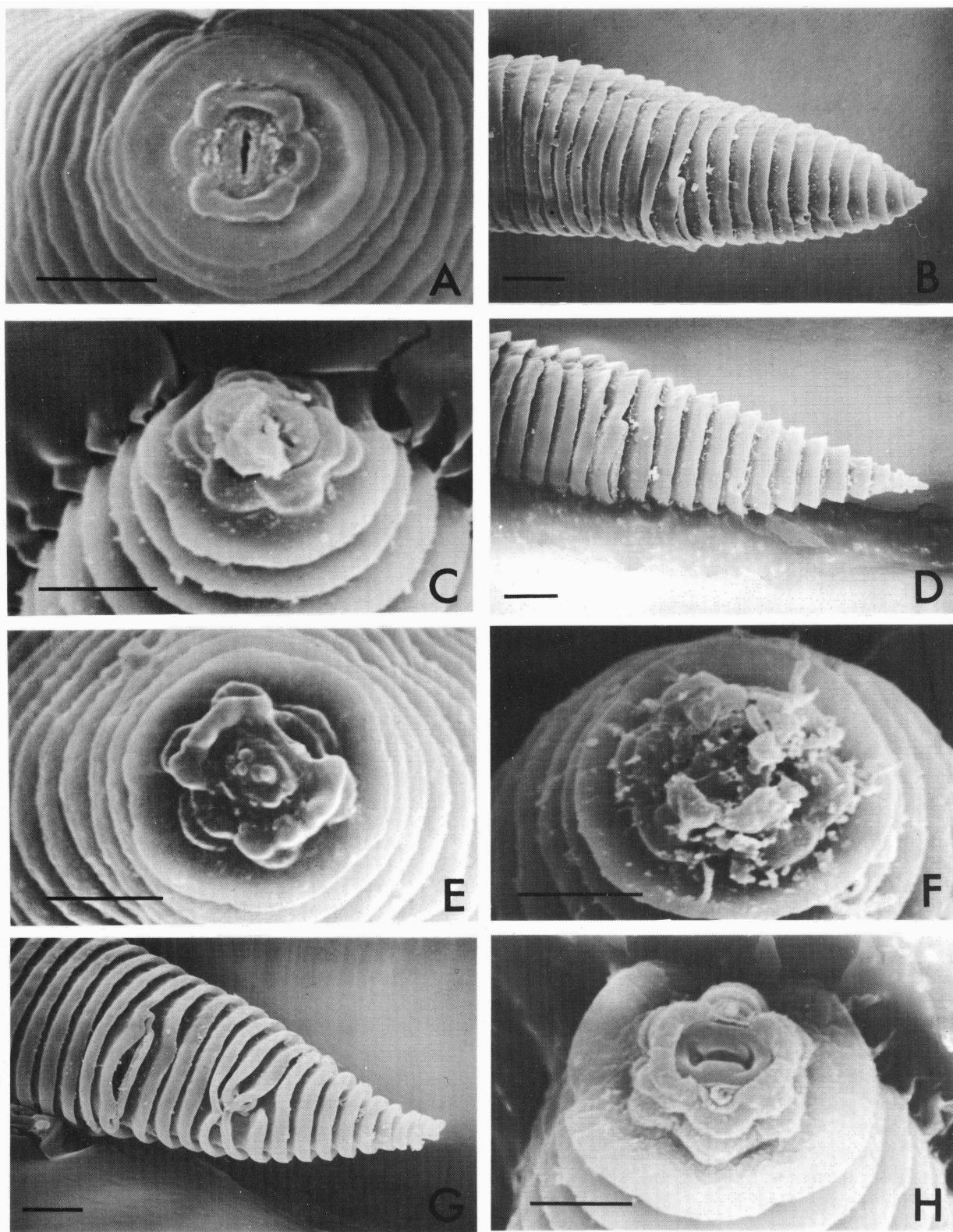


Fig. 9. Scanning electron micrographs *Criconema (Nothocriconemella)* females. A-B, C. (*N.*) *sphagni*. A: Face view; B: Postvulval region. C-D, C. (*N.*) *macilentum*. C: Face view; D: Postvulval region. E-G, C. (*N.*) *dugdalei* sp. n. E-F: Face views; G: Postvulval region. H: C. (*N.*) *farrelli* sp. n. face view. Scale bar - 5 µm for A, C, E, F, H, 10 µm for B, D, G.

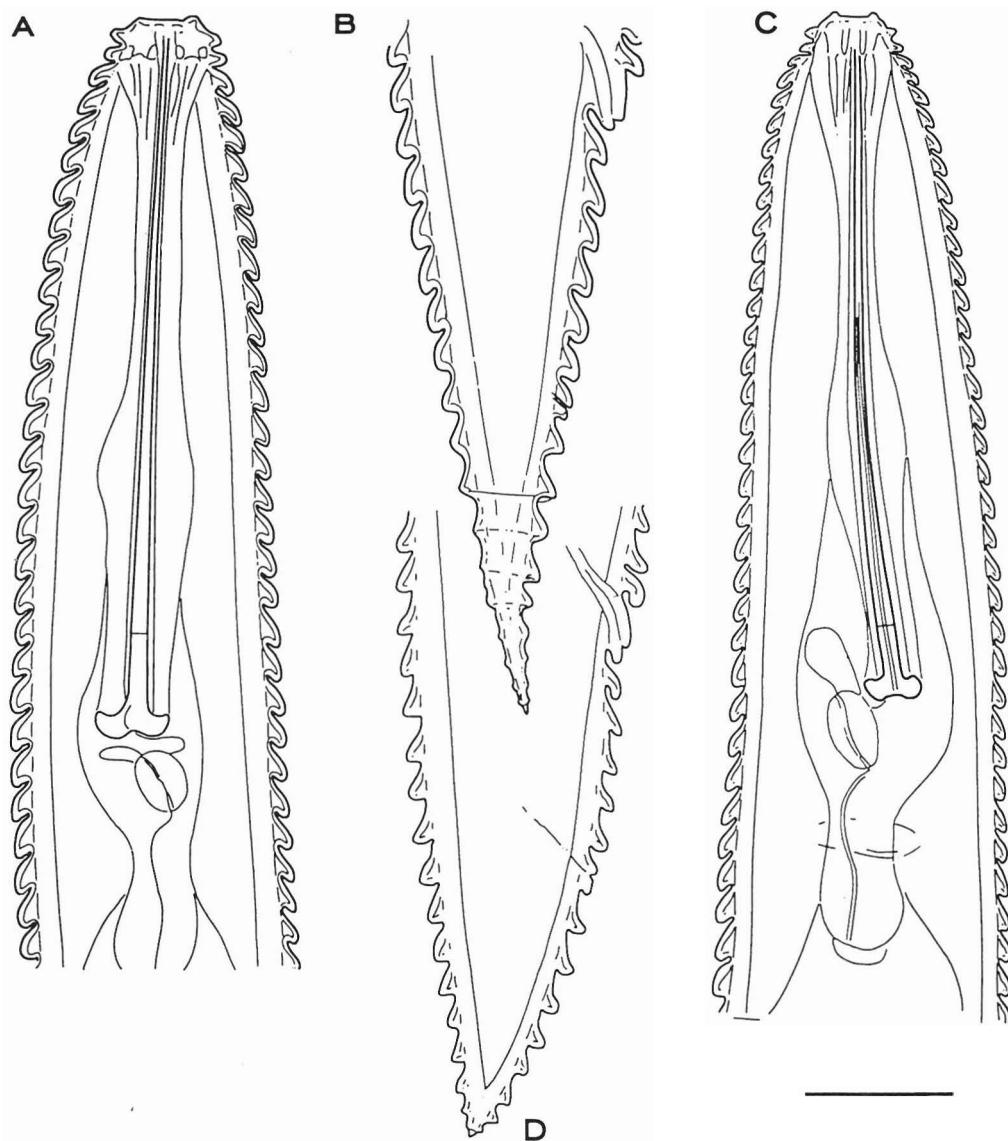


Fig. 10. *Criconema (Nothocriconemella)* females. A - B, C. (*N.*) *crosbyi* sp. n. A: Anterior region; B: Postvulval region. C - D, C. (*N.*) *farrelli* sp. n. C: Anterior region; D: Posterior region. Scale bar - 20 μm .

Collection of New Zealand (NNCNZ), Landcare Research, Auckland. Paratypes distributed as indicated in Table 2.

Differential diagnosis. *Criconema (Nothocriconemella) crosbyi* sp. n. can be distinguished from all other species of the subgenus by the fused, extended posterior annules of the female tail, forming a digital tail terminus.

Criconema (Nothocriconemella) farrelli sp. n. (Figs. 9H, 10C-D & 12A-D)

The measurements of the holotype and female paratypes of *C. (N.) farrelli* sp. n. are presented in Table 1.

Body longer than in most other species of the subgenus, gently curved ventrad, tapering anteriorly from base of stylet and posteriorly from about one body width anterior to level of vulva. Lateral lines of lateral field not observed. Outline of annules with faint undulations in most specimens, especially in the lateral region. Faint indentations in the lateral field of some annules of the tail present in some specimens. The morphology of the lip region and the flexibility and size of the first lip annule, resemble that of *C. (N.) californicum*. Lip cap high, with four distinct submedian pseudolips resting on hexagonal base-ring which rests on first lip annule. First lip annule crenate, generally retrorse, but may be directed outward or somewhat forward. Second lip annule retrorse, intermediate in size between first lip

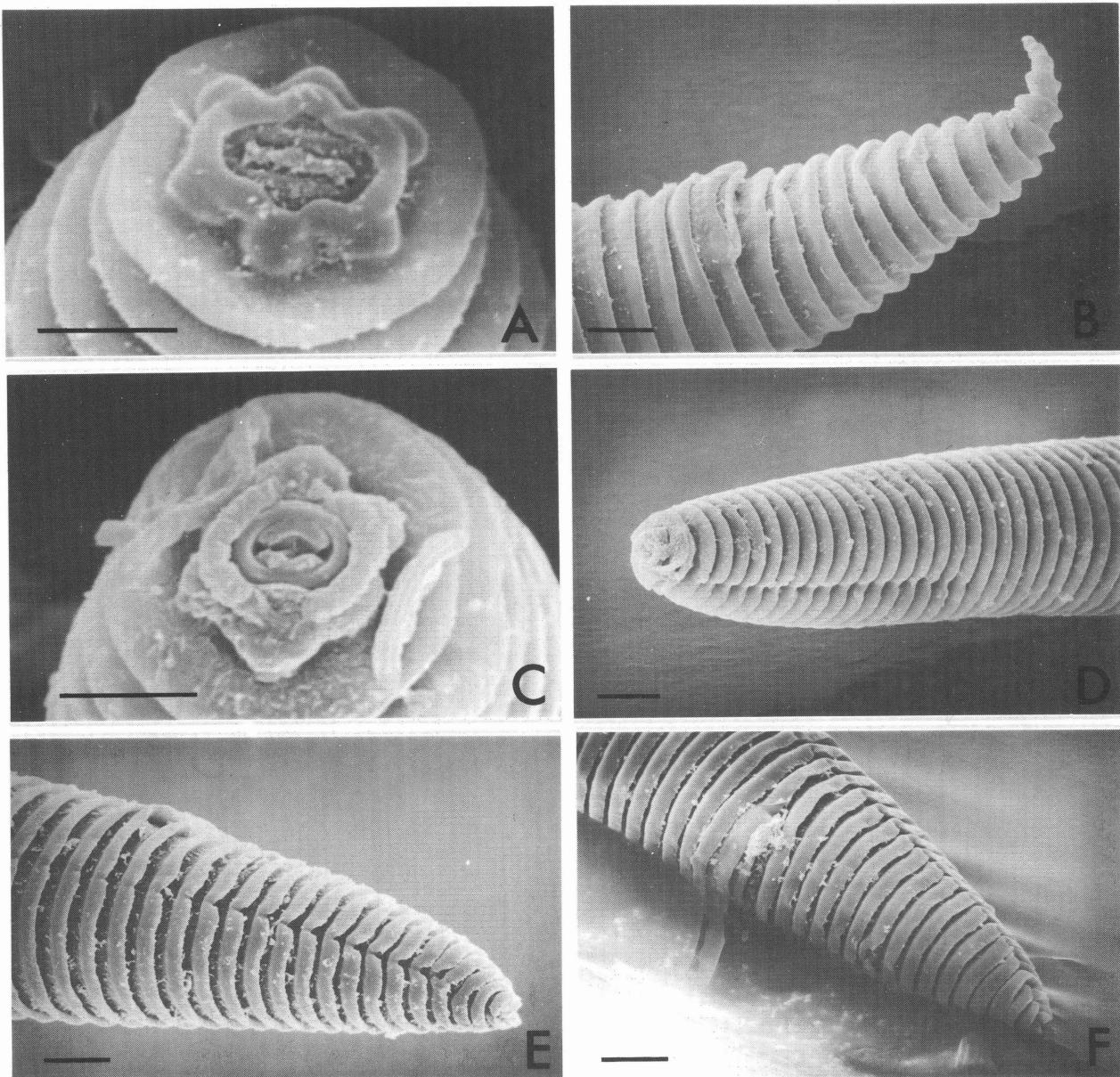


Fig. 11. Scanning electron micrographs *Criconema (Nothocriconemella)* females. A-B, C. (*N.*) *crosbyi* sp. n. A: face view; B: postvulval region. C-F, C. (*N.*) *ramsayi* sp. n. C: Face view; D: Anterior region; E: Postvulval region, lateral view; F: Postvulval region subventral view. Scale bar - 5 µm for A, C, 10 µm for B, D, E, F.

annule and first body annule. Body annules retrorse, outer edge without hairs or particulate matter adhering to it, anastomoses rare. Excretory pore obscure in most specimens. Cephalic sclerotisation distinct. Stylet straight in most specimens, flexible, stylet base narrow, delicate compared to the length of the stylet. Ovaries generally with double flexure, in some specimens reaching base of oesophagus. Vulval slit wide, closed, anterior vulval lip overlapping posterior lip, almost continuous with body contour of animal. Body tapering gradually posterior to vulva. Spermatheca oval to round, offset, ventrad,

filled with small sperm c. 1 µm in diameter. Anus distinct. Tail annules not fused, tail conically pointed, gently turned dorsad in most specimens. Last 2-3 tail annules not set off from rest of tail, generally less far extended than annules on rest of body.

Males. Not observed.

Type locality and host. Native vegetation, Mt D'Urville, Auckland Islands (50°41'S, 166°05'E).

Type material. Holotype and 54 paratypes from the type locality, coll. J.A.K. Farrell, 4 January 1973.

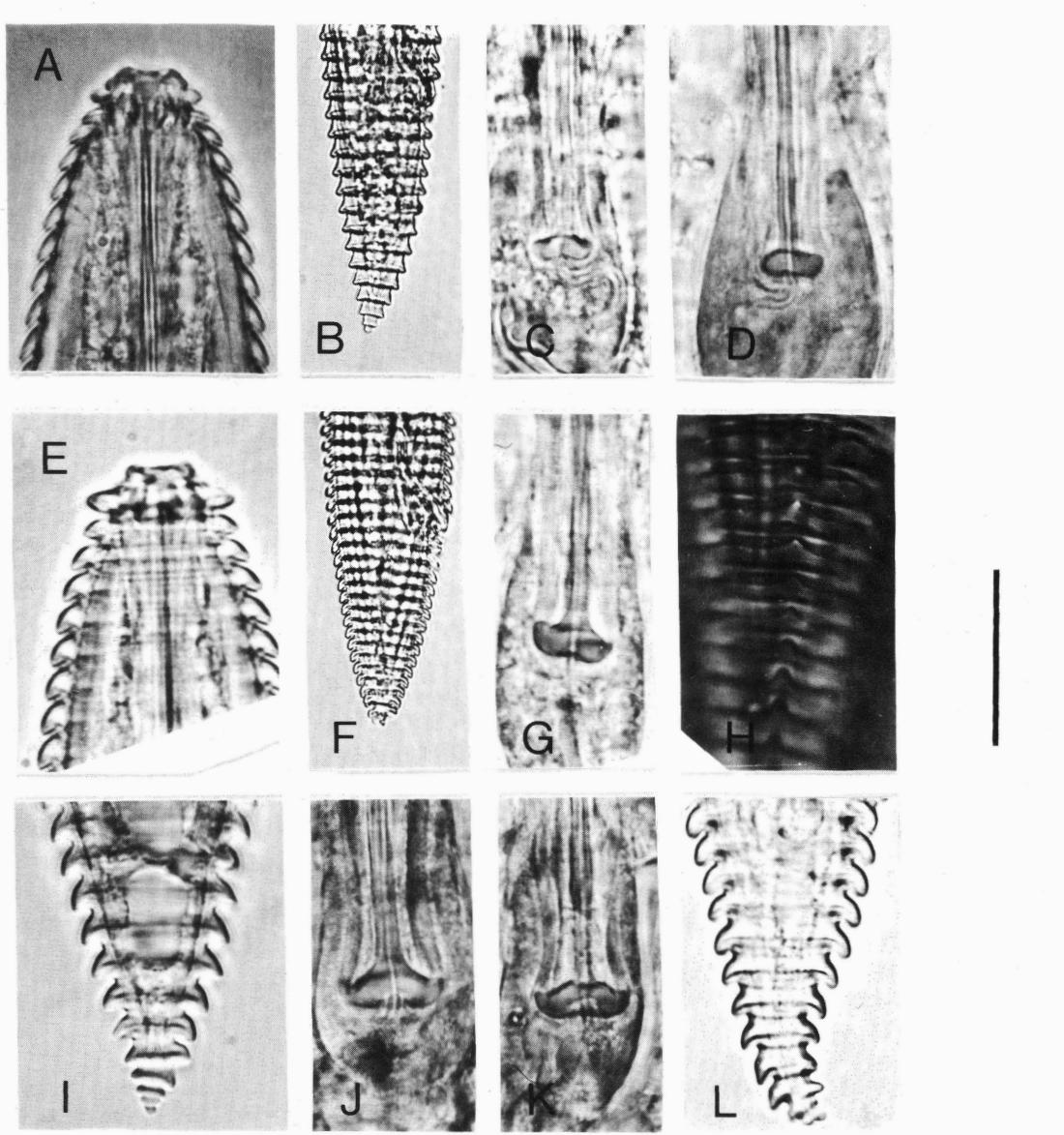


Fig. 12. *Criconema (Nothocriconemella)* females. A-D, C. (*N.*) *farrelli* sp. n. A: Anterior region; B: Postvulval region. C - D: Stylet base of two specimens. E-H, C. (*N.*) *ramsayi* sp. n. E: Anterior region; F: Postvulval region; G: Stylet base; H: Lateral field with groove on tail. I-L, C. (*N.*) *dugdalei* sp. n. I: Tail; J: Stylet base Mt Dundas population; K: Stylet base Mt Domett population; L: Tail. Scale bar - 50 μm for B, F, 20 μm for A,C-E,G-L.

Holotype on slide 169 National Nematode Collection of New Zealand, Landcare Research, Auckland. Paratypes distributed as indicated in Table 2.

Differential diagnosis. *Criconema (N.) farrelli* sp. n. closely resembles *C. (N.) alpinum*, *C. (N.) sphagni* and *C. (N.) macilentum* but can be distinguished from these species by the narrow stylet base of less than 9 μm wide and the more than 0.50 mm long body. It can also be distinguished from *C. (N.) alpinum* by the greater number of annules on the body ($R=110-124$ vs 83-91) and the postvulval region ($RV=15-19$ vs 10-13). It can further be distinguished from *C. (N.) sphagni* by the shorter stylet, high lip cap and

prominent median lobes, and from *C. (N.) macilentum* by the less extended tail terminus.

Criconema (Nothocriconemella) ramsayi sp. n. (Figs. 11C-F, 12E-H & 13A-B)

The measurements of the holotype and female paratypes of *C. (N.) ramsayi* sp. n. are presented in Table 1.

Body gently curved ventrad, tapering anteriorly from base of stylet and posteriorly from about one body width anterior to level of vulva. Lateral line of lateral field distinctly present on the annules posterior to the vulva, gradually disappearing anterior to

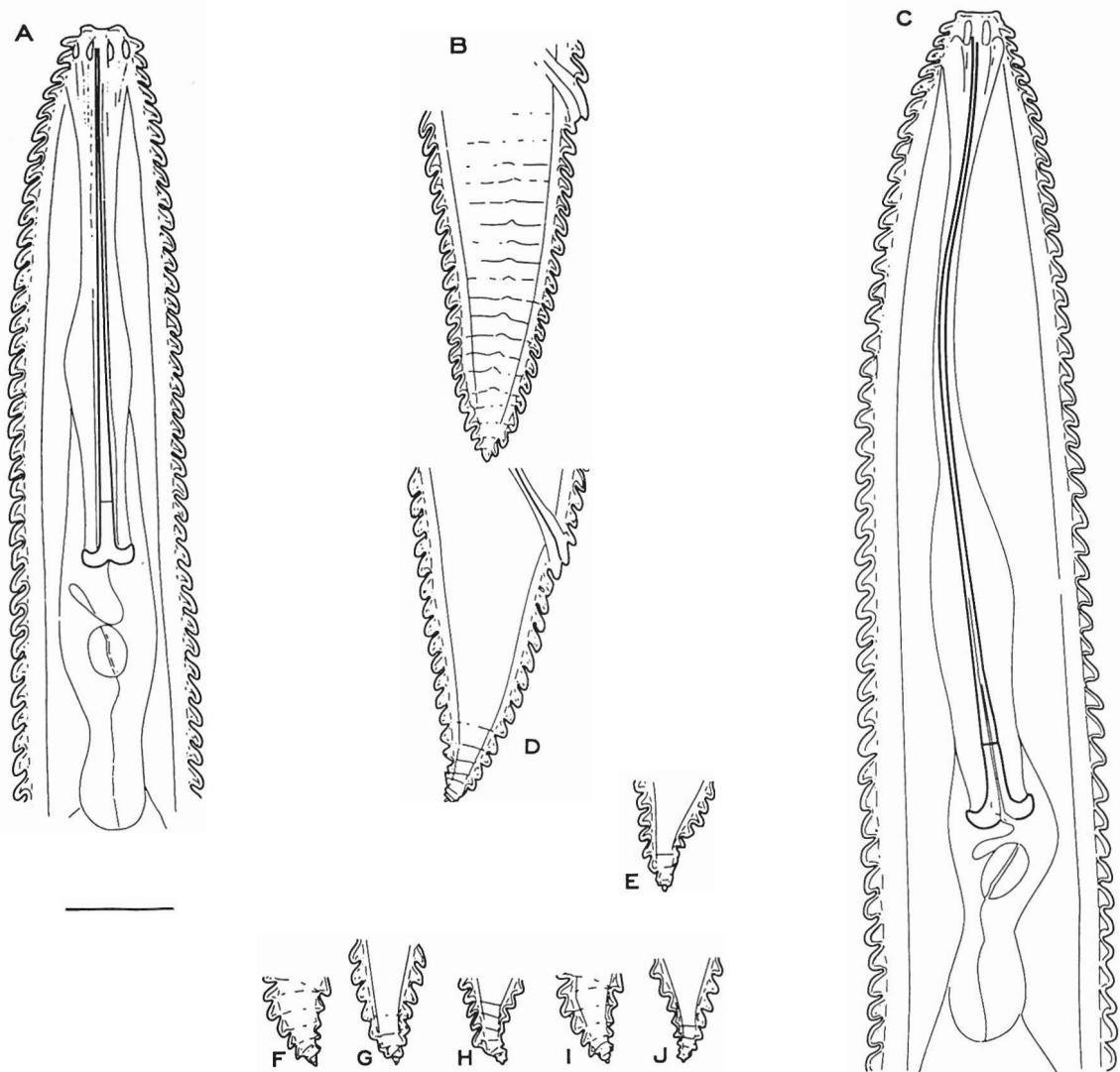


Fig. 13. *Criconema (Nothocriconemella)* females. A - B, C. (*N.*) *ramsayi* sp. n. A: Anterior region; B: Postvulval region. C-J, C. (*N.*) *dugdalei* sp. n. C: Anterior region; D: Postvulval region; E-J: Tail terminus variants. Scale bar - 20 μm .

the vulva, not observed anterior to midbody. Lip cap with four distinct submedian pseudolips resting on hexagonal base-ring which rests on first lip annule. First lip annule, generally directed slightly anteriorly or sideways, rarely retrose. Second lip annule retrose, occasionally directed sideways or anteriorly, intermediate in size between first lip annule and first body annule. Body annules retrose, outer edge without hairs or particulate matter adhering to it, some particulate matter trapped between most annules, anastomoses rare. Excretory pore obscure in most specimens. Cephalic sclerotisation heavy. Stylet straight, probably rigid, stylet base well developed. Ovaries generally with double flexure, in some specimens reaching base of oesophagus. Vulval slit wide, closed, anterior vulval lip overlapping posterior lip, almost continuous with body contour of animal. Body tapering gradually

posterior to vulva, more acutely posterior to anus giving both dorsal and ventral side a convex appearance. Spermatheca oval to round, offset, ventrad, filled with small sperm c. 1 μm in diameter. Anus distinct. Tail conically pointed. Last 2-3 tail annules not set off from rest of tail, generally partially extended like on rest of body, often irregularly divided. Tail terminus conically pointed, generally not turned dorsad.

Males. Not observed.

Type locality and host. Lancewood (*Pseudopanax crassifolius*) in native vegetation, opposite radio mast, Hokitika (NZMS 260 J32/576465).

Type material. Holotype and 110 paratypes from the type locality, coll. W.M. Wouts, 16 October, 1971. Holotype on slide 170, National Nematode

Collection of New Zealand, Landcare Research, Auckland. Paratypes distributed as indicated in Table 2.

Differential diagnosis. *Criconema (N.) ramsayi* sp. n. closely resembles the *Nothocriconemella* species with an average stylet length of about 100 µm. It can be distinguished from them by the distinct lateral groove present posterior to the level of the vulva and the greater value for RV. It can be further distinguished from *C. (N.) sphagni* and *C. (N.) macilentum* by the shorter stylet and the less drawn out tail terminus and from *C. (N.) sphagni* by the high lip cap and prominent median lobes. It can be further distinguished from *C. (N.) farrelli* sp. n. by the heavier stylet base and the less drawn out tail terminus and from *C. (N.) crosbyi* sp. n. by the absence of fused tail annules.

Criconema (Nothocriconemella) dugdalei sp. n. (Figs. 9E-G, 12I-L & 13C-J)

The measurements of the holotype and female paratypes of *C. (N.) dugdalei* sp. n. are presented in Table 1.

Body somewhat wider than in most other members of the subgenus, gently curved ventrad, tapering anteriorly from base of stylet and posteriorly from about midbody. Lateral lines of lateral field not observed. Faint indentations on some annules of the tail present in some specimens. Lip cap with four distinct submedian pseudolips resting on hexagonal base-ring which rests on first lip annule. Both lip annules retrorse. Second lip annule continuous with body annules, recognisable as lip annule only by its position over the cephalic framework, intermediate in size between first lip annule and first body annule. Body annules retrorse, outer edge smooth without hairs or particulate matter adhering to it, anastomoses rare. Cephalic sclerotisation prominent. Stylet flexible, base wide and heavy. Ovaries generally with double flexure, in some specimens reaching stylet base. Spermatheca oval to round, offset, ventrad, filled with small sperm c. 1 µm in diameter. Vulval slit wide, closed, anterior vulval lip overlapping posterior lip, slightly extending outside body contour of animal. Body abruptly narrowing somewhat immediately posterior to vulva. Annules posterior to vulva not extending progressively. Anus distinct. Last 4-6 tail annules not fully extended and fused, not set off from rest of tail, somewhat irregular in appearance in most specimens, partially extended like rest of tail annules, rarely fully extended. Tail terminus conically pointed, turned dorsad in most specimens.

Males. Not observed.

Type locality and host. *Olearia colensoi*, Mt Domett, 4200', Nelson (NZMS 260 M26/521158).

Type material. Holotype and 35 paratypes from the type locality, coll. J.S. Dugdale 2 December 1971. Holotype on slide 168, National Nematode Collection of New Zealand (NNCNZ), Landcare Research, Auckland. Paratypes distributed as indicated in Table 2.

Other hosts and localities. *Olearia colensoi*, Dundas Hut spur, Northern Tararuas, (NZMS 260 S25/183515), coll. G.W. Ramsay, 13 February 1985. *Olearia hyallii*, Penguin Creek, The Snares Islands, lat 48° 02', long 166° 36', coll. D.S. Horning Jr, 11 March 1971.

Differential diagnosis. *Criconema (N.) dugdalei* sp. n. most closely resembles *C. (N.) sphagni* and *C. (N.) macilentum* from which it can be distinguished by the heavy stylet base 11 µm wide. It can further, be distinguished from *C. (N.) sphagni* by the high lip cap and prominent, raised, sublateral pseudolips and from *H. macilentum* by the plumper body and the less drawn out dorsally curved tail terminus.

Remark. This species was found in three localities in association with *Olearia* species of the *colensoi* group, in the North Island (Mt Dundas), in the South Island (Mt Domett) and on The Snares Islands. The population of the South Island has longer specimens with longer stylets than the other populations. As body and stylet lengths vary considerably within the species of the genus generally, these differences are considered population variations.

The base of the stylet as a diagnostic character

Species of the family Criconematidae are identified by the length of the stylet and characters of the head and the tail. The size and shape of the base of the stylet are generally not used as diagnostic characters. It was, therefore, assumed that for Criconematidae generally a longer stylet would represent a heavier stylet base. In *C. (N.) farrelli* sp. n., however, the base is too small relative to the length of the stylet, for this assumption to be correct. To determine if there is a direct relationship between the size of the stylet base and the length of the shaft of the stylet, the dimensions of the stylet base and the length of the shaft were measured for ten specimens of each of the species studied in this paper. The averages presented in Fig. 14 show that both length and width of the stylet base are proportionate to the

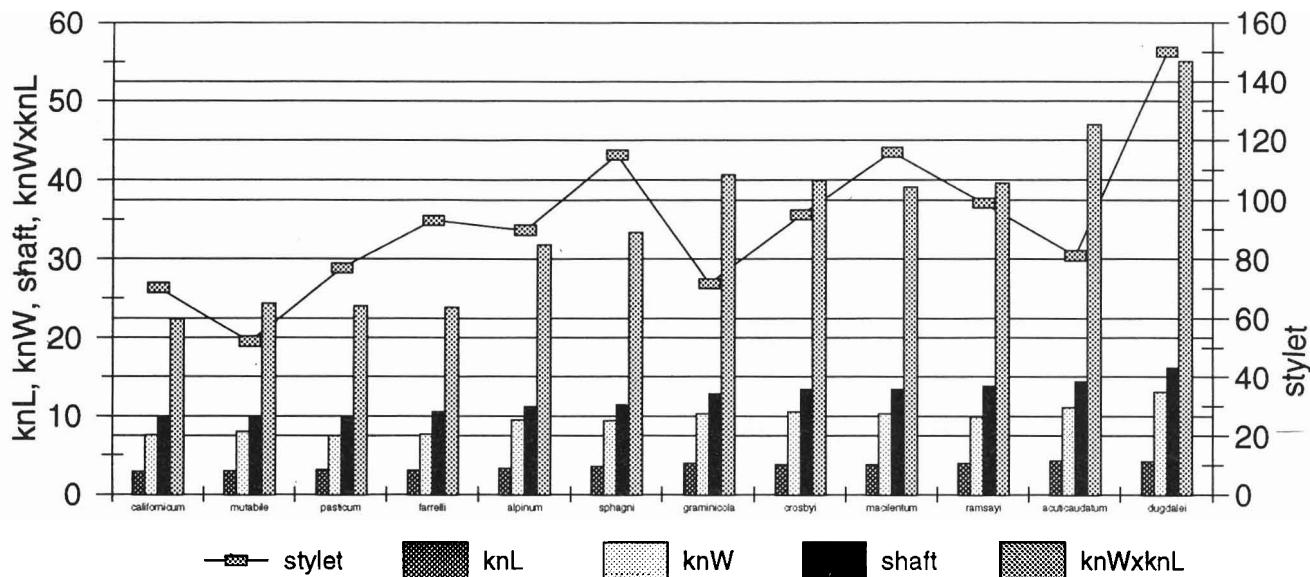


Fig. 14. Stylet length, height (knL) and width (knW) of the stylet base, length of the shaft of the stylet and the knLxknW product arranged in sequence of increasing length of the shaft of the stylet.

length of the shaft of the stylet. However, the low values do not demonstrate clearly this relationship. Length and width values were therefore multiplied, to obtain a measure for the size of the base. Presented in Fig. 14 in order of shaft length, the relationship between the stylet base size and the length of the shaft of the stylet becomes immediately apparent. The absence of a correlation between base size and stylet length is equally obvious. There is almost no difference in stylet base size between *C. (N.) californicum*, *C. (N.) mutable*, *C. (N.) pasticum* and *C. (N.) farrelli* sp. n. with a gradual increase in base size from *C. (N.) alpinum* through *C. (N.) sphagni*, *C. (N.) graminicola*, *C. (N.) crosbyi* sp. n., *C. (N.) macilentum* and *C. (N.) ramsayi* sp. n. to *C. (N.) acuticaudatum* and a very large base in *C. (N.) dugdalei* sp. n. a trend closely followed by the length of the shaft of the stylet. The value of the shaft of the stylet effectively separates an extreme like *C. (N.) farrelli* sp. n. with the small stylet base from *C. (N.) acuticaudatum*, a species with a similar stylet length but with a heavy stylet base.

Diagnosis of the *Nothocriconemella* species present in New Zealand

The characters of the stylet base, cephalic region and postvulval region for each of the species studied in this paper are presented in Fig. 15, in sequence of the length of the shaft of the stylet and size of stylet base.

Criconema (N.) mutable, *C. (N.) californicum*, *C. (N.) pasticum* and *C. (N.) farrelli* sp. n. are species

with a small stylet base (Fig. 15A-L). Of these, *C. (N.) mutable* is distinct by the short blunt tail terminus and straight vagina. Also, its lip region is rather flat which may be caused by a somewhat rigid first lip annule of which the edges are more or less fixed in lateral direction. In this characteristic it resembles *C. (N.) graminicola*, but is smaller in size and has a smaller stylet base. In some *C. (N.) californicum* populations, single specimens possess the rigid lip configuration of *C. (N.) mutable*, with a population from Lyell consisting solely of specimens with such lip configuration, but generally in *C. (N.) californicum*, *C. (N.) pasticum* and *C. (N.) farrelli* sp. n. the first lip annule is more delicate, most commonly folding posteriad. *Criconema (N.) farrelli* sp. n. is unique because of its long stylet relative to the size of the stylet base and *C. (N.) californicum* and *C. (N.) pasticum* can be distinguished from each other by their different stylet lengths.

Criconema (N.) alpinum, *C. (N.) crosbyi* sp. n., *C. (N.) sphagni*, *C. (N.) macilentum*, *C. (N.) ramsayi* sp. n., *C. (N.) graminicola* and *C. (N.) acuticaudatum* are species with a moderately heavy stylet base (Fig. 15M-X). Of these species, *C. (N.) crosbyi* sp. n. is very distinct because of its attenuated tail terminus, and *C. (N.) ramsayi* sp. n. because of the lateral line on the postvulval region. *Criconema (N.) ramsayi* sp. n. particularly resembles *C. (N.) sphagni*, but the lip region and stylet base are more robust, the stylet is shorter and the postvulval region has consistently more annules, has a lateral groove and looks somewhat swollen. *Criconema (N.) alpinum* can be distinguished from *C. (N.) sphagni* and *C. (N.)*

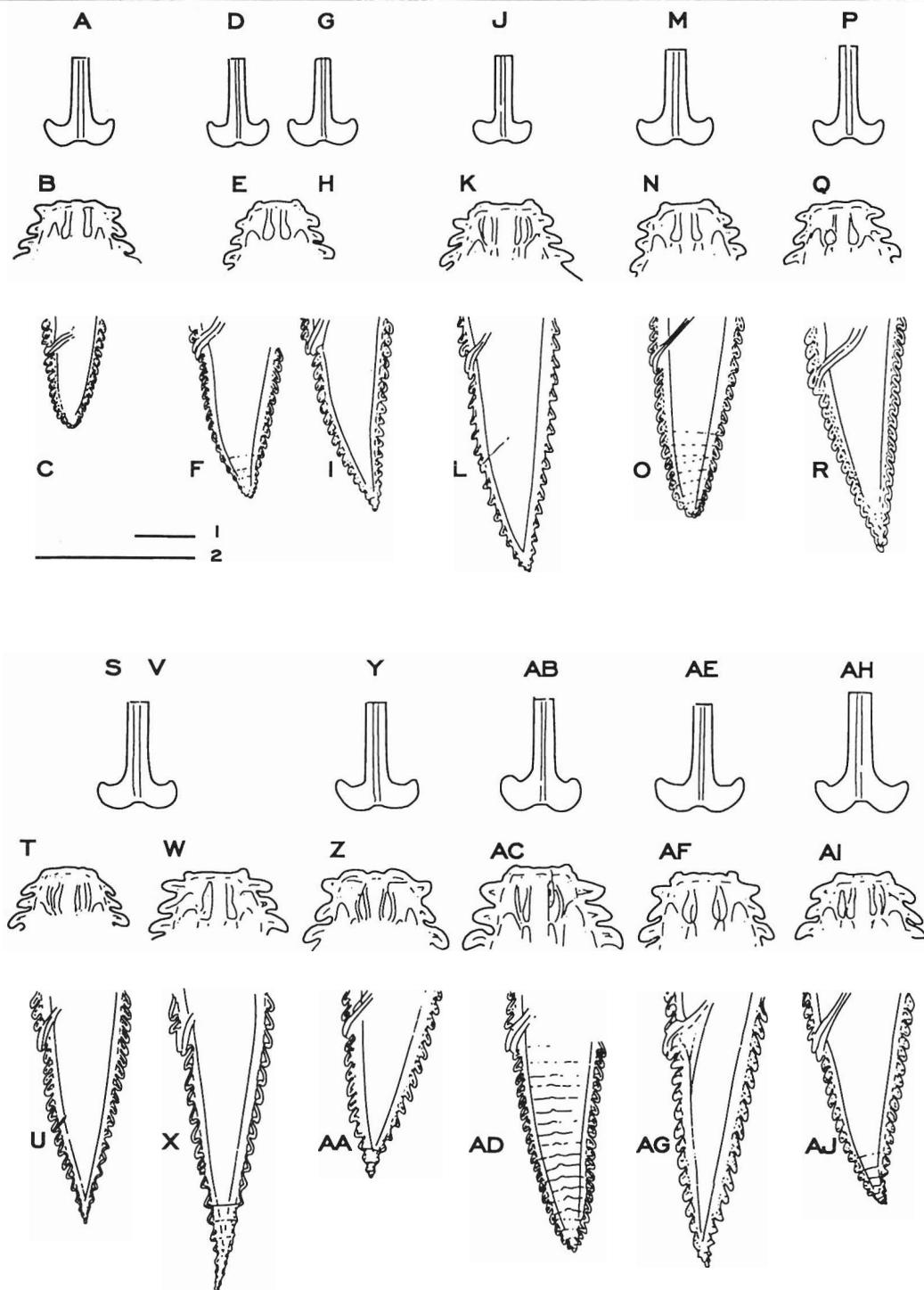


Fig. 15. *Criconema (Nothocriconemella)* female stylets, lip regions and postvulval areas. A-C: *C. (N.) mutable*; D-F: *C. (N.) californicum*; G-I: *C. (N.) pasticum*; J-L: *C. (N.) farrelli* sp. n.; M-O: *C. (N.) alpinum*; P-R: *C. (N.) sphagni*; S-U: *C. (N.) macilentum*; V-X: *C. (N.) crosbyi* sp. n.; Y-AA: *C. (N.) graminicolum*; AB-AD: *C. (N.) ramsayi* sp. n.; AE-AG: *C. (N.) acuticaudatum*; AH-AJ: *C. (N.) dugdalei* sp. n. Scale bar for postvulval areas (1) - 20 μm ; scale bar for stylets and heads (2) - 20 μm .

macilentum by its shorter stylet of less than 100 μm , and from *C. (N.) graminicola* and *C. (N.) acuticaudatum* by its smaller stylet base, especially relative to the length of the stylet. *Criconema (N.) alpinum*

is also characterised by its somewhat blunt tail terminus but here this species is included with several populations with more or less sharp tails, because no other characters could be found to distinguish

Table 1. Diagnostic values of *C. (N.) macilentum* females and holotypes (hol.) and female paratypes, of four new species of *Criconema* subgenus *Nothocriconemella* (All measurements in μm , except for L).

Species	<i>C. (N.) macilentum</i>	<i>C. (N.) crosbyi</i> sp. n.		<i>C. (N.) farrelli</i> sp. n.		<i>C. (N.) ramsayi</i> sp. n.		<i>C. (N.) dugdalei</i> sp. n.	
	Females	Hol.	Female paratype	Hol.	Female paratype	Hol.	Female paratype	Hol.	Female paratype
n	20		20		20		20		20
L ¹	0.42±32.8 (0.36-0.48)	0.54	0.54±0.038 (0.46-0.61)	0.55	0.56±0.028 (0.50-0.62)	0.48	0.49±0.025 (0.46-0.58)	0.44	0.48±0.03 (0.44-0.53)
Diameter at midbody	35±1.09 (33-37)	37	40±1.7 (36-43)	41	39±2.3 (35-44)	40	38±1.7 (33-41)	43	43±1.8 (40-46)
Width of first lip annule	12.1±0.62 (11.5-13.5)	14	15.2±0.78 (14-17)	13.5	12.5±0.56 (11.5-13.5)	16	16.8±0.84 (15-18)	13.5	13.8±0.47 (13-15)
VB ²	29±1.6 (27-32)	31	32±2.1 (28-35)	35	32±2.3 (28-36)	33	34±1.7 (30-37)	32	34±1.4 (32-37)
PV ³	60±5.7 (46-70)	86	79±10.9 (57-92)	66	70±6.4 (56-84)	59	63±5.4 (54-78)	54	60±4.7 (54-72)
PV/VB	2.0±0.19 (1.6-2.4)	2.8	2.4±0.31 (1.7-2.8)	1.9	2.2±0.11 (1.9-2.4)	1.8	1.9±0.12 (1.6-2.1)	1.6	1.8±0.1 (1.6-2.0)
Diameter at level of anus	20±1.2 (18-22)	21	21±1.67 (17-24)	23	23.5±1.64 (21-27)	23	23±1.4 (19-25)	19	20±1.3 (17-23)
Length of tail	33±3.6 (26-41)	52	46±5.8 (30-54)	30	37±4.8 (29-48)	30	32±4.5 (22-42)	23	29±3.0 (23-35)
Length of stylet	116±3.74 (111-125)	95	95±2.4 (90-99)	92	93±3.8 (89-102)	102	99±2.6 (94-104)	152	150±3.9 (141-159)
St%L ⁴	28±2.2 (24-31)	17.7	17.5±1.14 (15.7-20.1)	16.8	16.7±1.10 (14.7-18.3)	21	20.2±1.23 (16.7-22.1)	34.5	31±2.0 (28-36)
Length of stylet shaft	13.4±1.26 (11-16)		13.4±0.79 (12-15)		10.5±0.76 (9-12)		13.8±0.96 (12-15.5)		16.2±1.0 (15-18)
Height of stylet base	3.8±0.41 (3.0-4.5)	3.5	3.8±0.42 (3.0-4.5)	3	3.1±0.28 (2.5-3.5)	3.5	4.0±0.37 (3.5-4.5)	3.5	4.2±0.26 (3.5-4.5)
Width of stylet base	10.3±0.55 (9.5-11.0)	10	10.5±0.57 (9.5-11.5)	8	7.7±0.62 (7.0-9.0)	11	9.9±0.43 (9.0-11.0)	13	13.1±0.72 (12.0-14.5)
Length of oesophagus	152±5.51 (140-161)	137	137±4.8 (130-150)	140	140±6.05 (131-152)	154	150±5.0 (142-166)	190	188±5.3 (177-197)
Width of medial bulb of oesophagus	17.1±1.41 (15-21)	20	19±0.98 (17-22)	21	21±1.89 (16-23)	19	18±1.30 (16-21)	19	22±1.7 (19-26)
Width of basal bulb of oesophagus	10.8±1.12 (9.5-13)	10	11.2±1.25 (10-14)	12	12.0±1.62 (10-16)	10	11.4±1.08 (9.5-14)	11.5	12.6±0.94 (11-14)
R ⁵	100±3.32 (91-105)	102	104±2.74 (98-108)	113	117±3.9 (110-124)	125	128±4.4 (118-136)	106	110±2.35 (105-115)
L/R ⁶	4.2±0.38 (3.6-5.1)	5.3	5.3±0.40 (4.4-5.9)	4.9	4.8±0.34 (4.1-5.6)	3.8	3.9±0.22 (3.4-4.5)	4.2	4.4±0.24 (3.9-4.8)
RV ⁷	15.9±0.93 (14-18)	19	17.9±1.01 (15-19)	16	17.1±0.97 (15-19)	19	20±1.0 (18-22)	17	17.3±0.79 (16-19)
Ran ⁸	9.7±0.8 (8-11)	13	11.4±1.07 (10-14)	9	10.5±0.83 (9-12)	11	11.3±0.73 (10-13)	10	9.8±0.70 (9-11)
RVan ⁹	6.2±0.67 (5-7)	6	6.2±0.79 (5-8)	7	6.7±1.04 (5-9)	8	8.6±0.77 (7.0-10.0)	7	7.5±0.60 (7-9)
a	12.1±1.1 (10.6-14)	14.5	13.5±0.70 (12.1-14.8)	13.4	14.5±0.67 (13.4-15.7)	12.0	12.9±0.95 (11.2-15.2)	10.2	11.3±0.67 (10.1-12.4)
b	2.8±0.17 (2.5-3.1)	3.9	4.0±0.27 (3.3-4.3)	3.9	4.0±0.21 (3.5-4.3)	3.1	3.3±0.14 (3.1-3.5)	2.3	2.6±0.14 (2.3-2.8)
c	12.9±1.7 (10.3-16.3)	10.3	11.9±1.67 (10.2-17.1)	18	15.4±1.78 (12.3-18.8)	15.9	15.7±2.35 (12.9-22.4)	19.1	17.0±1.59 (14.2-20.3)
c'	1.6±0.16 (1.2-2.0)	2.5	2.3±0.26 (1.6-2.7)	1.3	1.6±0.14 (1.3-1.8)	1.3	1.4±0.16 (1.2-1.7)	1.2	1.4±0.11 (1.3-1.7)
V	86±1.2 (84-88)	84	86±1.6 (84-90)	88	88±0.8 (86-90)	88	87±0.9 (86-89)	89	88±1.0 (86-89)

¹- Total body length in mm; ² - Diameter at level of vulva; ³ - Length of postvulval part of body; ⁴ - Stylet length as percentage of total length; ⁵ - Total number of body annules; ⁶ - Average width of body annules; ⁷ - Number of the annule on which the vulva lies, counting from the tail end; ⁸ - Number of the annule on which the anus lies, counting from the tail end; ⁹ - Number of annules between vulva and anus.

Table 2. The number of voucher and paratype specimens of *Nothocriconemella* species described in this paper that have been distributed to various Collections.

Collection	Species name	<i>macilentum</i>	<i>crosbyi</i>	<i>farrelli</i>	<i>ramsayi</i>	<i>dugdalei</i>
		(voucher)	(paratypes)	(paratypes)	(paratypes)	(paratypes)
National Nematode Collection of New Zealand (Slide numbers)		122 1263-1279	75 2488-2492	22 2503-2507	57 2508-2516	10 2493-2502
IACR-Rothamsted, England		5	5	5	7	7
Agricultural University Wageningen, the Netherlands		12	5	4	5	7
Institute für Nematologie und Wirbeltierkunde, BBA, Münster, Germany		14	4	6	5	—
University of California, Davis, USA		5	5	5	6	9
University of California, Riverside, USA		5	4	3	5	—
USDA Nematode Collection, Beltsville, Maryland, USA		5	5	5	6	2
Centre for Land and Biological Resources Research, Central Experimental Farm, Ottawa, Canada.		6	4	4	8	—
Zoological Institute, RAS, St. Petersburg, Russia		6	6	6	11	—

Table 3. Key diagnostic characters of species of the subgenus *Nothocriconemella* in sequence of stylet length.

Species	L mm	Stylet µm			R	RV	Postvulval area		Tail ann. fused	Vagina S-shaped
		length	W base	L shaft			lateral 1.	extended		
<i>bellatum</i>	0.32 (0.26-0.38)	45 (41-48)	6.3-7.9	—	81 (77-84)	14 (12-15)	absent	no	no	yes
<i>misanthi</i>	0.35 (0.29-0.41)	55 (51-59)	—	—	66 (63-69)	9 (8-10)	absent	no	no	yes
<i>mutable</i>	0.35 (0.29-0.42)	55 (52-60)	8	9.8	103 (97-114)	11 (9-12)	absent	no	no	no
<i>meridiana</i>	0.47 (0.39-0.55)	61-68	8-9.5	—	121-133	14-17	absent	no	no	no
<i>californicum</i>	0.33 (0.29-0.39)	66 (55-74)	7.5	9.8	96 (86-105)	13.4 (11-17)	absent	no	no	yes
<i>graminicola</i>	0.35 (0.29-0.40)	68 (62-81)	10.3	12.8	80 (73-86)	12.8 (11-14)	absent	no	no	yes
<i>acuticaudatum</i>	0.43 (0.40-0.46)	76 (72-78)	11.1	14.3	93 (88-95)	15.2 (14-16)	absent	yes	no	yes
<i>pasticum</i>	0.34 (0.27-0.39)	77 (73-82)	7.5	10	102 (94-111)	13 (12-17)	absent	no	no	yes
<i>justum</i>	0.41-0.56	78-86	7.2-8.7	—	70-72	5	absent	no	no	yes
<i>alpinum</i>	0.33 (0.29-0.37)	91 (83-99)	9.5	11.2	88 (83-91)	11.0 (10-13)	absent	no	no	yes
<i>farrelli</i>	0.56 (0.50-0.62)	93 (89-102)	7.7	10.5	117 (110-124)	17.1 (15-19)	absent	no	no	yes
<i>crosbyi</i>	0.54 (0.46-0.61)	95 (90-99)	10.5	13.4	104 (98-108)	17.6 (15-19)	absent	yes	yes	yes
<i>ramsayi</i>	0.49 (0.46-0.58)	99 (94-104)	9.9	13.8	128 (118-136)	20 (18-22)	present	no	no	yes
<i>sphagni</i>	0.39 (0.35-0.41)	114 (106-120)	9.4	11.4	94 (90-97)	15 (13-16)	absent	no	no	yes
<i>macilentum</i>	0.42 (0.36-0.48)	116 (111-125)	10.3	13.4	100 (91-105)	15.9 (14-18)	absent	yes	no	yes
<i>dugdalei</i>	0.48 (0.44-0.53)	150 (140-159)	13.1	16.2	110 (105-115)	17.3 (16-19)	absent	no	no	yes

them as separate species. *Criconema* (*N.*) *graminicola* and *C.* (*N.*) *acuticaudatum* are very similar. Their heavy stylet base relative to their short stylet of about 80 µm, combined with the sideways directed first lip annule, make these species distinct from *C.* (*N.*) *sphagni* and *C.* (*N.*) *macilentum* (stylet 100 µm long) and easy to recognise, even in complex species mixes. A high lip region and longer postvulval region distinguish *C.* (*N.*) *acuticaudatum* from *C.* (*N.*) *graminicola*. *Criconema* (*N.*) *sphagni* and *C.*

(*N.*) *macilentum* are also very similar, but *C.* (*N.*) *macilentum* has a higher lip region and a more sharply pointed tail with attenuated tail annules.

Criconema (*N.*) *dugdalei* sp. n. (Fig. 15AH-AJ), the species with the heaviest stylet base, is characterised by having a very long stylet, which can be more than 150 µm long. The last tail annules have only weak edges, are generally not fully extended and seem very flexible, causing the tail terminus to point in any direction.

Key to the species of the *Criconema* subgenus *Nothocriconemella*

Key characteristics of the species are summarised in Table 3.

1. Lateral line distinctly present on postvulval region..... *C. (N.) ramsayi* sp. n. (NZ)
 - Lateral line on postvulval region generally absent, partially present in some specimens..... 2
2. Tail annules extended, fused, to form a finely pointed tail terminus *C. (N.) crosbyi* sp. n. (NZ)
 - Tail annules not extended and fused, not forming finely pointed terminus 3
3. Stylet < 105 µm long 4
 - Stylet > 105 µm long 15
4. R < 86 5
 - R > 86 9
5. Stylet < 50 µm long *C. (N.) bellatulum*
 - Stylet > 50 µm long 6
6. R < 70 *C. (N.) miscanthi*
 - R > 70 7
7. RV < 8 *C. (N.) justum*
 - RV > 8 8
8. R > 80 *C. (N.) alpinum* (NZ)
 - R < 80 *C. (N.) graminicola* (NZ)
9. Stylet base heavy, > 11 µm wide, shaft of stylet > 12 µm long *C. (N.) acuticaudatum* (NZ)
 - Stylet base not heavy, < 10 µm wide, shaft of stylet < 11 µm long 10
10. Average stylet < 74 µm long 11
 - Average stylet > 74 µm long 13
11. Anterior vulval lip overlapping posterior vulval lip *C. (N.) californicum* (NZ)
 - Anterior vulval lip not overlapping posterior vulval lip 12
12. Last two tail annules contracted forming rounded tail terminus, stylet < 60 µm long, R < 120, RV < 12 *C. (N.) mutabile* (NZ)
 - Last two tail annules extended forming pointed tail terminus, stylet > 60 µm long, R > 120, RV > 12 *C. (N.) meridiana*
13. Average L > 0.45 mm, R > 110 *C. (N.) farrelli* sp. n. (NZ)
 - Average L < 0.45 mm, R < 110 14
14. R > 93, average length of stylet < 82 µm *C. (N.) pasticum* (NZ)
 - R < 93, average length of stylet > 82 µm *C. (N.) alpinum* (NZ)
15. Stylet base > 12 µm wide, shaft of stylet > 14 µm long *C. (N.) dugdalei* sp. n. (NZ)
 - Stylet base < 12 µm wide, shaft of stylet < 14 µm long 16
16. Last five tail annules more or less normally folded *C. (N.) sphagni* (NZ)

- Last five tail annules extended..... *C. (N.) macilentum* (NZ)

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Wouts W.M. Нематоды подрода *Nothocriconemella* Ebsary, 1981 (Nematoda: Criconematidae) с описанием четырех новых видов из Новой Зеландии.

Резюме. Обсуждается состав подрода *Nothocriconemella* рода *Criconema*, предлагается его новый диагноз. Приводятся краткие описания видов из Новой Зеландии: *C. (N.) acuticaudatum*, *C. (N.) alpinum*, *C. (N.) californicum*, *C. (N.) graminicola*, *C. (N.) macilentum*, *C. (N.) mutabile*, *C. (N.) pasticum* и *C. (N.) sphagni*. Дано описание четырех новых видов: *C. (N.) crosbyi* sp. n., *C. (N.) farrelli* sp. n., *C. (N.) dugdalei* sp. n. и *C. (N.) ramsayi* sp. n. Предложен ключ для определения видов этого таксона.