The Systematics and Ecology of the Genus *Macropathus* Walker, 1869 (Orthoptera, Rhaphidophoridae).

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Abstract

The synonymy of the genus *Macropathus* is discussed, the genus and two species are redefined and a new species is described. The confusion over the correct name of *M. filifer* is discussed in detail. Attention is drawn to the large range of variability which may occur within a species, so that it is difficult to find a constant character on which to base the species The ecology of the three species is discussed, and while the genus is seen to occur throughout New Zealand only, attention is drawn to the world-wide distribution of the Family Rhaphidophoridae and the similarity in habitat and behaviour between the members of the three sub-families.

Introduction

The genus *Macropathus* belongs to the Sub-Family Macropathinae Karny, 1928, of the Family Rhaphidophoridae. This family is placed in the Super-Family Gryllacridoidea, belonging to the Sub-Order Ensifera of the Order Orthoptera. The Rhaphidophoridae are hydrophilous insects of which a number of types have become cave-dwelling, although some occur in the open. Those insects living in caves are often found in groups of several hundred, while those living in the open are usually solitary or in pairs. Colloquially the members of the genus *Macropathus* are known as " Cave-wetas", because of their superficial resemblance to *Hemideina,* the tree-weta, which belongs to another family, the Henicidae. " Weta " is the Maori name for these insects, but it has become adopted into the everyday language of the Europeans. The chief characteristics of the family consist of lack of elytra, lack of auditory tympanums and possession of long, compressed tarsi without euplantulae.

The Rhaphidophoridae have a long fossil history, and it is interesting to note that *Dolichopoda* and *Troglophilus,* both closely related to *Macropathus,* are the only two survivors of an ancient sub-tropical fauna of European Orthoptera dating from the Tertiary. An incising of *Troglophilus* on a fragment of a bison's bone found in the " Trois Frères " cave at Ariège in the French Pyrenees is the most ancient evidence we have of real cave fauna

The group has world-wide distribution, but is especially well represented in New Zealand, where there is an unusually rich Orthopteran fauna. The distribution of *Macropathus* throughout New Zealand has been found to extend from Auckland to Fiordland. Special attention has been paid to the Wellington area where *M. filifer* has been extensively studied. Examination of specimens collected from the Waitakere Ranges and Fiordland has shown the genus *Macro-*

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pathus to include at least three species. The Auckland species *M. acanthocera* was first recorded by Milligan (1926), but it has not as yet been adequately described; while the Fiordland specimens belong to a new species.

SECTION A—SYSTEMATICS

Order ORTHOPTERA
Sub-Order ENSIFERA
Super-Family GRYLLACRIDOIDEA
Family RHAPHIDOPHORIDAE
Sub-Family MACROPATHINAE
Genus *Macropathus* Walker, 1869.

1888. *Pachyrhamma* Brunner, *Monog. Steno. Gryll Verh z-b* Wien, XXXVIII, p 302
1896. *Pachyrhamma* (Brunner) Hutton. *Trans. Roy. Soc. N.Z.*, 29, pp. 223-240.

In 1869 Walker erected the genus *Macropathus* to describe three species of cave-weta collected by H. Drew Esq. from caves in New Zealand. The genus is confined to New Zealand. From the descriptions which he gives it is shown later in this paper that the three species can be synonymised into one. The cave-weta described by Walker is one of the largest and commonest of the group occurring in New Zealand. The generic description he gives, using *filifer* as the type species for the genus, fails to record the shape of the suranal and subgenital plates of both male and female; but the rest of the description, allowing for variation, appears to agree with the insects I have examined, except for the fore part of the head being " nearly horizontal " whereas it is vertical, and the " eyes small . . . not prominent " while they are both large and prominent.

In 1888 Brunner erected a new genus *Pachyrhamma* for the species *Hadenoecus edwardsii* of Scudder, not realising that he was describing the same genus as Walker had in 1869 under the name *Macropathus*. Brunner correctly describes the head as vertical, and the eyes as large and reniform in shape. His description differs from my specimens in having the antennae " touching at the base " and " the intermediate tibiae unarmed above," but it agrees in all other respects He describes the subgenital plate for both male and female.

Hutton (1896) in his paper on " New Zealand Stenopelmatidae " says that in the sub-family Dolichopodinae, to which the genus *Macropathus* then belonged, there are " no ocelli in any of the New Zealand species ". This I have found to be incorrect, as the three species in the genus *Macropathus* recorded in this paper all possess a single median ocellus.

Hutton redescribes both *Pachyrhamma* and *Macropathus* Of *Macropathus* he says, " I have had to reconstruct this genus in order that it may be understood It is very different from *Pachyrhamma* ". In describing *Pachyrhamma* Hutton says the antennae are covered with long hairs and touching at the base, the face is glabrous, the fore coxae of the legs touch each other and the middle femora have a short stout apical spine on the inner side. None of these details tally with my specimens in which I have found the antennae are thickly clothed with short setae, and approximating but not touching at their bases; the face is sparsely covered with setae; the fore coxae of the legs although close together are never in actual contact in a living insect. It is possible Hutton's specimens may have been badly preserved, and shrinkage may have drawn the fore coxae more closely together. In all specimens that I have examined, the middle femora possess both prolateral and retrolateral spines. Hutton's description of the supra-anal

plate as " short, rounded " does apply to some specimens but is definitely not common; short, convex terminally, being much more usual. His description of *Macropathus* is completely different from that given by Walker. In having " the three last joints of the maxillary palpi about equal," the " fore coxae not spined ", and " none of the femora with apical spines " it differs from my specimens which all have the last joint of the maxillary palp longer than the third and fourth joints; the fore coxae always possess a spine, and all the femora are armed with apical spines

Neither of Hutton's descriptions of the two genera tallies with my specimens; but they approximate *Pachyrhamma* more closely than *Macropathus*. However, as will be shown later in this paper, in the synonymy of *Macropathus filifer*, Hutton transposed the two genera, so that the correct name of the genus *Pachyrhamma* is really *Macropathus*.

The genus *Macropathus* therefore, must now be redefined as follows:—

Body rather stout and sparsely clothed with short setae. Legs long and slender Antennae very long and tapering; almost touching at their bases; scape about four times as large as pedicel, which is narrower than scape, but broader than other segments; third segment on dorsal aspect narrower than scape, but half as long again, and on ventral aspect equal or subequal with pedicel; from fourth segment onwards, segments subequal, although steadily decreasing in size; all segments thickly clothed with short setae; antennae of male stouter and longer than those of female Head vertical; compound eyes, laterad, nearly elliptical, twice as long as broad; a single anterior, white, median ocellus only Fastigium rises abruptly, slightly sulcate, with base touching scape of antennae. Mandibles small. Maxillary palpi with third and fourth joints subequal in length. Pronotum rounded anteriorly and produced in front over occiput, truncated posteriorly, sternum transversely narrowed; pronotum and mesonotum distinctly margined laterally and posteriorly Fore coxae close together, but not quite touching, each armed with a spine All femora sulcate ventrally Femora, tibiae and first and second proximal segments of hind tarsi armed with variable numbers of spines. Apical spines on femora, tibiae and first and second proximal segments of hind tarsi constant in number. Fore femur bears one spine prolaterally; fore tibia bears four spines, one above and one beneath, both prolaterally and retrolaterally; fore tarsus is unarmed. Middle femur bears two spines beneath, one prolateral and the other retrolateral; middle tibia bears four spines, one above and one beneath, both prolaterally and retrolaterally; middle tarsus is unarmed. Posterior femur bears two spines above, one prolateral and one retrolateral; posterior tibia has a pair of apical spurs above, a pair of apical spines beneath, and a pair of subapical spines beneath, one from each pair being prolateral and the other retrolateral; posterior tarsus two proximal segments each has two spines above, one prolateral and one retrolateral, other two segments are unarmed. Neither apical nor any other spines occur on fore or middle tarsi Cerci long, tapering, unsegmented, clothed with long and short setae. Subgenital plate of female with distal margin widely emarginate Ovipositor sabre-shaped, subequal with length of body. Subgenital plate of male triangular, one and a-quarter times as long as wide, sides spreading slightly proximally, tapering to concave distally, with a rounded apex, or spatulate distally with lateral margins curved

back over plate; dorsal surface glabrous; ventral surface with apical protuberance thickly clothed with short setae. Lateromedianly the plate bears two small styli, one to each side.

Type species for the genus. *Macropathus filifer* Walker.

KEY TO THE SPECIES OF *Macropathus*

1. Posterior femora bearing approximately 21 retrolateral spines beneath; antennae in male with 5 or 6 large blunt spines; subgenital plate in female varies from sides short and slightly convex, to sides longer, straight or slightly concave, with distal margin widely emarginate . 2
   Posterior femora bearing approximately 4 retrolateral spines beneath; numerous small sharp spines on antennae in male; subgenital plate in female with sides convex, distal margin deeply emarginate *M. filifer* Walker
2. Suranal plate unarmed; all femora armed with spines beneath; subgenital plate in male with sides concave distally .. *M. acanthocera* (Milligan)
   Suranal plate with a small median spine in the female, and a large blunt median spine in the male, subgenital plate in male spatulate distally; middle femora unarmed beneath . . . *M. delli* n.sp

Macropathus filifer Walker, 1869.

1869. *Macropathus fascifer* Walker, *Cat. Derm. Salt. Blat.*, pp. 206–207
1869. *Macropathus altus* Walker, *Cat. Derm. Salt. Blat.*, pp 207–208.
1881. *Hemideina speluncae* Colenso. *Trans. Roy. Soc. N.Z.*, 14, pp 280–281.
1888. *Pachyrhamma edwardsii* (Scudd., 1869). Brunner, *Monog. Steno. Gryll. Verh. z-b* Wien, XXXVIII, p. 302.
1888 *Pachyrhamma novae-seelandiae* Brunner, *Monog. Steno. Gryll. Verh. z-b* Wien, XXXVIII, p. 302, Pl. VII, Fig. 29.
1896. *Pachyrhamma fascifer* (Walker, 1869), Hutton, *Trans. Roy. Soc. N.Z.* 29, pp. 230–232, Figs. 12–12c
1901. *Gymnoplectron stephensiensis* Alfken. *Abhand. Naturwiss. Ver. Bremen*, XVII Band 1 Heft. pp. 150-152
1923. *Pachyrhamma fascifer* (Walker, 1869), Chopard, *Trans. Roy. Soc. N.Z.*, 54, pp. 231–233, Text-fig. p 232.

Plates 1 and 2. Text-fig. 1. Figs. 1–7.

Macropathus filifer was first described by Walker (1869) as belonging to his new genus *Macropathus*. Specimens were collected from caves in New Zealand by H. Drew Esq., some being stated to occur "half a mile within", and sent to England. Walker divides his genus into three species—*M. filifer, M. fascifer* and *M. altus*. His descriptions of *M. filifer* and *M. fascifer* are from male specimens and *M. altus* is from a female. From the similarity between the three descriptions, and making allowances for minor variations which have been found to occur, these three species of Walker would appear to be the male and female of the same species. As *M. filifer* has page priority over *M. fascifer* and *M. altus* the name of the species must therefore become *M. filifer*

In New Zealand Colenso (1881) described a new species of weta from one specimen collected " in dark underground caves near the head of the Manawatu River, in the ' Forty mile bush ' 1879 " as *Hemideina speluncae*. He says, " This peculiar and very interesting animal, (of which I regret to say I have but one whole specimen), inhabits in great numbers those small caves which are difficult of access; there they hop and spring about like shrimps, and having such excessively long and fine horns and legs, it is a very difficult matter to secure a perfect

specimen; of course the necessity of having a candle burning when in those dark recesses, greatly increases the difficulty." From his description of the long slender legs of the specimen, giving the length and number of spines present on each, and the extreme length of the antennae, bearing short obtuse spines for one-third of their length it is fairly safe to say he had a male specimen of *Macropathus filifer*.

In 1862 Scudder erected the genus *Hadenoecus* and described species from Europe and North America in the *Boston Journal of Natural History* VII. Then in 1869 he described "A New Cave Insect from New Zealand" in *Ent. Notes Proc Bost. Soc. Nat. Hist.* 12, and added it to his genus under the name *Hadenoecus edwardsii*. The colour and measurements Scudder gives are not sufficient to give a clear description, and he admits that it is described from "one imperfect specimen, much the largest of the genus, . . presented to me by my friend Mr. Henry Edwards, who captured it himself in a limestone cave at Collingwood, Massacre Bay, Middle Island, New Zealand. The cave is close to the sea shore and near a very large coal deposit, which occasionally crops out in the interior. The Hadenoeci were rather numerous but very difficult to catch, disappearing in the crevices of the rocks on the approach of lights. They appeared to be most abundant near the streams of water which percolated through the rocks. The sex of my specimen cannot be determined."

In 1888 Brunner took *H edwardsii* and made it the type species of his new genus *Pachyrhamma* which contained two species, *P. edwardsii* (Scudd. 1869) and *P. novae-seelandiae* n sp. both from New Zealand. Brunner makes no reference to Walker's paper of 1869 and his genus is synonymous with *Macropathus*. From Brunner's descriptions *P. edwardsii* and *P novae-seelandiae* are synonymous with *Macropathus filifer* and *Macropathus fascifer* respectively. Brunner says of *P. edwardsii*, "The fore femora are unarmed beneath, the posterior femora are the longest and the most graceful and beneath the inner margin are 4–6 rather long spines. The outer margin is armed with smaller spines close together." Walker's description says, "Legs very slender, extremely long, thrice longer or more than the body; hind femora with six minute spines beneath, slender except near the base." Both were describing males, and the similarity between the two descriptions is obvious. Of *P. novae-seelandiae* Brunner says, "Anterior femora armed beneath with four or five small spines. Posterior ones thickened at base, beneath, inner margin has 8–10 small spines, outer margin armed with 4 spines." Walker says, "Legs rather slender, very long; femora and fore anterior tibiae armed with a few spines on each side beneath." It is a pity Walker gives no record of the exact number of spines present. As Walker described *Macropathus fascifer* in 1869, it has priority over Brunner's new species *Pachyrhamma novae-seelandiae*. But *Macropathus filifer* and *M. fascifer* have been shown to be synonymous, therefore *Pachyrhamma edwardsii* and *P novae-seelandiae* must also be synonymous Examination of over one hundred and twenty specimens of *Macropathus filifer* has shown me the wide range of variability which occurs within the species, especially in the number of spines of the legs, and because of this, I have no hesitation in grouping all these species under the name *Macropathus filifer* Walker, 1869.

In 1952 a limestone cave near Collingwood was visited by Dr. J. T. Salmon and cave-wetas collected from it The cave is near the sea, and it appears to agree with the description given by Scudder as the habitat of *H edwardsii*. I

was allowed to examine a pair of these wetas, which were small and very difficult to catch, disappearing into the crevices of the limestone as described by Edwards. These wetas were the only species in the cave and they definitely do not belong to the genus *Macropathus*. The measurements of these wetas show them to be smaller than the specimen described by Scudder, but the wetas collected in 1952 may have been immature specimens. Brunner erected a new genus for the cave-weta from Collingwood, but the weta he described as his type specimen of the genus was not the one used by Scudder. Brunner describes both male and female, whereas Scudder's specimen could not be sexed. Brunner obviously had obtained specimens of the more widely distributed cave-weta *Macropathus filifer*. Thus Brunner's genus *Pachyrhamma* is a synonym of *Macropathus* and the wetas from Collingwood must still be called *Hadenoecus edwardsii* until they are placed in a new genus.

In 1897 Hutton published a paper on the Systematics of the Stenopelmatidae of New Zealand. In his introduction to this paper he says, " The cave-wetas are in the greatest confusion, and we do not know whether there are six or only two species." He completely ignores the descriptions of Walker and Brunner and redescribes the two genera *Pachyrhamma* and *Macropathus*. He obviously used the species *fascifer* to redescribe the genus *Pachyrhamma*, but from examination of Brunner's monograph the type species of *Pachyrhamma* must be *filifer* and not *edwardsii* as shown by Hubbell (1936), so Hutton used the wrong species for his reconstruction of the genus *Pachyrhamma* and *fascifer* should belong to *Macropathus*.

After his description of the genus *Macropathus* Hutton says, " I have had to reconstruct this genus in order that it may be understood. It is very different from *Pachyrhamma*." He disregards the genus *Hadenoecus* Scudder and places the two species *Macropathus filifer* Walker and *Hadenoecus edwardsii* Scudder in this genus. Thus it can be seen from the foregoing synonymy that Hutton crossed the names of the two genera so that *Pachyrhamma* should be *Macropathus* and *Macropathus, Pachyrhamma*.

With regard to the genus *Pachyrhamma* he says, " There is considerable confusion among the species of this genus, if, indeed, there are more than one. I shall commence with the only species that has been adequately described, and then point out the characters which may possibly separate the others from it." The species which he describes in great detail is *Pachyrhamma speluncae*, the synonym of *Hemideina speluncae* Colenso (1881) which Colenso had put into the wrong sub-family. The other two species in his genus are *P novae-seelandiae* Brunner and *P. fascifer* Hutton had realised that *Macropathus fascifer* Walker and *Macropathus altus* Walker were the male and female of the same species, and he was the first to call them *P fascifer* (Walker). Hutton separates out his three species by differences in number of the spines on the legs. He separates *P. novae-seelandiae* from *P speluncae* on the basis of *P. novae-seelandiae* having no spines on the middle femora, no spines on the upper surfaces of the fore and middle tibiae and no peculiarities in the antennae. *P novae-seelandiae* is separated from *P. fascifer* by having four or five spines on the lower surface of the fore femora instead of two together with no mention being made of the two spines on the lower surface of the middle tibia. *P. fascifer* is separated from *P speluncae* by no reference being made to peculiarities of the antennae and

no spines being present on the upper surface of the middle tibiae. Also the fore femora have only two spines below and the middle tibiae three in each row, while *P. speluncae* has five and four respectively. One thing is obvious from this, Hutton had examined very few specimens of *Pachyrhamma,* and he could never have collected any in the field. If he had he would have realised the great range of variability that occurs in the number of spines present on the legs of *Pachyrhamma.* So variable is this number that there often is fluctuation in the number of spines on the right and left fore, middle or hind legs. Thus it is obvious that the number of spines present could never be used as a taxonomic character. With regard to the antennae, he would have realised that the presence of spines on the proximal half of the antennae is a secondary sexual characteristic of the male and the female never possesses them. *P. speluncae* was described from one specimen only, a male, therefore it was natural for spines to be present on the antennae. *P. novae-seelandiae* was described from females only, so consequently no spines would occur. *P. fascifer* is described by Walker from both male and female specimens, but it is possible the male was immature, as it is only on the antennae of fully mature male cave-wetas that spines are present. Thus Hutton's three species can be synonymised and as *fascifer* has priority because it was described first in 1869, they all become *P. fascifer,* which as I have already shown is correctly *Macropathus filifer.* Another point Hutton overlooked in his description of the genus *Pachyrhamma* was the presence of a short retrolateral apical spine on the middle femora. This spine has been present on every specimen I have examined, and as the number of apical spines present on the legs of each weta is constant, it is a good generic character.

Alfken (1901) records a new member of the Rhaphidophoridae collected from Stephens Island during the Schauinsland Expedition 1896-97. The species is described from a single male and four male nymphs. No females were collected. Alfken connects this species with *Hadenoecus* Scudder but, because its fore and middle femora bear spines beneath and the middle femora have two apical spines, he places it in the genus *Gymnoplectron* Hutton, 1896. However, from the body and leg measurements he gives, the number of spines on the legs, and the particulate description of the colour pattern, it is obvious that he was describing specimens of *Macropathus filifer.* This is the first record of *M. filifer* from Stephens Island

In my own work on *Macropathus filifer* I have examined a representative number of specimens from Trio Islands, Stephens Island, Percy's Reserve, Karori and Ruakokopatuna. Tables were made from spine counts of the legs and Table I shows the wide range of variability which occurs within the species. From careful examination of this material six constant features emerged by which the species can be recognised:

1. Apical spines on femora and tibiae of fore and middle legs, and on femora, tibiae and two proximal segments of tarsi of hind legs are always constant.
2. Fore coxae only, always armed with a retrolateral spine.
3. Neither apical spines nor any other spines occur on fore or middle tarsi.
4. Subgenital plate in both male and female is always constant in shape.
5. Sexually mature males always bear spines on the proximal half of their antennae; females never possess them at any stage in their life history.

6. There is very little difference in size between males and females collected from the same locality, but there is considerable variability when specimens from different areas are compared.

The species *Macropathus filifer* is now redefined as follows:—

Colour. Basic colour medium to dark ochrous, with anterior and posterior borders of pronotum and posterior borders of mesonotum, metanotum and abdominal terga a dark reddish-brown; lateral and posterior margins pale ochrous; femora and tibiae of all legs transversely banded with broad bands of light brown and dark reddish-brown, interspersed with narrow bands of pale ochrous; antennae medium brown; ovipositor deep reddish-brown.

Body. Length up to 41 mm., average 35 mm. Body sparsely clothed with golden setae. Ovipositor seven-eighths as long as body. Antennae 4·5–5 times as long as body. Head vertical. Compound eyes laterad, nearly elliptical, twice as long as broad; a single anterior, white, median ocellus only. Fastigium as high as long, rising abruptly, slightly sulcate, with base touching scape of antennae. Mandibles small. Maxillary palps with third and fourth joints subequal in length. Pronotum rounded anteriorly and produced in front over occiput, truncated posteriorly; sternum transversely narrowed; pronotum and mesonotum distinctly margined laterally and posteriorly. Cerci Fig. 1 (C), long, tapering, unsegmented, clothed with long and short setae. Bodies of male and female from same locality subequal, but considerable variability in specimens from different localities.

Antennae. Fig. 4 Very long, slender, tapering flagellum (F), thick and almost touching at base; scape about four times as large as pedicel, which is narrower than scape, but broader than other segments; third segment on dorsal aspect narrower than pedicel, but half as long again, and on ventral aspect equal in length with pedicel; from fourth segment onwards segments unequal in length, although steadily decreasing in size; all segments thickly clothed with short golden setae. Sexual dimorphism is present in antennae, male possessing longer, stouter antennae than female; middle portion of flagellum (F) in male armed with a number of short ventral retrolateral spines (SP), each borne on a swelling

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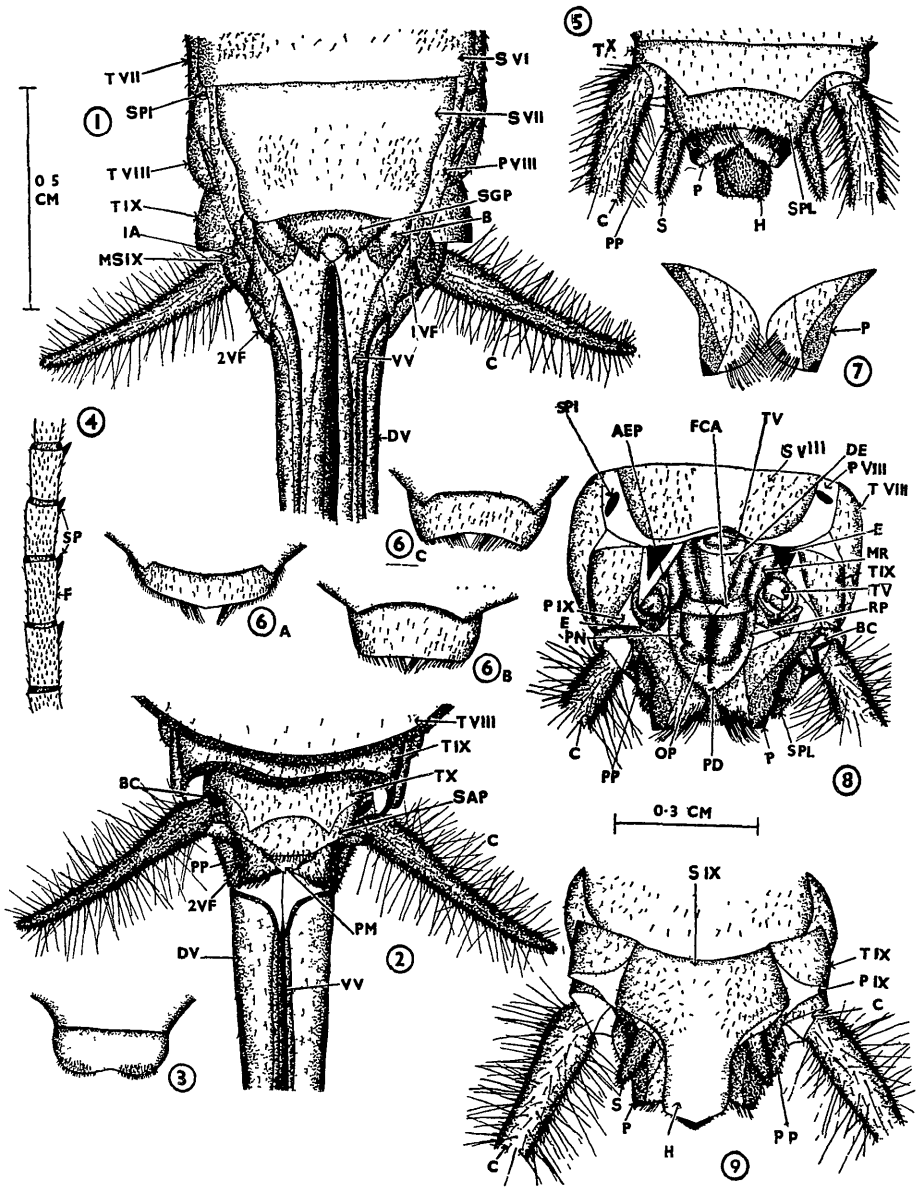
Index to Text-figures

AEP—apophysis of endoparamere.
B—basivalvula.
BC—basal segment of cercus
C—cercus.
DE—ductus ejaculatorius
DV—dorsal valve.
E—endapophysis.
EP—endoparamere.
F—flagellum.
FCA—feebly chitinised arch connecting rami.
H—hypandrium (subgenital plate male)
IA—intersegmental apodeme.
MC—muscle of cercus.
MR—muscle attached to ramus
MS IX—membrane of sternite IX
OP—opening of penis.
P—paramere (ectoparamere).
P VII, P VIII, P IX, P X—pleurite VII, VIII, IX, X.
PD—pseudosternite
PM—perianal membrane.
PN—penis.
PP—paraproct.
RP—rami of pseudosternite.
S—stylus
S VI, S VII, S VIII, S IX—sternite VI, VII, VIII, IX.
SAP—suranal plate female
SGP—subgenital plate female
SP—spine.
SPI—spiracle.
SPL—suranal plate male.
T VII T VIII, T IX, T X—tergite VII, VIII, IX, X.
TV—tube of vesicula seminalis
1 VF—first valvifer
2 VF—second valvifer.
VV—ventral valve.



TEXT-FIG. 1. *Macropathus filifer* Walker.

FIG. 1—Female genitalia ventral view. FIG. 2—Female genitalia dorsal view. FIG. 3—Variation in shape of suranal plate of female. FIG. 4—Male antenna, middle portion of flagellum showing spines. FIG. 5—Male genitalia dorsal view. FIG. 6—A, B, C, variations in shape of suranal plate of male. FIG. 7—Parameres. FIG. 8—Male genitalia ventral view, hypandrium removed to expose structures beneath. FIG. 9—Male genitalia ventral view, hypandrium in place. Scale 0.5 cm. applies to Figs. 1–4, Scale 0.3 cm. applies to Figs. 5–9,

on the upper part of its segment; variability in number of spines present is common; female never possesses these spines.

LEGS. Long and slender. Fore and middle legs subequal, with hind leg about a third as long again. Fore coxae close together, but not quite touching, each armed with a spine. All femora sulcate below. Femora, tibiae and two proximal segments of hind tarsi armed with variable numbers of spines (see Table I of Variability of Spines on the Legs). No spines occur on fore or middle tarsi. Ratios of length of legs to length of body are: Fore leg, 2:1; Middle leg, 1·9:1; Hind leg, 3·17:1.

GENITALIA. *Female*: Suranal plate (SAP) variable in shape between two extremes, one rounded and notched medianly, Fig. 3, while other is obtuse-angled laterally and truncated distally, Fig. 2; distal margin clothed with short golden setae. Subgenital plate, Fig. 1 (SGP) constant in shape, being deeply notched posteriorly, and thickly clothed with setae. *Male*: Suranal plate, Figs. 5 and 6 (SPL) variable in shape, being terminally either concave, Fig. 6C, or convex, Fig. 6A, or an intermediate stage between, Fig. 6B. Subgenital plate (hypandrium), Fig. 9 (H) triangular, 1 25 times as long as wide; sides spreading slightly proximally, tapering to concave distally with a rounded apex; ventral surface with apical protuberance thickly clothed with red-brown setae. Dorsal surface glabrous. Laterally the plate bears two styli, Figs. 5, 9 (S) thickly clothed with short setae; length of styli being just over one-third length of sternite IX Parameres, Fig. 7 (P) broad at base, twice as long as broad, with prolateral edge thickly clothed with long setae. Pseudosternite, Fig. 8 (PD) almost as long as broad, tapering to a point distally. Penis, Fig. 8 (PN) two-lobed, each lobe being twice as long as broad. Paraprocts, Figs. 5, 8, 9 (PP) small, two and a-half times as small as parameres.

LOCALITIES. Nelson and Marlborough districts; Stephens Island; Trio Islands, Mana Island; Wellington district; Levin; Wairarapa; Havelock North; Waikato

TYPES. Holotype male and female in British Museum collection, but much damaged. Hypotypes in Dominion Museum collection.

Macropathus acanthocera (Milligan, 1926)

1926. *Pachyphamma acanthocera* Milligan. *Trans. Roy. Soc. N.Z.*, 56, p. 422, Pl. 79-80.

Plates 29 and 30. Text-fig. 2 Figs. 1–8.

In describing this species Milligan (1926) comments on the similarity in general build and colouring with *M. filifer*. He says, "The peculiarity which distinguishes this species from all others so far known is that several of the antennal segments carry distinct spines." Milligan could not have examined any male specimens of *M. filifer* or he would have observed a number of small, but distinct pointed spines borne on the middle portion of the flagellum. The spines on *M. acanthocera* however are distinctive, being fewer in number and larger than those of *M. filifer* and rounded apically. Milligan's species was described from a male specimen only. Examination of both males and females has shown that Milligan had correctly described a new species, but had missed several of its distinctive characters—e.g., the sexual dimorphism in the length of the legs, so that a redescription of the species is necessary.

The species *Macropathus acanthocera* is now redefined as follows —

COLOUR. Basic colour medium to dark ochrous, with pronotum, mesonotum, metanotum and abdominal terga irregularly mottled with medium brown mixed

TABLE I.

Variability in the Number of Spines on the Legs of *Macropathus filifer*.

		Trio.			Stephens.			Percy's Reserve			Karori and Ruakokopatuna.		
		Arith. Mean	Std. Dev.	No.	Arith. Mean	Std. Dev.	No.	Arith. Mean	Std. Dev.	No.	Arith. Mean	Std. Dev.	No.
Prolat.	Fore Femur	5.3 – 5.7	0.9 – 0.9	10 – 10	5 – 4.9	0.8 – 0.32	10 – 10	4.1 – 4.4	0.54 – 0.71	10 – 10	4.8 – 4.9	1.67 – 1.14	14 – 14
Retrolat.		0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	14 – 14
Prolat.	Fore Tibia	4 – 3.8	0 – 0.4	10 – 10	4 – 4	0 – 0	10 – 10	3.8 – 3.9	0.17 – 0.10	10 – 10	3.8 – 3.7	0.13 – 0.34	14 – 14
Retrolat.		4 – 3.7	0.2 – 0.45	10 – 10	3.9 – 3.9	0.1 – 0.1	10 – 10	3.9 – 4	0.1 – 0	10 – 10	3.9 – 3.9	0.07 – 0.22	14 – 14
Prolat.	Fore Tarsus	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	14 – 14
Retrolat.		0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	14 – 14
Prolat.	Mid. Femur	2.2 – 1.5	0.84 – 1.16	10 – 10	2.2 – 2.6	1.51 – 0.68	10 – 10	1.6 – 2.1	0.80 – 0.98	10 – 10	2.6 – 1.8	1.94 – 1.82	14 – 14
Retrolat.		2.7 – 2.4	1.34 – 1.37	10 – 10	3.1 – 3.1	0.32 – 0.54	10 – 10	2 – 2.2	0.44 – 0.62	10 – 10	2.2 – 1.9	2.07 – 2.07	14 – 14
	Mid. Tibia Sup.	5.5 – 5.1	2.5 – 2.98	10 – 10	5 – 5.5	1.77 – 0.72	10 – 10	5 – 4.8	1.33 – 1.66	10 – 10	4.2 – 3.8	1.15 – 1.67	14 – 14
		3.5 – 3.5	1.38 – 1.16	10 – 10	3.4 – 3.2	0.48 – 0.4	10 – 10	3.3 – 3.5	0.45 – 0.72	10 – 10	3.8 – 3.8	1.52 – 1.82	14 – 14
Prolat.	Mid. Tibia Inf.	3.6 – 3.7	0.48 – 0.23	10 – 10	3.6 – 3.6	0.26 – 0.26	10 – 10	4 – 3.6	0 – 0.48	10 – 10	3.7 – 3.7	0.34 – 0.18	14 – 14
Retrolat.		3.8 – 4	0.17 – 0	10 – 10	3.9 – 3.8	0.1 – 0.17	10 – 10	4.1 – 4	0.1 – 0	10 – 10	3.8 – 4	0.13 – 0	14 – 14
Prolat.	Mid. Tarsus	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	14 – 14
Retrolat.		0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	10 – 10	0 – 0	0 – 0	14 – 14
Prolat.	Post. Femur	9.2 – 9.3	1.06 – 1.23	10 – 7	10.6 – 10.7	1.82 – 4.32	10 – 7	9.6 – 9.6	0.93 – 0.5	10 – 9	9.1 – 10	2.13 – 2.46	14 – 14
Retrolat.		3.7 – 3.8	0.23 – 0.48	10 – 7	5.2 – 5	2.62 – 2.3	10 – 7	4.1 – 4.2	0.54 – 0.19	10 – 9	3.5 – 4	0.73 – 0.53	14 – 14
Prolat.	Post. Tibia	29.9 – 30	11.21 – 3.66	10 – 7	29.0 – 29.3	6.66 – 2.57	10 – 7	28.8 – 29.5	5.02 – 13.4	9 – 8	28.8 – 29	6.75 – 11.23	14 – 14
Retrolat.		34.2 – 34.2	10.84 – 9.91	10 – 7	33.5 – 33	6.72 – 1.66	10 – 7	34.1 – 33.5	5.46 – 10.85	9 – 8	33.2 – 31.9	10.33 – 10.68	14 – 14
Prolat.	Post. Tarsus 1	2.1 – 2.3	0.32 – 0.57	10 – 7	2.2 – 2.5	0.17 – 0.29	10 – 7	2.1 – 2.2	0.86 – 0.21	9 – 8	2 – 1.7	0.3 – 0.37	14 – 14
Retrolat.		2.3 – 2	1.12 – 1	10 – 7	2.4 – 2	0.27 – 0.33	10 – 7	2.5 – 2.8	1.03 – 0.70	9 – 8	2.7 – 2.2	0.52 – 0.79	14 – 14
Prolat.	Post. Tarsus 2	0.8 – 0.7	0.17 – 0.23	10 – 7	0.9 – 0.8	0.1 – 0.16	10 – 7	1 – 1	0 – 0	9 – 8	1 – 0.9	0 – 0.07	14 – 14
Retrolat.		0.7 – 0.3	0.23 – 0.23	10 – 7	1.0 – 1.0	0.22 – 0	10 – 7	1.2 – 1.3	0.44 – 0.27	9 – 8	1.1 – 1	0.13 – 0.07	14 – 14

INDEX TO TABLES

Arith. mean—Arithmetic mean.
Std. Dev.—Standard Deviation.
No.—Number of Specimens.
Std. Err.—Standard Error.
M.—Male.
F.—Female.
Prolat.—Prolateral.
Retrolat.—Retrolateral.

with light brown; lateral and posterior margins pale ochrous; femora and tibiae of all legs transversely banded with broad bands of light brown interspersed with narrow bands of pale ochrous; tarsi pale ochrous; antennae light brown; ovipositor deep reddish-brown.

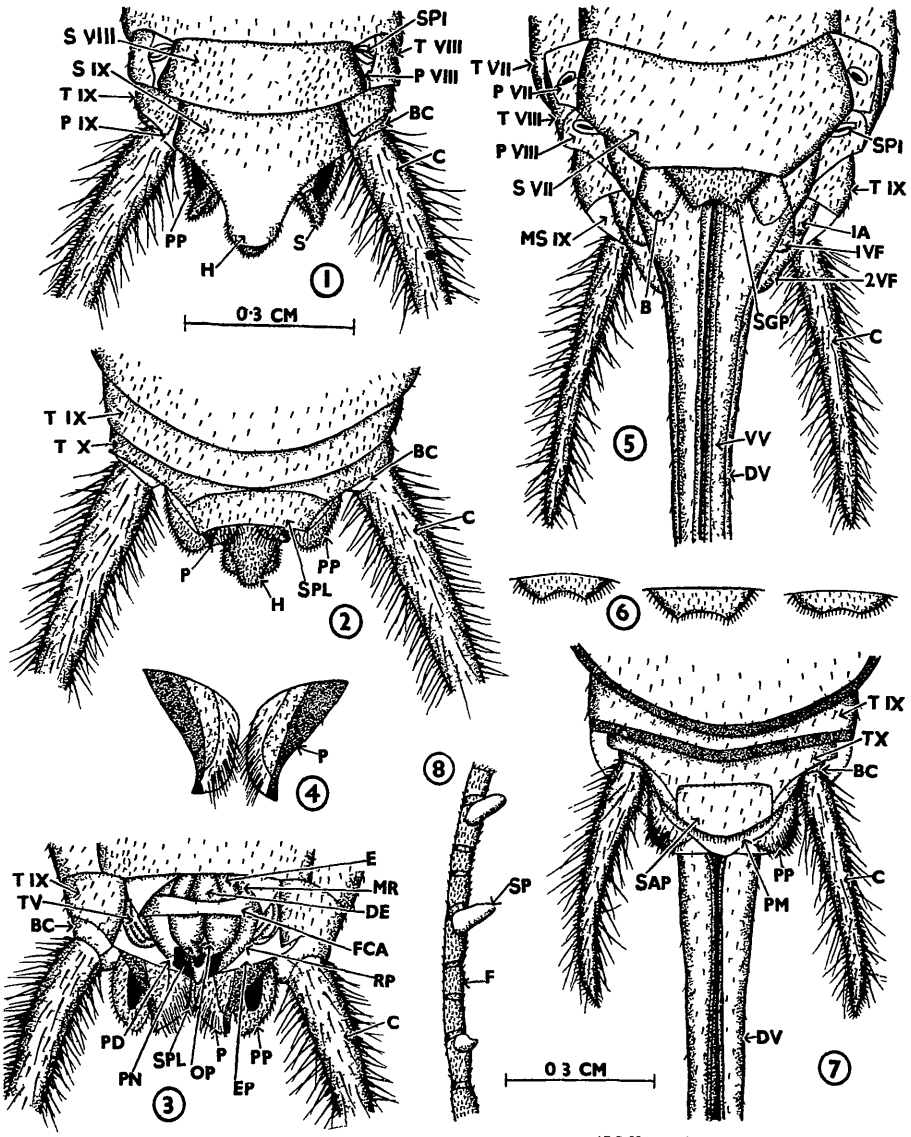
BODY. Length up to 37 mm. Body sparsely clothed with setae. Ovipositor equal to, or seven-eighths as long as body. Antennae in female 5–6 times as long

TABLE II.
Variability in Number of Spines on the Legs

Macropathus delli—Caswell Sound. *Macropathus acanthocera*—Waitakeres.

		M. delli Arith Mean	*M. delli* Std. Dev.	*M. delli* No.	*M. acanthocera* Arith Mean	*M. acanthocera* Std. Dev.	*M. acanthocera* No.
Prolat.	Fore Femur	0.5 – 0.3	0.05 – 0.56	8 – 8	4.5 – 3.8	1.38 – 8.17	10 – 10
Retrolat.	Fore Femur	0 – 0	0 – 0	8 – 8	0 – 0	0 – 0	10 – 10
Prolat.	Fore Tibia	4 – 3.3	0.57 – 0.27	8 – 8	3 – 3	0 – 0	10 – 10
Retrolat.	Fore Tibia	3.5 – 3.5	0.57 – 0.57	8 – 8	3 – 3	0 – 0	10 – 10
Prolat.	Fore Tarsus	0 – 0	0 – 0	8 – 8	0 – 0	0 – 0	10 – 10
Retrolat.	Fore Tarsus	0 – 0	0 – 0	8 – 8	0 – 0	0 – 0	10 – 10
Prolat.	Mid. Femur	0 – 0	0 – 0	8 – 8	3.2 – 2.6	5.51 – 4.04	10 – 10
Retrolat.	Mid. Femur	0 – 0	0 – 0	8 – 8	8.2 – 8.5	34.17 – 38.05	10 – 10
Prolat.	Mid. Tibia Superior	3.6 – 4.1	0.26 – 0.69	8 – 8	4.1 – 4.1	0.54 – 0.54	10 – 10
Retrolat.	Mid. Tibia Superior	1.7 – 2.1	0.5 – 0.69	8 – 8	2.7 – 2.2	2.9 – 2.62	10 – 10
Prolat.	Mid. Tibia Inferior	3.2 – 3.1	0.21 – 0.12	8 – 8	3 – 3	0 – 0	10 – 10
Retrolat.	Mid. Tibia Inferior	3.5 – 3.2	0.57 – 0.21	8 – 8	3 – 3	0 – 0	10 – 10
Prolat.	Mid. Tarsus	0 – 0	0 – 0	8 – 8	0 – 0	0 – 0	10 – 10
Retrolat.	Mid. Tarsus	0 – 0	0 – 0	8 – 8	0 – 0	0 – 0	10 – 10
Prolat.	Post. Femur	9 – 9.2	2.28 – 2.24	8 – 8	12.1 – 12.2	3.61 – 5.24	10 – 7
Retrolat.	Post. Femur	5.3 – 5.2	1.13 – 1.91	8 – 8	21.4 – 21.4	37.26 – 42.95	10 – 7
Prolat.	Post Tibia	19.2 – 20.4	2.5 – 5.28	8 – 7	34.9 – 34.5	4.1 – 11.95	10 – 7
Retrolat.	Post Tibia	21.8 – 21	4.13 – 1.33	8 – 7	39.1 – 38.1	3.87 – 7.47	10 – 7
Prolat.	Post Tarsus 1	2.2 – 2.1	0.5 – 0.14	8 – 7	1.1 – 1.5	0.54 – 1.95	10 – 7
Retrolat.	Post Tarsus 1	2.3 – 2	0.27 – 0	8 – 7	1.9 – 2.2	0.32 – 0.58	10 – 7
Prolat.	Post Tarsus 2	1.1 – 0.8	0.12 – 0.14	8 – 7	0 – 0	0 – 0	10 – 7
Retrolat.	Post Tarsus 2	1.1 – 1	0.12 – 0	8 – 7	0 – 0	0 – 0	10 – 7

as body, and in male 7–8 times as long as body. Head vertical. Compound eyes laterad, nearly elliptical, twice as long as broad; a single anterior, white, median ocellus only. Fastigium almost as high as long, rising abruptly, slightly sulcate, with base touching scape of antennae. Mandibles small. Maxillary palp with third joint three-quarters length of fourth joint. Pronotum rounded anteriorly



TEXT-FIG. 2. *Macropathus acanthocera* (Milligan).

FIG. 1—Male genitalia ventral view, hypandrium in place. FIG. 2—Male genitalia dorsal view. FIG. 3—Male genitalia ventral view, hypandrium removed to expose structures beneath. FIG. 4—Parameres. FIG 5—Female genitalia ventral view. FIG 6—Variations in shape of female subgenital plate FIG. 7--Female genitalia dorsal view. FIG. 8—Male antenna, middle portion of flagellum showing spines. Scale below Fig. 1 applies to Figs. 1–4. Scale below Fig. 7 applies to Figs. 5–8.

TABLE III.

Geographic Variation in *Macropathus filifer*.

		Length Pronotum mm.				Width Pronotum mm.				Length Hind Tibia mm.				Length Hind Femur mm.				Length Ovipositor mm.			
		Arith. Mean	Std. Dev.	No.	Std. Err.	Arith. Mean	Std. Dev.	No.	Std. Err.	Arith. Mean	Std. Dev.	No.	Std. Err.	Arith. Mean	Std. Dev.	No.	Std. Err.	Arith. Mean	Std. Dev.	No.	Std. Err.
Trio	M.	10.4	0.75	3	0.43	14.6	1.34	3	0.77	45.3	10.33	3	5.97	37	7	3	4.04	—	—	—	—
	F.	10	0	5	0	14	0.5	5	0.22	43.9	5.82	5	2.59	35.8	2.7	5	1.2	35	3.87	5	1.72
Stephens	M.	9.9	0.03	9	0.01	13.5	0.53	9	0.17	40.5	0.71	9	0.23	33.4	0.34	9	0.11	—	—	—	—
	F.	9.1	0.04	10	0.01	12	0.22	10	0.06	37.5	2.94	10	0.93	31.8	2.89	10	0.91	30.7	1.52	10	0.48
Percy's Reserve	M.	8.1	0.02	10	0.01	11.1	0.1	10	0.03	37.7	1.06	10	0.33	31.4	0.25	10	0.07	—	—	—	—
	F.	7.1	0.11	10	0.03	9.8	0.17	10	0.05	33.2	4.9	10	1.55	28.3	2.34	10	0.74	23.6	1.15	10	0.36
Karori	M.	8.1	0.1	10	0.03	11.1	0.1	10	0.03	37.2	1.28	10	0.4	31.4	0.48	10	0.15	—	—	—	—
	F.	7.3	0.23	10	0.07	9.9	0.1	10	0.03	34.6	2.48	10	0.78	29.2	1.28	10	0.4	26.1	5	10	1.58
Ruakokopatuna	M.	7	0.62	9	0.2	9.6	0.25	9	0.08	33.6	3.75	9	1.25	28.6	3.75	9	1.25	—	—	—	—
	F.	6.5	0.03	9	0.01	8	0	9	0	30.2	3.57	9	1.19	25.9	3.03	9	1.01	21	0.18	9	0.06
Te Mata Peak	M.	6.2	0.2	5	0.08	8.2	0.2	5	0.08	30.5	1	5	0.44	26	1.5	5	0.66	—	—	—	—
	F.	6.7	0.25	4	0.12	8.5	0.33	4	0.08	32	0.16	4	0.08	28.2	0.25	4	0.12	25.5	1.5	4	0.75

Results from grouping of six localities into three pairs, but keeping sexes separate.

		Length Pronotum mm.			
		Arith. Mean	Std. Dev.	No.	Std. Err.
Trio and Stephens	M.	10.1	0.16	12	0.046
	F.	9.4	0.22	15	0.056
Percy's Reserve and Karori	M.	8.1	0.06	20	0.01
	F.	7.25	0.17	20	0.038
Ruakokopatuna and Te Mata Peak	M.	6.7	0.08	14	0.02
	F.	6.6	0.09	13	0.02

Results from comparison of island with mainland specimens.

		Length Pronotum mm.			
		Arith. Mean	Std. Dev.	No.	Std. Err.
Trio and Stephens	M.	10.1	0.16	12	0.046
	F.	9.4	0.22	15	0.056
Mainland	M.	7.5	0.67	34	0.11
	F.	7.3	0.32	33	0.05

and produced in front over occiput, truncated posteriorly; sternum transversely narrowed; pronotum, mesonotum and metanotum distinctly margined laterally and posteriorly. Cerci Figs 5, 7 (C), long, tapering, unsegmented, slightly crescent-shaped, clothed with long and short setae. Bodies of male and female subequal

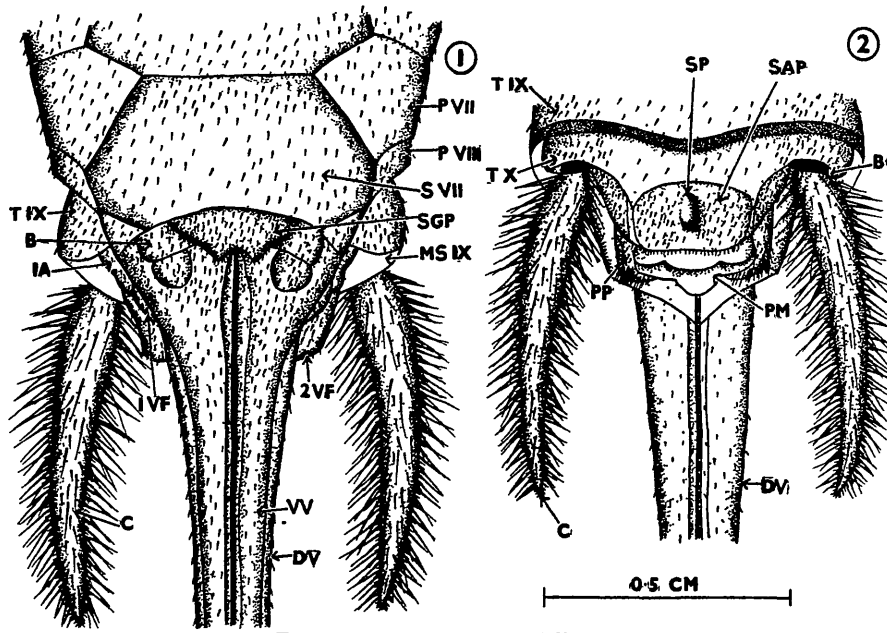
ANTENNAE. Fig. 8. Very long, slender, tapering flagellum (F), thick and almost touching at base, scape about four times as large as pedicel, which is narrower than scape but broader than other segments; third segment on dorsal aspect narrower than pedicel, but half as long again, and on ventral aspect one quarter as long as pedicel; from fourth segment onwards segments unequal in length, although steadily decreasing in size; all segments thickly clothed with short golden setae Sexual dimorphism present in antennae, male possessing longer, stouter antennae than female; in male only, at about two-thirds along flagellum (F) from scape, five to seven ventral retrolateral blunt spines (SP) occur, each borne on a swelling on the upper part of its segment; these spines are fewer in number than those of *M filifer,* but are larger and have their apices rounded

LEGS. Long and slender. Fore and middle legs subequal, with hind leg approximately twice length of fore and middle legs Sexual dimorphism is shown by fore and middle legs of female being two-thirds as long as male, and hind legs of female seven-tenths as long as male. Fore coxae close together, but not quite touching, each armed with a spine. All femora sulcate below. Femora, tibiae and proximal segment of hind tarsi armed with variable numbers of spines (see Table II of Variability of Spines on the Legs). No spines occur on fore or middle tarsi. Ratios of length of legs to length of body: Foreleg, male 2 9 :1; female 1·9 :1. Middle leg, male 2 83·1; female, 1 86·1. Hind leg, male 5 86 :1; female 3·42 :1.

GENITALIA. *Female*: Suranal plate, Fig. 7 (SAP) with lateral and distal margins rounded; subgenital plate, Fig 5 (SGP) variable in shape, Fig. 6, showing a gradual change from sides short and slightly convex, with distal margin widely emarginate, to sides longer straight or slightly concave, with distal margin widely emarginate. *Male* · Suranal plate, Fig 2 (SPL) slightly concave laterally, slightly emarginate terminally; subgenital plate (hypandrium), Fig. 1 (H), triangulate, 1 4 longer than broad, sides spreading slightly proximally, tapering to concave distally with a rounded apex, glabrous on dorsal side, but with apical protuberance on ventral surface, thickly clothed with short red-brown setae Subgenital plate completely shields genitalia. It bears laterally two styli (S) one on each side thickly clothed with short setae, length of styli being one-fourth length of sternite IX Parameres, Fig. 4 (P) attenuated, broad at base and tapering to a point, three times as long as broad, prolateral margin thickly clothed with long setae. Pseudosternite, Fig 3 (PD) compressed dorso-ventrally, nearly twice as broad as long, tapering to a point distally. Penis, Fig 3 (PN) two-lobed, each lobe nearly as broad as long. Paraprocts, Fig 3 (PP) large, longer than parameres, one and a-half times as long as broad.

LOCALITIES. Titirangi coll J S Edwards, A. M. Richards; Waitakere Ranges, coll. R. K. Dell, Auckland. No occurrences of this species have been recorded south of Auckland.

TYPES. Holotype and paratype males in Cawthron Institute collection.



TEXT-FIG. 3. *Macropathus delli* n sp.
FIG. 1—Female genitalia, ventral view. FIG. 2—Female genitalia, dorsal view.

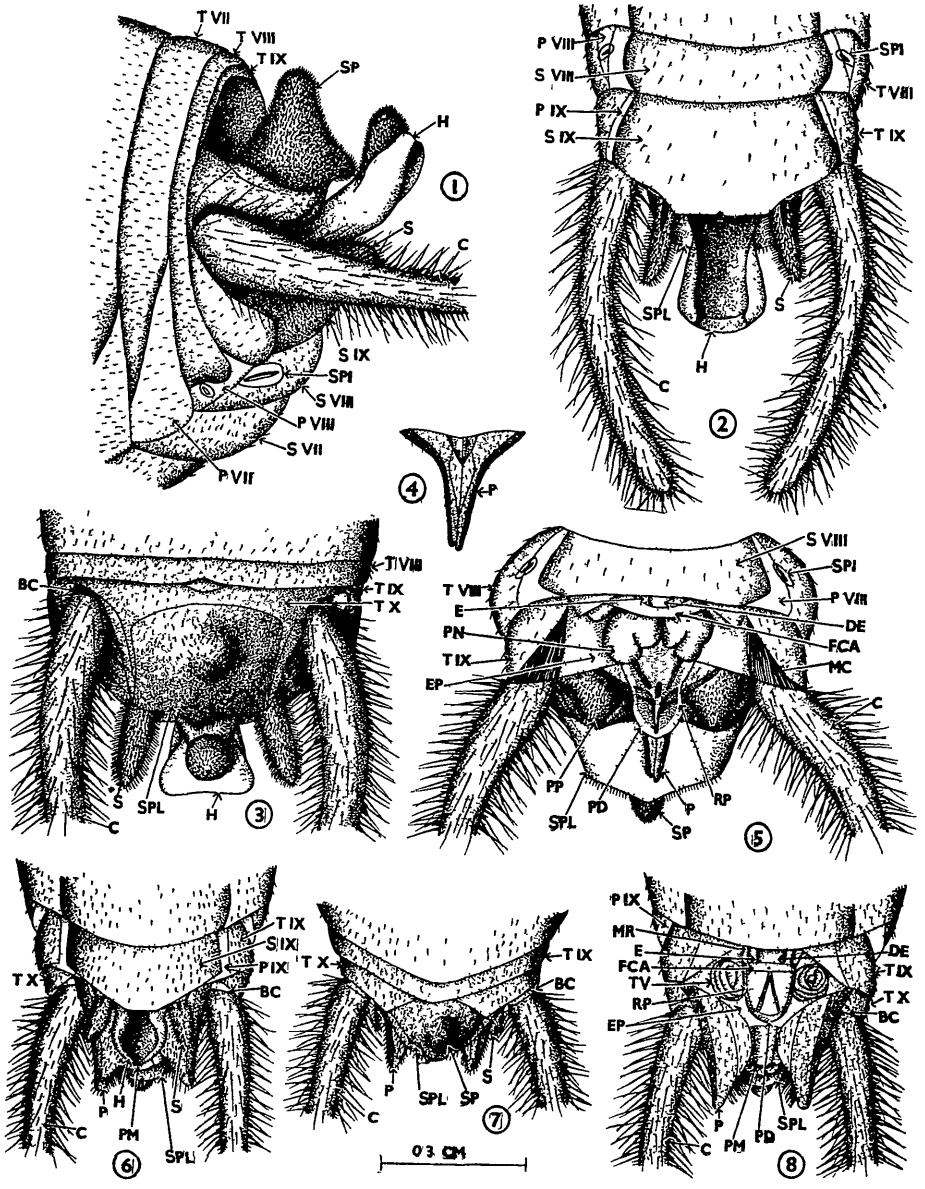
Macropathus delli n.sp.

Plates 29 and 30. Text-fig. 3. Figs. 1–2. Text-fig. 4. Figs. 1–8.

COLOUR. Basic colour deep ochrous, with posterior borders of pronotum, mesonotum, metanotum and abdominal terga dark brown; lateral and posterior margins ochrous; nota irregularly mottled with light brown; abdominal terga banded with light brown and ochrous; femora and tibiae ochrous, light brown at their junctions; hind femur with colour pattern poorly defined in pale and deeper ochrous; tarsi pale ochrous; antennae light brown; ovipositor deep reddish-brown.

BODY. Length, 26 mm. in male; 31 mm. in female. Body sparsely clothed with setae. Ovipositor five-sixths as long as body. Antennae 3 5–4 times as long as body. Head vertical. Compound eyes laterad, nearly elliptical, twice as long as broad; a single anterior, white, median ocellus only. Fastigium as high as long, rises abruptly, slightly sulcate, with base touching scape of antennae Mandibles small. Maxillary palps with third and fourth joints subequal in length. Pronotum rounded anteriorly and produced in front over occiput, truncated posteriorly; sternum transversely narrowed; pronotum and mesonotum distinctly margined laterally and posteriorly. Cerci long, tapering in female, Text-fig. 3, Figs. 1, 2 (C), but blunted terminally in male, Text-fig. 4, Fig. 2 (C), unsegmented, clothed with long and short setae.

ANTENNAE. A very long, slender, tapering flagellum, but bases thick and almost touching; scape about four times as large as pedicel, which is narrower than scape, but broader than other segments; third segment on dorsal aspect narrower than pedicel, but half as long again, and on ventral aspect one quarter as long as pedicel; from fourth segment onwards, segments unequal in length, although steadily decreasing in size; all segments thickly clothed with short



TEXT-FIG. 4 *Macropathus delli* n sp

FIG. 1—Male genitalia, lateral view, adult. FIG. 2—Male genitalia, ventral view, adult, hypandrium in place. FIG. 3—Male genitalia, dorsal view, adult FIG 4—Parameres, adult. FIG. 5—Male genitalia, ventral view, adult, hypandrium removed to expose structures beneath FIG. 6—Male genitalia, ventral view, nymph FIG. 7—Male genitalia, dorsal view, nymph. FIG. 8—Male genitalia, ventral view, nymph, hypandrium removed to expose structures beneath.

golden setae; sexual dimorphism poorly developed, antennae of male slightly stouter at base than female; no spines present on flagellum of male or female.

LEGS. Long and slender. Fore and middle legs subequal, while hind leg is about two-thirds as long again. Fore coxae close together, but not quite touching, each armed with a spine. All femora sulcate below. Fore femora either unarmed or possessing one or two prolateral spines beneath, middle femora unarmed, posterior femora bearing a variable number of spines beneath; fore, middle and hind tibiae and two proximal segments of hind tarsi armed with variable numbers of spines (see Table II of Variability of Spines on the Legs). No spines occur on fore or middle tarsi. Ratios of length of legs to length of body: Fore leg, male, 1·9:1; female, 1 6·1. Middle leg, male, 1 9:1; female, 1 6:1. Hind leg, male, 3·25:1; female, 2·7:1.

GENITALIA. *Female*: Text-fig. 3. Suranal plate, Fig. 2 (SAP), with central dorsal surface bearing a small elongate spine (SP); terminal margin slightly emarginate, bearing a row of setae. Sub-genital plate, Fig. 1 (SGP), sinuous laterally, terminal margin deeply emarginate; whole plate clothed with setae. *Male*: Text-fig. 4. Suranal plate, Fig. 3 (SPL), with terminal margin bluntly pointed medianly; central dorsal surface bearing a very large, blunt spine, thickly clothed with short golden setae, Figs. 1, 3 (SP). Subgenital plate (hypandrium), Fig. 2 (H), triangulate 1 2 as long as wide, sides concave, apex rounded, distal portion spatulate, with lateral margins curved back over plate; glabrous on dorsal side, but with apex of ventral surface thickly clothed with short golden setae. It bears two styli, Fig. 2 (S) thickly clothed with short setae, length of styli one-third length of sternite IX (S IX). It completely shields genitalia. Parameres. Fig. 4 (P) attenuated, broad at base, and tapering to a point; three times as long as broad. Pseudosternite, Fig. 5 (PD) longer than broad, concave laterally, rounded terminally. Penis, Fig. 5 (PN) two-lobed, each lobe a little broader than long. Paraprocts, Fig 5 (PP) short, much broader than long.

LOCALITIES. Stillwater River Base Camp, Caswell Sound, Fiordland, under a log and in rotten tree trunk, coll. R. K. Dell (type locality); Lake Te Au, near South Arm of Lake Te Anau, in a rotten log, coll. R. R. Forster.

TYPES. Male Holotype and two female Paratypes have been deposited in the Dominion Museum. Another female Paratype is in the Canterbury Museum.

DISCUSSION

From the foregoing it can be seen in what a muddle the systematics of the New Zealand representatives of the Macropathinae are in. The insects themselves are so variable within each species—particularly so in *M. filifer* which has the widest range of distribution and exhibits geographic as well as local variation—that it is difficult to find concrete characters on which to found either the species or the genus. It is primarily from this tendency towards variation—in some specimens I examined, the number of spines on the right and left legs of the same insect are different—that all the confusion in the systematics of the groups has arisen. New species have been named purely on differences in spination and, I feel, after examination of tables on the variability of the spines on the legs of over one hundred specimens, that I am justified in placing them all in the one species.

Another cause for confusion has been the failure to recognise the sexual dimorphism within each species. Apart from differences in spine counts *P. novaeseelandiae,* which is described from a female, is separated from *P. speluncae,* described from a male, by there being " no peculiarities in the antennae ". I have found that apart from the external genitalia, there is sexual dimorphism in the length of the legs and in the structure of the antennae within a species Part of the cause for the large number of unnecessary species must be due to inaccuracy of description of the habitats of the specimens by the collectors, or lack of actual field collecting on the part of the worker. This seems to me the only way to account for males and females of the same species, collected from the same locality, and living together in such large numbers as *Macropathus* does in caves, being placed in separate species.

It appears to me that the most reliable character on which to erect the genus is the constancy in the number of the apical spines on the legs. This number never varies and yet for some unknown reason it was ignored by earlier workers in favour of less inflexible characters.

At the moment three species are placed in the genus *Macropathus,* but it is quite possible that there are others not yet recorded, or still waiting to be untangled from among those already described

SECTION B—ECOLOGY

There have been very few published records on the distribution and habits of members of the genus *Macropathus* in New Zealand. Hutton (1896) records *M. filifer* from Wellington and Chopard (1923) mentions its occurrence more specifically in caves at Karori and Kaiparoro. six miles south of Eketahuna. Chopard also records a female from the bush on Mana Island. He says, "As far as I am aware, no representative of this remarkable genus has until now been found in the South Island I do not think there is more than one species in the North Island, although local varieties may possibly exist." Both these statements can now be proved incorrect, as I have been able to trace *M. filifer* from Nelson and the Marlborough Sounds as far north as the Waikato, while in the Auckland area *M. filifer* is replaced by another distinct species, *M. acanthocera* and in Fiordland yet another species, *M. delli,* occurs. The material I have acquired on the distribution of *M. filifer* throughout the North and South Islands is not complete, and there are large gaps yet to be filled in; but from what information I have obtained it seems safe to say that, apart from the Auckland area and the southern part of the South Island, *M. filifer* occurs quite plentifully throughout the whole country, especially in limestone regions, although they are also found in large numbers in greywacke tunnels and native bush.

The ecology of *M. filifer* in the Wellington area has been the most extensively studied, and it seems impossible to account for its occurrence in some areas and not in others. Ideal conditions appear to be almost complete darkness, and a constant high humidity, yet often when these are present there are no wetas The two main localities studied were a tunnel near the Karori Reservoir and a cave at Percy's Reserve, Petone

The Karori Cave, an old mining tunnel, has moss and bryophytes at its mouth and is surrounded by *Brachyglottis rangiora, Macropiper excelsum, Melicytus ramiflorus, Geniostoma ligustrifolium* and *Coprosma* species. Examination of stomach contents (Richards, 1954) revealed the presence of vegetative material,

but in the laboratory, from samples of all these plants only *Melicytus* and *Macropiper* were eaten. *M. filifer* is found in a dim twilight from five to fifteen yards from the mouth of the tunnel, occurring on the walls and roof and often hidden in groups behind out-jutting rocks or in crevices (Plate 31). Usually the young congregate nearer the mouth than the adults. The floor of the cave in the region in which the wetas are found consists of two large pools of stagnant water which maintain a high degree of humidity in the atmosphere. Other animals sharing the habitat with the cave-wetas consist of a few spiders, opiliones, glow-worms, and a member of the Tipulidae.

The tunnel at Percy's Reserve is smaller than that at Karori. On either side of the mouth of the cave are large trees of *Melicytus ramiflorus* and one bush of *Macropiper excelsum* which probably form part of the cave-wetas' diet. Here the wetas occur in larger numbers, spread over a greater area, and yet further back in the cave than those at Karori. Unlike the Karori Cave there is a concrete floor, which prevents accumulation of water, and there is no percolation of water through the roof or walls. Although I have visited Percy's Reserve several times during rain, there has never been a trace of moisture inside it, and it is possibly because of this that there is no sign of lichen or moss. However the still atmosphere of the tunnel has a high humidity. The only other inhabitant apart from *M. filifer* is a smaller species of cave-weta.

It seems that the caves at Percy's Reserve and Karori must have been comparatively recently colonised by *Macropathus,* which presumably once inhabited the bush surrounding the caves, and became attracted to them because of the ideal conditions they offered for protection, darkness and humidity.

Cave-wetas also occur in a large greywacke cave surrounded by native bush at the side of the Eastbourne Road, Lowry Bay. Again there is no trace of water but the humidity is high. At Days Bay, *M. filifer* is found in the bush, and, according to Dr. R. A. Falla, he and his neighbours have found it on the walls of their garages and inside their houses. Two specimens of *M. filifer* from native bush at Pinehaven form another locality. I have been told by several people of a greywacke cave on the Makara-Johnsonville Road which contains a large colony of cave-wetas, but, although I have searched for it, I have been unable to locate it. Other places in the Wellington area visited and examined with no success were the Wainui-o-mata Pipe Tunnel, Koro-Koro, the Ngahauranga Gorge Tunnel and caves in the Tinakori Hills. Darkness, dampness and native bush occurred in each place, but no wetas—only spiders and a few glow-worms.

At Karori *M. filifer* is known to inhabit the basement of some of the houses if they are sufficiently damp and dark. In one house I discovered a small colony of a mature male and female and about a dozen offspring of various sizes. The outer wall of the basement is damp with a narrow opening at the bottom, which permits the insects to go out into the open whenever they please. They are found on the wooden rafters or hidden behind the loose folds of building paper which line the basement. In the United States of America both Banta (1907) and Hubbell (1936) record *Ceuthophilus* as occurring in cellars and even inside houses where one species is reported to have chewed holes in some lace curtains.

Spelaeologists exploring limestone caves in the Wairarapa discovered *M. filifer* at Dannevirke and Ruakokopatuna so, in May, 1952, a collecting trip was arranged to the latter place. The cave visited had a low, narrow tunnel at its mouth which widened out into a larger chamber with high funnels in the roof and,

although nymphs were collected near the floor, it was in the cracks and crevices of these inaccessible places that the mature *M. filifer* congregated. Blatchley (1920) writing on *Ceuthophilus stygius* observed that the adults seemed more or less gregarious. He says, " In one instance in Sibert's Well Cave, more than twenty were found in a small cranny in the wall. They were grouped in a circle, in a space about six inches square, with their antennae pointing towards the centre of the circle, and appeared to be holding a conference or cricket convention." In the Saltpetre Cave they were never seen on the floor, but always on the sides of small projections and in small cavities of the walls or roof. This habit of the adult cavernicolous members of the Rhaphidophoridae to frequent the upper regions in caves seems common in all areas where they occur. Sharing the same habitat with *M. filifer* at Ruakokopatuna were very large opiliones, several species of spiders, numerous glow-worms and one solitary *Peripatus.* Running water and several deep pools maintained a constant humidity. Surrounding the cave was typical limestone country with many sinkholes and caves. Very little vegetation occurred except for grass, rotting tree trunks. and one solitary *Hoheria* Practically no light entered the cave because of the narrow entrance. This was the darkest place in which I have found *M. filifer.*

A trip to Trio Islands and Stephens Island in April, 1953, threw more light on the habitats of *M. filifer.* Middle Trio Island is the home of tuataras (*Sphenodon punctatus*), dove petrels (*Pachyptila turtur*), diving petrels (*Pelecanoides urinatrix*), fluttering shearwaters (*Puffinus gavia*) and mutton birds (*Puffinus griseus*). These animals all live in burrows, the tuataras during the daytime and the petrels and shearwaters at night. *M. filifer* was found to inhabit the old damp, unused burrows during the daytime and to come out at night to feed on the leaves and young branches of *Melicytus ramiflorus,* one of the main components of the flora on the upper part of the island. As there were numerous unused burrows, in many cases the wetas did not congregate in them in large numbers, but each burrow was found to contain a pair and sometimes one or two nymphs as well. However, several burrows have been unearthed containing large colonies living together. At night there was definite segregation among the wetas—only a solitary weta or perhaps a pair were found on each *Melicytus* tree. Numerous nymphs were seen, but these also were solitary. Searching for wetas was carried out over the whole upper area of the island, and *M. filifer* was found to occur in every direction, but confined exclusively to *Melicytus.*

On Stephens Island the habitat of *M. filifer* is inside large unused concrete water tanks attached to the lighthouse keepers' houses. Lining the walls and roof are hundreds of wetas, most of them in their characteristic attitude of hanging head downwards (Plate 31). Here there is no segregation into adults and nymphs, possibly because of the confined space. On Stephens Island *Melicytus ramiflorus* and *Macropiper excelsum* form a part of the main vegetation, and although no cave-wetas were observed on *Melicytus* trees at night, it is highly probable they feed on it as well as on grass, because in most localities where they both occur, *Melicytus* forms a part of their diet.

A female of *M filifer* was recorded by Chopard (1923) from the bush on Mana Island To-day Mana Island is almost entirely farmland with very little scrub, and in 1952 when a party landed there no trace could be found of *M. filifer.* However, in April, 1954, a headless male specimen was found at the southern end of the island at the mouth of a mutton bird burrow, but none were found

inside any of the burrows examined. As *M. filifer* inhabits the old petrel burrows on Middle Trio Island, it would seem probable that it does the same on Mana Island. The southern end of Mana Island has little vegetation, but a few *Melicytus* trees do occur at the more northern end of the island, and might form a source of food for the wetas.

At Waitomo *M. filifer* occurs in large numbers in the Aranui and Ruakuri Caves, but is absent from the Glow-worm Cave. This absence from the Glow-worm Cave may be accounted for because the Cave is closed by a wooden door which would cause conditions of total darkness and prevent the wetas from coming out into the bush at night. The Aranui Cave, however, is closed by a gate which permits a dim light to filter into the anterior portion of the cave, and also enables the wetas to come and go at will. As cave-wetas always occur where there is both a dim light and an opening to the outside world, they evidently form limiting factors in the distribution of the group, which are more important to the wetas than a constant high humidity and a still atmosphere.

In the South Island no records of *M. filifer* have been taken from either the far south, the east coast or the west coast, but it is possible they do occur in these areas. They have been found in Nelson in native bush near the Maitai and also in a greywacke waterworks tunnel near the Waimere Plains. At Cannibal Cove, in the Marlborough Sounds, they have been collected from among rocks near a stream, and they have also been caught from both Trio Islands and Stephens Island.

In the North Island, apart from the Wellington area, *M. filifer* has been recorded from limestone caves in two areas in the Wairarapa—Ruakokopatuna and Kaiparoro, and further north from Dannevirke. At Te Mata Peak, Havelock North, there is a large colony living in a limestone cave. In the centre of the Island they occur in a greywacke tunnel near the railway line at Ohakune The Waikato area is riddled with limestone caves, and it seems highly probable cave-wetas inhabit them. They have been definitely recorded from Waitomo and Te Anga. Caudell (1927) while collecting at Roto Eho, Rotorua, found a medium-sized immature female and a very small male, both of which he doubtfully referred to *M. filifer*. This is the only record of *M. filifer* from Rotorua. North of this area *M. filifer* does not seem to occur.

Summarising these facts: *M. filifer* is to be found throughout the greater part of New Zealand, either in bush, house basement, greywacke tunnel, limestone cave or burrow. This wide range of habitat shows that the weta when seeking protection is not limited by the actual material of its home. It requires conditions of high humidity and is found in various degrees of darkness, but never total darkness; it occurs in varying abundance, from solitary to several hundred insects in one habitat, and is nocturnal in its habits. Although they may share the same habitat as spiders, opiliones and glow-worms, cave-wetas are frequently found alone, so it would seem there is no dependence upon other animals. As far as is known they do not occur in arid areas.

The description Hubbell (1936) gives of *Ceuthophilus gracilipes* is very similar to that of *Macropathus filifer*, showing the correlation between the two groups. He describes the habitat as being " In caves; under bark of dead trees and in hollow trees; under logs and stones; from foundations and cellars. It is characteristically a forest inhabitant which occurs in a variety of environments. Wherever it occurs it takes advantage of such shelter as is afforded by caves,

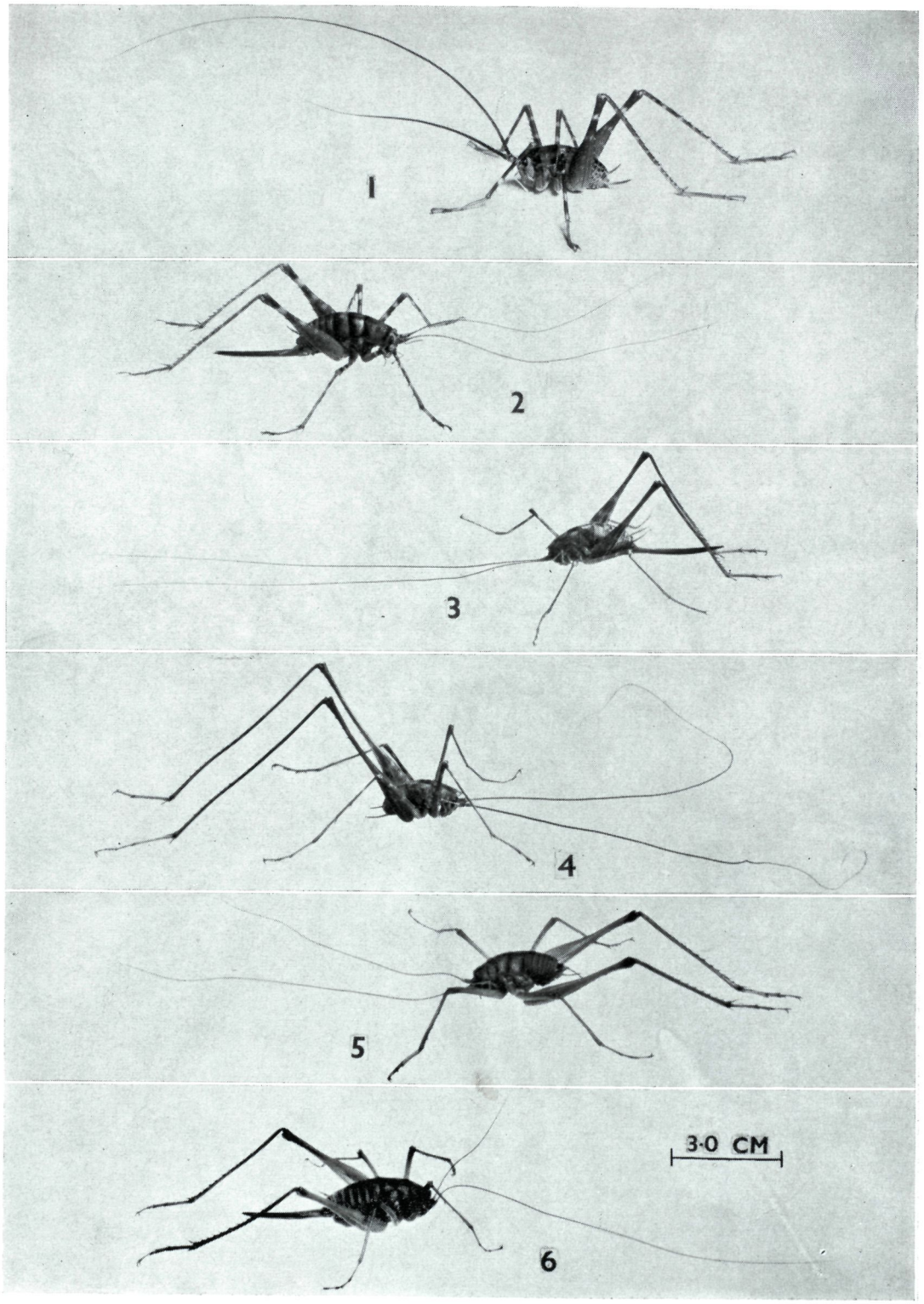


FIG. 1.—*Macropathus filifer* male, lateral view. FIG. 2.—*M. filifer* female, lateral view. FIG. 3.—*Macropathus acanthocera* female, lateral view. FIG. 4.—*M. acanthocera* male, lateral view. FIG. 5.—*Macropathus delli* male, lateral view. FIG. 6.—*M. delli* female, lateral view.

Photos M. D. King, A.R.P.S.

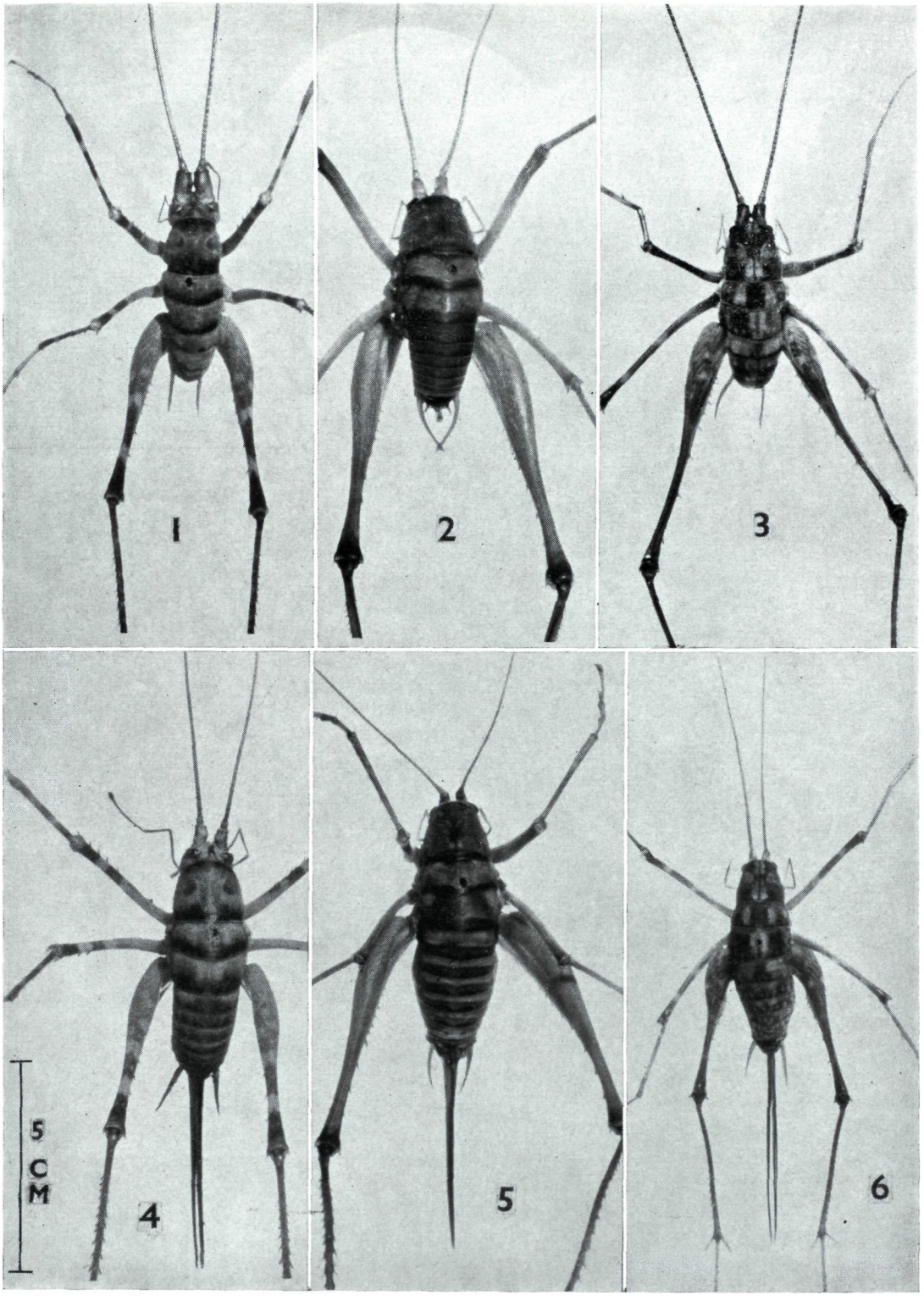
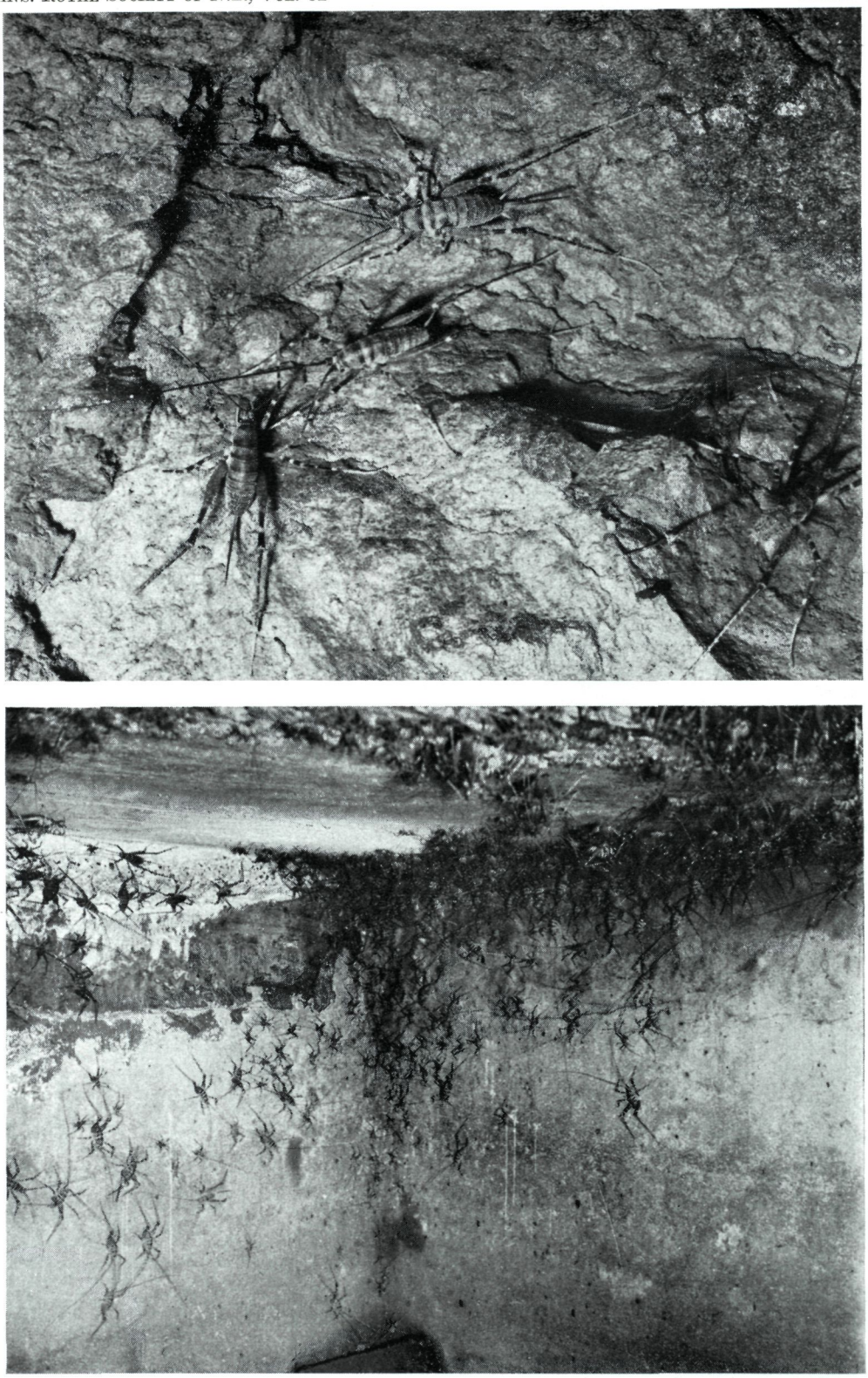


FIG. 1.—*Macropathus filifer* male, dorsal view. FIG. 2—*Macropathus delli* male, dorsal view. FIG. 3.—*Macropathus acanthocera* male, dorsal view. FIG. 4.—*M. filifer* female, dorsal view. FIG. 5.—*M. delli* female, dorsal view. FIG. 6.—*M. acanthocera* female, dorsal view.

Photos M. D. King, A.R.P.S.



TOP. Greywacke wall of Karori Cave showing sparse population of *Macropathus filifer* as compared with those on Stephens Island (below). BOTTOM. Inside concrete water tank on Stephens Island, showing large numbers of *Macropathus filifer* clustered together on walls and roof with no segregation of adults and nymphs.

Photos M. D. King, A.R.P.S.

cellars, hollow logs and other natural cavities. Occasionally it may even penetrate some distance into the larger limestone caves, where it has been found 300ft. from the entrance The species is neither a true troglobiont nor, apparently, a burrower in the soil."

An interesting character in the distribution of a species is the geographic variation which sometimes occurs. In some cases among the Ceuthophilinae this is so great that superficially there does not appear to be the remotest resemblance between the insects, and it is only by examining genitalia or other distinctive taxonomic characters that the true relationship is discovered. In discussing the geographic variation in *Ceuthophilus gracilipes,* in North America, Hubbell (1936) says, " The species exhibits local and regional differentiation in average size, proportions and colouration. In most instances these differences are of a minor nature and show gradual transitions from one area to the next; thus the average size gradually increases from north to south, and also from the Appalachian region to the Interior Lowland and Mississippi Basin." With *Macropathus filifer* specimens from six localities ranging from the Marlborough Sounds area to Havelock North were examined, and it was found that there was a gradual increase in size from north to south Measurements of the length and width of the pronotum, length of the hind femur and hind tibia, and length of the ovipositor were taken and the results analysed. The same gradations in size were observed in each case. (See Table III on Geographic Variation in *M. filifer.*) The "t" test applied to the length of the pronotum showed that the six localities could be grouped into three pairs, as the tests between Trio and Stephens, Percy's Reserve and Karori, and Ruakokopatuna and Te Mata Peak respectively were non significant. In males from Trio and Stephens Island "t" was 1 16; in males from Percy's Reserve and Karori "t" was 0 03; in females from Ruakokopatuna and Te Mata Peak "t" was 0 16, all these results being non significant However, when any member of these pairs was compared with a member of another pair, the results were highly significant Females from Trio and Percy's Reserve had a value of "t" of 96·6.

By combining the measurements of Trio and Stephens, Percy's Reserve and Karori, and Ruakokopatuna and Te Mata Peak respectively all "t" tests for both males and females were highly significant.

Values of "t".

	Males	Females
Trio and Stephens Island Percy's Reserve and Karori	42.5	32
Trio and Stephens Island Ruakokopatuna and Te Mata Peak	68	46 6
Percy's Reserve and Karori Ruakokopatuna and Te Mata Peak	70	46.4

In all cases there was a slight difference in size between males and females. Length of body was not used as a measurement because it was greatly affected by the degree of telescoping of the segments, and attitude of the body.

Poikilothermal terrestrial animals generally attain larger size in warmer climates, and this is considered also to apply to insects. Peterson and Weber (1949) comparing growth ratio and geographic variation of *Omocestus viridulus* from six Scandinavian localities found that the size of most insects investigated decreased the further north they were collected, and that the relative size of extremities decreased in the same direction This result is in agreement with

Hubbell's results so it is interesting to find the direct opposite to be the case with *Macropathus filifer* in New Zealand.

The largest specimens of *Macropathus filifer* were collected from Trio and Stephens Island. Combination of measurements from Trio and Stephens Island compared with the combined mainland measurements gave a value for "t" of 21·6 in the males, and 28 in the females, both of which were highly significant and agree with the theory that island fauna is larger than that on the mainland. This increase in size is perhaps an evolutionary response to island life with its absence of predators and competitors.

M. acanthocera has been recorded from Titirangi and the Waitakere Ranges, Auckland, and from no other part of New Zealand. It has been collected from a waterworks tunnel, Titirangi, and also from another old waterworks tunnel at Mackie's Rest, Waitakeres. The tunnel at Titirangi has patches of dampness on the walls and ceiling and the wetas are found closely associated with them. In December, 1952, when the tunnel was examined, about fifty wetas were present in groups of ten to twenty, on the walls of the tunnel. Males were in greater numbers than females, there being about five to eight males to one female. No nymphs were present. The only other inhabitant of the tunnel was a *Neonetus* The vegetation surrounding the mouth of the tunnel consists of typical Waitakere rain forest, the most common plants being *Fuchsia excorticata, Schefflera digitata, Nothopanax arboreum* and *Coriaria sarmentosa. Melicytus* is absent, but is probably replaced by some of these plants in the weta's diet. In May, 1954, I visited the tunnel and found the population was much larger than that recorded for 1952, there being over one hundred and fifty wetas present. As in 1952 there was a larger proportion of mature males to females. More than half of the population consisted of nymphs at various instars, there being a gradation of five instars represented. The very smallest occurred about three yards from the mouth of the tunnel, and they gradually increased in size till the mature insects were found about ten yards within. They were all grouped on the walls and none on the ceiling. There was no water in the tunnel, but the humidity was very high. No specimens of *Neonetus* were seen, and it is possible that some of the nymphs of *M. acanthocera* may have been mistaken for it in 1952. Spiders and glow-worms occurred throughout the whole length of the tunnel, and at the far end was a single basidiomycete, the only one I have ever seen in a cave containing *Macropathus,* although I have found basidiospores in the stomach contents of *M filifer* collected from the Karori Cave (Richards, 1954).

In contrast to Titirangi, the tunnel at Mackie's Rest is situated in open scrubby country according to Mr R K Dell, who collected cave-wetas from there in 1949. The floor of the tunnel is filled with water so that a high humidity must be maintained in the atmosphere. Unfortunately I was unable to examine this tunnel, but the wetas collected from there are all *M. acanthocera*

M. delli has been recorded only from the southern part of the South Island It was first collected on the New Zealand-American Fiordland Expedition, 1949, at Stillwater River Base Camp, Caswell Sound. The wetas were found in the warm, moist interior of a rotten tree trunk, near a stream, and were the only occupants. A mature male and female, two immature males and two immature females were collected. Another mature female was found inside a rotten log. No *Melicytus* occurred in this locality, but *Macropiper excelsum* was common and may have formed part of their food. In January, 1953, on the Canterbury

Museum Fiordland Expedition, another mature female of this species was collected from the inside of a rotten log in the bush at Lake Te Au, near the southern arm of Lake Te Anau. Large numbers of this species are reported to occur in the limestone caves on the west of Lake Te Anau, but so far I have been unable to obtain any material for examination to confirm this.

Animals found in caves have been grouped in three categories—those which lost their power of reproduction in a cave environment (troglosseni), those which retained this power and could still live in daylight (troglophili), and those which were compelled to spend their whole existence underground, from birth to death, and could not survive in daylight (troglobi). It is important to remember that the troglosseni only arrive in caves by accident, whereas the troglophili actively seek out and prefer the underground dark. It is obvious from this that the Rhaphidophoridae belong to the troglophili. Typical cavernicolous animals commonly exhibit certain well marked characters. They are very often blind or have eyes much reduced in size or efficiency and frequently they are colourless. All these conditions to a greater or lesser degree are to be found in the family. *Dolichopoda bolivari* from Europe is pale in colour and its eyes are reduced in size and simplified in structure. *Ceuthophilus pallidus* from U.S.A. is another example showing loss of pigmentation. To compensate for these deficiencies organs of tactile sense are often highly developed. These consist of very elongated antennae which the insect waves about to detect any unusual movements. The normal stillness of the air within the cave creates an environment in which slight, small movements are more readily perceptible than in the open air. Another peculiarity among cavernicolous insects, which is well illustrated in the Rhaphidophoridae, is the tendency to develop long, thin, spindly legs, thickly covered with sensory setae, which enable the insects to beat a quick retreat when they sense unusual vibrations.

In his section on Insects in the Cambridge Natural History, Sharp (1901). discussing cave dwelling Locustidae says, " The species though found in the most widely separated parts of the world have a great general resemblance so that one would suppose the specimens found in the caves of Austria, in the Mammoth cave of Kentucky and in the rock-cavities of New Zealand to be one species although they are now referred to by entomologists to different genèra ". Although this statement cannot be accepted to-day, it does draw attention to the superficial similarity in the whole family, especially with regard to their habitats and the conditions necessary for their existence. This similarity however, may be due to separate evolution along similar lines because of similar conditions, instead of being due to close relationship.

The distribution of the three sub-families of the Rhaphidophoridae covers a wide area, but with the exception of North America, is confined to-day principally to the Southern Hemisphere. The Macropathinae which are the most primitive, are typically paleantarctic, including New Zealand, South Australia, Patagonia and the Cape of Good Hope. They are most abundant in the Australian region where there are thirteen genera and about thirty species so far recorded (Chopard, 1949). The great majority of these are localized in New Zealand. The Rhaphidophorinae are found in the Indo-Australian region as far north as Japan, and also include some of the cave-dwelling forms of Europe; while the Ceuthophilinae are confined to North America.

The Rhaphidophoridae are considered to be representatives of a very primitive group of insects which have changed but little during the long intervening period since they arose. It has been pointed out by Chopard (1944) that the Macropathinae are most abundant to-day in the New Zealand area. The fact that New Zealand has been isolated from the rest of the world for many millions of years probably accounts for the large number of endemic species distributed throughout the country. As yet very little is known about this interesting group in New Zealand, but further study on their habits and distribution should yield much interesting information.

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