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A new family of Asellota (Crustacea, Isopoda) from the deep sea of Zealandia

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Abstract. A new family-level taxon of deep-sea isopods, *Basoniscus hikurangi* gen. et sp. nov., was recovered from the Hikurangi Plateau in the deep sea off eastern New Zealand. The broad-bodied, eyeless, seemingly unremarkable isopod was unusual in its possession of features that characterize two different families: the shallow water Joeropsididae Nordenstam, 1933 and the deep-sea Haploniscidae Hansen, 1916. An analysis of superfamily Janiroidea G.O. Sars, 1897 was conducted to establish the affinities of the species. Multiple analyses were done using unweighted and implied weighted characters. Existing families were well supported, with *B. hikurangi* intermediate between Joeropsididae and Haploniscidae. The new species, however, cannot be placed in either family owing to its lack of important defining synapomorphies of each family. As a result, Basoniscidae fam. nov. was created to contain this new species. That rocky hard substrates are undersampled is another implication. Our understanding of deep-sea species richness will not be accurate until more efforts are made to survey these habitats, especially more sites in the southern hemisphere. These gaps in our knowledge of the deep sea impairs any general claims about the distribution of biodiversity on a global scale. This find demonstrates that museums hold underused but valuable resources for understanding and describing the biodiversity of the deep sea.

Keywords. Deep Sea, hard substrates, Hikurangi Plateau, superfamily Janiroidea, phylogenetic analysis.

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Introduction

The Chatham Rise, the Campbell Plateau and the Lord Howe Rise with the islands of New Zealand are collectively known as Zealandia (Luyendyk 1995). This region has large igneous provinces (LIP) with manganese encrusted basaltic substrates that are difficult to sample with standard biological samplers. In 2002, a team of geologists and biologists on *R/V Sonne* cruise SO168 (Hoernle *et al.* 2003) to this region recovered biological specimens from sediment cores and rock dredges, among which was a small collection of deep-sea isopods that were deposited in the Museum für Naturkunde Berlin (ZMB). One sample from the Hikurangi Plateau (Fig. 1; Wood & Davy 1994; Davy *et al.* 2008), a LIP located in deep water east of New Zealand, included 4 specimens of a broad white asellotan isopod species that are representatives of a previously unknown clade of janiroidean isopods. This location was south of the Palmer Seamount (Fig. 2) and north of the Hikurangi Trough (Lewis *et al.* 1998).

These isopods had an appearance that resembled the family Haploniscidae Hansen, 1916. They, however, were found to have many differences from known familial autapomorphies of the Haploniscidae (Lincoln 1985). To establish their classification, an analysis of a broad range of taxa of the asellote superfamily Janiroidea G.O. Sars, 1897 was required. The data for the analysis were based upon multiple previous studies since 1987 until now. The dataset was substantially updated and reorganized to include the new taxon from which the description is partially derived. A new analysis to compare this new taxon with the broadest range of janiroideans finds strong support for a new clade that includes the Haploniscidae, Joeropsididae Nordenstam, 1933 and the new taxon. These results necessitated the description of a new

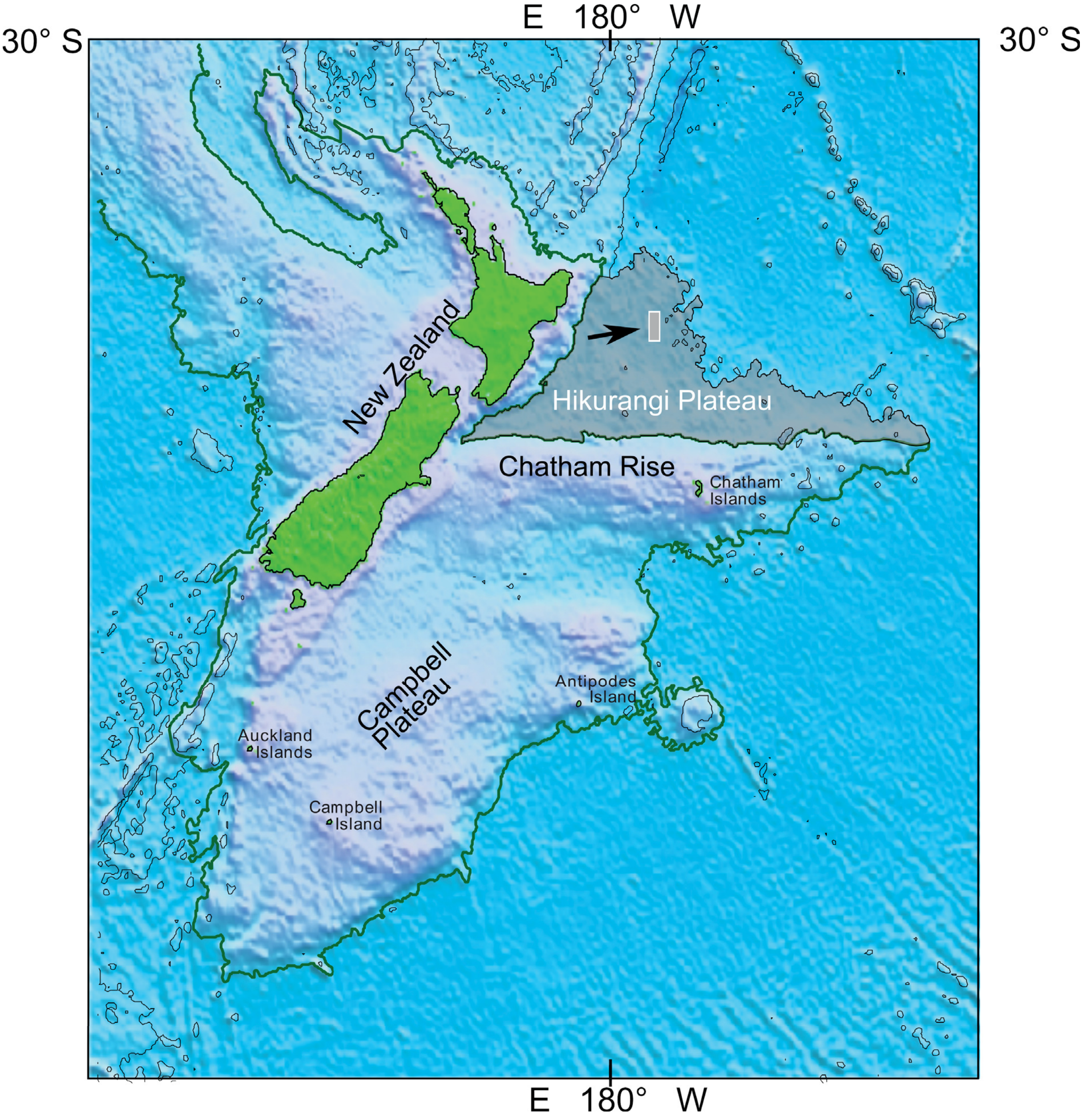

Fig. 1. General topography of the Zealandia submerged continent (dark green line), including the lands of New Zealand and submerged topography. Arrow indicates approximate location of the Palmer Seamount chart (grey rectangle, Fig. 2) on the Hikurangi Plateau north of the Chatham Rise. Modified from Hoernle *et al.* 2003: fig. 4.1.

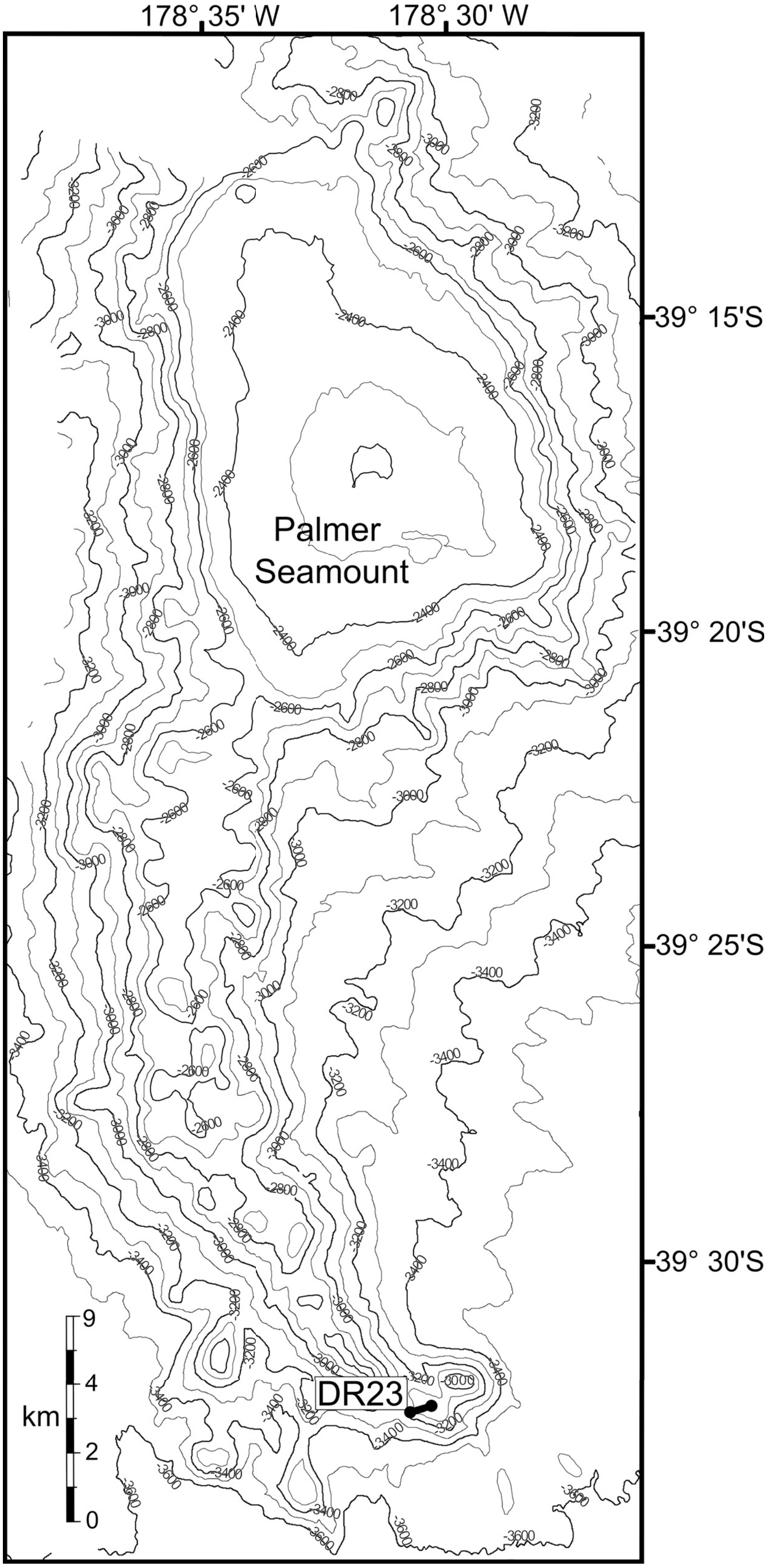

Fig. 2. Topography of Palmer Seamount and southward trending Palmer Ridge. Type locality Rock Dredge Station DR23 shown toward the end of the ridge. Scale 1 : 260 000, Mercator projection (WGS 84). Modified from Hoernle *et al.* 2003: fig. 6.8.

monotypic family Basoniscidae fam. nov. for *Basoniscus hikurangi* gen. et sp. nov. This discovery has other implications that bear mentioning. Finding examples of this new family from such a small sample size demonstrates that deep-sea biological research lacks detailed quantitative and qualitative sampling of macrofauna from hard substrates, particularly in the South Pacific and Indian Oceans. These specimens were found on a museum shelf with only the general label of "isopods" from the Zealandia Cruise SO168. The specimens that already reside on museum shelves and storage are an underused resource for understanding the species richness of the world ocean.

Material and methods

Material

Specimens were found in the Crustacea collection of Museum für Naturkunde, Berlin, during a 2005 visit. Type specimens were deposited at the National Institute of Water & Atmospheric Research Ltd, Wellington, New Zealand (NIWA) and Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany (ZMB). The specimens were studied in glycerin using an Olympus BH-2 compound microscope and a Wild M5 stereomicroscope. Photographs of the types were taken with a photomicrographic system using a Canon EOS 550D camera. Several images were focus stacked and processed using Zerene Stacker (https://zerenesystems.com/cms/home) to produce single in-focus images. Pencil drawings were made using a camera lucida attached to the BH-2. All figures were rendered using Inkscape (www.inkscape.org; ver. 1.2) and GIMP (www.gimp.org; ver. 2.10.30). Parenthetic abbreviations in the descriptions are: H = holotype; F = paratype female.

Taxonomic database

Characters of *Basoniscus hikurangi* gen. et sp. nov. were contradictory for deciding a family-level placement of this new taxon. Because monotypy would be established at one or more taxonomic levels, support for the uniqueness of the new taxon was required. Its features were entered into a taxonomic database, which was also updated with new characters and character definitions, and the data were transferred to phylogenetic analysis software where the results were tested for support and robustness. The affinities of the new species were investigated using a phylogenetic analysis of family-level taxa in the higher Janiroidea, excluding some ground water taxa.

The Delta system (Dallwitz 1980; Dallwitz *et al.* 2000) was used to develop character concepts (see below) and record states. The Delta system can generate natural language output or identification tools such as keys, but it also can generate Nexus files (Maddison *et al.* 1998) to be used in phylogenetic analysis. The Delta system, which has not been updated since 2000, generates Nexus files that have truncated character descriptions so interpreting character results is difficult. The characters were corrected using a script that generated complete character descriptions for a Nexus file; the resulting file was imported into Mesquite (ver. 3.70, build 940, Maddison & Maddison 2021), which was used to generate the TNT analysis files and to study the resulting trees. A complete list of characters used for analysis is included in the supplementary data.

Descriptions

Because a new family is being named, all data that might be relevant for future studies should be included, including apomorphies for the superfamily Janiroidea. Although the Janiroidea is generally thought to be a well established clade of the Asellota Latreille, 1802, its basal relationships remain unknown because the composition and features of the other superfamilies remain incompletely described. The description was generated from the DELTA database and edited for conciseness and punctuation.

Taxon choice

To avoid introducing hypothetical traits for superspecific taxa, an exemplar approach was taken for the families of the Janiroidea G.O. Sars, 1897. Where possible the type species of each genus and the type genus of each family were used. Additional taxa were added to provide more character data when the type was poorly described (a common occurrence). The genera were selected to represent the morphological range of taxa within each family. The Janiridae G.O. Sars, 1897 is known to be nonmonophyletic (Wilson 1994) and is in need of complete revision. As a result, multiple taxa have been chosen to represent the diversity of taxa, ranging from the core group containing *Janira maculosa* Leach, 1814 and related taxa to more derived taxa such as *Caecianiropsis psammophila* Menzies & Pettit, 1956. *Caecianiropsis thunderstruckae*, described by Zemko & Kaiser (2012) as *Thambema thunderstruckae*, proved to be a member of *Caecianiropsis* Menzies & Pettit, 1956 after its characters were coded. Currently the synonymy is not published but the species was used in the analysis owing to useful detail in the description. Small interstitial taxa placed in Microparasellidae Karaman, 1933 were omitted; this cluster of genera needs reillustration of the types (e.g., details of the head are missing). Some janiroidean families are quite diverse so a broad selection of species were used. Some species might have traditional classifications but are clearly not members of any existing family; these were considered incertae sedis for the purposes of this analysis. The classification of the taxa other than *Basoniscus* gen. nov. is left for another project. The supplementary data has a species list used in this analysis and their presumed family-level classification.

Character conceptualization

The basis for the character set comes from modifications of data used in studies of the Janiroidea as families (Wilson 1987), diverse taxa of the Munnopsidae Lilljeborg, 1864 (Wilson 1989), Janiridae G.O. Sars, 1897 (Wilson 1994; Wilson & Wägele 1994) and Paramunnidae Vanhöffen, 1914 (Just & Wilson 2004). Characters relevant for isopods were taken from Wilson (2009) and updated. Features apomorphic for all Janiroidea may be invariant and have no effect on the analysis but are retained for completeness for broader analyses. Many observations are derived from the literature as well as the author's study of many taxa from the Janiroidea, such information on the spermathecal duct (Wilson 1991; unpublished data). New characters were introduced in Riehl *et al.* (2014) in the first description of the family Urstylidae, relative to the relationships with the Macrostylidae Hansen, 1916. The discussion below derives homologies from the position of structures as well as detailed form. The evolutionary independence of somites and limbs was a central assumption of homology in Wilson (2009) and is used in this database. The diversity of pereionite and pereiopod forms in the deep-sea Janiroidea support this approach. New characters introduced here deal with features of the head and are numbered according to their position in the database (the first 3 characters are only metadata). The matrix characters (-3) are in the same order.

Hessler (1970: 18) and Wilson (1989: fig. 38) referred to the shape of the frons as an important feature for the identification of taxa in the Desmosomatidae G.O. Sars, 1897 and Munnopsidae Lilljeborg, 1864, respectively. Although the head has not been broadly discussed in the literature, the shape of the anterior head and its primary structures, clypeus and labrum, is almost certainly associated with the lifestyle and feeding adaptions of each group (e.g., the form of the head in the Ilyarachinae Hansen, 1916; Gudmundsson *et al.* 2000). Because *Basoniscus* gen. nov. has head structures that partially resemble those of other asellotan family-level taxa, new characters were constructed to account for the observed variation.

Features of the anterior head (characters 4–5). The frons, noted by Hessler (1970: 18, fig. 5) as useful in the taxonomy of the Desmosomatidae G.O. Sars, 1897, is the anterior part of the head that is below its dorsal surface. Extensions of the frons may project anteriorly between separated antennular sockets. This character is independent of structures of the clypeus. Some Janiridae G.O. Sars, 1897 have small separations of the antennulae. In these, the frons has a projecting arch of cuticle, perhaps as a support structure for the clypeal articulations of the mandibles.

Character 4. Head frons in dorsal view with medial extensions projecting between antennular insertions:
1. not projecting anteriorly between antennular insertions;
2. projecting between antennular insertions.

If the frons does have anteromedial extensions, asellotan taxa show a range of differences, with examples within some families (e.g, Munnopsidae Lilljeborg, 1864; see Wilson 1989: fig. 38). In taxa with substantial anterior projections, such as Paramunnidae Vanhöffen, 1914 or Nannoniscidae Hansen, 1916, the frons can have ridges projecting dorsolaterally and perhaps anteriorly, referred to as keels (state 1). The frons can be simply a rounded feature sloping down to the articulation of the clypeus (state 2). In these, the boundary between the dorsal surface and the frons may not be marked by a clear boundary of the apex. Some anterior projections of the frons can take the form of lobes or spines (state 3). The frons can also be expanded ventrally to form a rounded head capsule where the antennae are separated from mandibles, which plesiomorphically are adjacent to the mandibular attachment on the clypeus (state 4).

Character 5. Head frons medial extensions in dorsal view:
1. lateral keels;
2. blunt anterior projection;
3. anterior projections (lobes or spines);
4. frons confluent with lateral margin separating antennae from mandibles.

Pseudorostrum (character 6). The frons may project anteriorly in dorsal view and is dorsal to the clypeus but ventral to a well-defined vertex or the anteromedial margin of the head. The pseudorostrum is not articulated and is positioned between the antennae and antennulae. Using positional homology, this structure may be similar to the frontal lamina in non-asellotans such as cirolanoideans. Just (2001) referred to the clypeus of the Joeropsididae Nordenstam, 1933 as a pseudorostrum. The illustration of *Rugojoeropsis* described by Just (2001: fig. 9*)* shows that this structure is articulated and, on the lateral margins, forms an articulation with the mandibles; therefore it is a clypeus. The frons of the genus *Triaina* described by Just (2009: fig. 1), on the other hand, has a pseudorostrum: large spined plate on the frons just below the vertex and a separate clypeus underlying this. Similarly, *Stenetrium* Haswell, 1881, has a pseudorostrum, although the margin between vertex and frons is often not illustrated but is clear in photographs.

Character 6. Head pseudorostrum on frons above clypeus:
1. absent;
2. present.

Rostrum (characters 7–8). The anterodorsal margin of the head or vertex may have various projections. Munnopsidae show a range of these frontal structures. For example, Eurycopinae Hansen, 1916 may have a rostral structure projecting anteriorly but also have a well defined anterior vertex while others like Munnopsinae have a sloping frons articulating with the clypeus and no well defined vertex at the dorsal surface. Ilyarachninae Hansen, 1916 and Lipomerinae Tattersall, 1905 have a flat frons with a well defined dorsal vertex margin.

Character 7. Head anterodorsal margin:
1. without rostral projections;
2. with rostral projections.

Character 8. Head anterior rostrum (if rostrum on vertex)
1. single medial structure;
2. paired projection;
3. broad plate;
4. multiple projections (spines).

Clypeus and labrum (characters 9–13). The clypeus has been misidentified as a pseudorostrum in some taxa (character 6) but is an important structure of the head. The clypeus bears the labrum or upper lip that, with the paragnaths, forms an enclosure (atrium oris) for the gnathal margin of the mandibles. The clypeus may be distinguished from other structures on the frons by articular sutures; some species may not express articulations or may be obscured in SEM images. Laterally, the clypeus provides the articulation points for the dorsal condyles of the mandibles; this is another way of distinguishing the clypeus. The clypeus might be considered a structure of the labrum but here it is treated separately because of its heavier cuticle and distinct articulation with the labrum. The labrum, however, is structurally flexible with cuticular hairs and folds on its posterior (mandible) side. Treating both structures separately is useful because they differ in relative height and width across the range of janiroidean isopods and may be consistently shaped within family-level groups. The following characters deal with these comparative features. Taxa with an enlarged, dorsally projecting clypeus may have rostral structures that prevent viewing the clypeus dorsally; this is typical of many Haploniscidae. Anterior or anterior oblique views are most helpful for viewing these features.

Character 9. Head clypeus general form:
1. narrow arch between frons and mandibular articulations;
2. projecting anteriorly from frons and mandibular articulations;
3. projecting dorsally from frons and mandibular articulations;
4. projecting anterodorsally from frons and mandibular articulations.

Character 10. Head clypeus anterior shape:
1. robust and thickened;
2. flattened.

Character 11. Head clypeus dorsal shape:
1. rounded in anterior view;
2. triangular in anterior view.

Character 12. Head labrum width:
1. as wide as clypeus;
2. narrower than clypeus.

Character 13. Head labrum medial height:
1. higher than clypeus in anterior view (projecting downwards);
2. shorter than clypeus in anterior view (projecting downwards);
3. projecting anteriorly (e.g. *Sugoniscus* Menzies & George, 1972).

Head lateral margin (characters 17–18). Many janiroideans have pedunculate eyes or projections of the head lateral margin that bear eyes. Closely related species may show a range of eye development, from well developed to absent. In some species, the eyes may be absent but a cuticular structure remains; these can be homologised with eye peduncles or lobes. Some completely blind groups (such as Katianiridae Svavarsson, 1987) have structures that project from the eye region separate from the lateral margin of the head. Many deep-sea isopods lack eyes or any projection from the eye region.

Character 17. Head eye region structures:
1. completely sessile (no projections);
2. sessile but projecting;
3. lateral projection (lobe or spine).

Character 18. Head eye region lateral projection (if lobe or spine, relative to anterolateral margin of pereionite 1):

1. extending to anterolateral margin of pereionite 1;
2. extending beyond anterolateral margin of pereionite 1;
3. not extending to anterolateral margin of pereionite 1.

Phylogenetic analysis

A Nexus data file for phylogenetic analysis was generated from the DELTA database. The data were processed in Mesquite (ver. 3.70; Maddison & Maddison 2021), which generated a TNT format file for analysis as well as vector-based tree files from the results. Because the DELTA database was constructed for the entire suborder Asellota, modifications of derived characters in one clade often have no relevance to other clades. These inapplicable characters in taxa with missing structures were treated as unknowns in the analyses. Because any character is not known a priori to be phylogenetically useful without analysis within a set of taxa, all discrete characters were included. The data were analyzed using parsimony with TNT, 64 bit, ver. 1.5 (Goloboff & Catalano 2016). Mesquite was used to evaluate trees resulting from the TNT analyses. The data were analyzed using unweighted characters as well as using implied weighting that applies weights to characters during the analysis relative to the amount of homoplasy (Goloboff 1993, 1997; Goloboff *et al.* 2008). For implied weighting analyses, a script, setk.run (Salvador Arias, Instituto Miguel Lillo, San Miguel de Tucumán, Argentina; setk-trans.run is updated with an explanatory banner and translation to English), was used to find the concavity parameter k that minimized both overweighting or underweighting against homoplasy. The TNT commands for both unweighted and implied weighted character analyses were: hold 4000; drift : fitd 2 rfitd 0.1; sect:slack 20; xmu = verbose hit 20 drift 10 ratchet 10. Support for clades was found using symmetric jackknife resampling (see Goloboff *et al.* 2003), 1000 replicates, probability P = 0.33, to give group frequencies and GC values (group supported minus groups contradicting) for non-terminal branches. To test the strength of the relationships of *Basoniscus* gen. nov. to other janiroideans, trees were collected in multiple implied weights analyses, where the data were analyzed using a range of concavity parameters k = 3 to 30. Consenses of the resulting trees, strict and majority rule (≥50% retained), to find those clades that survived a broad range of weights from minimal (k = 30) to strong weighting against homoplasy (k = 3). This treatment ensures that any clades remaining in the consensus are strongly supported, regardless of character weighting. The dataset was also analyzed without the *Basoniscus* gen. nov. to test the effect of the new characters on the relationships.

Supplementary data, including exemplar species list for family-level groups, character state descriptions, resultant trees, and a Mesquite nexus file as well as the TNT analysis file are available from Zenodo (https://doi.org/10.5281/zenodo.7791408).

Results

Phylogenetic analysis

The dataset had 121 taxa and 397 characters (complete lists and graphical results in supplementary data). The unweighted analysis (all characters weighted 1) produced 24 trees, tree lengths 3037, consistency index 0.1881, retention index 0.6555. Fig. 3 shows an unweighted analysis with family-level clades grouped into a triangle; any branch with a support level of 50% or less was collapsed creating a large polytomy. Overall, the trees were well resolved with most variability occurring among species in the same family. In the unweighted analysis, the clade (Joeropsididae (*Basoniscus* gen. nov., Haploniscidae)) appeared in all trees. The symmetric jackknife of these data (P = 0.33) found GC = 65/58, that is, the clade of all three families was supported in 65% (58% without contradiction) of the trees; the clade of *Basoniscus* gen. nov. and Haploniscidae support was 66% (43% without contradiction) (Fig. 3, see supplementary data for all taxa shown in tree).

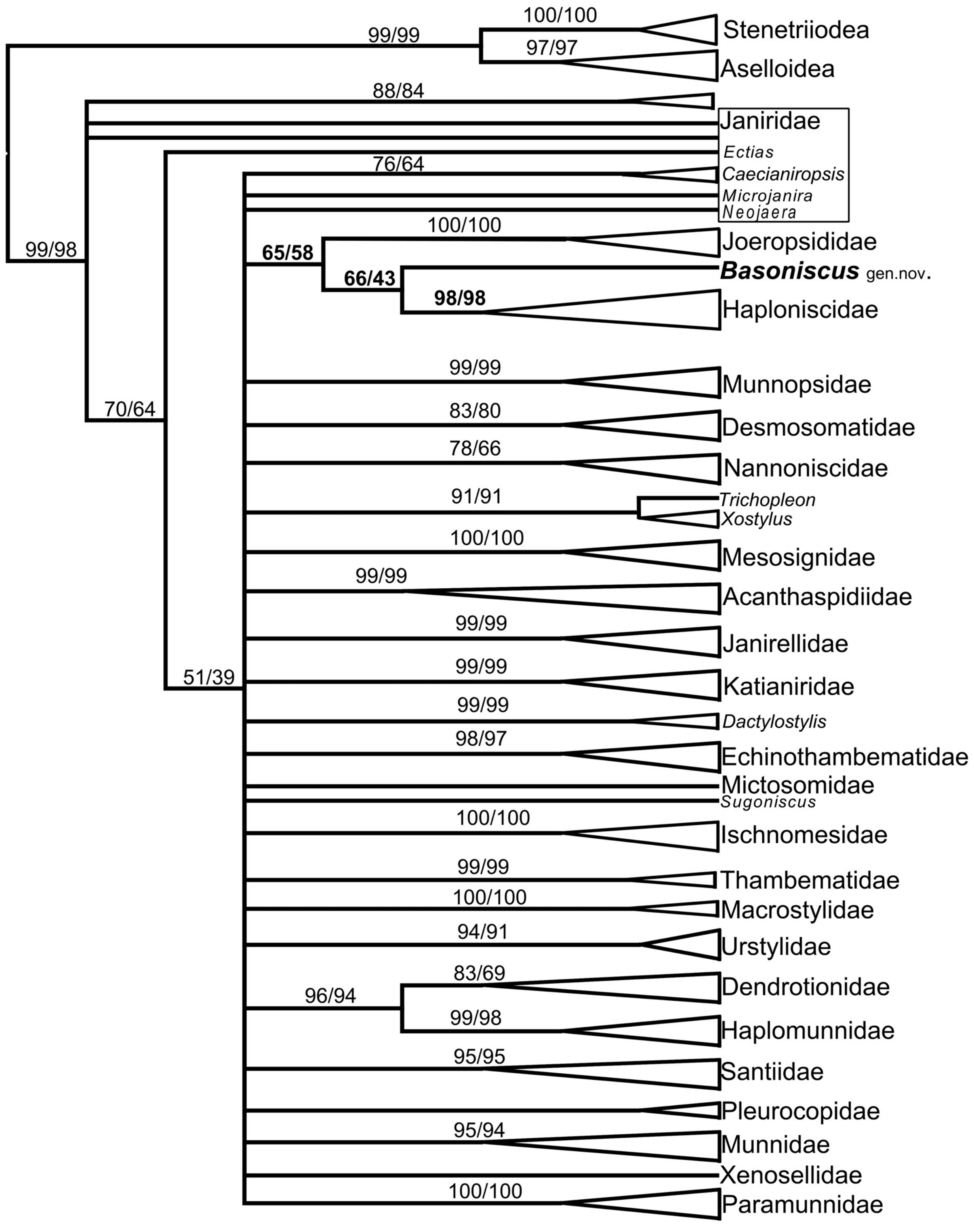

Fig. 3. Parsimony analysis of Janiroidean Exemplars, characters equal weighted. Data were subjected to a symmetric jackknife resampling, modifying 33 percent of the characters in each of 1000 iterations. Numbers on the branches are the GC values, or percent of trees with the branch and percent of the trees that were uncontradicted (groups minus groups contradicted). All branches 50% or lower are collapsed and family level clades collapsed into triangles. See supplementary data for uncollapsed trees. Taxa of the Janiridae enclosed in a box owing to non-monophyly.

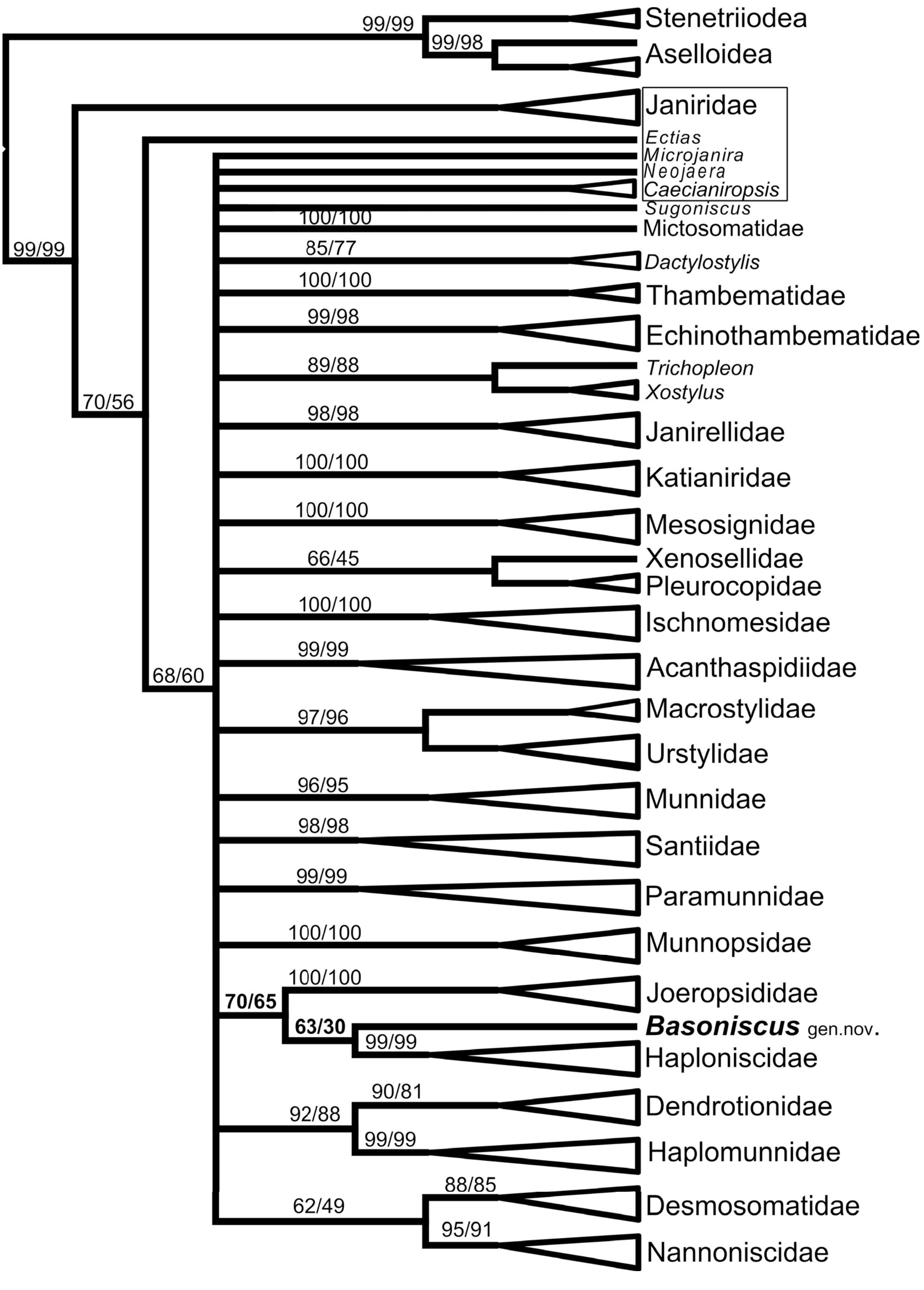

Fig. 4. Parsimony analysis of Janiroidean Exemplars, characters implied weighted, k = 24.355468. Data were subjected to a symmetric jackknife resampling, modifying 33 percent of the characters in each of 1000 iterations. Numbers on the branches are the GC values, or percent of trees found with the branch and percent of the trees that were uncontradicted (groups minus groups contradicted). All branches 50% or lower are collapsed and family level clades collapsed into triangles. See supplementary data for uncollapsed trees. Taxa of the Janiridae enclosed in a box owing to non-monophyly.

The script ‘setk.run’ found an optimal value of k = 24.355468. The concavity parameter at this high value weights homoplasy only to a small degree for the majority of the characters. A single tree resulted (Fig. 4, see supplementary data for all taxa shown in tree), length 66.804; the weights reset to 1 for comparison with the unweighted tree gave a length of 3050 (consistency index 0.1875, retention index 0.6543). The same clade (Joeropsididae (*Basoniscus* gen. nov., Haploniscidae)) was found (Fig. 4). The support level for this clade was 70% (63% without contradiction), and the subclade was 63% (30% without contradiction). The lower uncontradicted support value in both the unweighted and implied weighted analyses for the *Basoniscus* gen. nov. + Haploniscidae clade indicates that either alternative resolution might be possible.

The survey of implied weights for the concavity parameter = 3 to 30, produced 28 trees, most of which were largely identical to the initial implied weights analysis. Thus all trees, whether unweighted or weighted against homoplasy, found strong support for a clade containing the families Joeropsididae, Haploniscidae and *Basoniscus* gen. nov. but only weak support for a close alignment of the latter two taxa. The unweighted analysis without *Basoniscus* gen. nov. found 73 trees of length 2997; GC support value (P = 0.33) for the clade Haploniscidae + Joeropsididae was 54/24. The script ‘setk.run’ found k = 23.877, a slightly higher level of homoplasy than the analyses with the new genus. These data analyzed with the optimal k value found the same clade again, with a GC support value of 60/36.

Supplementary data include results from all analyses, including lists of taxa and characters, a simplified version of the Nexus file, trees showing all species-level taxa, with symmetric resampling (P = 33 GC) values, and the trees resulting from the analyses without *Basoniscus* gen. nov.

Taxonomy

The phylogenetic analyses found strong support for a surprising clade of *Basoniscus* gen. nov., Haploniscidae Hansen, 1916 and Joeropsididae Lilljeborg, 1864. The apomorphies inferred from the topology were used to assemble the features (Table 1) that show the relationships of the three groups. Although the analysis found that the Haploniscidae possibly was the sister group of *Basoniscus* gen. nov., many features are also shared with the Joeropsididae and not the former family. Revising the diagnoses of either Haploniscidae (diagnosis: Lincoln 1985: 14) or Joeropsididae (diagnosis: Just 2001: 303) to contain the new genus would render those families unidentifiable. As a result, a new monotypic family of the superfamily Janiroidea G.O. Sars, 1897 is needed for this new genus.

Class Malacostraca Latreille, 1802
Order Isopoda Latreille, 1816
Suborder Asellota Latreille, 1802
Superfamily Janiroidea G.O. Sars, 1897

Family **Basoniscidae** fam. nov.

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Type genus *Basoniscus* gen. nov., monotypic.

Diagnosis

Head broad, without anteromedial rostral projections, antennal insertions separate (not adjacent), lateral margin linear, broadening posteriorly, without eyes or eye lobes. Pereion broad with tergal projections, medially vaulted but laterally flattened; without specialization of pereionites, without defined tagmosis; pereion lateral margins confluent with head and pleotelson margins. Pereionites free dorsally and ventrally, pereionite 1 and head articulated; pereionite 7 and pleotelson articulated. Coxae positions ventral, not

Table. Comparison of shared synapomorphies between *Basoniscus* gen. nov. and Haploniscidae Hansen, 1916 and Joeropsididae Nordenstam, 1933. Rows may represent more than single character from the data matrix. Symbols: ‡ = shared only with Joeropsididae; * = shared only with Haploniscidae; † = shared with both families.

Feature	***Basoniscus* gen. nov.**	**Joeropsididae**	**Haploniscidae**
Head anterior margin	no rostral projections	paired angular projections	various
Perion shape	broad tergal projections †	broad tergal projections †	broad tergal projections †
Pereion tagmosis	none	3 : 4 (weakly)	3 : 4
Pereion coxal insertions	midway between lateral margin & midline †	midway between lateral margin & midline †	midway between lateral margin & midline †
Posterior pereionites	projecting, lateral margins confluent *	projecting posterolaterally	projecting, lateral margins confluent *
Coxae positions	ventral, midway between lateral margin and midline, not converging medially †	ventral, midway between lateral margin and midline, not converging medially †	ventral, midway between lateral margin and midline, not converging medially †
Oostegites	develop internally only †	develop internally only †	develop internally only †
Cuticular organ (spermathecal duct)	opening anterodorsally on pereionite 5 †, covered by pereionite margin ‡	opening anterodorsally on pereionite 5 †, covered by pereionite margin ‡	opening anterodorsally on pereionite 5 †, exposed dorsally
Penes	Covered by pereionite 7 margin ‡	Covered by pereionite 7 margin ‡	Covered † or not covered by pereionite 7 margin
Pleopodal chamber	enclosed, set anterior to posterior margin *	open posteriorly, extends to posterior margin	enclosed, set anterior to posterior margin *
Anus position	ventral, postanal margin	posteroventral, no margin	posteroventral, no margin
Clypeus	anteriorly flattened *	anteriorly rounded	anteriorly flattened *
Clypeus	projecting to dorsal margin ‡	projecting to dorsal margin ‡	not projecting to dorsal margin
Clypeus	dorsally angular *	dorsally rounded	dorsally angular *
Labrum	shallower and narrower than clypeus †	shallower and narrower than clypeus †	shallower and narrower than clypeus †
Antenna exopod	articulated lobe	absent	spine, fused to article 3
Antenna flagellum first article	single, unmodified *	conjoint, enlarged	single, unmodified *
Mandible molar process	cylindrical, distally two ridges of sharp denticles distally spinulate spines posteriorly *	long curved rod, no denticles or spinules	cylindrical, distally two ridges of sharp denticles distally spinulate spines posteriorly *
Mandible incisor process and lacinia mobilis	not enlarged, distal cusps only, left lacina distinct *	enlarged, blade-like, with dorsal and distally dentate lobes, left lacina reduced, similar to spine row	not enlarged, distal cusps only, left lacina distinct *
Maxilliped endite	with distomedial concavity †	with distomedial concavity †	with distomedial concavity †
Maxilliped epipod	projecting beyond palp insertion *	shorter than distance to palp insertion	projecting beyond palp insertion *
Maxilliped palp	article 2 narrow, article 5 longer than wide *	article 2 broad, article 5 tiny	article 2 narrow, article 5 longer than wide *
Pereopod II–VII dactylar ventral claw	more robust than dorsal claw ‡	more robust than dorsal claw ‡	tiny to absent
Pleopod IV exopod	distally narrowing margins ‡	distally narrowing margins ‡	vestigial unarticulated bud
Uropod protopod	broad, covering anus ‡	broad, covering anus ‡	short, rod like, not covering anus
Uropod exopod	squat ‡	squat ‡	absent

visible dorsally, positioned midway between lateral margin and midline, not converging medially in posterior pereionites. Oöstegites developing internally before deploying at parturition. Cuticular organ (spermathecal duct) opening anterodorsally on pereionite 5, covered by pereionite margin. Penes emerging medially into male pleopod I, covered by pereionite 7 margin. Pleon single somite, all pleonites merged into pleotelson. Pleopodal chamber enclosed, positioned anterior to posterior margin. Anus ventral, with postanal margin. Clypeus anteriorly flattened, projecting to dorsal margin of head, dorsally angular. Labrum shallower and narrower than clypeus. Antennula shorter than width of head, basal article longer than broad, tapering distally. Antenna elongate, projecting anteriorly, podomere articles unmodified; article 3 longer than articles 1, 2 and 4, with convex margins, exopod single segment distally rounded with setae; flagellum first article single, unmodified (not conjoint or inflated). Mandible molar process cylindrical, two distal ridges of sharp denticles, spinulate spines posteriorly; incisor process not enlarged, with distal cusps only, left lacina mobilis distinct from spine row, right lacinia mobilis indistinguishable from spine row. Maxilliped endite with distomedial concavity; epipod projecting beyond palp insertion; palp article 2 narrow, article 5 longer than wide. Pereiopod I dactylar ventral claw robust, shorter and basally narrower than dorsal claw. Pereiopod II–VII dactylar ventral claw more robust than dorsal claw. Pleopod III exopod uniarticulate, shorter than endopod, with fringe of fine setae laterally; endopod with 3 plumose setae, with large gap between medial seta and lateral two setae. Pleopod IV exopod uniarticulate, shorter than endopod, with distally narrowing margins. Uropod protopod broad, with medial lobe covering anus; endopod longer than protopod, rod-like, distally rounded; exopod, tiny, squat, on medial margin.

Basoniscus gen. nov.

urn:lsid:zoobank.org:act:505F93B6-43AF-4DE0-99CF-5868A3627763

Figs 5–12

Type species *Basoniscus hikurangi* gen. et sp. nov., monotypic.

Etymology

The genus name is composed of 'basal' (or 'basis'), referring to its basal position in the phylogeny of the Haploniscidae and Joeropsididae, and the common word for isopod 'oniscus'. The name is construed as masculine.

Remarks

See the diagnosis for the family Basoniscidae fam. nov. Without additional taxa in the family, diagnoses for the genus and species would be ad hoc.

Basoniscus hikurangi gen. et sp. nov.

urn:lsid:zoobank.org:act:4BE8DF59-B79A-4381-A26B-DEE543C35BC1

Figs 5–12

Etymology

The species name 'hikurangi' is taken from the sacred Mountain Hikurangi given to it by the Māori, the indigenous people of New Zealand. Several offshore undersea features, a subduction zone and the plateau on which the Palmer Seamount resides where this species was collected also bear the same name. The name is treated as noun in apposition to avoid changing the name.

Holotype

NEW ZEALAND • ♂, 3.1 mm; Hikurangi Plateau, Palmer ridge tip, west side of small twin cone south of Palmer Seamount; 39°32.39′–32.291′ S, 178°30.747′–30.291′ W; depth 3183–2974 m; 21 Dec. 2002;

B. Neuhaus, B. Berning, J. Hoffmann and C. Lüter leg.; from 0.5 m manganese boulder with corroded cores of volcanic breccia; R/V Sonne cruise 168, dredge station DR23; NIWA162662.

Paratypes

NEW ZEALAND • 1 ♀, 3.4 mm, dissected, (slides No. 5131–34); same collection data as for holotype; NIWA162663 • 2 ♂♂, 3.3 mm and 3.1 mm; same collection data as for holotype; ZMB 34579.

Description

Body (Figs 5, 6A, 8A, C). Broad, length 1.7–1.8 (F, H) width, wide, depth 0.39 (F) width; body smoothly arched dorsomedially with thin flat cuticular margin on all body segments (Fig. 5). Cuticle color white, well calcified. Margins with evenly spaced short straight sharp setae, setal length less than width of thin cuticular margin, and scattered longer simple setae; each seta with cuticular channel from body to setal base (similar but larger channels seen in *Mastigoniscus pistus*, described in Lincoln (1985: fig. 21j). Head and pleotelson with pairs, rarely 3, of robust squat distally sensillate setae curved in opposing directions, both male and female with 3 groups on each lateral margin of head and 4 groups on each lateral margin of pleotelson, posterolateral corner of pereionites 6–7 with single squat sensillate seta. Margins without marginal denticles or spines.

Head (Figs 5A, 7A, 8B–C). Length 0.41–0.42 (H, F) width. Vertex and frons in dorsal view not projecting anteriorly, without pseudorostrum or rostral projections. Clypeus projecting anterodorsally from mandibular articulations, anteriorly flattened and dorsally acute and triangular between antennulae in anterior view. Labrum narrower than clypeus, medially shorter than clypeus in anterior view. Anterolateral antennal processes absent. Eyes absent, eye region without structures. Head margins widening posteriorly, aligned with anterolateral margins of pereion, width subequal to pereionite 1 anterolateral margin. Head articulation with pereionite 1 fully expressed dorsally and ventrally. Head depth subsimilar to anterior pereion depth. Antennula and antenna with recessed insertions under anterior margin of head, sides separated with gap for clypeus.

Pereion (Figs 5E, 6A, 8A, C). Pereiopodal insertions midway between lateral margin and midline of pereion. Pereion somites free, articulations fully expressed. Pereion without dorsal midline spines. Tergites projecting laterally on all pereionites, extending over coxae. Coxae placed on medioventral surface, not projecting laterally from pereionite, without spines or setation. Pereionites 1–7 not substantially differentiated, mainly expressed by orientation and position of legs on pereion; dorsum and sternite articulations fully expressed. Sternites without sternal keels, without ventral midline spines or anterolateral robust setae on margin.

Pereionite 1. Lateral length in male similar to female. Pereionites 2–7 tergites projecting, lateral margins confluent, serially homologous, without integrated subgroups. Pereionite 4 length subequal to pereionite 3, without collum (apomorphy of Macrostylidae Hansen, 1916). Pereionite 5 distinctly longer than pereionites 3–4, longer in female than in male, length ratios 0.73–0.83, 0.64–0.83 (H, F), respectively. Pereionite 7 width slightly narrower than pereionite 6 width, ratio 0.93–0.95 (H, F); lateral margins not enclosed by preceding segment.

Female genitalia (Fig. 8C–E). Cuticular organ (spermathecal duct) separate from oviduct, emerging anterodorsally under articular margin of pereionite 5, roughly halfway between midline and tergite margin; dorsal orifice opening to shallow funnel. Oopore ventral, adjacent medially to coxa V. Both ducts meeting in a vestibule (spermatheca) on posterior part of ovary in pereionite 4.

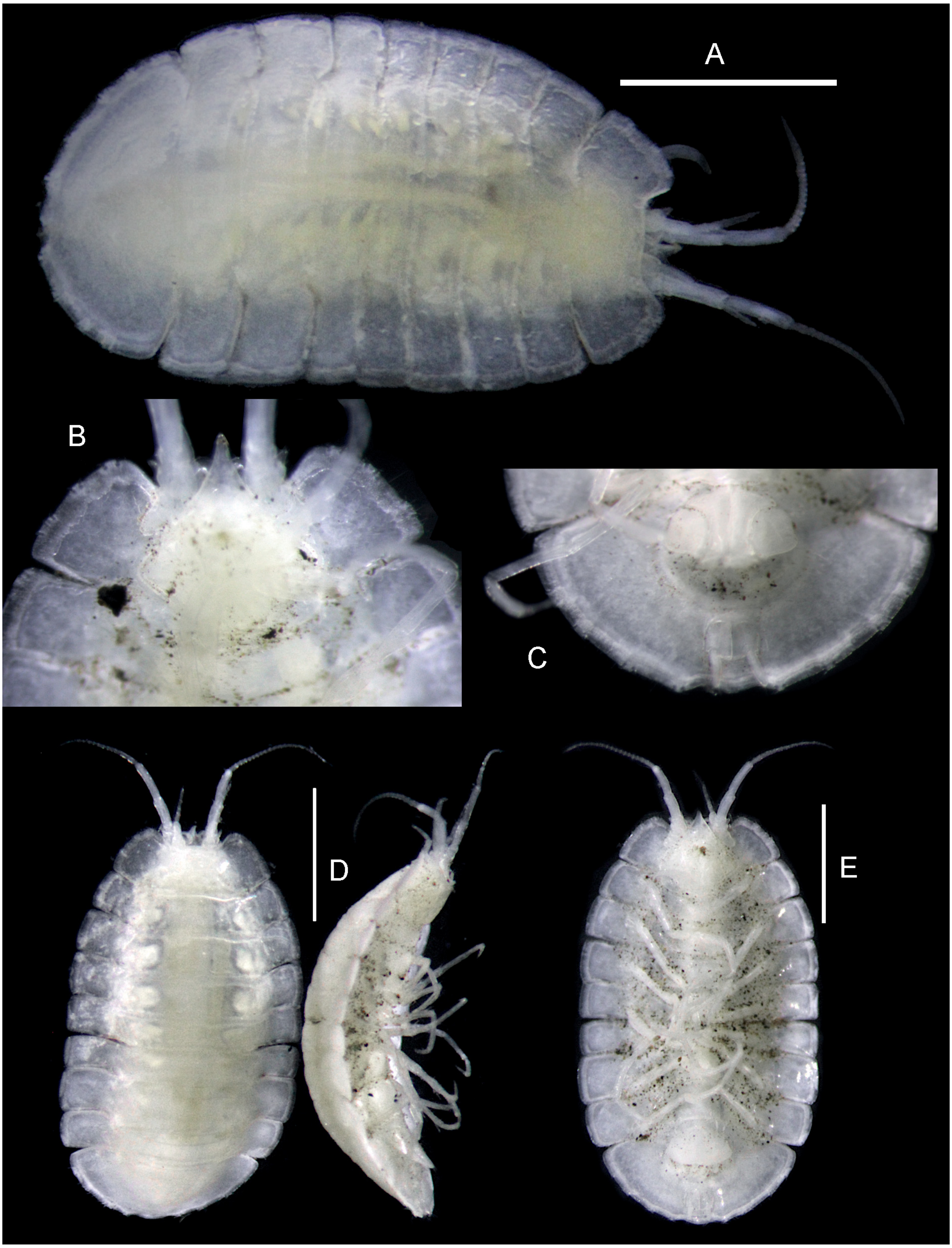

Fig. 5. *Basoniscus hikurangi* gen. et sp. nov. **A–C**. Holotype ♂, NIWA162662. **A**. Habitus, dorsal oblique. **B**. Head, ventral view. **C**. Pleotelson, ventral view. **D–E**. Paratype ♂♂, ZMB34579. **D**. Both paratypes, dorsal (left) and lateral oblique (right) views. **E**. Left paratype, ventral view. Scale bars = 1 mm.

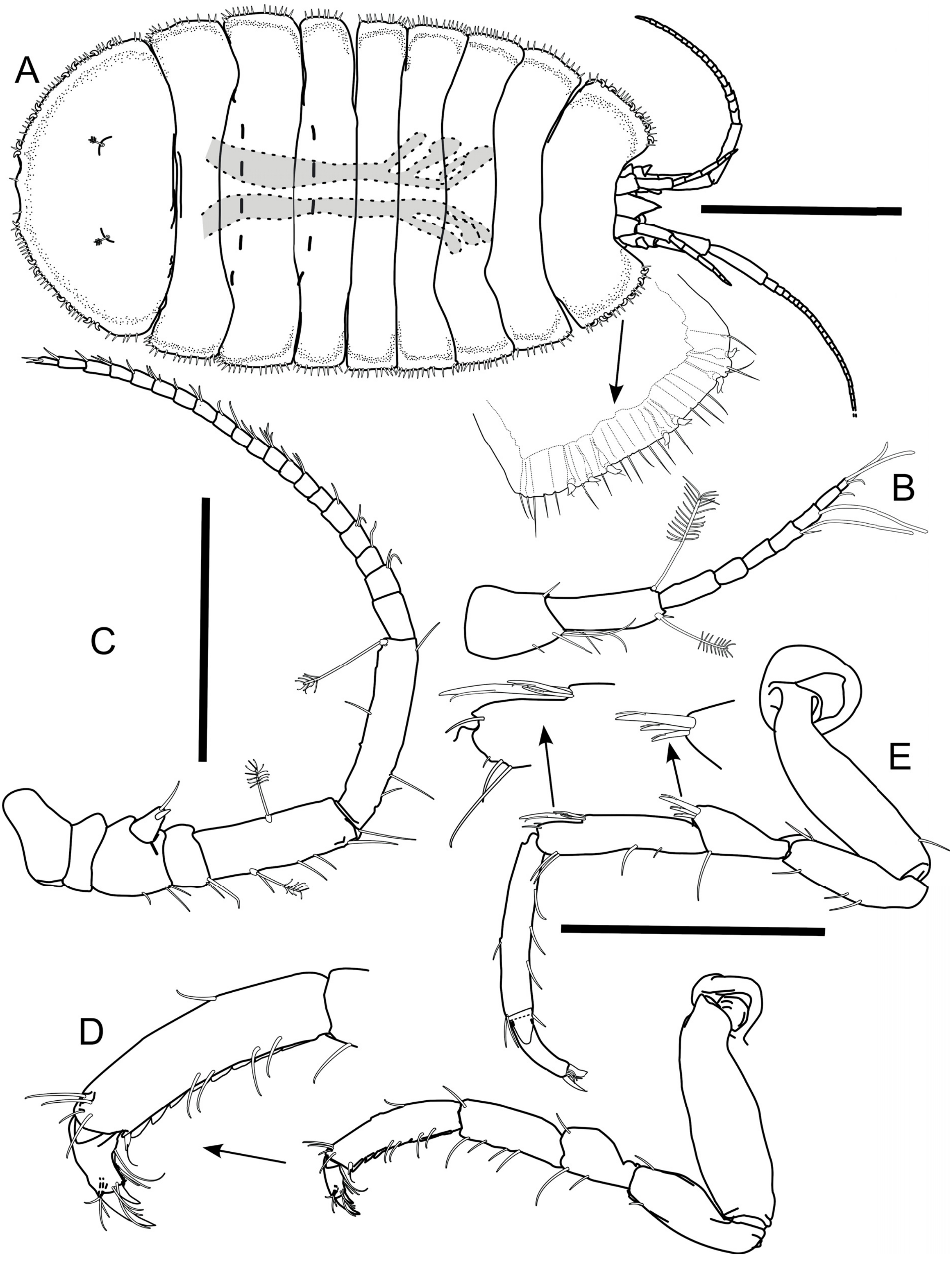

Fig. 6. *Basoniscus hikurangi* gen. et sp. nov., holotype ♂, NIWA162662. **A**. Dorsal habitus with enlargment of head right lateral margin, shaded regions indicate position of vas deferens. **B**. Antennula, dorsal view. **C**. Antenna, dorsal view. **D**. Pereiopod I, with enlargment of dactylus and propodus. **E**. Pereiopod II, with enlargements of setal groups on merus and carpus. Scale bars: A = 1 mm; B–C = 0.5 mm; D–E = 0.5 mm.

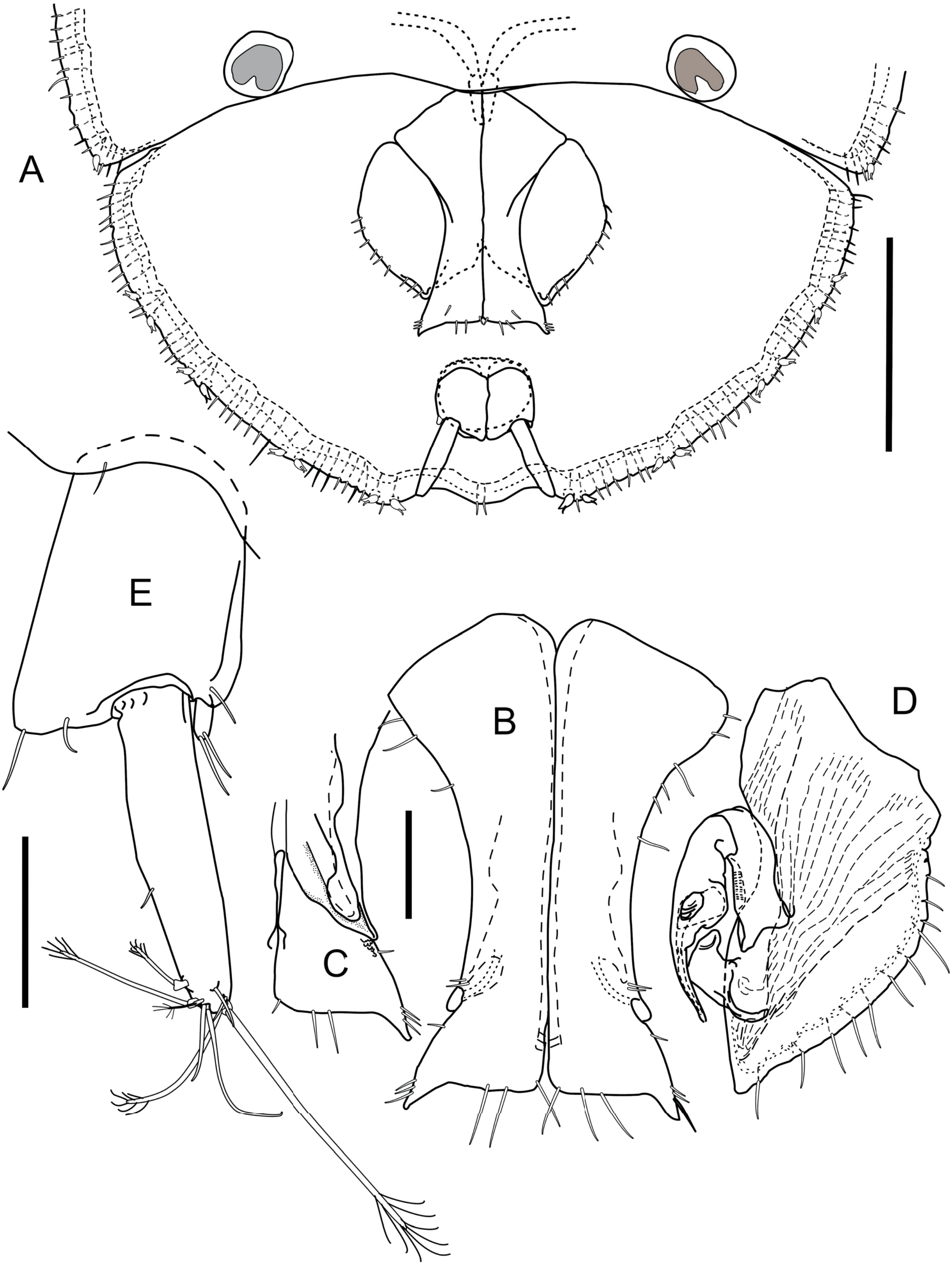

Fig. 7. *Basoniscus hikurangi* gen. et sp. nov., holotype ♂, NIWA162662. **A**. Pleotelson and posterior part of pereionite 7, ventral view. **B–C**. Pleopod I and enlargement, dorsal right side of distal lobes. **D**. Pleopod II, dorsal side. **E**. Uropod, right side. Scale bars: A = 0.5 mm; B–D = 0.1 mm; E = 0.1 mm.

PENES (Fig. 7A). Positioned medially, emerging internally, covered by posteromedial margin of pereionite 7 and anteromedial margin of pleopods I. Penes shorter than coxa VII diameter, width tapering medially, tip distally rounded.

PLEOTELSON (Figs 5C, 6A, 7A, 8A, C). Pleonites not expressed, merged into pleotelson. Pleotelson broad, length 0.42–0.53 (F, H) width, much broader than depth, deepest anteriorly, smoothly sloping to posterior margin; anterior margin adjacent and confluent with to pereionite 7 in frontal plane with pereion. Dorsal surface with paired sensory organs presenting as 2 epicuticular penicillate setae (see Riehl *et al.* 2014: 252), placed midway between anterior and posterior margin, each approximately ⅓ pleotelson width from lateral margin; dorsal surface sparsely setose, without spines. Posterior margin apex without spine-like projections, with shallow concavities behind positions of ventral uropods. Posterolateral margin without spines or denticles. Ventrolateral surface without ridges or setal rows. Ventral surface without preanal ridge; pleopodal cavity closed posteriorly, completely enclosed by opercular pleopods. Anus ventral, subterminal, outside pleopodal cavity, covered by uropodal protopods, with postanal margin projecting to broadly rounded apex between shallow concavities.

ANTENNULA (Fig. 6B, 9A). Length less than head width female shorter than male, ratios 0.48–0.65 (F, H), shorter than antenna length, ratios 0.42–0.55 (H, F). Positioned anteriorly on head; basal articles orientated anteriorly. Antennula with 7 articles in female, 9 in male (H). First article wider than second article, length:width ratio 1.8–2.0 (F, H), flattened in cross-section, broader basally. Article 4 shorter than article 3, length ratio 0.5, shorter than article 5, length ratio 0.83 (H). Flagellum in adult male not hypertrophied but with more articles than in female, 4 articles after article 5 in male (H), 2 in female, with only one aesthetasc per article, aesthetasc length much longer than flagellar segment. Terminal article cylindrical and distally rounded, shorter than penultimate article.

ANTENNA (Fig. 6C). Directed anteriorly; podomere axis with only moderate bends at articles 3–5, distal podomeres not folding against proximal podomeres; all articles cylindrical, straight, with flexible obtuse bend between articles 5 and 6. Article 1 fully articulated. Article 2 squat, wider than long. Article 3 longer and wider than articles 1–2 or 4, widest midlength, margins rounded, length less than twice width, not distally embedded in article 4; exopod cone-like, distally rounded, basally articulated, not scale-like or spinose, length greater than width. Articles 4–5 approximately linear with article 3. Article 5 not distally geniculate, rounded in cross section, shorter than combined length of articles 1–4, shorter than article 6. Article 6 longer than articles 1–4 together. Flagellum length subequal to (H) or shorter than (F) podomeres length, with 20–23 articles in male (H), not hypertrophied, 7 articles in female; flagellum basal article length longer than but less than twice next article length; flagellum basal article derived from single article (not conjoint), not inflated relative to distal articles.

MANDIBLE (Fig. 9A–G). Molar process subcylindrical, approximately parallel sided to distal margin; gnathal surface ridged and concave, with 2 rows of robust sharp spines on projecting margin, posterior row with more elongate spines and subdistal fine spines. Incisor process multidentate, with 5 cusps, approximately in transverse linear row. Left lacinia mobilis differentiated from other members of spine row, with 4 cusps. Right lacinia mobilis indistinguishable from spine row. Spine rows well-developed, with 3–2 single shaft (not bifurcate) distally dentate spines and 3–2 (right, left) distally spinulate spines, spines as long as or longer than incisor process, spine row basal length less than 50% molar–incisor distance. Palp subequal to mandible body length, insertion on lateral margin without lateral seta; article 1 without setae, shorter than article 2, length ratio 0.66; elongate article 2 with 2 subdistal bispinulate setae; article 3 laterally curved through approximate right angle, with dorsal margin with approximately 20 monospinulate setae increasing in length proximally to distally.

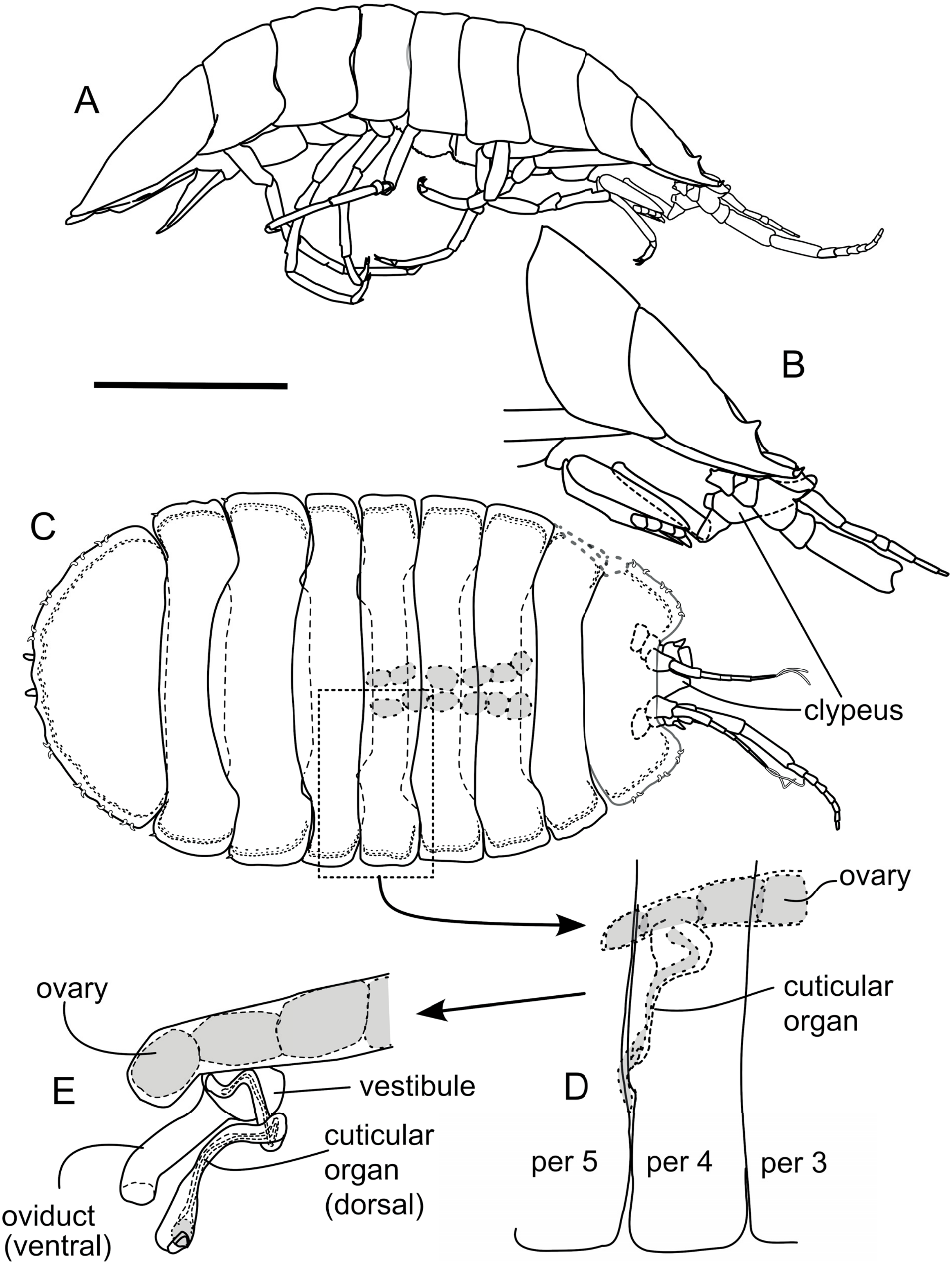

Fig. 8. *Basoniscus hikurangi* gen. et sp. nov., paratype ♀, NIWA162663. **A**. Lateral habitus. **B**. Enlargement of head, lateral view. **C**. Dorsal habitus. **D**. Enlargement of area in box on C, showing internal reproductive organs in pereionites 3–5, ovary and cuticular organ. **E**. Enlargement of internal reproductive organs. Scale bar: A, C = 1 mm. Indications: per = pereionite.

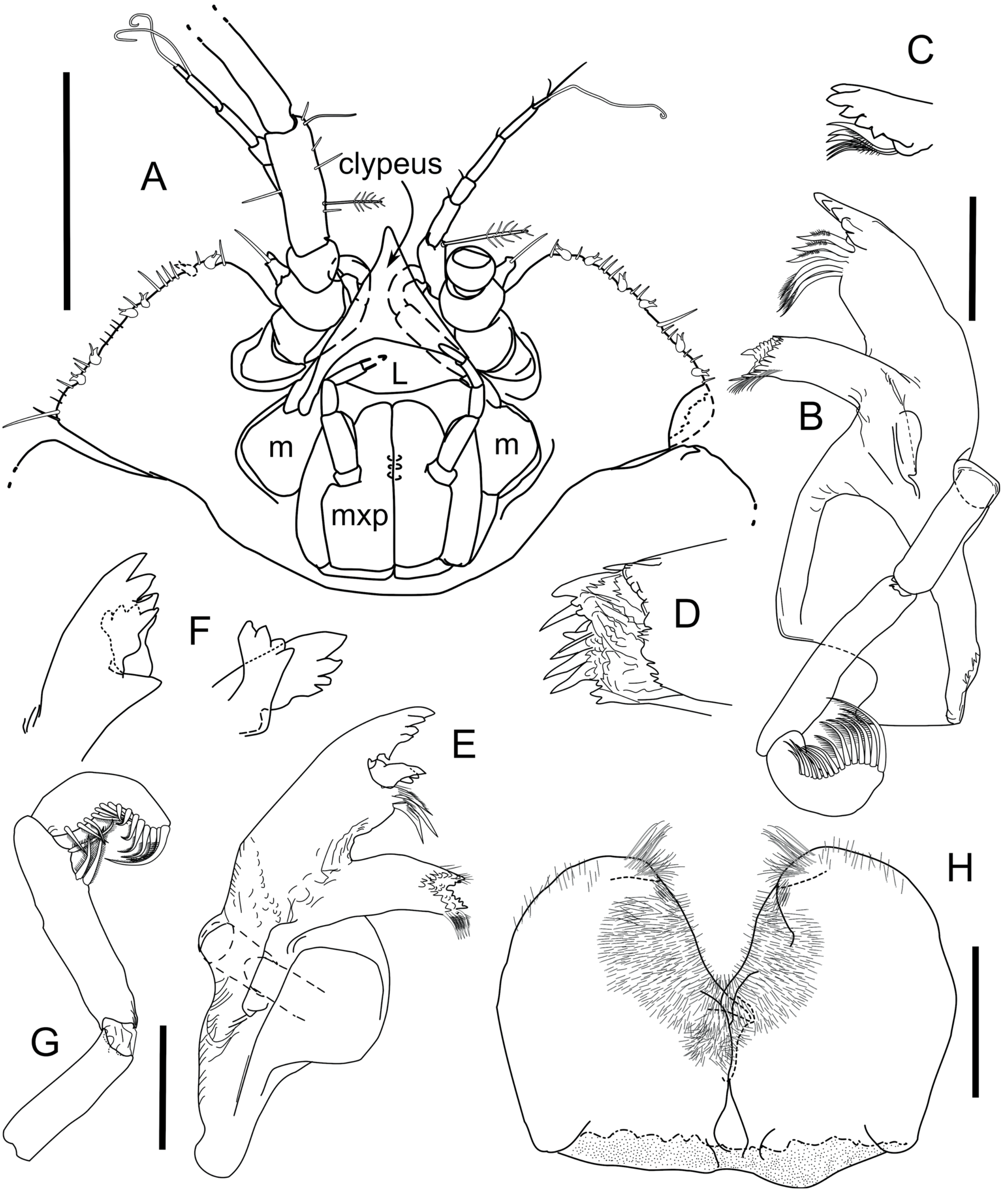

Fig. 9. *Basoniscus hikurangi* gen. et sp. nov., paratype ♀, NIWA162663. **A**. Head, ventral view. **B**. Right mandible, dorsal view. **C**. Right incisor process and spine row, anterior view. **D**. Right molar process, anterior view. **E**. Left mandible, dorsal view. **F**. Incisor process and lacinia mobilis, anterior and posterior views. **G**. Palp. **H**. Paragnaths, ventral view. Scale bars: A = 0.5 mm; B = 0.1 mm; E–F = 0.1 mm; H = 0.1 mm. Indications: L = labrum; m = mandible; mxp = maxilliped.

Paragnaths (Figs 9H). Broad, length 0.74 width, strongly curved medially, with reduced proximomedial lobes. Medial margin v-shaped, with many fine cuticular hairs. Mediodistal margins with medially projecting group of fine spinules. Distolateral margins with scattered cuticular hairs.

Maxillula (Fig. 10A). Lateral lobe with 11 robust setae of which 3 lateral setae lack denticles or spinules, 1 medial seta distally spinulate, and remaining setae distally denticulate; margin adjacent to medial lobe with row of fine setae. Medial lobe distal tip with single elongate distally spinulate seta and 3 small setae; medial margin with 3 elongate fine setae.

Maxilla (Fig. 10B). Medial lobe distally with 6 setae in 2 overlapping layers; medial margin distally with one elongate monospinulate seta, centrally with 5 pairs of fine setae, proximally with 6 elongate curved setae. Lateral lobes distally with 2 (inner), 3 (outer) long setae; inner lobe mediobasal margin with cluster of setae; outer lobe medial margin with 2 groups of setae, distal group longer than proximal group, lateral margin with elongate fine setae grading proximally to fine setae. Lateral base of lobes with small group of cuticular hairs.

Maxilliped (Figs 9A, 10C). Coxa laterally narrowing, longest medially, extending beyond lateral margin of basis, without oöstegite. Endite length 0.39 basis total length; medial margin with 2 coupling hooks, with group of approximately 7 setae; distolateral margin with 4 bifurcate sinuate robust setae, one branch distally spinulate, sizes decreasing proximally; distal margin with distomedial concavity, 2 fan setae lateral to concavity, one narrow and tapering, one distally truncate and broad; distolateral margin with scattered fine setae and 3 closely-spaced thick tubular setae. Epipod well developed, narrow, length 3.2 width, epipod projecting beyond palp insertion, length 1.1 basis length, lateral margin with obtuse angle and shallow concave margin distally to narrow rounded apex. Palp with 5 free articles, width distinctly less than endite width, ratio 0.62; male articles 3–5 similar to female; article 1 length less than width, without distolateral process; article 2 width near to article 1 width, lateral length greater than width, ratio 1.5, lateral length subequal to medial length, without distomedial projection, width 2.2 article 4 width; article 3 without distomedial projection, medial length 1.2 width, 1.1 lateral length; article 4 length 2.9 width, without distomedial projection; article 5 length greater than width.

Pereiopods (Figs 6D–E, 10D–F, 11, 12A–B). Pereiopods I–VII similar in length and shape, similar in male and female, without broadened podomeres, long setae or spination. Pereiopod I shortest; pereiopods IV–V shorter than pereiopods II–III and VI–VII, length : body length ratios, respectively: 0.45, 0.52, 0.54, 0.43, 0.49, 0.57, 0.58. Coxae lacking anterolateral robust setae; oöstegites on coxae I–IV only, developing internally, buds or ridges not present externally in preparatory female, until deployed at maturation. Basis lengths longer than ischium lengths, ratios 2.2 (I–V), 1.8 (VI–VII). Pereiopod ventral margins without robust setae, with fine setae, more frequent on carpus and propodus where setae may be elongate, straight sided and thin on pereiopods V–VII. Pereiopods II–VII dorsal margins of merus and carpus with groups of robust bifid setae, each merus with group of 3 each short bifid setae on distodorsal margin, each carpus with group of 5 bifid setae on distal third of dorsal margin, one distal branch of each seta finely spinulate, central seta being approximately twice as long as outer setae. Pereiopod I–VII dactylus with ventral claw, positioned distally on limb, shorter than dorsal claw; distal sensillae not enclosed by claws; medial sensillae thin, not projecting beyond claws; dactylus without third claw (accessory robust seta). Pereiopod I ventral dactylar claw basally slender and shorter than dorsal claw, length half dorsal claw length; pereiopods II–VII ventral claw length 0.8 dorsal claw length, basally wider and more robust than dorsal claw, basal width more than half dactylus distal width.

Pereiopod I. Projecting anteriorly and ventrally; length 0.44 body length (H, F), similarly robust as pereiopod II, shorter, length 0.80 pereiopod II length. Ischium dorsal margin weakly convex; merus dorsal length exceeding width and lacking distodorsal projection. Carpus and propodus with only ventral robust setae and subparallel margins, length 0.83 propodus length, elongate, dorsal and lateral margins subparallel, of subequal length; carpus ventral margin without expansion or projections; carpus and propodus not prehensile, not dimorphic, females and males similar. Propodus without distal elongate robust seta, ventral margin elongate, margins subparallel, ventral margin without comb of spinules; dactylus short, length (including claws) 0.09 pereiopod length.

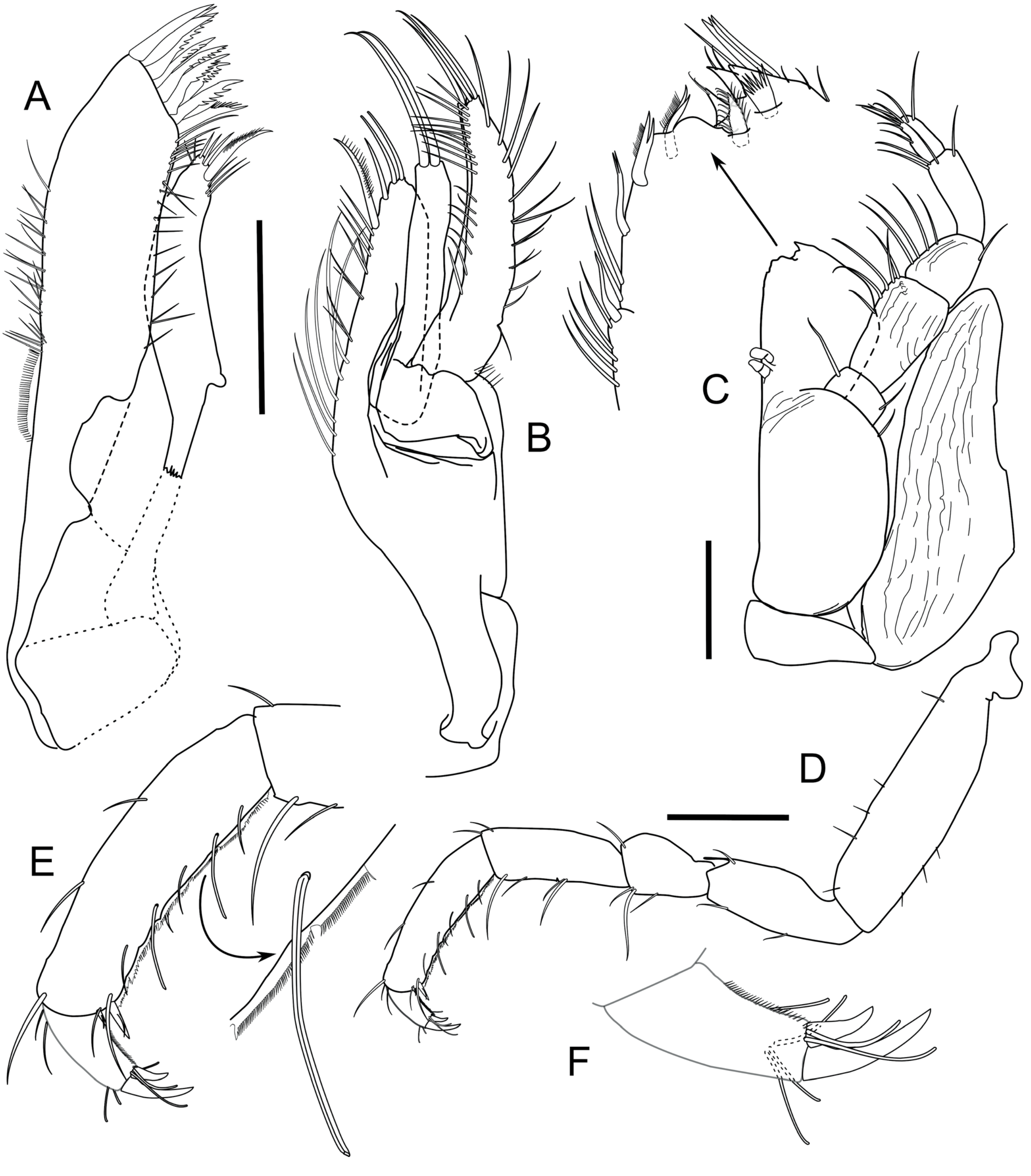

Fig. 10. *Basoniscus hikurangi* gen. et sp. nov., paratype ♀, NIWA162663. **A**. Maxillula, ventral view. **B**. Maxilla, ventral view. **C**. Maxilliped with enlargement of endite distal tip. **D**. Pereiopod I, lateral view. **E**. Pereiopod I propodus and dactylus with enlargment of ventral margin seta. **F**. Pereiopod I dactylus. Scale bars: A–B = 0.1 mm; C = 0.1 mm; D = 0.2 mm.

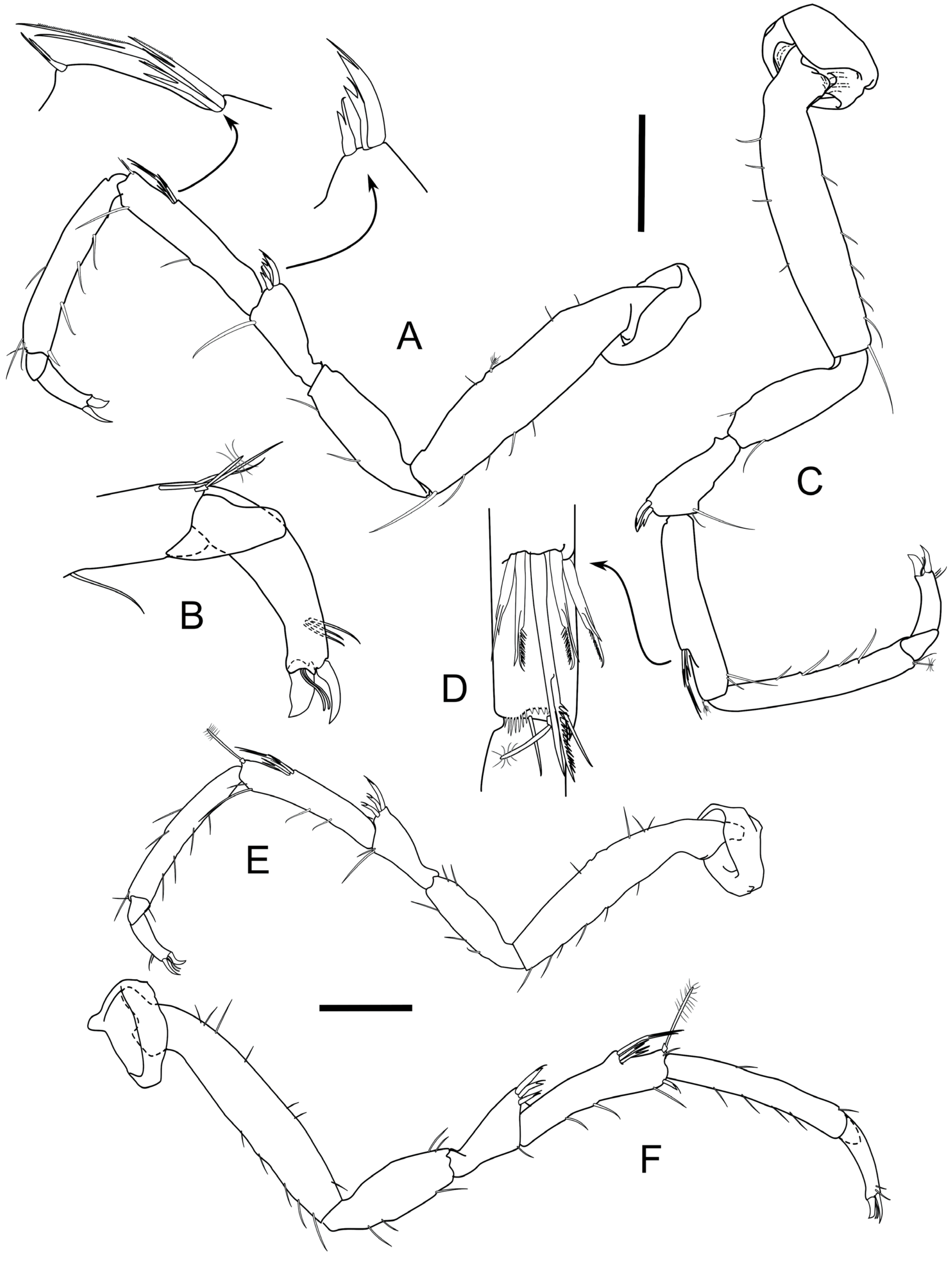

Fig. 11. *Basoniscus hikurangi* gen. et sp. nov., paratype ♀, NIWA162663. **A**. Pereiopod II, left, with enlargements of setal groups on merus and carpus. **B**. Pereiopod II, right, dactylus and distal part of propodus showing articular plate. **C**. Pereiopod III, left. **D**. Pereiopod II, enlargements of propodus distal setal group. **E**. Pereiopod IV, left. **F**. Pereiopod V, left. Scale bars: A, C = 0.1 mm; E–F = 0.2 mm.

Pereiopod II. Projecting anteriorly and ventrally, shorter or near body length; merus width near length; carpus and propodus without opposing margins, without multiple dense rows of setae, margins subparallel, near length of basal segments.

Pereiopod III. Projecting anteriorly and ventrally; carpus and propodus without opposing margins; ambulatory; carpo-propodal joint rotation absent; ischium dorsal margin with only simple setae; limb shorter or near body length, carpus and propodus near length of basal segments.

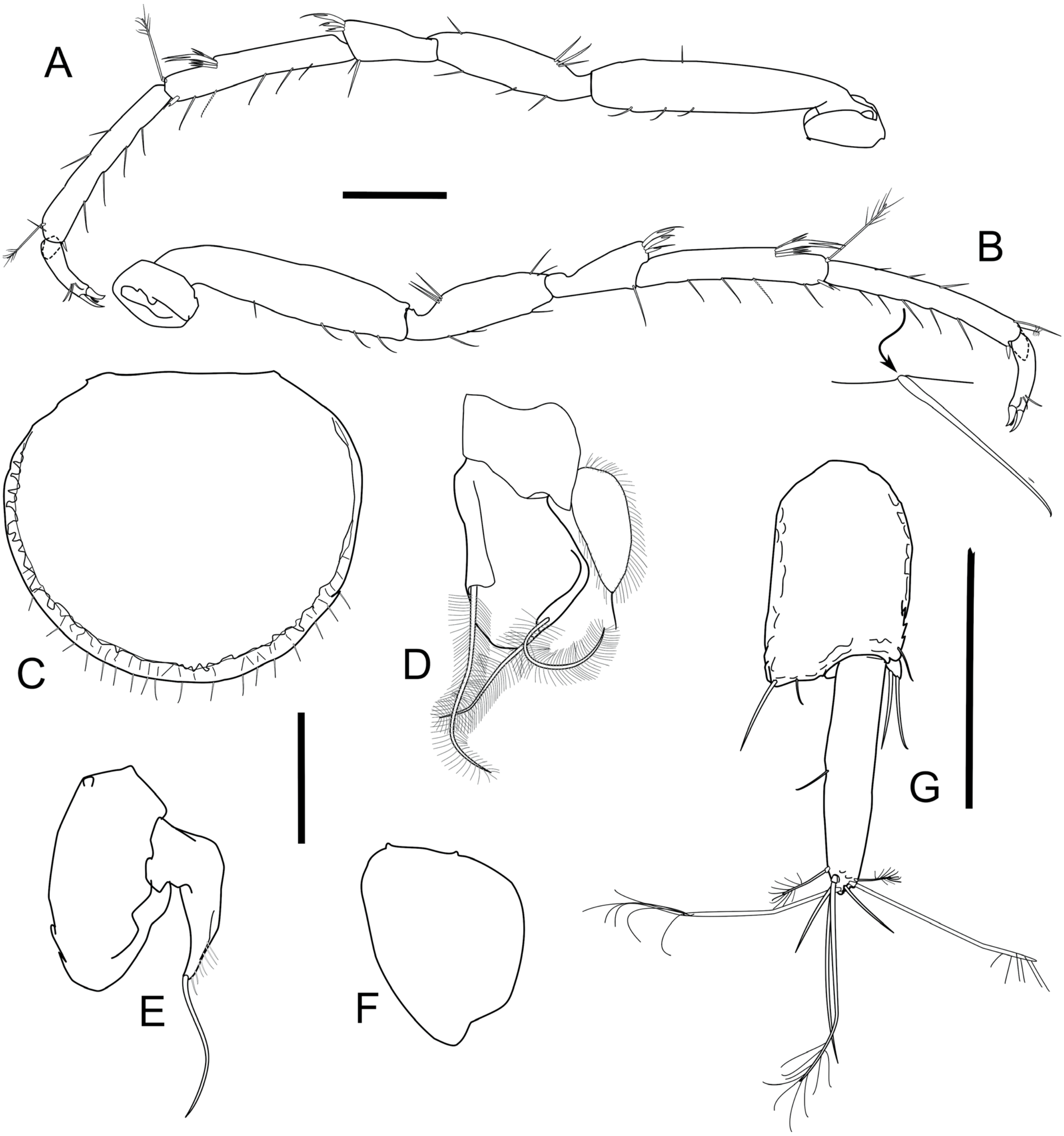

Fig. 12. *Basoniscus hikurangi* gen. et sp. nov., paratype ♀, NIWA162663. **A**. Pereiopod VI, right. **B**. Pereiopod VII, left, with enlargement of propodal marginal seta. **C**. Pleopod II, ventral view. **D**. Pleopod III, ventral view. **E**. Pleopod IV, ventral view. **F**. Pleopod V, ventral view. **G**. Uropod, left, ventral view. Scale bars: A–B = 0.2 mm; D–F = 0.2 mm; G = 0.2 mm.

Pereiopod IV. Projecting anteriorly and ventrally, shorter than pereiopods II–III and VI–VII; carpus and propodus without opposing margins, in male similar to female, not prehensile; carpus longer than merus, length ratio 1.9, shorter than propodus, length ratio 0.9, width near thickness.

Pereiopod V–VII. Carpus and propodus elongate with subparallel margins, sparsely setose along margins.

Pereiopod VII. length subequal to pereiopod VI length; male similar to female, not sexually dimorphic; basis posterior margin paucisetose.

Pleopods (Figs 7B–D, 12C–F). Pleopod I of female absent. Female pleopod II opercular; male pleopods I–II opercular.

Pleopod I of male. Length more than half pleon length, ratio 0.57. Medial margins fused, with medial sperm tube; broadest proximally, narrowest midlength, widening distally, with dorsolateral stylet guides, orientation transverse to body axis, opening subdistally and laterally. Medial and lateral lobes in single plane. Lateral lobes reduced, set proximally from distal margin, expressed as small lobe, distance 0.93 pleopod length from proximal margin. Medial lobes medially truncate with small distolaterally projecting horn, distally acutely pointed, with 3 medially placed stiff setae and several shorter setae on distolateral margin.

Pleopod II of female. Medially fused into operculum without endopods or exopods, ovoid, without rounded ridge or keel, without ventral spine-like projections; completely enclosing pleopodal cavity, not covering anus, length 0.86 width, 0.6 pleotelson length; lateral and distal margins with thin flange, with evenly placed short straight sharp setae, setal length less than width of thin cuticular margin.

Pleopod II of male. Protopod elongate and robust, longer than exopod; total length less than half pleon length. Endopod appendix masculina geniculate, articulation expressed, position on protopod margin medial; appendix masculina stylet shaped, with closed tube, opening only on distal tip, unidirectionally curved, short, length 0.74 protopod length, not projecting beyond protopod distal margin, proximal opening medial. Exopod medial position on protopod, single article, thick, not flattened; stout, length 0.6 width; without posterior appendage, with rounded hook on distal article.

Pleopod III. Length 0.38 pleotelson length. Endopod monoarticulate, distal margin with 3 plumose setae unevenly distributed, middle and lateral setae close together, medial seta subdistally. Exopod monoarticulate, distal tip not extending beyond endopod, length 0.7 endopod length, width 0.4 endopod width; distal margin acute, fine setae on medial and lateral margins, with one distal simple seta.

Pleopod IV. Biramous, length 0.44 pleotelson length. Exopod with only one segment, central articulation absent; narrow, width 0.4 length, with narrowing margins.

Pleopod V. Monoarticulate, uniramous, length 0.38 pleotelson length.

Uropod (Figs 7A, E, 12G). Shorter than pleotelson, length ratio 0.31–0.34 (H, F); inserting on posteroventral surface, emerging from ventral margin, adjacent to anus, covering anus ventrally. Protopod external to articular socket, axis of rotation suppressed, length 0.52–0.53 (F, H) pleopod length, distal width 1.3 proximal width, flattened, medial margin with lobe projecting over and covering anus. Rami biramous, positioned distally, exopod adjacent to endopod on distomedial margin. Exopod lateral to endopod, minute, length 0.03–0.05 (H, F) uropod length, proximal articulation expressed. Endopod ramus rod-like, distally rounded, proximal articulation free, length distinctly longer than protopod, ratio 1.1 (H, F).

Remarks

The ordinary isopodan appearance of *Basoniscus hikurangi* gen. et sp. nov. is unusual for janiroideans, which typically have many specializations of both limbs and body. No pereion segments of *Basoniscus hikurangi* are specialized compared to any other. Instead of the typical asellotan 4 : 3 tagmosis, this species has no obvious differentiation of the pereionites other than lateral curvature depending on their position on the body. The broad habitus with flanged lateral margins and short hidden uropods is remarkably like a fully terrestrial oniscidean isopod. If it had been collected on land in Australia or New Zealand, it might have been mistaken for a species of Armadillidae Brandt, 1831.

The broad body with thin flat marginal flanges and minute curved robust setae plus robust pereiopodal claws, especially the ventral claw, suggest that these isopods may have the ability to cling closely in scale-like fashion to surfaces, such as the hard volcanic surfaces from which the specimens were collected. The middle two pereiopods (45.75% body length) are shorter than those anteriorly (pereiopods II–III, 53.1% body length) or posteriorly (pereiopods VI–VII, 57.4% body length). This may also be a feature of a scale-like existence, which would require that the legs are held under the broad tergites. Asellotans that have a plesiomorphic ambulatory habitus typically have limbs that increase in length posteriorly. Unusual squat and curved robust setae on head and pleotelson margins may also be part of the scale-like adaptation, in that they might assist in maintaining contact with a surface. These robust setae have obvious subdistal sensillae so sensing the surface may also be important.

This species has attenuated sexual dimorphism, which is unusual for many isopods where the male is variably distinct from the female. The only apparent differences of males from the female specimen appears to be a longer antenna, more articles in both antenna and antennula, and perhaps the female being slightly larger than the males. Only one female was collected but was slightly larger (3.4 mm) than the largest male (3.3 mm), one of the paratypes. The holotype male was clearly adult because it had fully developed testis (Fig. 6A) as well as a pleopod II appendix masculina with a cuticular duct that was open at the end of the stylet (Fig. 7D). The single female was also fully mature with well developed ovaries containing ovae. All four specimens were approximately the same size, supporting the assumption that they were all adult.

The opening for cuticular organ (spermathecal duct) is found dorsally as in the Joeropsididae (see Just 2001: fig. 1) and is similar to that of the Haploniscidae (see Wolff 1962: 227, duct to "receptaculum seminis"). In *Basoniscus* gen. nov. (Fig. 8D), Joeropsididae and other janiroideans, it is positioned under the anterior margin of pereionite 5, either dorsally or laterally, whereas in Haploniscidae, similar to other deep-sea janiroideans (e.g., Ischnomesidae Hansen, 1916; see Cunha & Wilson 2006: fig. 10), it has moved to an external location posterior to the anterodorsal margin of the pereionite. The janiroideans have a range of positions for the opening on pereionite 5, ranging from ventral for Munnidae G.O. Sars, 1897 and Santiidae Kussakin, 1988 to fully exposed dorsally on Ischnomesidae. Whether this is an adaptation to deep-sea conditions (a parallelism) or an ancestral feature is not clear because the basal arrangements between multi-familial clades in the phylogeny (e.g., see unweighted or implied weighted jackknife trees in supplementary data) remain equivocal owing to low character support and absence of information on related taxa in other superfamilies.

Discussion

Janiroidean phylogenetics and Basoniscidae fam. nov.

When previous janiroidean character matrices were analyzed phylogenetically, the relationships between groups of families were uncertain. Although available analytical programs have considerably improved in speed and in ease of use for phylogenetic analysis over the years when the first computer analyses on Asellota were published (Wilson 1987), a lack of resolution between reasonably well-defined families remained in subsequent analyses. Among these families, the relative positions of Haploniscidae Hansen, 1916 and Joeropsididae Nordenstam, 1933 have been somewhat problematic because they didn't clearly group with any other family, or did so only weakly. Basoniscidae fam. nov. has drawn the relationships of these two seemingly unrelated taxa together, and at the same time reduced the overall uncertainty in the relationships within the Janiroidea G.O. Sars, 1897. When the analysis omitted *Basoniscus* gen. nov., the two families remained sister taxa in the analyses, although with reduced support. The new taxon allowed the recognition of similarity and apomorphies shared between these species, especially in the shape of the clypeus and labrum, which are new characters introduced here. Although the new genus did not by itself drive the rearrangement of family relationships, the process of studying its features created new data to be used for understanding the phylogeny of the Janiroidea.

New taxa remain undiscovered

The descriptions of previously unknown rare janiroidean taxa, such as Xenosellidae Just, 2005, Urstylidae Riehl, Wilson & Malyutina, 2014 and now Basoniscidae fam. nov., shows that the evolutionary structure of the Asellota is far from being well understood. Rare taxa such as these appear haphazardly in deep-sea samples owing to multiple factors. Sampling issues are discussed below but another reason might be that these taxa are remnants of a long period of diversification of the deep-sea isopods. Unlike many higher level taxa (e.g., polychaetes, molluscs or fish) that decline in species richness with depth into the deep sea, janiroidean isopods become more diverse (Poore & Wilson 1993; Rex *et al.* 1993; Wilson 1998). They also have exceptionally diverse morphologies (Wilson & Ahyong 2015), evincing a long span of evolutionary time. Fossil taxa that have come to light recently show that the Asellota have been evolving, at least since the Triassic period (Selden *et al.* 2016). Asellota were probably present in the Carboniferous period when isopod fossils first appear (Schram 1970; Wilson 1999). Early evolved deep-sea janrioideans may be rare in the modern fauna because they were largely replaced by younger, rapidly speciating and numerically dominant taxa like the Munnopsidae Lilljeborg, 1864 or Desmosomatidae G.O. Sars, 1897. The early arrivals to the evolutionary stage may still persist in the vast spaces and special environments of the deep sea. Taxa like *Basoniscus* gen. nov. and the genus *Urstylis* described by Riehl *et al.* (2014; see their discussion) may be examples of survivors from the early diversification of isopods, of which more surely exist in the abyss.

Great gaps in surveys of the deep sea

Finding these rare deep-sea isopods brings to light several deficiencies in our understanding of the abyssal fauna. Hard substrates are woefully undersampled. The southern hemisphere, relative to the northern hemisphere, is especially undersampled. *Basoniscus* gen. nov. came to light only because a primarily geological expedition to the Hikurangi Plateau region (Hoernle *et al.* 2003) included biological investigators who carefully recovered specimens from the rocks and boulders dredged from the deep slopes. Although the collection size, particularly of isopods, was small, each specimen had potential value. The high species richness of isopods of the South Atlantic deep sea (Rex *et al.* 1993; Poore & Wilson 1993; Wilson 1998) might also be characteristic of the South Pacific and Indian Oceans.

Museums are storehouses of unknown new taxonomic groups

Oceanographic expeditions over the last 50 years have collected literally millions of specimens (see Stuart *et al.* 2008), many of which are now stored in museums or other institutional collections. These valuable specimens are overlooked by funding agencies and research programs, which typically are aimed at collecting new materials for specific research aims. The value of this massive and costly effort of oceanographic sampling is only partially realized because the materials collected in those programs that reside in museums around the world are not being actively accessed for synoptic studies of deep-sea systematics and biodiversity. Sampling of the entire Atlantic Ocean deep-sea by various international programs has resulted in literally hundreds of thousands of specimens residing in Museum collections. For example, Sanders *et al.* (1965) was the beginning of a program to study all slopes and basins in the Atlantic Ocean, north and south; these collections currently reside in national museums in the USA and Australia. Most specimens may only be partially identified to genus or family because each sample might have collected thousands of specimens. Only specimens of interest to particular investigators have received taxonomic treatment to appear in taxonomic journals. Detailed taxonomic surveys of existing collections by experienced systematists might present new opportunities for investigation and discoveries of new higher level taxa. Overall, museum systematic research is cheap by orders of magnitude compared to the cost of oceanographic cruises where ship time alone can dominate the funding required. Government research agencies must re-evaluate their priorities for understanding evolutionary patterns and ecological structure of the deep-sea fauna by expanding studies of existing collections. Museums, institutional collections and their scientific staff can fulfill an important role in researching the biodiversity and evolutionary origins of the deep-sea fauna.

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