Description of a new gnathiid, *Afrignathia multicavea* gen. et sp. n. (Crustacea: Isopoda: Gnathiidae), from South Africa

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A new genus and species of gnathiid isopod, *Afrignathia multicavea* gen. et sp. n., is described from material collected during the 1960s and 1970s in False Bay, offshore between Still Bay and Mossel Bay, and off Cape Point. This gnathiid does not conform to any other known species, having morphological characteristics not seen in the other 11 recognized genera. Features making the genus unique include a pylopod consisting of only one article, a mandible with two rows of unequal teeth on the blade and apex, and cephalosome appendages that could be maxillae 1 (maxillules), which are usually absent in all known male gnathiids. This species is also characterized by clusters of sensory pits scattered over the cephalosome and pereon.

Key words: Gnathiidae, *Afrignathia,* description, morphology, taxonomy.

INTRODUCTION

Gnathiid isopods are temporary ectoparasitic crustaceans having free-living adults and parasitic larvae which feed on blood and tissue fluids of teleost and elasmobranch fishes (Smit & Davies 2004). The classification of these crustaceans was originally compiled by Monod (1926) and the descriptions of gnathiids are based on the unique morphology of the free-living male. The taxonomy of the Gnathiidae was reviewed by Cohen & Poore (1994), using 72 morphological characters for their phylogenetic analysis. Cohen & Poore's (1994) revised classification recognized the eight genera of Monod (1926): *Bathygnathia* Dollfus, 1901; *Bythognathia* Camp, 1988; *Caecognathia* Dollfus, 1901; *Elaphognathia* Monod, 1926; *Euneognathia* Stebbing, 1893; *Gnathia* Leach, 1814; *Paragnathia* Omer-Cooper, 1916; *Thaumastognathia* Monod, 1926; and added two new genera, namely *Gibbagnathia* Cohen & Poore, 1994 and *Monodgnathia* Cohen & Poore, 1994. Recently, Tanaka (2005) described another genus, *Tenerognathia* Tanaka, 2005, increasing the number of known genera to 11.

In South Africa, there are only six known species of gnathiids, five of which are from the genus *Gnathia* and one from *Caecognathia*. The *Gnathia* species include *Gnathia africana* Barnard, 1914, *G. disjuncta* Barnard, 1920, *G. nkulu* Smit & Van As, 2000, *G. pantherina* Smit & Basson, 2002, and *G. spongicola* Barnard, 1920 (see Smit & Van As 2000; Smit & Basson 2002). *Gnathia africana* and *G. pantherina* larvae are the only species with known hosts and these include, respectively, intertidal fishes such as *Clinus superciliosus, C. cottoides,* and *Chorisochismus dentex* for *G. africana,* and elasmobranchs such as *Poroderma pantherinum, Haploblepharus edwardsii* and *Torpedo fuscomaculata* for *G. pantherina* (Smit & Davies 1999; Smit *et al.* 1999; Smit & Basson 2002; Smit *et al.* 2003; Hayes *et al.* 2007). *Caecognathia cryptopais* (Barnard, 1925) is the only *Caecognathia* species from South Africa and has been found from Saldanha Bay on the west coast to Still Bay on the south coast (Smit *et al.* 2000). Fish hosts are unknown for *C. cryptopais,* as well as for *G. disjuncta, G. nkulu,* and *G. spongicola,* as in all these species only the free-living adults were collected during dredge sampling.

As part of a taxonomic study of gnathiids from the invertebrate collection of the South African Museum, Cape Town, a species that does not conform to the description of others known in South Africa, or elsewhere, was found. This gnathiid species also has unique morphological characteristics not present in any of the other 11 genera and will thus be described below as a new species and genus.

MATERIALS & METHODS

Sampling was done between 1961 and 1972 in False Bay, offshore between Still Bay and Mossel Bay, as well as off Cape Point. Gnathiids were collected by means of grab and dredge sampling at a depth of 26–73 m, and were preserved in 70% ethanol. Special care was taken when cleaning the samples due to the fragile state of the aged

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specimens (see Smit & Van As 2000). Light and scanning electron microscopes were used for the identification and description of the species.

Male gnathiids used in scanning electron microscopy were rehydrated in a descending sequence of ethanol and washed in distilled water to clean them of any salt and debris, dehydrated to absolute ethanol, using previously described techniques (Smit & Van As 2000), and critical-point dried in a BIORAD CPD 750. Specimens were mounted on aluminium stubs, gold-coated and studied using a JEOL WINSEM JSM 5600 at 15 kV. The morphological terminology and numbering of pereonites and pereopods follow Cohen & Poore (1994).

DESCRIPTION

Afrignathia gen. n.

Diagnosis. Eyes large. Cephalosome with dorsal sulcus present, paraocular ornamentation and posterior median tubercle absent. Frontal border slightly produced with processes present. Mandibles short with two rows of teeth on interior margin of blade and apex. Incisors, armed carina, internal lobe and pseudoblade absent. Single-articulated operculated pylopod. Long, slender maxillae 1 (maxillules) present, attached to mid-buccal cavity ridge, extending anteriorly on inside of buccal cavity ridge. Pereonite 7 not visible dorsally.

Type species. Afrignathia multicavea sp. n. designated here.

Etymology. The generic name is derived from Africa, referring to the location of discovery of the male and is used in combination with the generic name *Gnathia*. The gender is feminine.

Remarks. Afrignathia is currently a monotypic genus from the coast of South Africa with the only known species being *Afrignathia multicavea* sp. n. It is distinguished from other genera in the family Gnathiidae by its single-articled pylopod, presence of maxillae 1 (maxillules) and two rows of teeth on the interior margin of the mandibular apex and blade. It is closely related to the genus *Gnathia* and shares the presence of a produced frontal border and frontal processes, but differs in the number of pylopod articles and in the presence of maxillae 1.

Type material. Holotype: in the collection of the South African Museum, Cape Town (1 male, SAM A 43162).

Type locality. Off Port Alfred (33°39.3′S, 27°11.6′E)

Other localities. False Bay (34°12.5′S, 18°37′E), offshore between Still Bay and Mossel Bay (34°28′S, 21°50′E) and off Cape Point (34°58′S, 18°21′E).

Type host of parasitic larvae. Unknown

Other material. In the South African Museum collection in Cape Town (5 males: FAL 479 E; FAL 423 C; FAL 517 A; SCD 350 J; SST 314 V)

Etymology. The species name is derived from the Latin words, *multi,* meaning many, and *cavea,* meaning pit, in reference to the large number of sensory pits present on this specimen.

Afrignathia multicavea sp. n., Figs 1–20

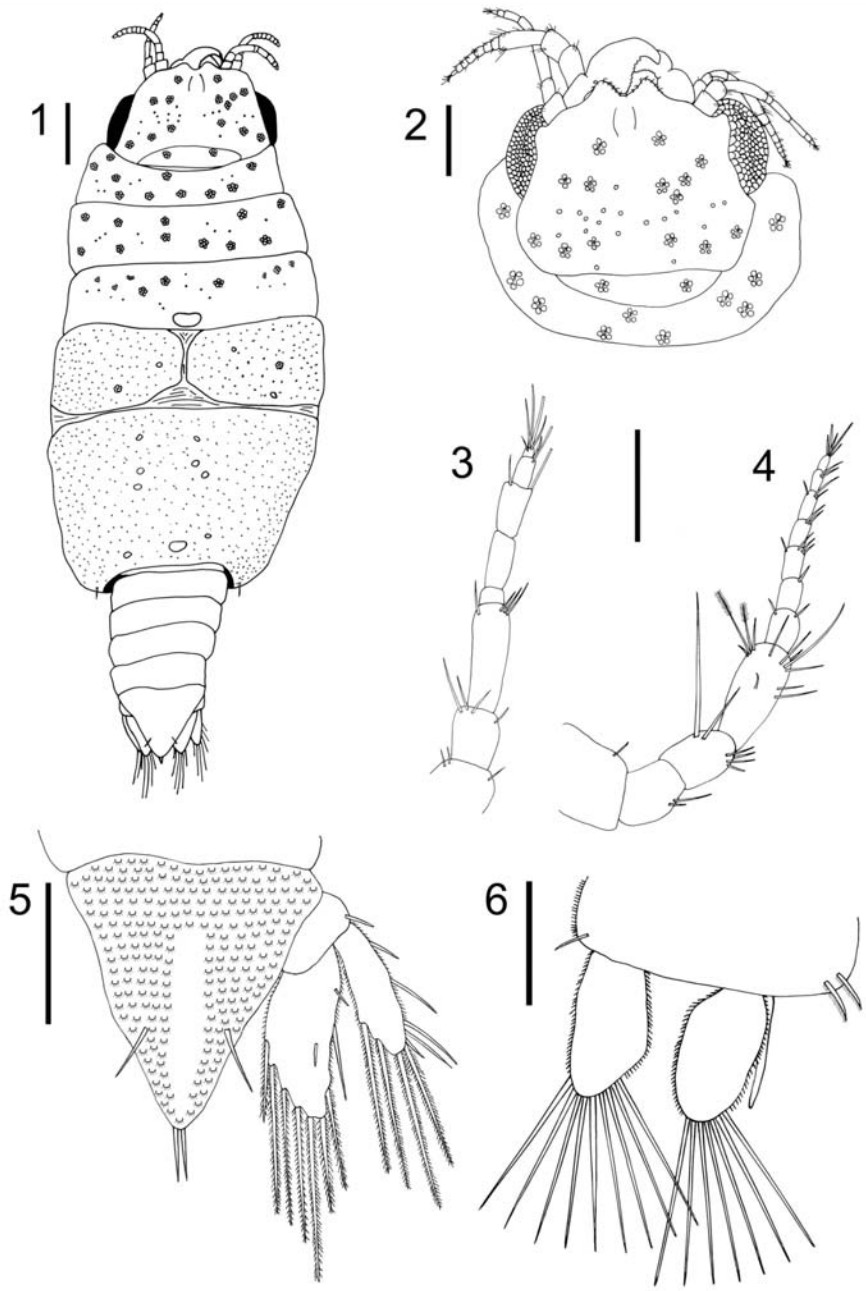
Adult male

Description. Total length of the holotype: 1.9 mm. Total length of other material: 1.5–2 mm (1.78 ± 0.23 mm, $n = 5$)

Cephalosome. Trapezium-shaped, 1.4 times broader than long, narrow and shallow dorsal sulcus, extending less than half length of cephalosome (Figs 1 & 2), lateral margins slightly convex, posterior margin slightly concave. Dorsal surface with 14–16 clusters of sensory pits, each group comprising 4–5 such pits with a short, simple sensory seta in the centre of some clusters (Fig. 16). Randomly distributed single sensory pits also present, no sensory pits in dorsal sulcus. No setae on ventral and lateral sides of buccal cavity. Well-developed large, oval, bulbous, sessile compound eyes on anteriolateral margins of cephalosome, length of eye almost three quarters the length of cephalosome (Fig. 2). Paraocular ornamentation and posterior median tubercle absent.

Frontal border. Slightly produced, superior frontolateral process triangular, directed anteriorly (Figs 2 & 16). Mediofrontal process inferior, anterior and ventral borders of superior frontolateral processes covered with small, oval tubercules with at least seven simple setae randomly distributed on lateral and medial margins. External scissura shallow and no lamina dentata. Supraocular lobe not pronounced (Fig. 2).

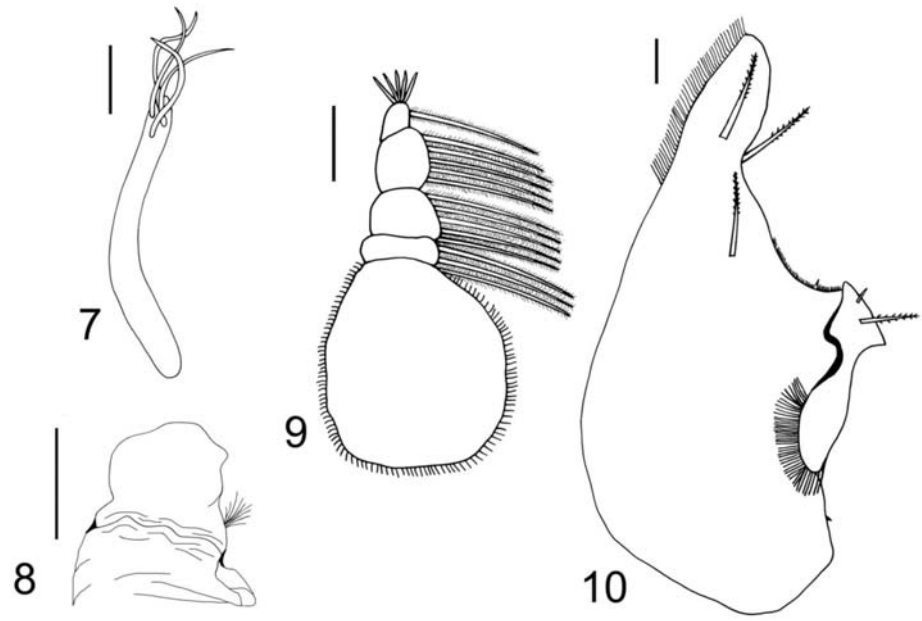
Antennae. Antenna 2 slightly longer than antenna 1. Antenna 1 has three peduncle articles which increase in length distally. Third article longer than first two articles together. Flagellum of antenna 1 with five articles. Articles 2 and 3 are the largest with article 3 and 4 each with a simple and aesthetasc seta. Article 5 terminates with four simple setae and one aesthetasc seta (Fig. 3). Antenna 2 has four peduncle articles with the longest being article 4. Article 1 with single simple



Figs 1–6. *Afrignathia multicavea*, male. **1**, Full length dorsal view; **2**, frontal border and cephalosome; **3**, first antenna; **4**, second antenna; **5**, pleotelson and uropods; **6**, right pleopod 2 with appendix masculina. Scale bars: Fig. 1 = 200 µm; Figs 2–6 = 100 µm.

seta and article 2 with two. The third article has four short and two long simple setae. Distal article of peduncle with 10 simple setae as well as two plumose setae. The flagellum is made up of seven articles which decrease in size distally. Articles 1–6 with simple setae, article 7 terminating in four simple setae (Fig. 4).

Mandible. Short and stout, less than half the length of cephalosome, blade at widest point almost as wide as long, basal neck appears as separate



Figs 7–10. Cephalosome appendages of *Afrignathia multicavea*, male. **7**, Left maxilla 1; **8**, left maxilla 2; **9**, left maxilliped; **10**, left pylopod. Scale bars = 50 µm.

article to blade, cylindrical apex of blade curved inwards. Dentate blade with at least 23 unequal teeth in two rows of 10–12 each on interior margin of blade and apex, irregular distribution of setae between teeth (Fig. 17). Incisors, armed carina, internal lobe and pseudoblade absent. Mandibular setae absent from blade but short simple setae present on posterior dorsal side of distal article (Fig. 17).

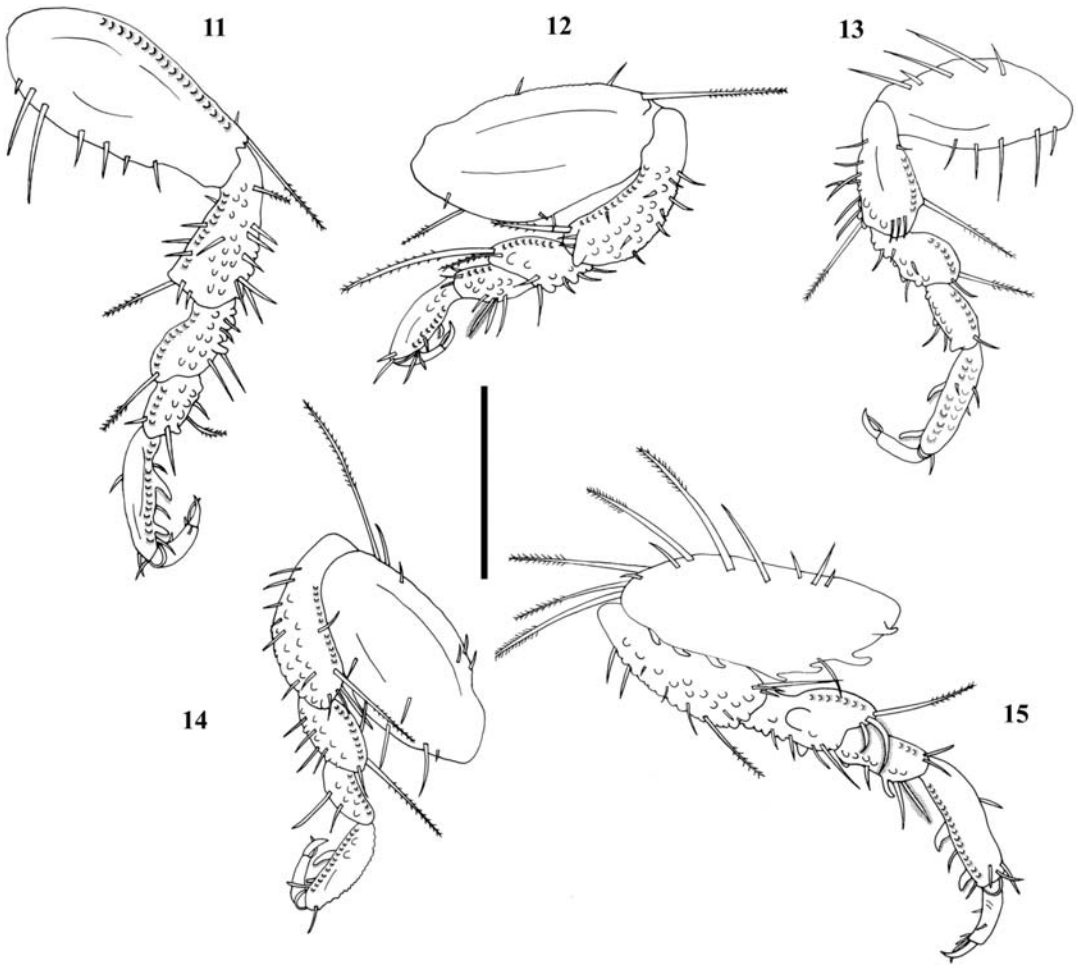
Possible maxilla 1. Consisting of a single, long, slender article terminating in four long simple robust setae (Figs 7, 18–20). Attached to mid-buccal cavity ridge, extending anteriorly on inside of buccal cavity ridge (Fig. 20).

Maxilla 2. Completely reduced form present, on lateral sides of ventral buccal opening, slightly longer than wide, with tuft of at least nine small, simple setae on lateral border (Figs 8 & 20).

Maxilliped. Five-articled appendage with proximal article largest and mediodistal endite absent (Figs 9 & 19). Complete outer margin of proximal article densely setose. Distal four articles bearing plumose setae on lateral margins in the order 3-5-5-1. Distal article with one plumose seta and five short simple setae. Mesial border with short simple setae. Palp 1.2 times as long as wide. No coupling hooks present (Fig. 9).

Pylopod. Large appendage, slightly longer than wide, consisting of a single article. Article greatly enlarged with convex mesial border, with short simple setae on proximal margin, single short and simple setae and denser row of short hair-like setae from attachment to half the length to distal tip on lateral margin and longer setose setae on the distal border (Figs 10 & 18). Row of dense, short, simple hair-like setae from mid-medial border to distal tip of pylopod. Three simple setae are also found at the distal narrowing of the article (Fig. 10).

Pereon. Approximately 1.7 times as long as wide, wider than cephalosome, no setae present (Fig. 1). Pereonite 1 fused with cephalosome, dorsally visible, not reaching lateral margins, anterior border slightly convex, posterior margin slightly concave. Size of the pereonites increase proximally, in both width and length. Pereonite 2 with a slightly convex anterior margin and concave posterior margin. Pereonite 2 and 3 with lateral margins pointing anteriorly, containing many randomly distributed deep sensory pits (Fig. 1). These pits may be singular or occur in clusters, clusters with a single seta in the centre of the pit. Pereonite 4 with fewer sensory clusters and a prominent, oval indentation near the median posterior margin. No anterior construction visible separating pereonite 3 and pereonite 4, posterior margin slightly concave. Pereonite 5 widest part of body. Pereonite 5 with areae laterales, median



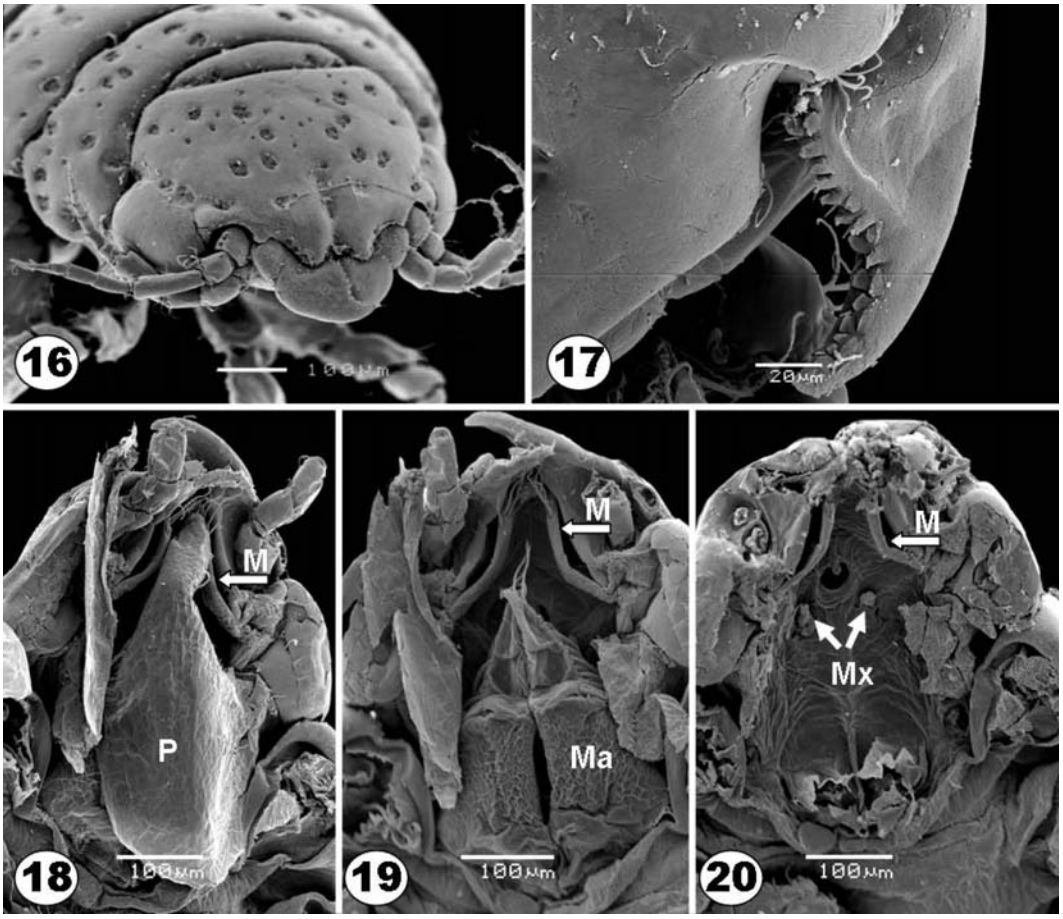
Figs 11–15. Lateral view of pereopods 2–6 of *Afrignathia multicavea*, male. **11**, Left pereopod 2; **12**, left pereopod 3; **13**, left pereopod 4; **14**, left pereopod 5; **15**, left pereopod 6. Scale bar = 200 µm.

groove present, dorsal sulcus as thin groove and many singular sensory pits. Pereonite 5 and 6 not fused. Pereonite 6 more than twice as long as other pereonites, 1.6 times as long as wide, posterior margin slightly concave, single setae on either side of pereon near posterior border, with lobi laterales and lobuii absent. Pereonite 7 not visible dorsally (Fig. 1).

Pleon. Pleon and pleotelson less than a third of total length. Five subequal pleonites, only posterior margin of first pleonite dorsally visible, epimera dorsally visible, many pectinate scales present on dorsal surface (Fig. 1).

Pleotelson. Triangular, base longer than wide, lateral margins slightly concave, dorsal surface with one pair of proximal short simple setae, many pectinate scales on dorsal surface, distal apex terminating in pair of short simple setae (Fig. 5).

Pereopods. Pereopod 2 base elongated, oval in shape with five short and four long simple setae and sparsely covered with pectinate scales on the lateral borders (Fig. 11). Ischium nearly two-thirds length of basis, 3–6 anterior setae and up to nine scattered simple setae, very distinct tooth-like tubercles cover anterior margin. Merus half the length of ischium with anterior bulbous protrusion, simple setae and pectinate scales on bulbous protrusion, posterior margin with tooth-like tubercles as well as simple setae. Carpus almost same shape as merus, but slightly smaller and without anterior bulbous protrusion, posterior margin with tooth-shaped tubercles, pectinate scales and simple setae. Propodus about twice the length of carpus, two elongated denticulated compound spines



Figs 16–20. Scanning electron micrographs of the male of *Afrignathia multicavea*. **16**, Anterodorsal view of cephalosome; **17**, dorsal view of mandible with dentate blade; **18**, ventral view of pylopod (P) and arrow pointing to maxilla 1 (M); **19**, ventral view of maxilliped (Ma) and arrow pointing to maxilla 1 (M); **20**, ventral view of maxillae 2 (Mx) on either side of the buccal opening and arrow pointing to maxilla 1 (M). Scale bars: Figs 16, 18–20 = 100 µm; Fig. 17 = 20 µm.

ending in sharp points situated on middle and distal part of posterior margin, respectively, only few short simple setae on anterior and posterior margins with pectinate scales on posterior border. Dactylus half length of propodus, terminates in sharp posterior pointing unguis, prominent spine on posterior side proximal to unguis, few simple setae on dorsal and ventral sides of spine (Fig. 11). Pereopods 3–6 similar in basic shape to pereopod 2, but differ in setation as well as distribution of tubercles. Pereopod 3 has additional pectinate scales on basis, distinct tooth-like tubercules on propodus, long denticulated spine on posterior carpus margin and one situated in middle posterior margin on propodus (Fig. 12). Pereopod 4 with distinct pectinate scales on ischium and tooth-like tubercles on propodus (Fig. 13). Pereopod 5 with distinct pectinate scales on ischium and tooth-like tubercles on propodus (Fig. 14). Pereopod 6 with large, distinct claw-shaped tubercles on basis, two strong denticulated compound spines on posterior bulbous protrusion of merus and one on proximal anterior margin of carpus (Fig. 15).

Pleopod. Endopod slightly longer than exopod. Endopod and exopod fringed distally with 7–9 long plumose setae, respectively, short simple setae on lateral and posterior margins of sympodite as well as lateral borders of endopods and exopods. Sympodite with retinaculae on medial margin, two denticulated setae on medial margin and one simple seta on lateral margin. Two short simple setae present on distal margin of exopod. All pleopods similar except pleopod 2 with appendix masculine attached to mesial junction between

endopod and sympodite, appendix masculina three quarters length of rami (Fig. 6).

Uropod. Rami not reaching apex of pleotelson, endopod longer and wider than exopod, endopod with seven plumose setae and exopod with four plumose setae and five simple setae. Uropodal basis with two simple setae on distal margin (Fig. 6).

Penis. Not very prominent, with two contiguous papillae, wider than long.

Remarks. Afrignathia multicavea differs from all known South African species specifically in the presence of maxillules and a single articled pylopod. These characteristics, together with the presence of two rows of teeth on the mandibular apex, distinguish it clearly from all other known gnathiid species world wide, and will be discussed below.

DISCUSSION

Characteristic features of *Afrignathia* include large sessile eyes which take up almost three quarters of the cephalosome. The cephalosome and pereonites 1–3 also possess clusters of four or five sensory pits with a single seta in the centre. The frontal border is slightly produced with a superior frontolateral process and an inferior mediofrontal process. All species of *Bathygnathia* and *Bythognathia* lack frontal processes, but their borders form a produced rostrum (Cohen & Poore 1994; Smit & Davies 2004). *Elaphognathia* has an excavated transverse frontal border and *Euneognathia* has a combination of frontal processes. All the species of *Caecognathia, Monodgnathia* and *Paragnathia* have produced frontal borders without processes with only *Gibbagnathia* having a slightly produced border, and *Gnathia* having a straight frontal border with processes (Smit & Davies 2004). *Thaumastognathia* has a variable frontal border and *Tenerognathia* has a narrow border with small mediofrontal processes (Tanaka 2005).

The mandibles of adult male gnathiids are pronounced and protrude anteriorly beyond the frontal border of the cephalosome. The plesiomorphic state of the mandibles, as defined by Cohen & Poore (1994), is that of a relatively straight and symmetrical mandible with a single dentate blade. Camp (1988) described the mandible of *Bythognathia* as sickle-shaped, slightly asymmetrical, with the dorsal carina produced anteriorly as a strong tooth and the ventral margin with a strong and rounded tooth projecting anteroventrally. The mandibles of both *Bathygnathia* and *Gibbagnathia* have a simple mandible lacking a distinct blade or features (Cohen & Poore 1994). Members of *Elaphognathia* also lack a mandibular blade, but may possess several specialized structures (Cohen & Poore 1994). Those of *Caecognathia* and *Monodgnathia* contain mandibles usually with a smooth mandibular blade. In addition, the mandibles of *Monodgnathia* species are also curved and occluding (Smit & Davies 2004). The mandibles of *Euneognathia* have a blade and pseudoblade present, with *Tenerognathia* having small mandibles with smooth blades (Tanaka 2005). Species belonging to *Paragnathia* and *Thaumastognathia* both have crenulated blades, with *Paragnathia* mandibles being simple and *Thaumastognathia* mandibles being curved (Smit & Davies 2004). *Gnathia* species have non-elongated mandibles with a dentate blade and a mandibular incisor present. The *Afrignathia* genus thus shares similarities with *Gnathia* in possessing dentate mandibles, but lacks a carina and mandibular setae, and has a random distribution of setae in-between the teeth, as well as two rows of unequal teeth extending along the blade and the apex, which makes it unique.

Afrignathia multicavea has an additional pair of seemingly unique cephalosome appendages attached to the mid-buccal cavity ridge, extending anteriorly on the inside of the buccal cavity ridge (Fig. 19). Since this is the first record of such appendages, it is difficult to name them with certainty. Monod (1926) considered the produced appendages found on either side of the buccal orifice to be maxillae 2. He further proposed that these maxillae 2 were present in all gnathiids. Since Monod's (1926) proposed maxillae 2 are present in *A. multicavea* (see Fig. 20), the additional pair of unique cephalosome appendages found in *A. multicave* cannot be this form of maxillae. The only cephalosome appendages of larval gnathiids not normally present in adult males are the paragnaths and the maxillae 1. The paragnaths are bilobed, U-shaped appendages which are elongated and bear an acute point distally, with no teeth. The maxillae 1, also known as the maxillules, are paired appendages with a swollen base and styliform tips, usually denticulated at the end of the internal border with no setae present. It seems more likely that *A. multicavea*'s unique cephalosome appendages originate from the larval maxillae 1 (maxillules) than from paragnaths.

In a recent review of isopods by Brandt & Poore (2003), the Gnathiidae were grouped together with the Aegidae White, 1850; Anuropidae Stebbing,

1893; Corallanidae Hansen, 1890; Cymothoidae Leach, 1814; Protognathiidae Wägele & Brandt, 1988 and Tridentellidae Bruce, 1984 into the superfamily Cymothooidea Leach, 1814. For more clarity the mouthparts of some members of these families are compared with *A. multicavea*'s unique cephalosome appendages. The maxillae 1 of *Alitropus typus,* a member of the family Aegidae was described by Ho & Tonguthai (1992) as slender tipped with one large recurved spine and four smaller straight spines. This appears similar in shape to the appendage seen in *A. multicavea*. Moreover, the mouthparts of isopods from the family Cymothoidae described by Thatcher (1997) have five recurved spines near their tips (3–4 terminal and 1–2 subterminal) in the freshwater species and four terminal spines in the marine species. The general shape and form of these marine forms are also very similar to the *A. multicavea* appendages. Based on all the above, it is concluded that this unknown cephalosome appendage appears to be a maxilla 1 (maxillule).

According to Cohen & Poore (1994) the pylopod defines the Gnathiidae and usually consists of two to six articles which are directed anteriorly and fringed by large plumose setae. Monod (1926) stated that these appendages vary in shape according to genus and subgenus, and 'are excellent systematic characters'. Since the morphology of the male pylopod differs greatly in every genus, it has become a defining characteristic to determine new taxa. In Cohen & Poore's (1994) key to the genera of Gnathiidae, the number of pylopod articles is used as the second main characteristic to distinguish between the gnathiid genera. The two options given include, either a pylopod with five or six articles and article 3 not reduced, or a pylopod with two or three articles and article 3 reduced or absent. With its single-articled pylopod, *A. multicavea* cannot be keyed into any known genus and this further supports its proposed status as belonging to an undescribed gnathiid genus.

Cohen & Poore (1994) defined the plesiomorphic state of the pylopod as a simple pereopod analogous to the 'gnathopode' of the larval *Paragnathia formica* (see Monod 1926). The pylopod of the *Bythognathia* males has retained the six articles and is like a walking leg with a well-developed terminal article, and is not operculated (Camp 1988). Male *Paragnathia* pylopods also have six articles, but the second article is reduced and the pylopod is operculated (Smit & Davies 2004). *Bathygnathia, Euneognathia,* and *Monodgnathia* all have five-articled pylopods, which are operculated, non-operculated and devoid of plumose setae, respectively (Smit & Davies 2004). The pylopods of *Gibbagnathia,* and *Thaumastognathia,* are both small, thin, elongated and contain four articles (Monod 1926; Cohen & Poore 1994). Pylopods of *Caecognathia, Elaphognathia* and *Gnathia* species have either two or three articles with article 1 enlarged (Monod 1926; Cohen & Poore 1994). Tanaka (2005) described the pylopod of the eleventh genus, *Tenerognathia,* by indicating the link with *Caecognathia, Elaphognathia* and *Gnathia,* as it has two articles, but possesses a unique shape which is narrow, elongated and curves anteriorly. This apomorphic condition has now been simplified to a single large article in the *Afrignathia* species with the operculated pylopod having only simple setae on the distal tip.

In his classic work, Monod (1926) raised the following question: 'Peut-être découvrira-t-on un jour un genre à pylopode uni-articulé, représenté alors par le seul article operculaire?' which, directly translated means, 'Will we perhaps one day discover a genus with a uni-articled pylopod, represented by a single operculated article?' Considering all the above morphological characters, it seems as if we have indeed found this new genus.

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