

## A new genus of aquatic cave-dwelling isopod from Namibia (Crustacea: Isopoda: Asellota)

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A new genus *Namibianira*, represented by four new species, *N. aigamasensis*, *N. dracobalitus*, *N. arnhemensis*, and *N. aikabensis* is diagnosed. The new genus is intermediate between *Protojanira* and *Protojaniroides* and is characterized by the possession of ambulatory first pereopods, and a reduced molar process of the mandible. The new species are the first record of cavernicolous freshwater isopods from Namibia.

### INTRODUCTION

A survey of the invertebrate fauna of Namibian caves by Dr. J. Irish and Mr. E. Marais of the State Museum, Windhoek, yielded blind aquatic asellote isopods from four limestone caves in central and northern Namibia. Descriptions of two of these caves, Drachenhauchloch (Dragon's Breath Cave) and Aigamas Cave, may be obtained from Sefton *et al.* (1986). The former contains an under-ground lake over 200 m long and up to 150 m wide, and not less than 40 m deep. The water of Aigamas Cave contains a species of blind fish, *Clarias cavernicola*. Arnhem Cave, the longest yet known in Namibia, contains five pools all about 5 x 8 m in extent, and less than 1 m deep, inhabited by amongst others, ingolfiellid amphipods (J. Irish, pers. comm.). The Aikab Hemicenote contains a roughly circular lake with direct surface access. This underground lake has a diameter of about 100m, and a minimum depth of 19m (E. Marais, pers. comm.).

While superficially similar, the isopods in the four lots did differ in size; further additional subtle differences were found, suggesting that four separate species were involved. Even though all the specimens had lost their antennal flagella and uropods, most had lost some or all of their legs, and males were present in only two of the lots, it was decided to name and

describe them, given that they occupy a taxonomically intriguing position and that stygobiont asellotes were previously unknown from Namibia.

Type material is deposited in the State Museum, Windhoek, Namibia (SMN); a few paratypes of *N. arnhemensis* and *N. aikabensis* have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

### SYSTEMATICS

SUPERFAMILY GNATHOSTENETROIDOIDEA  
Kussakin, 1967

FAMILY PROTOJANIRIDAE Fresi, Idato, & Scipione, 1980

#### *Namibianira* gen. nov.

DIAGNOSIS: Eyes lacking. Cephalon with rostral projection barely discernible. Antennal peduncle with 4 basal articles short, article 3 bearing scale. Mandibular palp of 3 articles; molar thin-walled, conical, bearing 2-3 apical setae. Maxillipedal endite bearing 2 coupling hooks, palp articles 1-3 broad, articles 4-5 slender. Pereopod 1 ambulatory, dactylus biunguiculate, not folding on propodus. Pereopods 2-7 ambulatory, dactyli triunguiculate. Pleopod 1 in male with rami lamellar, basally fused, lacking sperm tube. Pleopod 2 in male, exopod lobe-like, of 2 articles,

endopod distally tapered and stylet-like with tube opening at apex, not reaching apex of protopod. Pleopod 2 of female broad, opercular, bearing marginal setae, and with roughly circular central denser area. Pleopod 3 biramous, rami biarticulate. Pleopod 4 and 5 uniramous, rami biarticulate. One short free pleonite.

**TYPE SPECIES:** By present designation, *Namibianira arnhemensis* **sp. nov.**

**ETYMOLOGY:** The generic name is derived from the state of Namibia, plus the Latin suffix '-ianira', indicating its asellotan affinity.

**DISCUSSION:** Two protojanirid genera have been diagnosed from southern Africa, *viz.* *Protojanira* Barnard, 1927, and *Protojaniroides* Fresi, Idato, and Scipione, 1980 (Table 1). The species of these genera are morphologically all very similar; two characters have been found to be of importance in distinguishing them:

1. Pereopod 1, which is primitively ambulatory, and resembles the remaining pereopods. The apomorphic state of this character is a subchelate pereopod 1, with the propodus somewhat expanded.

2. The mandibular molar process, which primitively is stout and distally truncate with a grinding surface, and thin-walled, tapered, and lacking a grinding surface in the apomorphic state. *Protojanira* is characterized by possessing an

ambulatory pereopod 1 and a stout distally truncate mandibular molar. *Protojaniroides* possesses a strongly subchelate pereopod 1 and a thin-walled conical mandibular molar. Other than in *Protojanira lucei* Enckell, 1970, none of the species of these two genera have been described as possessing a free pleonite, but this is probably an oversight, given the difficulty in seeing this very short segment. The present genus appears to occupy an intermediate position, in that it resembles *Protojanira* in having an ambulatory pereopod 1, and *Protojaniroides* in the form of the mandibular molar; it clearly possesses a short, free pleonite.

***Namibianira aigamasensis* sp. nov.**

Figures 1, 2

**MATERIAL:** Holotype, SMN 51603, ♀ tl 3.6 mm, Paratypes, SMN 51257, 3 ♀ tl 3.0 - 3.6 mm, Aigamas Cave, 3-8 m, Otavi District, coll. A. Penney, 27 Jul 1987.

**DESCRIPTION:** Body about 3.7 times longer than greatest width, widest at pereonite 3; with sparsely scattered setae on cephalon, pereon, and pleon. Cephalon about one-fourth wider than mid-length; anterior margin with low convex rostral area. Pereonites 1 and 2 subequal in length; pereonites 1-3 increasing in width posteriorly, anterolaterally rounded, broadening posteriorly; pereonites 4-6 subequal in width;

**Table 1.** Records of Protojaniridae from Southern Africa and Sri Lanka.

<i>Namibianira aigamasensis</i> <b>sp. nov.</b>	Aigamas Cave, Otavi District, Namibia.
<i>Namibianira aikabensis</i> <b>sp. nov.</b>	Aikab Hemicenote, Etosha National Park, Namibia
<i>Namibianira arnhemensis</i> <b>sp. nov.</b>	Arnhem Cave, Windhoek District, Namibia.
<i>Namibianira dracobalitus</i> <b>sp. nov.</b>	Dragon's Breath Cave, Grootfontein District, Namibia.
<i>Protojanira leleupi</i> Grindley, 1963.	Kalk Bay Mountains, Cape Peninsula, South Africa.
<i>Protojanira prenticei</i> Barnard, 1927.	Kogelberg, Hottentots Holland Mountains, Cape Province, South Africa.
<i>Protojaniroides ficki</i> (Chappius & Delamare, 1957).	Kaapsehoop, Eastern Transvaal, South Africa.
<i>Protojaniroides lucei</i> (Enckell, 1970).	North-central Sri Lanka.
<i>Protojaniroides perbrincki</i> (Barnard, 1955).	Tugela River, Natal, South Africa.

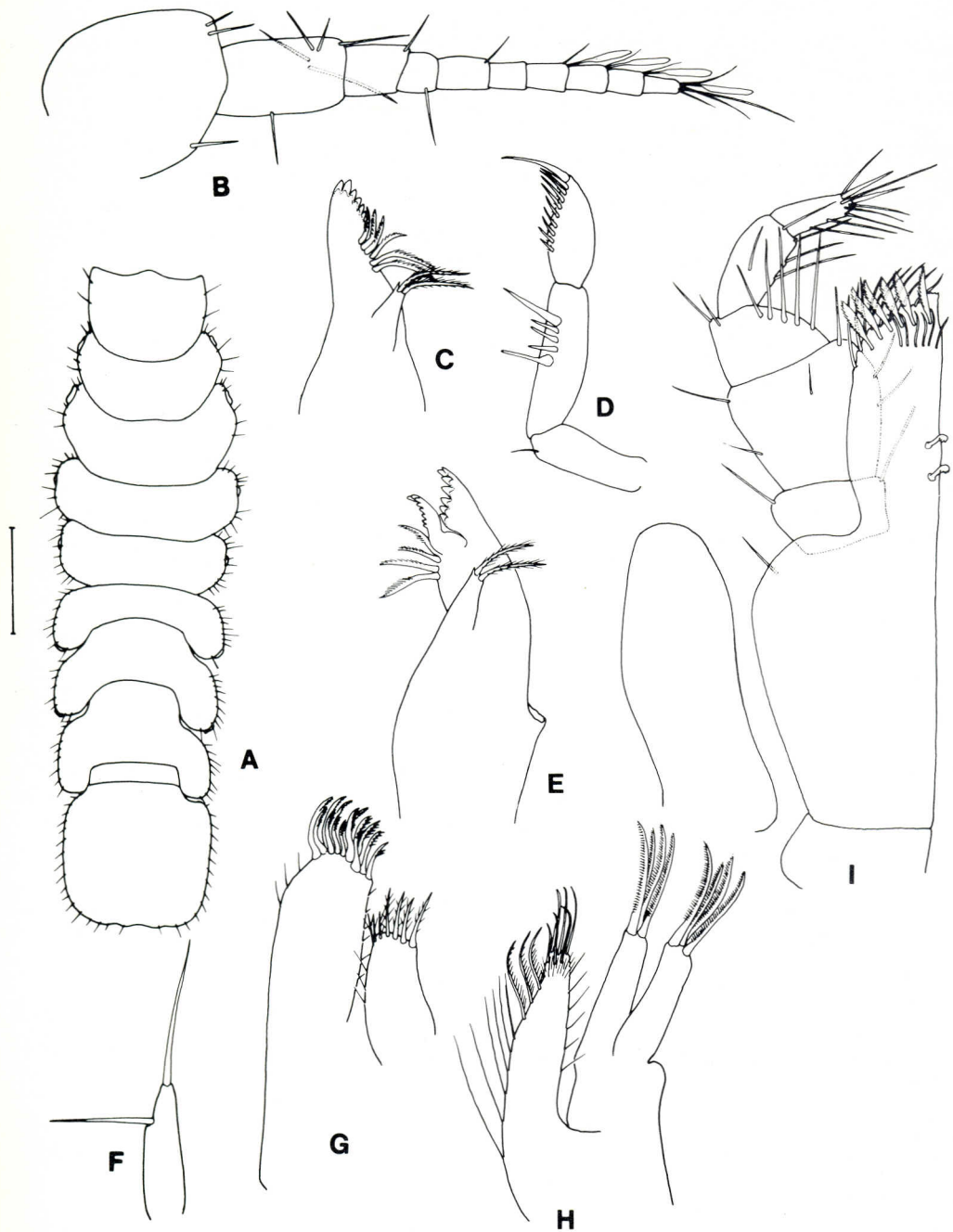


Figure 1. *Namibianira aigamasensis*. A, whole animal, dorsal view, antennae and uropods lacking, scale = 0.5 mm; B, antennule; C, right mandible; D, mandibular palp; E, left mandible; F, antennal scale; G, maxilla 1; H, maxilla 2; I, maxilliped with epipod.



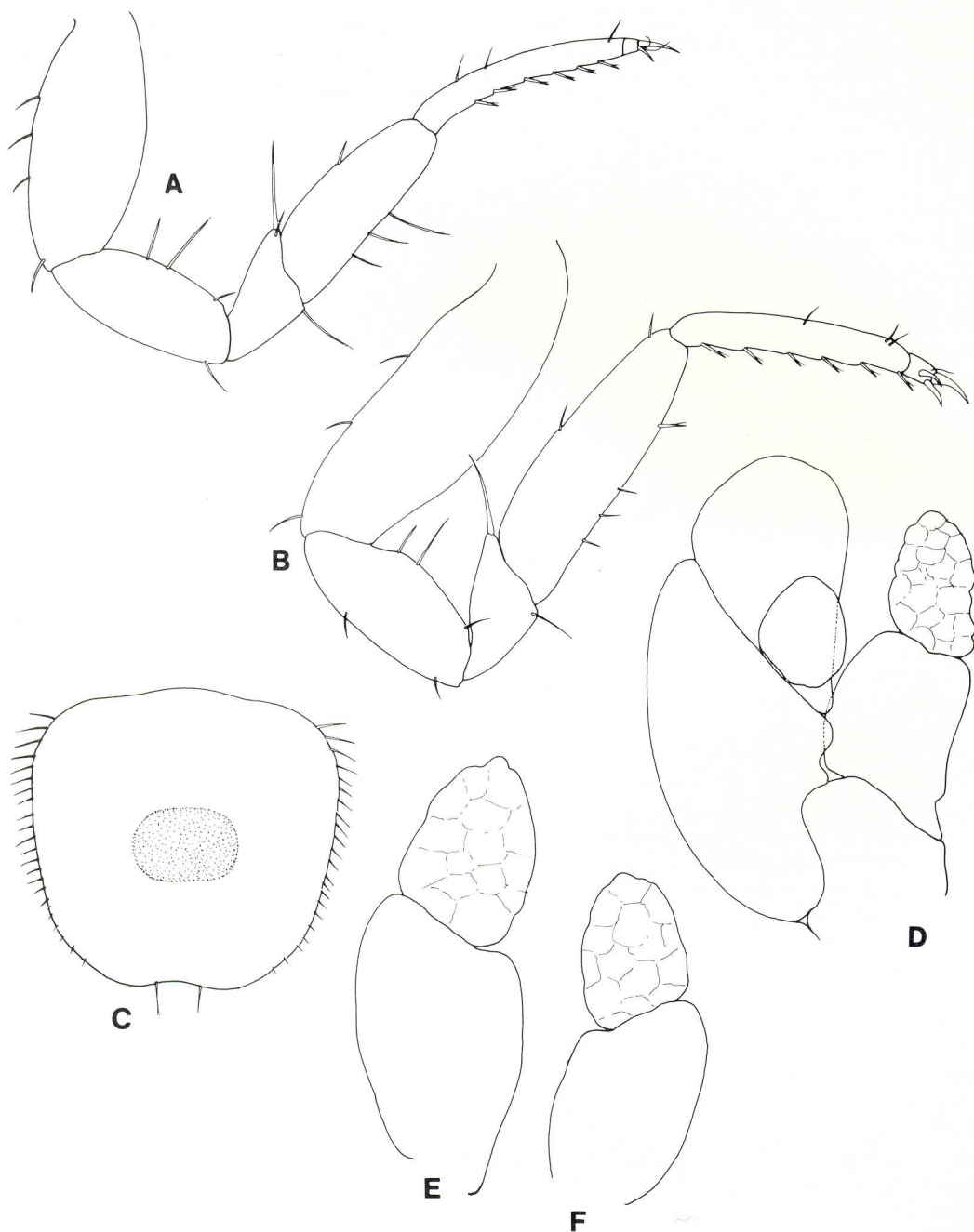


Figure 2. *Namibianira aigamasensis*. A, pereopod 1; B, pereopod 7; C, ♀ pleopod 2 operculum; D, pleopod 3; E, pleopod 4; F, pleopod 5.

pereonite 7 slightly narrower than preceding somites; pereonites 5-7 laterally broadly rounded, posteriorly directed, increasing in length posteriorly. Pleon consisting of single dorsally-free short anterior pleonite plus pleotelson; pleonite overlapped laterally by posterolateral lobes of pereonite 7. Pleotelson roughly rectangular, wider than mid-length, posterior margin with 2 faint submedian convexities.

Antennule with broad basal article wider and longer than article 2, latter twice longer than wide, article 3 about half length of 2; flagellum of 7-12 articles, distal 4-6 articles each bearing single aesthetasc. Antenna having 4 short basal articles, article 3 bearing strong lateral scale, latter with 2 distal setae. Mandibular incisor having 7 cusps; left mandible having lacinia mobilis with 7 or 8 teeth plus spine row of 4 fringed spines, right mandible with spine row of 5 or 6 fringed spines; molar process thin-walled, tapering, with single short seta and 2 elongate fringed setae distally; palp of 3 articles, article 2 1.3 times length of article 1, with 5 distolateral bifringed spines, first and last in series larger; article 3 with row of 9 or 10 spines increasing in length distally. Maxilla 1, mesial lobe with 5 distal setae; lateral lobe almost twice width of mesial, with double row of about 13 curved pectinate spines. Maxilla 2 with 2 lateral lobes each bearing 4 elongate pectinate setae; mesial lobe with several simple setae on mesial and distal margin. Maxillipedal epipod length about 2.5 times width, distally rounded; endite with 2 coupling hooks on mesial margin, 3 rows of subdistal setae, middle row consisting of 6 broad fringed setae; palp with basal article about half length of article 2, latter wider than endite, mesial margin convex, article 3 distally tapering, articles 4 and 5 slender, subequal in length. Pereopod 1 with basis and ischium broad; merus anterodistally somewhat produced; carpus about three-fourths length of propodus; latter slender, about 7 times longer than wide; dactylus bearing 2 slender curved ungui. Pereopods 2-7 similar, increasing slightly in length posteriorly, dactyli bearing 3 curved ungui. Pleopod 2 operculum having about 22 short marginal lateral setae on each half (excluding pair of poste-

rior submedian setae); with centrally located, relatively small, ovoid, denser area. Pleopod 3 endopod of 2 articles, basal article rectangular, distal article shorter and narrower, roughly ovate; exopod of 2 articles articulating obliquely, distal article broadly rounded, with circular proximomesial area. Pleopods 4 and 5 uniramous, with broad basal article and shorter and narrower distal article, pleopod 5 slightly shorter than 5.

ETYMOLOGY: The specific epithet is derived from the type locality, Aigamas Cave.

***Namibianira dracohalitus* sp. nov.**

Figures 3, 4

MATERIAL: Holotype SMN 51605, ♀ tl 5.0 mm, Paratypes, SMN 51260, 3 ♀ tl 5.0 mm, Dragon's Breath Cave, 32 - 38 m, Grootfontein District, coll. P. Church, 22 Jul 1987.

DESCRIPTION: Body about 3 times longer than wide, widest at pereonites 6 and 7. Integument with scattered setae, especially along lateral margins of pereonites and pleon. Cephalon one-fourth wider than mid-length, anterior margin with very faint rostral convexity. Pereonites 1-4 with anterolateral rounded margin becoming wider posteriorly. Pereonites 5-7 with posterolateral areas slightly produced posteriorly. Pereonite 7 longest. Single free pleonite short, overlapped laterally by lobes of pereonite 7. Pleotelson slightly wider than mid-length, posterior margin with 2 faint submedian convexities.

Antennular flagellum of 12-15 articles, 8 distal articles each bearing single aesthetasc. Four basal articles of antenna short, article 3 bearing scale on lateral margin; scale having 2 distal setae. Mandibular incisor having 6 or 7 cusps; lacinia mobilis with 8 teeth; spine row of 5 (on lacinia bearing mandible) or 7 fringed spines; molar thin-walled, distally tapering, with one short and 2 elongate fringed setae; palp with article 2 about three-fourths length of article 1, bearing row of 9 fringed spines, first and last of row longer, article 3 curved, with row of about 15 spines on lateral margin. Maxilla 1, lateral lobe with 13 curved pectinate spines distally; mesial lobe with 4 elongate, and several shorter setae on mesiodistal margin. Maxilla 2, 2 lateral lobes each

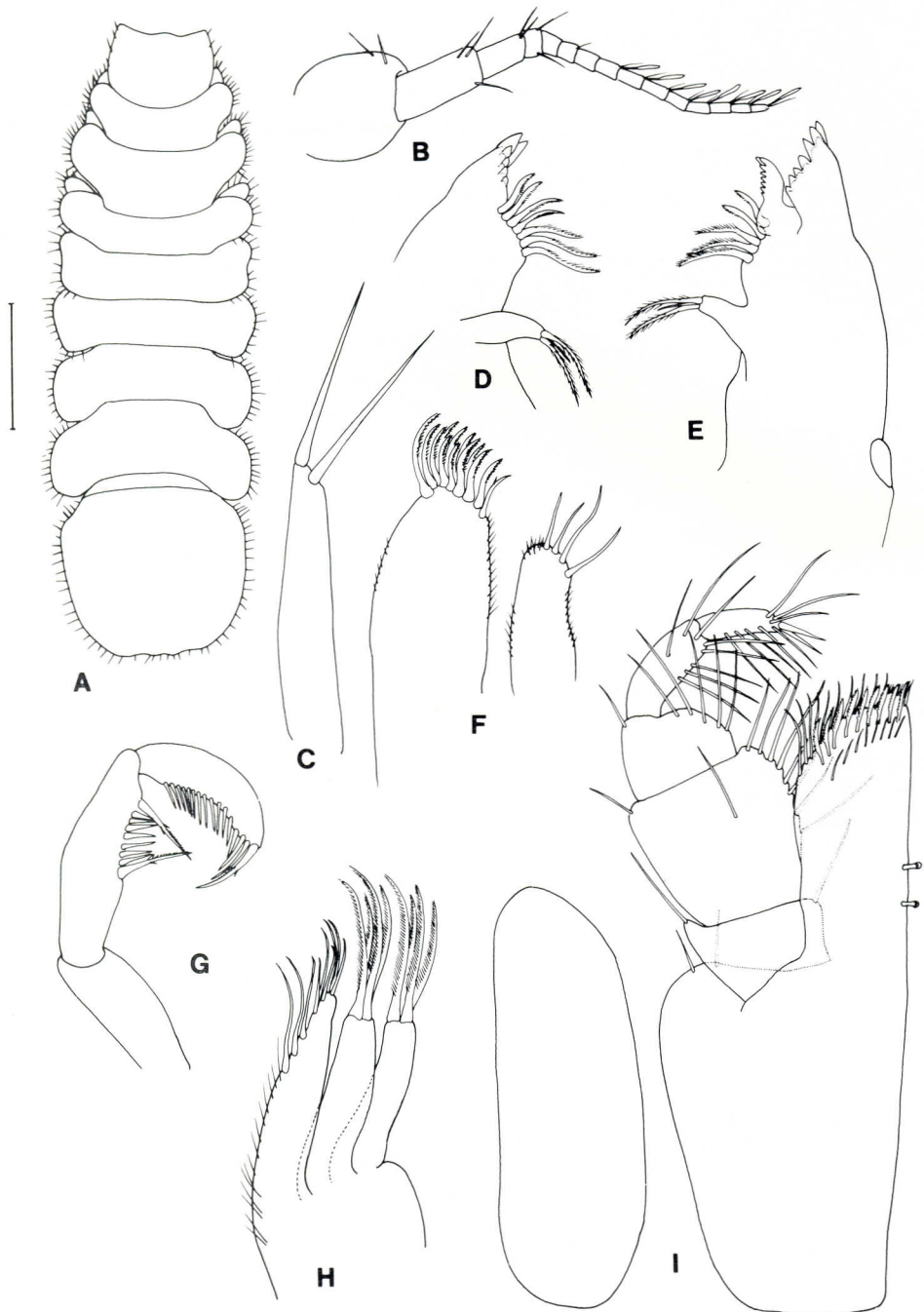


Figure 3. *Namibianira dracobalitus*. A, whole animal, antennae and uropods omitted, scale = 1.0 mm; B, antennule; C, antennal scale; D, right mandible; E, left mandible; F, maxilla 1; G, mandibular palp; H, maxilla 2; I, Maxilliped with epipod.

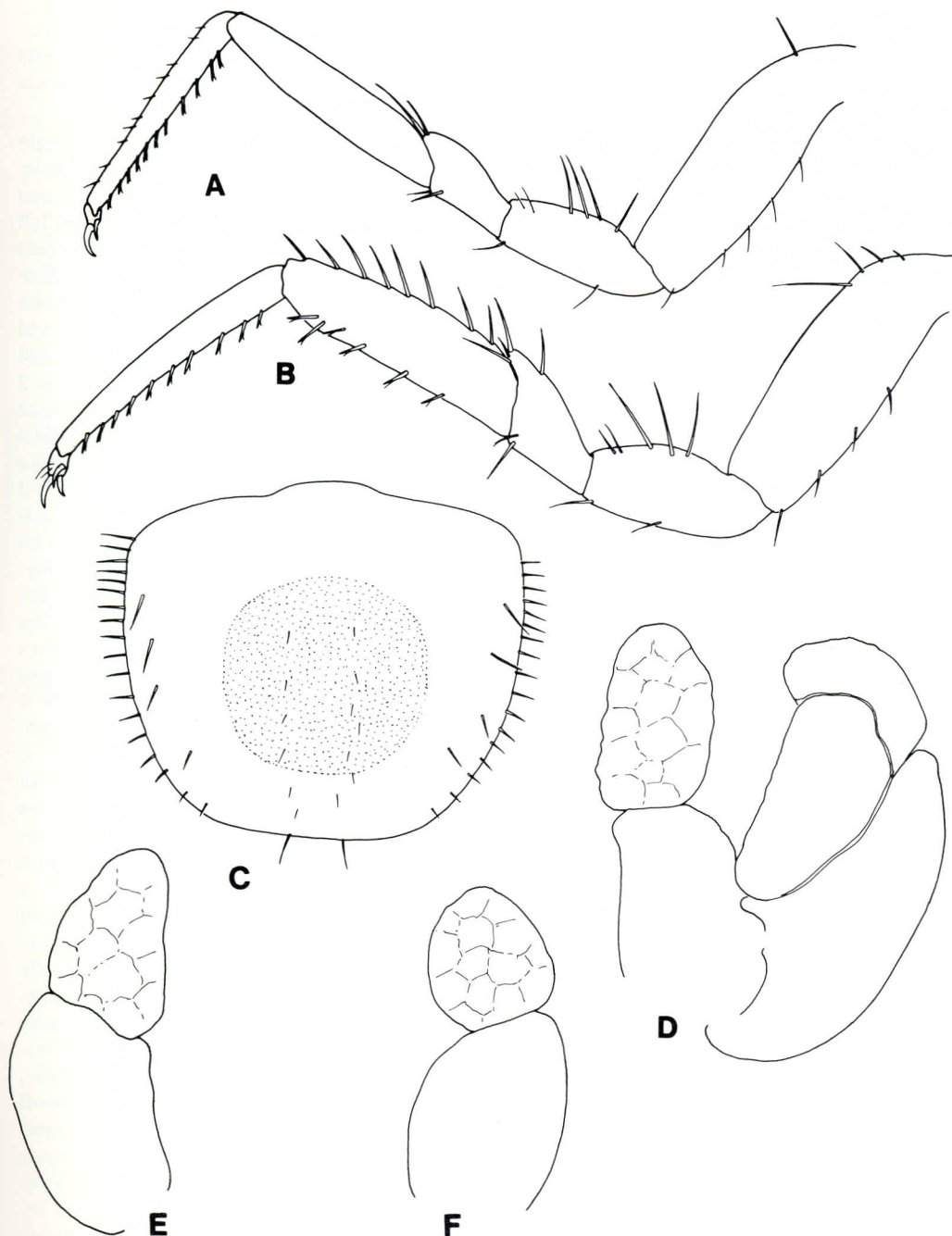


Figure 4. *Namibianira dracopalitus*. A, pereopod 1; B, pereopod 7; C, ♀ pleopod 2 operculum; D, pleopod 3; E, pleopod 4; F, pleopod 5.



bearing 4 elongate fringed setae; mesial lobe with 9 setae on mesiodistal margin. Maxillipedal epipod 3 times longer than wider, distally rounded; endite with 2 coupling hooks on mesial margin, distal margin with 2 subdistal rows of simple setae, between which, row of 9 broad feather-setae; palp article 1 less than half length of article 2, somewhat laterodistally produced, article 2 broadest and longest, mesial margin setose, article 3 about half length of article 2, tapering distally, articles 4 and 5 slender, setose. Pereopod 1, basis subequal in length to carpus and merus together; propodus subequal in length and about half width of carpus; dactylus bearing 2 curved ungui. Pereopods 2-7 similar, becoming more elongate posteriorly, dactyli bearing 3 curved ungui. Pleopod 2 operculum slightly wider than mid-length, bearing about 18 short marginal setae in each half; with roughly circular centrally located and relatively large, denser area. Pleopod 3, endopod of 2 articles, basal article broader and longer than distal article; exopod of 2 obliquely articulating articles. Pleopods 4 and 5 uniramous, each of 2 articles, distal article smaller than basal, pleopod 5 shorter than 4.

ETYMOLOGY: The specific epithet is derived from the type locality, and is a combination of the Latin 'draco', a dragon, and 'halitus', breath.

***Namibianira arnbemensis* sp. nov.**

Figures. 5, 6

MATERIAL: Holotype, SMN 51604, ♂ tl 2.0 mm, Paratypes, SMN 51263, 1 ♂ tl 1.8 mm, 11 ♀ tl 1.6 - 2.9 mm, Paratypes, USNM 243571, 1 ♂ tl 2.0 mm, 5 ♀ tl 2.0 - 2.6 mm, Arnhem Cave, Windhoek District, 103 m, coll. J. Irish & E. Marais, 14 Aug 1987.

DESCRIPTION: Body about 4.8 times longer than greatest width, widest at pereonite 5; with sparsely scattered setae on cephalon, pereon, and pleon. Cephalon about one-fourth wider than mid-length; anterior margin with very low rostral convexity. Pereonites 1-3 increasing in length posteriorly, anterolateral area broadly rounded; pereonites 4 and 5 subequal in length; pereonites 6 and 7 longer than preceding pereonites. Posterolateral rounded lobes of

pereonites 5-7 somewhat produced. Pleon consisting of single short free pleonite plus pleotelson; latter slightly longer than greatest width, posterior margin broadly convex.

Antennular flagellum of 5 articles, single aesthetasc on terminal and subterminal article. Antennal scale on article 3 bearing 2 terminal setae. Mandibular incisor having 6-7 cusps; left mandible having lacinia mobilis with 6 teeth plus spine row of 4 fringed spines; right mandible having spine row of 5 or 6 fringed spines; molar process thin-walled, tapering, with 2 short and 2 elongate setae distally; palp article 2 with distal row of 4 fringed spines, 2 outer larger than 2 inner spines; article 3 with row of 10-12 spines increasing in length distally. Maxilla 1, mesial lobe with 5 mesiodistal setae plus several finer setules; lateral lobe with 13 distal curved pectinate spines. Maxilla 2, 2 lateral lobes each with 4 elongate fringed setae; mesial lobe with several elongate simple setae mesiodistally. Maxillipedal epipod elongate-ovate, about 2.5 times longer than wide, distally rounded; endite with 2 coupling hooks on mesial margin, 3 rows of subdistal setae, middle row of 6 broad fringed setae; palp with articles 1-3 broad, article 2 widest and longest, articles 4 and 5 slender, setose, article 5 about half length of article 4. Pereopod 1, carpus with posterodistal row of fringed scales; propodus with 4 sensory spines on posterior margin; dactylus biunguiculate. Pereopods 2-7 similar, becoming more elongate posteriorly, dactyli triunguiculate. Paired penes on posterior margin of pereonite 7 sternite about half length of rami of pleopod 1 in male. Pleopod 1 consisting of 2 broadly ovate, basally fused rami, each ramus bearing 2 distal setae. Pleopod 2 in male with protopod distally broadly rounded; exopod lobe-like, of 2 articles; endopod basally broad, tapering to short stylet, latter not reaching apex of protopod. Pleopod 2 of female opercular, 1.2 times wider than mid-length, bearing 8 lateral marginal setae on each side, distal margin with slight median concavity; with relatively small, circular, centrally located, denser area. Pleopod 3 biramous, endopod of 2 subequal articles, exopod with broad distal article set obliquely on proximal, with discrete rounded area proximomesially.



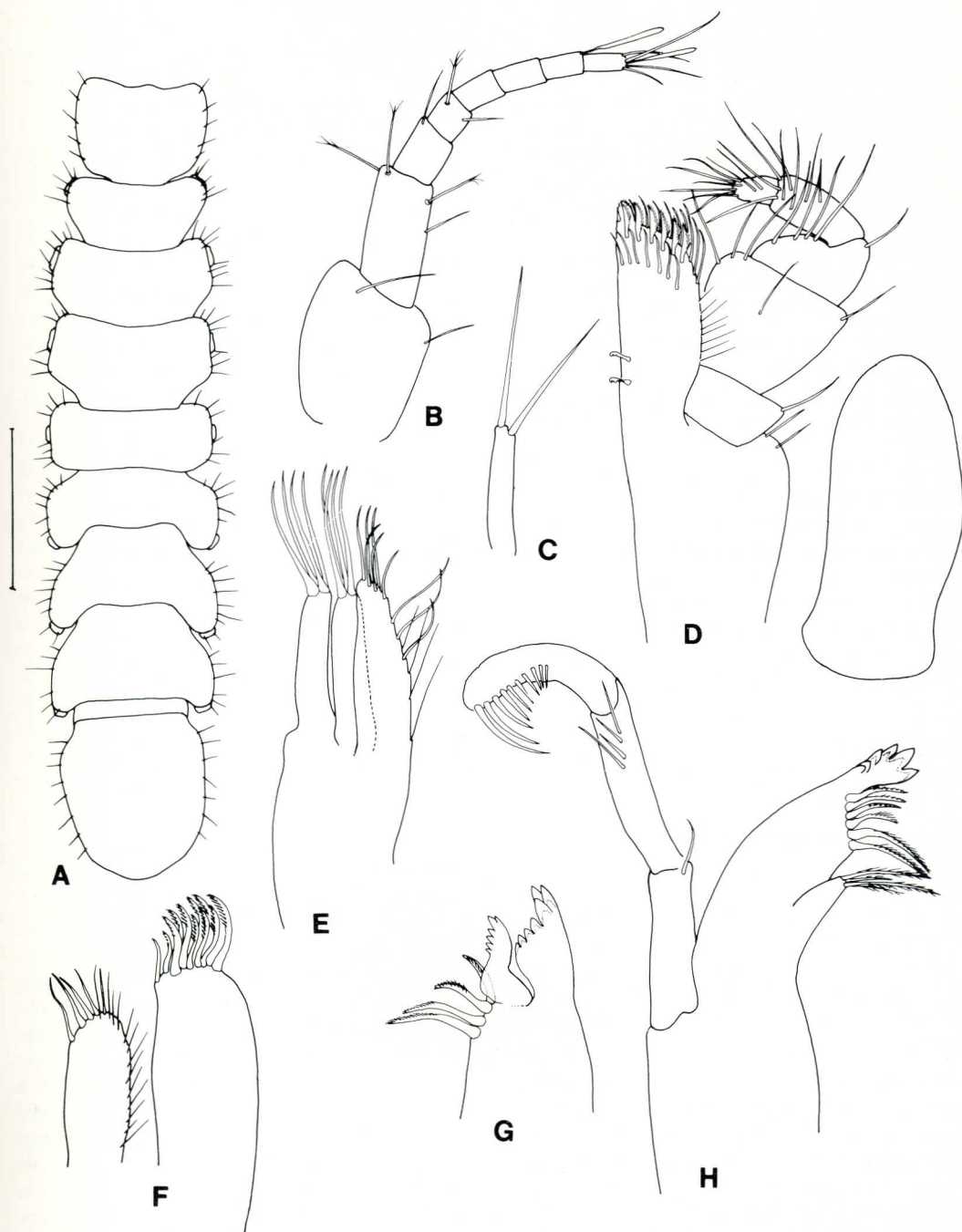


Figure 5. *Namibianira arnbemensis*. A, whole animal, antennae and uropods omitted, scale = 0.5 mm; B, antennule; C, antennal scale; D, maxilliped and epipod; E, maxilla 2; F, maxilla 1; G, right mandible; H, left mandible.

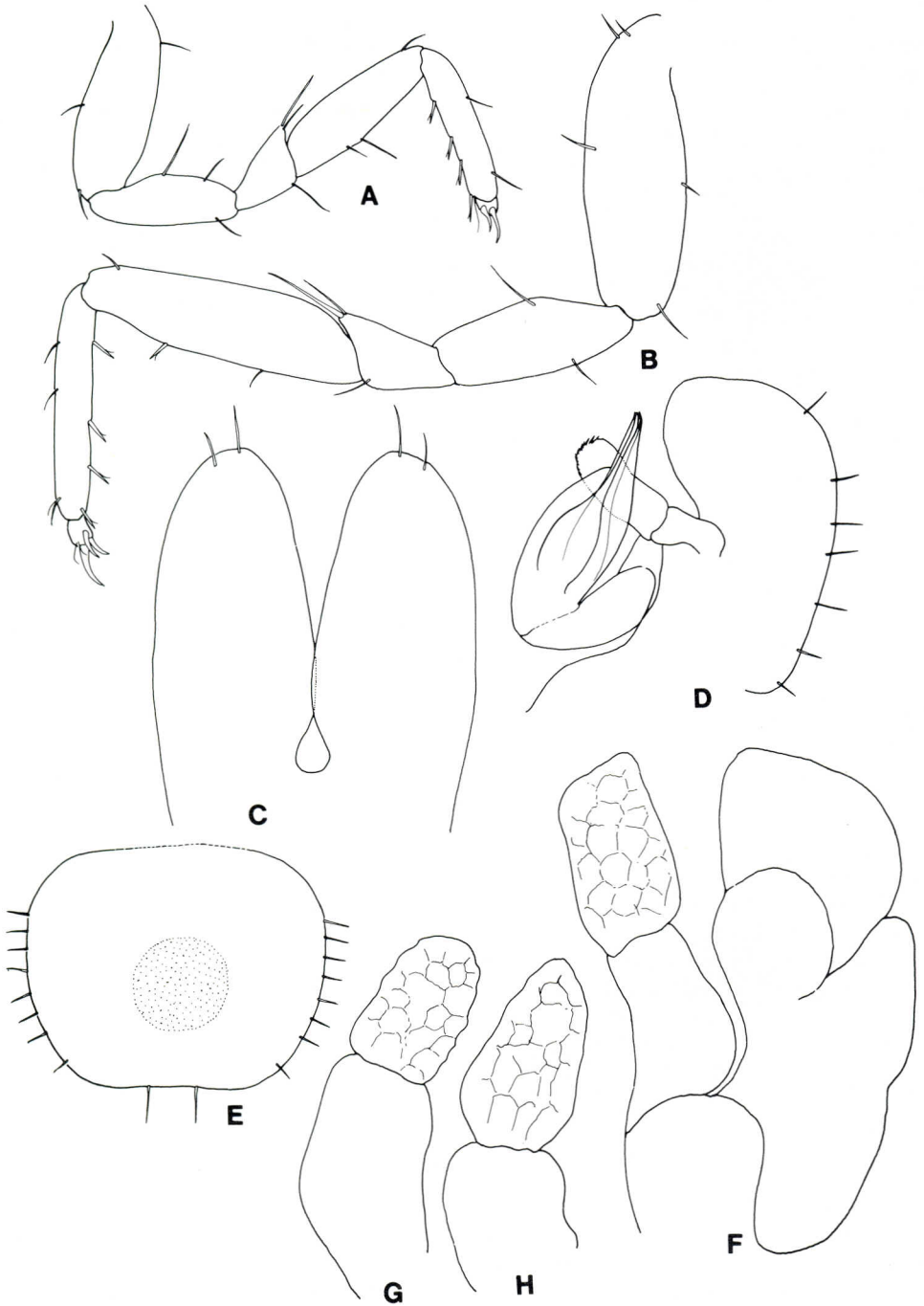


Figure 6. *Namibianira arnbemensis*. A, pereopod 1; B, pereopod 7; C, ♂ pleopod 1; D, ♂ pleopod 2; E, ♀ pleopod 2 operculum; F, pleopod 3; G, pleopod 4; H, pleopod 5.

Pleopods 4 and 5 uniramous, former slightly longer than latter.

ETYMOLOGY: The specific epithet is derived from the type locality, Arnhem Cave.

***Namibianira aikabensis* sp. nov.**

Figures 7, 8

MATERIAL: Holotype, SMN 51615, ♂ tl 4.4 mm, Paratypes, SMN 51615, 2 ♂ tl 3.9, 4.6 mm, 1 ovigerous ♀ damaged, 4 ♀ tl 4.2-4.9 mm, Paratypes, USNM 243592, 1 ♂ 4.1 mm, 1 ♀ tl 4.2 mm, Aikab Hemicenote, Etosha National Park, 30 m, coll. A. Maartens, 26 Aug 1992.

DESCRIPTION: Body about 3.4 times longer than greatest width, widest at pereonite 5; with sparsely scattered setae on cephalon, pereon, and pleon. Cephalon about one-fourth wider than mid-length; anterior margin with moderately produced rostral convexity. Pereonites 1-3 increasing in length posteriorly, anterolateral area rounded; pereonites 4 and 5 subequal in length; pereonites 6 and 7 longer than preceding pereonites. Posterolateral rounded lobes of pereonites 6 and 7 somewhat produced. Pleon consisting of single short free pleonite plus pleotelson; latter very slightly longer than greatest width, posterior margin broadly convex.

Antennular flagellum of 22-24 articles in male, fewer in female. Antennal scale on article 3 bearing 2 terminal setae. Mandibular incisor having 5-6 cusps; lacinia mobilis with 8 sclerotized cusps; spine row of 5 fringed spines; molar process thin-walled, tapering, with 1 short and 2 elongate setae distally; palp article 2 with distal row of 8 fringed spines, 2 outer larger than 6 inner spines; article 3 with row of 15 spines increasing in length distally. Maxilla 1, mesial lobe with 4 stout distal setae plus several finer setules; lateral lobe with 13 distal curved pectinate spines. Maxilla 2, 2 lateral lobes each with 4 elongate fringed setae; mesial lobe with several elongate simple setae mesiodistally. Maxillipedal epipod elongate-ovate, about 3 times longer than wide, distally rounded; endite with 2 coupling hooks on mesial margin, 3 rows of subdistal setae, middle row of 8 broad fringed setae; palp with articles 1-3 broad, article 2 widest and long-

est, articles 4 and 5 more slender, setose, article 5 slightly shorter than article 4. Pereopod 1, basis with row of 4 setae on posterior margin, several scattered setae on anterior surface; ischium with several elongate setae on anterior margin; merus short, with strong sensory seta anterodistally; carpus with several setae on posterior margin, row of 6 setae on anterior margin; propodus with 12 sensory spines on posterior margin, several setae on anterior margin; dactylus biunguiculate. Pereopods 2-7 similar, becoming more elongate posteriorly, dactyli triunguiculate; basis with about 6 setae on posterior margin; merus with 2 setae on anterior margin; carpus with 2 sensory spines on posterior margin; propodus with 4 sensory spines on posterior margin. Paired penes on posterior margin of pereonite 7 sternite one-third length of rami of pleopod 1 in male. Pleopod 1 consisting of 2 broadly ovate, basally fused rami, each ramus bearing 3 distal marginal setae. Pleopod 2 in male with protopod distally expanded, subcircular; exopod lobe-like, of 2 articles; endopod basally broad, tapering to short stylet, latter not reaching apex of protopod. Pleopod 2 of female opercular, about 1.2 times wider than mid-length, bearing 26-29 lateral marginal setae on each side, distal margin straight, with denser circular, centrally located area. Pleopod 3 biramous, endopod with distal article shorter and narrower than proximal; exopod with broad distal article set obliquely on proximal, with discrete rounded area proximomesially. Pleopods 4 and 5 uniramous, each consisting of broad basal article and shorter subcircular distal article; 4 slightly longer than 5.

ETYMOLOGY: The specific epithet is derived from the type locality, Aikab Hemicenote in Etosha National Park.

**DISCUSSION**

Several fairly subtle characters can be used to distinguish these four species, including size, number of articles in the antennular flagellum, the proportions of the pleotelson, number of margin setae and relative size of the circular central denser area on the opercular pleopod 2 of the female, and number of spines on articles



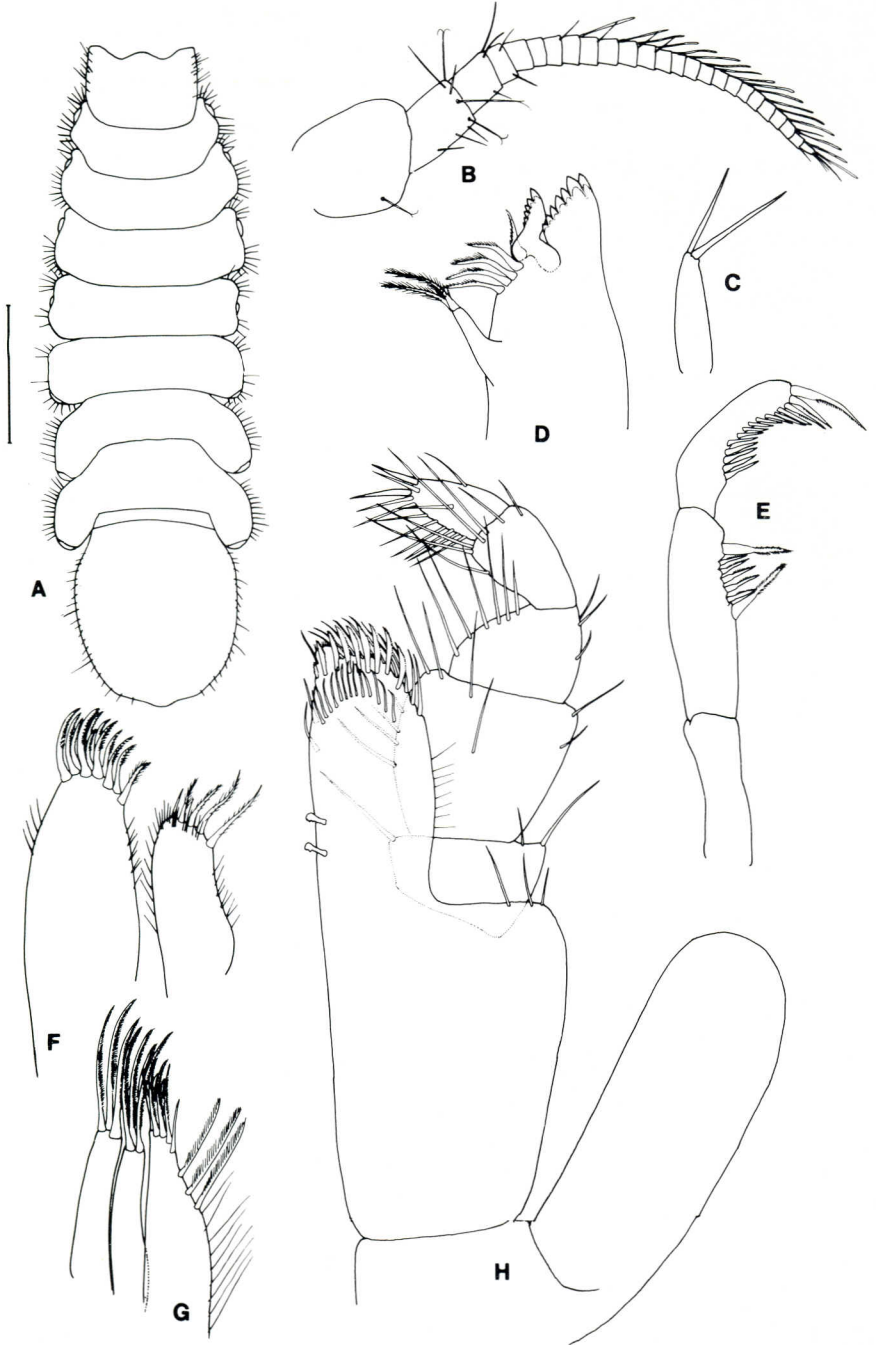


Figure 7. *Namibianira aikabensis*. A, whole animal, antennae and uropods omitted, scale = 1 mm. B, antennule. C, antennal scale. D, mandible. E, mandibular palp. F, maxilla 1. G, maxilla 2. H, maxilliped and epipod.

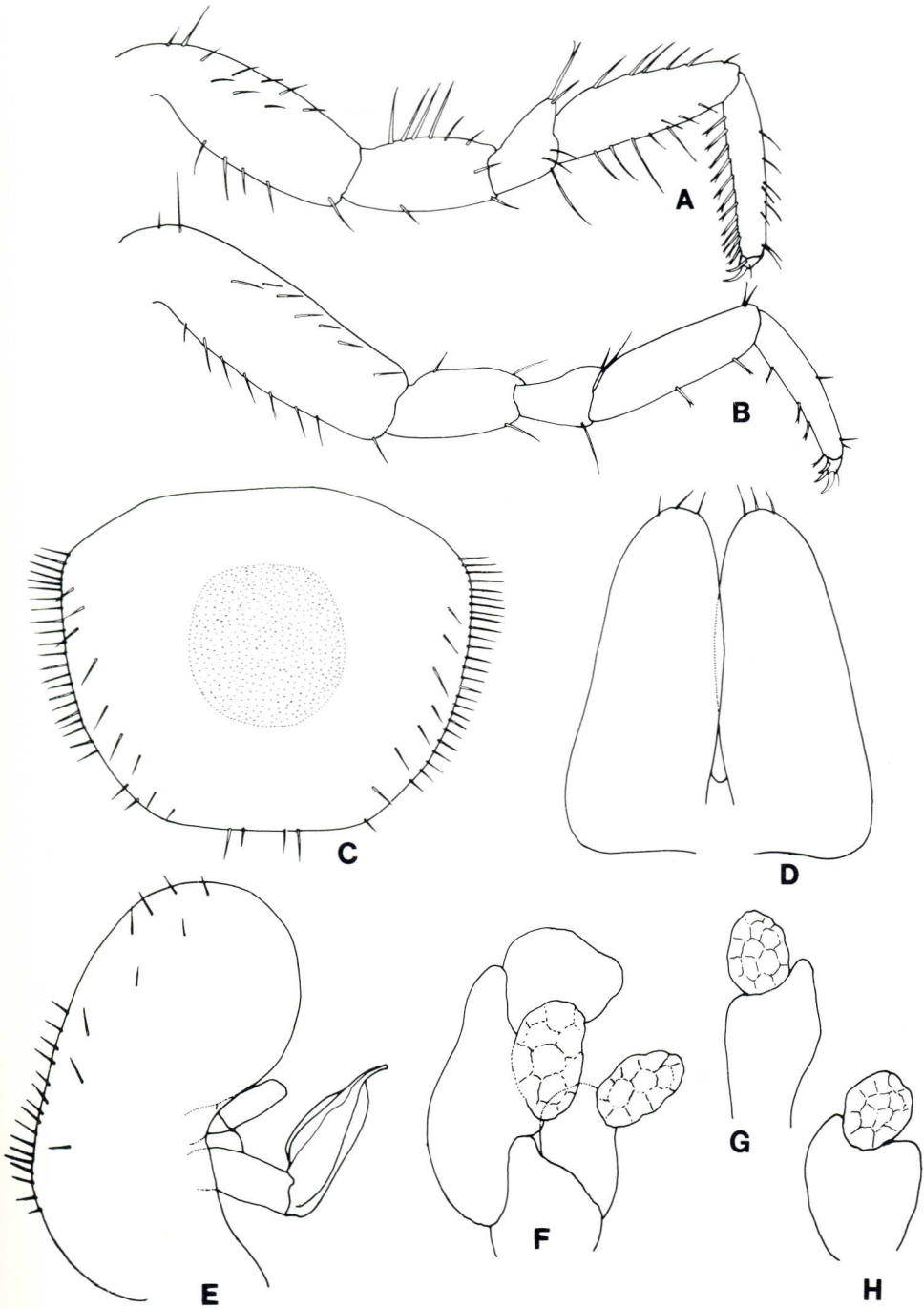


Figure 8. *Namibianira aikabensis*. A, pereopod 1. B, pereopod 7. C, ♀ pleopod 2 operculum. D, ♂ pleopod 1. E, ♂ pleopod 2. F, pleopod 3. G, pleopod 4. H, pleopod 5.

2 and 3 of the mandibular palp (see Table 2). In addition, differences can also be seen in the degree to which the posterolateral lobes of pereonites 5-7 are produced, the greatest seen in *N. aigamasensis*, the least in *N. dracobalitus*. The antennal scale on article 3 also shows a difference in the siting of the 2 distal setae: in *N. aigamasensis*, the setae are widely separated, in *N. dracobalitus*, *N. aikabensis* and *N. arnbemensis* they are basally contiguous at the apex of the scale. From these differences it seems clear that four separate species are involved here, with *N. arnbemensis* being most easily distinguished primarily by its smaller size. *N. aigamasensis*, *N. aikabensis*, and *N. dracobalitus* are superficially more similar but even here the differences listed make separation fairly easy. *N. arnbemensis* is geographically separated from the other three by about 300 kilometres, which may account for its greater distinctness, assuming that all four species arose from a common ancestor. Given that *N. aigamasensis*, *N. aikabensis*, and *N. dracobalitus*, from localities about 100-150 km apart, show divergence in a number of

characters, it must be assumed that there is no present connection between these populations. The distribution of the eight protojanirid species from southern Africa, along with *Protojaniroides lucei* (Enckell, 1970) from Sri Lanka, certainly indicate a Gondwanan origin for the group (Wagele 1990). How the evolution and radiation of the group occurred is a subject for speculation. A simplistic interpretation suggests that a *Protojanira*-like ancestor evolved in a southern Gondwanan region (presumably in a non-marine habitat), and that with radiation northwards the stout mandibular molar became reduced. The north-west population in the limestone region of Namibia (where isolation in separate cave systems brought about by a major decrease in rainfall, led to speciation) was cut off from the north-east group that entered the Natal/Transvaal/Sri Lanka region, the latter group developing a strongly subchelate pereopod 1. At which point the cave habitat was invaded and eyes and pigment were lost cannot yet be answered. Investigation of cave areas in Madagascar, India, and Australia might yield material relevant to this evolutionary story.

**Table 2.** Summary of some differences among four Namibian species of Namibianira.

	<i>aigamasensis</i>	<i>dracobalitus</i>	<i>arnbemensis</i>	<i>aikabensis</i>
Total length (mm)	3.0-3.6 ♀	5.0 ♀	1.8-2.0 ♂ 2.1-2.9 ♀	3.9-4.6 ♂ 4.2-4.9 ♀
Antennular articles	7-12	12-15	8	22-24
Mandibular palp spines				
article 2	5	9	4	8
article 3	9-10	15	10-12	15
Pleotelson	0.94	0.91	1.14-1.18	1.15
length/width				
♀ Opercular	20-22	18	8	26-29
setae/side				



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I thank Ms. Barbara Curtis of the State Museum of Namibia for making the present material available for study, and, along with Dr. John Irish and Mr. Eugene Marais, for providing additional collection and locality data.

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