A new *Rakaia* species (Opiliones, Cyphophthalmi, Pettalidae) from Otago, New Zealand

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Abstract

*Rakaia macra* sp. nov. is described from three lots of specimens collected by Ray Forster in 1977 from Waipori, Otago, South Island of New Zealand. This species is currently known only from the Waipori area (exact locality unspecified) where it is extremely abundant. Clearly a member of the family Pettalidae, *R. macra* sp. nov. presents unusual chelicerae, with a conspicuous outer lateral ridge on the second segment, and without the two types of denticles in the mobile digit that characterize the New Zealand pettalids. The relationships between the new species and its closest relatives are discussed, and the distinction between the genera *Rakaia* and *Neopurcellia* is questioned.

Key words: Opiliones, Cyphophthalmi, *Rakaia*, New Zealand

Introduction

Cyphophthalmids are mostly small, inconspicuous, slow-moving arachnids with a worldwide distribution. Within this suborder of Opiliones, the family Pettalidae Shear 1980 has a typical Gondwanan distribution with representatives known from Chile, Madagascar, Sri Lanka, South Africa, New Zealand, and Australia. 48 species and subspecies are known for the family (including the new species presented here) (Giribet 2000); 29 of them, or 60% of the total diversity of the family and 25% of the total diversity of the suborder, occur in New Zealand in what appears to be a spectacular peak in the diversity of the group.

Most pettalid species are known from very few specimens collected only from the type locality. Hirst (1925) described the first New Zealand genus and species, *Rakaia antipodiana* Hirst 1925, from the South Island. Subsequently, Phillipps and Grimmett (1932) described *Rakaia dorothea* Phillipps and Grimmett 1932 from the North Island, and in 1948 and 1952 Ray Forster published two extensive monographs describing the majority of the species currently known, as well as the new genus *Neopurcellia* Forster 1948.
Current morphological and molecular data indicate that the Pettalidae are a monophyletic group and the putative sister taxon to all other cyphophthalmids, although alternatively they could constitute a derived group related to Sironidae (see alternative rooting possibilities in Giribet and Boyer 2002). However, the internal relationships of these organisms have not been studied extensively, and there is reason to believe that the generic classifications within Pettalidae are problematic.

In this paper we describe a new pettalid species from Waipori, Otago, in the South Island of New Zealand. It is readily distinguished from all other previously described members of this group by the presence of a prominent outer lateral ridge (apodeme) on the the second article of the chelicerae.

**Methods**

Two male and two female specimens were examined with an FEI Quanta 200 Scanning Electron Microscope (SEM). Two males and one female were dissected and their genitalia studied as temporary mounts (embedded in glycerin) under a compound microscope.

Measurements were taken from SEM images and, except where stated otherwise, are given in mm. Total body length refers to the distance between the anterior median and posterior median margins of the dorsal scutum. Lengths of leg and palp articles were measured on their dorsal side, from anterior to posterior margin, along the mid-line; widths (depths) on the lateral side, at the widest portion, except for tarsus IV of the male, which was measured at the distal point of insertion of the adenostyle. Tarsal length does not include the claw. The position of the adenostyle on tarsus IV is given from the more clearly marked distal point, where it first begins to rise from the tarsus. All appendage measurements refer to the paratype specimens studied under the SEM.

**Abbreviations.** MCZ: Museum of Comparative Zoology, Cambridge, MA (USA); MONZ: Museum of New Zealand Te Papa Tongarewa, Wellington (New Zealand); OMNZ: Otago Museum, Dunedin (New Zealand)

**Taxonomy**

*Rakaia* Hirst 1925

**Type species:** *Rakaia antipodiana* Hirst 1925.

**Species account and distribution:** 23 valid species (including the new species described here) are known, with 3 occurring in Queensland (Australia) and the rest in New Zealand. Six of these species comprise two subspecies each.
**Rakaia macra** sp. nov.  
(Figs. 1-30)

**Types.** Holotype: male from Waipori (Otago, South Island of New Zealand), 18 March 1977, R. Forster leg., deposited in OMNZ. Paratypes: 5 males and 6 females, same collecting data as holotype, deposited in OMNZ; 6 males and 6 females, same collecting data as holotype, deposited in MONZ; 6 males and 6 females, same collecting data as holotype, deposited in MCZ 48184-48195 (including 2 male and 2 females mounted on SEM stubs).

**Other material examined.** 39 males and 36 females from Waipori (Otago, South Island, of New Zealand), 18 March 1977, R. Forster leg., deposited in OMNZ; 16 males, 18 females and 6 juveniles from Waipori (Otago, South Island of New Zealand), 21 March 1977, R. Forster leg., deposited in OMNZ; 19 males, 19 females, and 10 juveniles from Waipori (Otago, South Island of New Zealand), 20 September 1977, R. Forster leg., deposited in OMNZ.

**Etymology.** Latin adjective: *macra* = lean, skinny. The specific epithet refers to the general appearance of the animal’s body, particularly in lateral view.

**FIGURES 1-2.** *Rakaia macra* sp. nov. 1. Dorsal view of male holotype; 2. Ventral view of male holotype. Total length: 2.25 mm.
**Diagnosis:** Pettalid with dorsal scutum flat (Figs 6, 7). Trochanter of palp with conspicuous ventral process (Fig. 11); chelicerae with distinct outer lateral ridge on the surface of the second article (Figs. 4, 5, 8), lacking a ventral process on the first article (Fig. 8); dentition of the mobile digit of chelicerae uniform (Fig. 9).

**Description:** Total length of male holotype (female paratype measurements in parentheses) 2.25 (2.60), width across ozophores 0.855 (0.769), greatest width 1.19 (1.29); length/width ratio 1.89 (2.02). Body brown-yellow (in alcohol) (Figs. 1, 2) with most of the dorsal surface and legs showing a tuberculate-granulate microstructure. Anterior margin of dorsal scutum with two projections delimiting the insertion of the chelicerae (Figs. 1, 3); prosomal region trapezoidal. Eyes absent. Ozophores conical and positioned dorsally, somewhere between types 2 and 3 of Juberthie (1970) (Figs. 3, 17). Transverse prosomal sulcus distinct but not conspicuous (Fig. 3). Transverse opisthosomal sulci distinct by lacking granulation, longitudinal opisthosomal sulcus absent (Figs. 1, 3). Dorsal scutum flat (Figs. 6, 7); opisthosomal region reaching its maximum width at segment II.

Coxae of legs I and II mobile; coxae of remaining legs fused. Ventral prosomal complex of male with coxae II, III, and IV meeting in the midline (Fig. 4). Male gonostome small, subtriangular, slightly wider than long, bordered on posterior margin by the first opisthosomal sternite (Fig. 19); male gonostome shorter than length of seam of contact of left and right coxae IV parallel to midline. Ventral prosomal complex of female with only coxae II and III meeting in the midline (Fig. 20). Female gonostome roughly round in shape, with the edges of coxae of leg IV and first opisthosomal sternite forming a partial “tube” at the posterior margin of the opening (Figs. 5, 20).

**FIGURE 3.** Rakaia macra sp. nov. Dorsal view of male paratype. Scale bar 1 mm.
Spiracles C-shaped (sensu Giribet and Boyer 2002), with one of the edges recurving internally as found in the “open circle” type (Fig. 18). Sternal opisthosomal region without modifications or glandular pores (Figs. 2, 4, 5). Anal region with sternites 8 and 9 and tergite IX free, not forming a corona analis (Figs. 21, 23). Area of contact of tergite IX and sternite 9 of “pettalid” type (Giribet and Boyer 2002) in which tergite IX laterally covers sternite 9 and clearly meets sternite 8. Anal plate of male without longitudinal carina; posterior margin of anal plate slightly concave, bearing a scopula (Fig. 23). Scopulae present on each lobe of tergite VIII (Fig 24). Cuticle with granular surface in all ventral areas including coxae and anal plate. Anal glandular pore not observed in males.

FIGURES 4-5. Rakaia macra sp. nov. 4. Ventral view of male paratype (scale bar 1mm); 5. Ventral view of female paratype (scale bar 1 mm).
Chelicerae short, extremely robust, with very few long setae. Proximal article with hook-like dorsal crest (“dorsal ridge” of Hansen and Sørensen 1904 and Forster 1948; “dorsal transverse crest” of Juberthie 1970), without ventral process, ornamented over almost its entire surface from the dorsal ridge to the second article (Fig. 8). Chelicerae of the protruding type described by Giribet (in press). Second article extremely wide, with a distinct longitudinal ridge on the outer lateral surface running towards the base of the mobile digit (Figs. 5, 8). Mobile digit with 12 uniform denticles of the same type (Fig. 9). Proximal cheliceral article of male paratype 0.697 long, 0.303 wide; second article 0.947 long, 0.273 wide; mobile digit 0.121 long, 0.083 wide, 13% of second article length.

Palp (Fig. 10) with a sharp, spiny ventral process on the trochanter (Fig. 11). Measurements of palpal articles in male paratype, length/width (L/W ratio), from trochanter to tarsus: 0.275/0.129 (2.13); 0.422/0.100 (4.22); 0.311/0.111 (2.80); 0.333/0.222 (1.5). Palpal claw 0.041 long.

FIGURES 6-7. *Rakaia macra* sp. nov., lateral view. 6. Male holotype; 7. Female paratype. Scale bar 1 mm.
Legs with all claws smooth, without ventral dentition or lateral pegs (Figs. 12-16). Surface of most articles clearly ornamented with granules, including metatarsi II and III; metatarsus of legs I and II with ornamentation only in the proximal half; tarsi without granules. Ventral side of tarsus I with a concentration of short sensory hairs occupying about half of the total tarsal length, not forming a distinct solea (Fig. 12). Tarsus IV of male entire, carrying a short, thick adenostyle projecting upward and slightly distally (Fig. 15). Leading edge of adenostyle base at about 40% of the tarsal length. Tarsus IV of the female without modifications (Fig. 16).

Leg measurements of male paratype in µm [length/width (L/W ratio)]:

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<tr>
<td>Leg I</td>
<td>224/210 (1.07)</td>
<td>605/171 (3.54)</td>
<td>468/171 (2.15)</td>
<td>447/171 (1.61)</td>
<td>289/145 (1.99)</td>
<td>500/184 (2.72)</td>
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<tr>
<td>Leg II</td>
<td>132/140 (0.94)</td>
<td>421/132 (3.19)</td>
<td>228/140 (1.63)</td>
<td>281/140 (2.01)</td>
<td>211/105 (2.01)</td>
<td>360/123 (2.93)</td>
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<td>Leg III</td>
<td>226/170 (1.33)</td>
<td>396/151 (2.62)</td>
<td>255/151 (1.69)</td>
<td>321/179 (1.86)</td>
<td>245/132 (1.86)</td>
<td>415/142 (2.92)</td>
<td>1858</td>
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<tr>
<td>Leg IV</td>
<td>224/184 (1.22)</td>
<td>579/184 (3.15)</td>
<td>342/197 (1.74)</td>
<td>395/197 (2.01)</td>
<td>289/158 (1.83)</td>
<td>526/188 (2.80)</td>
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Penis small, typical of pettalids (Figs. 25-28). Setal formula 3, 6, 3 or 4 (two penises examined). Ventral side ornamented with tiny denticles along distolateral and distal mar-
gins. Three ventral setae set back far from distal margin, their bases separated by distances roughly equal to setal diameter. Rounded distal margin of penis with 6 apical setae. Dorsal side of penis with a group of 3 or 4 long setae on each side, their broad bases separated by distances roughly equal to setal diameter and arranged in a V. Gonopore complex with two movable fingers (m.f.) in the shape of pronounced hooks, with denticles at their bases (Figs. 26, 28).

**FIGURES 12-16.** *Rakaia macra* sp. nov. tarsi. 12. Male left tarsus I (scale bar 300 µm) (12); 13. Male left tarsus II (scale bar 300 µm); 14. Male left tarsus III (scale bar 200 µm); 15. Male left tarsus IV (scale bar 300 µm); 16. Female left tarsus IV (scale bar 200 µm).

Ovipositor (Figs. 29, 30) wide, composed of two apical lobes and 29 circular articles, each of the latter furnished with eight setae. Apical lobes carrying several setae (increas-
ing in length towards the tip); a long terminal seta rising from a small socket at the end of each lobe. Sensitive processes carrying a long, multibranched seta on the distolateral side of each terminal lobe.

FIGURES 17-22. *Rakaia macra* sp. nov. 17. Ozophore of male paratype (scale bar 50 µm); 18. Spiracle (scale bar 20 µm); 19. Gonostome of male paratype (scale bar 100 µm); 20. Gonostome of female paratype (scale bar 100 µm); 21. Anal region of male paratype (scale bar 400 µm); 22. Anal region of female paratype (scale bar 300 µm).
Variation: Range of measurements: male (n = 6), female (n = 6) in parentheses: dorsal scutum length 2.24-2.50 (2.48-2.64).

Distribution and habitat: Known only from Waipori, Otago, South Island of New Zealand. Collected by Ray Forster three times in 1977: March 18, March 21, and September 20. Although there is a scenic reserve at this site, no further information about these collections is available. A collection of specimens of an undescribed species is also known from this locality.

FIGURES 23-24. *Rakaia macra* sp. nov. male paratype anal region. 23. Posterior view of anal region, showing scopulae on margin of the anal plate and on lobes of tergite 8 (scale bar 200 µm); 24. Dorsal angle, showing lobes and scopulae of tergite 8 (scale bar 300 µm).

Remarks: *Rakaia macra* sp. nov. clearly belongs to the family Pettalidae because of the ozophore position and the modified anal region. However, the dentition of its chelicerae is unusual for this group; a homogeneous dentition has been previously reported only in the genera *Purcellia* Hansen & Sørensen 1904 and *Parapurcellia* Rosas Costa 1950 among the Pettalidae. *Rakaia macra* sp. nov. resembles other *Rakaia* species which, in ventral view, appear to have scopulae only on the posterior margin of the anal plate. These include *Rakaia lindsayi* Forster 1952, *R. magna* Forster 1948, *R. media* Forster 1948, and *R. solitaria* Forster 1948.

*Rakaia macra* sp. nov. is distinguished from all other congeners by the presence of an outer lateral ridge on the second cheliceral article (Fig. 8). Additionally, it is distinguished
from *R. lindsayi* by the uniform dentition in the mobile cheliceral digit (Fig. 9), the presence of a ventral process on the trochanter of the pedipalp (Fig. 11), and the absence of a ventral process on the chelicerae (Fig. 8). *R. macra* sp. nov. is distinguished from *R. magna* by size; specimens of *R. magna* are 3.0 mm or more in length, while all specimens of *R. macra* are smaller than 2.70 mm in length. *R. macra* is distinguished from *R. media* by the shape of the male tarsus IV; *R. media* has a pyriform male tarsus IV (sensu Forster 1952), while the male tarsus IV of *R. macra* tends to be elongate (sensu Forster 1952). *R. macra* is distinguished from *R. solitaria* by elongate vs. pyriform male tarsus IV, and the shape of the adenostyle, which is long and slender in *R. solitaria* but stout in *R. macra* (Fig. 15).

**FIGURES 25-28.** *Rakaia macra* sp. nov. apex of penis. 25. Dorsal view; 26. Dorsal view showing movable fingers (mf); 27. Ventral view; 28. Light microscope image, dorsal view. Scale bar 100 µm for all.
The penis of *R. macra* sp. nov. (Figs. 25-28) is very similar to that of several pettalids: *R. daviesae* Juberthie 1989 (Juberthie 1989: figure 7), *Austropurcellia scoparia* Juberthie 1988 (Juberthie 1988: figures 10-13), *Chileogovea jocasta* Shear 1993 (Shear 1993: figures 9-10), and *Chileogovea oedipus* Roewer 1961 (Shear 1993: figures 15-16), but setal formula differs among the various species. For example, there are 8 or 9 dorsal setae in *R. daviesae* but only 3 or 4 in *R. macra* sp. nov. The ventral setae of the penis are also found in different numbers in the two species: 2 in *R. daviesae*, but 3 in *R. macra* sp. nov. The mobile digit with two prominent hooks is present in all of the species listed above, but is absent in the pettalid species *Purcellia illustrans* Hansen & Sørensen 1904 (Hansen and Sørensen 1904: Plate IV, figures 1o-1q).

**FIGURES 29-30.** *Rakaia macra* sp. nov. ovipositor. 29. Entire ovipositor structure (scale bar 400 µm); 30. Ovipositor tip (scale bar 200 µm).

The ovipositors of *Rakaia macra* and *Rakaia daviesae* appear nearly identical (Figs. 29-30, Juberthie 1989: figure 7) except in the number of circular articles: 26 in *R. daviesae*
but 29 in *R. macra* sp. nov. The sensitive processes and general configuration of the distal end of the first article and lobes appears identical to that illustrated for *Metasiro* and described as typical of *Chileogovea, Parapurcellia, Rakaia*, and the majority of *Siro* species (Fig. 30, Juberthie 1970: figure 12c).

**Discussion**

One of the unique features of the chelicerae of *Rakaia macra* sp. nov. is their uniform dentition, which is unusual for pettalids from New Zealand and Australia. Juberthie (1970: figure 3) states that all cyphophthalmids with dorsal ozophores have two types of dentition on the mobile digit of the chelicerae: a distal series of large triangular teeth, followed proximally by a series of small teeth. However, *R. macra* sp. nov. has dorsolateral ozophores (between the type 2 and type 3 sensu Juberthie 1970) and only one type of dentition (Fig. 9). This combination of characters has not been reported in specimens of other pettalid species. We note that the illustrations provided in Forster’s monographs of New Zealand cyphophthalmids (Forster 1948, 1952) do not always show the dual dentition, but the drawings of chelicerae are not always detailed in this area.

The phylogeny of Cyphophthalmi has been explored with morphology as well as some preliminary molecular data (Giribet and Boyer 2002; Giribet in press). Analyses of these data indicate that the family Pettalidae is monophyletic, but its internal resolution is not well corroborated, especially for the South Africa-Queensland-New Zealand clade. It is likely that when more pettalids and more characters are added to a phylogenetic analysis the separation of the two New Zealand genera, which are also present in Queensland (Australia) will prove to be artificial. At present they are separated by only one character: the males of *Neopurcellia* have a bipartite tarsus IV, whereas *Rakaia* males do not (Forster 1948, 1952). This character has been found in an intermediate state in the Australian species *Rakaia daviesae* Juberthie 1989 indicating that it may not be sufficient to separate the genera (Juberthie 1989). Furthermore, species within both genera show extensive variation in characters used to define other pettalid genera, such as the anal region or the ornamentation of tarsi and metatarsi of the walking legs. The most recent morphological cladistic analysis of the Pettalidae shows lack of resolution for both genera (Giribet in press), and it is likely that when the internal phylogeny of Pettalidae is explored further, revision of *Rakaia* and *Neopurcellia* will become necessary.

The genus *Rakaia* is remarkably diverse in New Zealand with 29 species and subspecies, including *R. macra* sp. nov. New Zealand has been identified as one of 25 biodiversity hotspots around the world which were chosen for their high proportion of endemic species and the loss of at least 70% of their primary vegetation (Myers *et al.* 2000). These hotspots are areas to which conservation resources and biodiversity documentation efforts, including description of new species, should be directed as a priority. Due to the pettalids’ small size and occurrence in leaf-litter it is likely that additional species will be discovered.
when new collections are made in New Zealand. In addition, as in this study, new species will continue to be discovered in unidentified museum lots.

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