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New species of *Munidopsis* (Decapoda: Anomura: Galatheidae) from hydrothermal vent areas of Indian and Pacific Oceans

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Two new species of Munidopsis *from the hydrothermal vent area, Kairei Field, Central Indian Ridge in the Indian Ocean and Forecast Vent Field, Mariana Back Arc Basin in the west Pacific are described and illustrated. Their affinities to closely related species are discussed. The number of* Munidopsis *species associated to hydrothermal vents in the world oceans has increased to 16. The habitat of new species is briefly described and the pattern of abundance of vent associated* Munidopsis *is briefly discussed.*

Keywords: Anomura, Galatheidae, *Munidopsis*, hydrothermal vent areas, Kairei Field, Forecast Vent Field

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INTRODUCTION

The discovery of deep-sea chemosynthetic communities associated with thermally active spreading centres has had a major impact on ocean sciences in the latter half of the 20th century. Many such communities have been reported along active margins in the Atlantic Ocean (Van Dover, 1995; Gebruk *et al.*, 1997) and Pacific Ocean (Tunnicliffe, 1991; Hashimoto *et al.*, 1995). Hashimoto *et al.* (2001) reported the first hydrothermal vent communities in the Indian Ocean. Vent fauna consisting of shrimps *Rimicaris kairei* Watabe & Hashimoto, 2000, gastropods *Alviniconcha* sp., bythograeid crabs *Austinograea rodriguezensis* Tsuchida & Hashimoto, 2002, stalked barnacles *Neolepas* sp., deep-sea mussels *Bathymodiolus marisindicus*, Hashimoto, 2001, anemones *Marianactis* sp., and 'scaly foot gastropods' Warén, Bengtsson, Goffredi & Van Dover, 2003 were found to be endemic to such chemosynthetic ecosystems and molecular comparisons support affinities between Indian Ocean and western Pacific taxa (Van Dover *et al.*, 2001). The first expedition to the hydrothermal vent in Mariana Back Arc Basin took place in 1987, since then several cruises have been carried out (Hessler & Lonsdale, 1991). Faunal communities were dominated by provannid gastropods *Alviniconcha hessleri* Okutani & Ohta, 1988, bythograeid crabs *Austinograea williamsi* Hessler & Martin, 1989, alvinocaridid shrimps *Chorocaris vandoverae* Martin & Hessler, 1990, barnacles *Neoverruca brachylepadoformis* Newman, 1989 and galatheid crabs *Munidopsis marianica* Williams & Baba, 1989. *Munidopsis* exhibit a unique pattern of distribution and abundance in the vent fields.

The genus *Munidopsis* is represented by more than 150 species in the Indo-Pacific and around 70 in the Atlantic Ocean (Baba, 2005; Macpherson, 2007) with ten reported only from active hydrothermal vent systems (Williams, 1988; Williams & Baba, 1989; Baba & de Saint Laurent, 1992; Baba, 1995, 2005; Macpherson & Segonzac, 2005; Cubelio, *et al.*, 2007; Macpherson, 2007). Five species occur in the western Pacific: *Munidopsis starmer* Baba & de Saint Laurent, 1992; *M. sonne* Baba, 1995; *M. lauensis* Baba & de Saint Laurent, 1992; *M. marianica* Williams & Baba, 1989; and *M. myojinensis* Cubelio, Tsuchida, Hendrickx, Kado & Watanabe, 2007. *Mundidopsis alvisca* Williams 1988; *Munidopsis* sp. near *M. recta* Baba, 2005 (the material reported by Van Dover *et al.* (1985) under *M. subsquamosa* Henderson, 1885 (see Baba (2005) and Macpherson & Baba in Desbruyères *et al.*, 2006)) and *M. lentigo* Williams & Van Dover, 1983 are reported from the east Pacific (Martin & Haney, 2005). *Mundiposis acutispina* Benedict, 1902 and *M. exuta* Macpherson & Segonzac, 2005 are found along the Mid-Atlantic Ridge.

A research cruise was planned by the Japan Agency for Marine Earth-Science and Technology (JAMSTEC) in order to study hydrothermalism and related biological communities in the Indian Ocean during February 2002 using RV 'Yokosuka' and the manned submersible 'Shinkai 6500' along the northern extremity of the Central Indian Ridge, approximately 22 km north of the Rodriguez Triple Junction. A previous cruise had been visiting Forecast Vent Field, Mariana Back Arc Basin during November–December, 1996 using RV 'Yokosuka' and the manned submersible 'Shinkai 6500'. During the dives different vent organisms were collected. The present paper reports the occurrence of two new species of vent associated *Munidopsis* from Kairei Field (25° 19.17′ S 70° 02.40′E) and Forecast Vent Field (13° 23. 07′ N/145° 55.02′E), respectively (Figure 1).

MATERIALS AND METHODS

The material reported on here was collected by JAMSTEC. Measurements of specimens, given in millimetres (mm),

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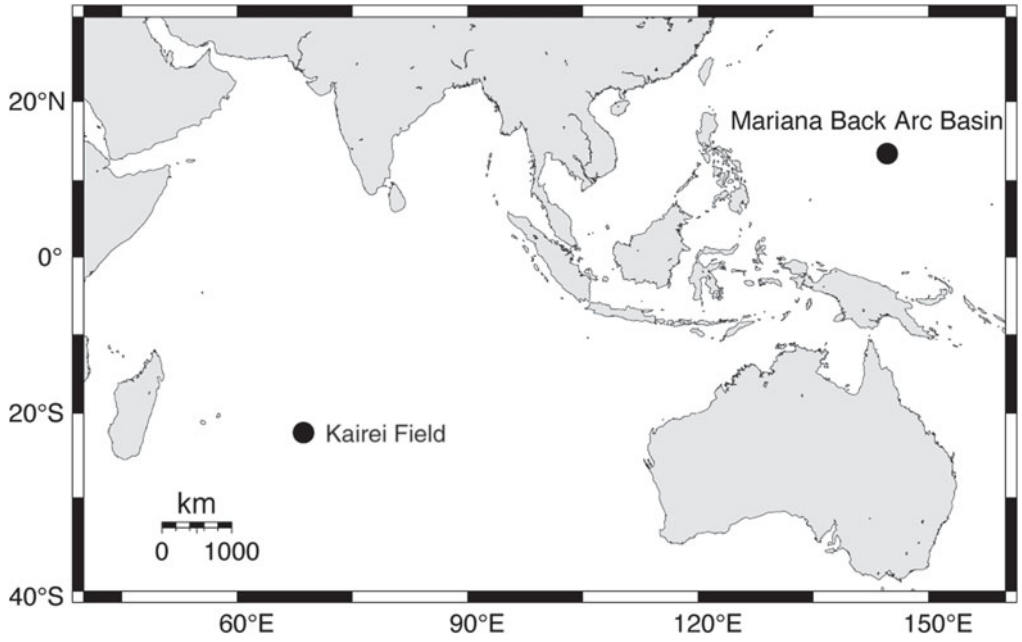

Fig. 1. Map showing the locality from where the new species were collected.

indicate the carapace length including the rostrum. Type specimens were deposited in the National Science Museum, Tokyo (NSMT) and paratypes in JAMSTEC.

SYSTEMATICS

Order DECAPODA
Superfamily GALATHEOIDAE Samouelle, 1819
Family GALATHEIDAE Samouelle, 1819
Genus *Munidopsis* Whiteaves, 1874
Munidopsis laticorpus sp. nov.
(Figure 2 A–I)

Type material

Holotype: 1F, 31.45 mm, (NSMT–Cr 16876), 'Shinkai 6500', dive 6 k # 664, Kairei Field, Indian Ocean 25°19.24′ S, 70° 2.40′ E, 2422 m, 23 February, 2002.

Paratypes: 2M, 26.70 mm, 23.61 mm, (JAMSTEC 046769, 046770), 'Shinkai 6500', dive 6k # 665, Kairei Field, Indian ocean 25°19.25′ S 70° 2.39′ E, 2435 m, 24 February, 2002.

Description

Carapace excluding rostrum 1.2 times as long as broad, moderately arched from side to side, anterior and posterior cervical groove distinct, mid-cervical groove dividing carapace almost equally into anterior and posterior halves, cardiac region strongly elevated. Rostrum 0.2–0.2 times the length of remaining carapace, triangular, strongly upturned at tip, lateral margin with fine serrations. Frontal margin strongly oblique without antennal spine and anterolateral spine. Gastric region highly dilated, with transverse rugae feebly tuberculate, two longer anterior rugae on epigastric region. Anterior branchial region with rugae, lateral margin with a distinct long and strong anterior spine, often followed by minute teeth. Posterior branchial region with interrupted rugae more pronounced than those on anterior branchial region. Posterior margin concave, preceded by highly elevated sub-marginal ridge. Pterygostomian flap with obliquely interrupted rugae, more distinct posteriorly, projecting anteriorly below antennal peduncle, anterodorsal margin minutely serrated and angular tip minutely spinous or serrated.

Abdomen unarmed; second to fourth segments, rather rounded transverse ridge about mid-length, preceded by a distinct concave trough on second segment, weaker on third and fourth segments, posterior half of each tergite with medially interrupted shallow transverse furrow; fifth and sixth segments smooth, tergite of latter without posterolateral flap. Telson composed of 12 plates, length–width ratio 0.85, posterolateral margin strongly convergent posteriorly.

Eyes moderate in size; well exposed smoothly ovate cornea cupped within broad-based ocular peduncle extended anteriorly into long and acute spine, directed laterally and accompanied by smaller mesioventral spine, peduncles immovable.

Basal segment of antennular peduncle, exclusive of spines, somewhat longer than broader, distolateral inflation bearing tubercular processes, often developed into small spine, dorsal to well developed distolateral spine; crenulated scalloped ventrodistal margin ending mesially into tubercles. Antennal peduncle having basal segment with well developed sharp and flat distomesial spine and smaller distolateral spines; second segment with moderate distolateral spine, third and fourth segments unarmed.

Third maxilliped with relatively broad endopod. Ischium nearly or barely half as long as merus when measured in midlateral line, mesial ridge with 23–24 denticles. Merus with two groups of small spines on proximal

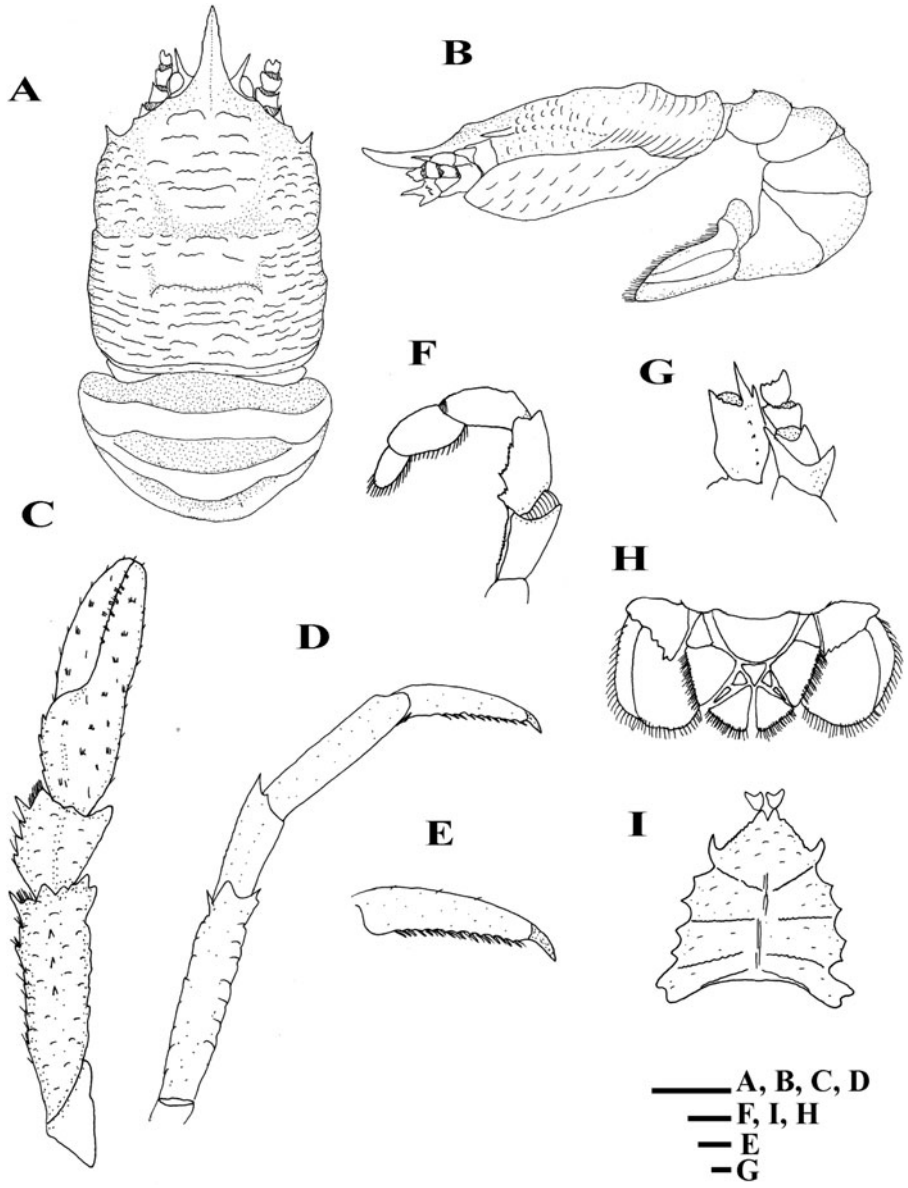

Fig. 2. *Munidopsis laticorpus* sp. nov. holotype female. (A), carapace and abdominal segment, dorsal view; (B), lateral view; (C), right P1, lateral; (D), right P2, lateral; (E), dactylus of P2, lateral; (F), endopod of right third maxilliped; (G), antennal peduncle and antennular basal article, ventral; (H), posterior part of abdomen with telson; and (I), thoracic; sternum. Scale: A, B, C, D, F, H = 5 mm, E, G = 2 mm.

half, and a small spine at distodorsal margin. Dactylus ending in rounded distal margin with brush of setae, distal end almost reaching the proximal end of ischium when folded. Sternite 3 relatively broad, occasionally divided by mid-longitudinal groove into left and right parts; anterior margin bearing 2 lobes distinctively tuberculate, anterolateral angle ending in blunt but distinct process on each side.

Epipods absent from all pereiopods.

Chelipeds (P1) 1.4 times as long as post-orbital carapace length with well developed setose rugosites, ischium with a small distodorsal spine, merus 2.2 times as long as carpus when measured in dorsal mid-line, bearing 3 long and strong terminal spines with additional and 2–3 strong spines distoventrally, with obsolescent tubercular processes, carpus with a long mesial marginal spine at the widest portion often with additional tubercular processes distolaterally. Fingers longer than palm (up to 1.6 in female and 1.7 in males), propodus with 2 strong and 3 weak distoventral spines, ventral surface tuberculate, fingers slightly curved, opposable margins of fingers fitting together, inner side forming a spooned shaped cavity, closely fit cutting edges, the latter with very fine teeth, bearing tuffs of setae, tips close fitting, spooned; fixed finger without denticulate carina on distolateral surface.

Pereiopods 2–4 (P2–4) relatively long and slender, P2 almost fully reaching the end of P1, merus strong rugosites turning into tubercular processes, a strong spine at terminal end. Carpus with distinct spine on disto dorsal corner with highly tuberculate ridge parallel to dorsal margin. Propodus without any spines, 1.5 times as long as dactylus, obliquely flattish dorsal surface bordered laterally by rounded longitudinal ridge often bearing row of scale like tubercles, ventrodistally with pair of slender movable spines flanking

distomedian groove. Dactylus somewhat uniformly tapering to end, flexor margin nearly straight with 13–14 teeth, each accompanied by seta like spine, corneous terminal claw strongly curving down.

Eggs few, diameter 2.41 mm.

Variation

The material we examined indicates that the holotype female is larger than paratype males. Telson is narrower in paratypes. P2 is longer than P1 in females whereas it is almost the same length as P1 in males. These variations are related to sexual dimorphism.

Colour

Carapace and appendages light brown, eyes pale orange.

Etymology

From the Latin, referring to the broad body.

Distribution

Known only from the type locality, Kairei Vent Field in Indian Ocean at a depth of 2422–2435 m.

Remarks

The new species belongs to the *Orophorhynchus* group of Alcock, which is characterized by P1 (cheliped) being shorter than the body, P2 fully reaching the end of the P1 and eye peduncles fixed, extending beyond the cornea with a mesial spine. *Munidopsis laticorpus* sp. nov. is distinguishable by unarmed dorsal carapace surface with rugae becoming more prominent towards posterior side, oblique frontal margin with no antennal and anterolateral spine, upturned triangular rostrum, absence of denticulate carina on distolateral surface of fixed finger of cheliped and absence of epipods on pereiopods. It is most closely related to *Munidopsis lauensis* Baba & de Saint Laurent, 1992, from South Pacific vent sites, in the unarmed dorsal surface of carapace, absence of epipods on the pereiopods and transverse posteriomedian margin of 6th abdominal segment. However, the rostrum of the new species is broad triangular, straight in profile and strongly upturned at the tip, whereas in *M. lauensis* it is narrow triangular and nearly straight or feebly upcurved in profile. The eyespine in *M. laticorpus* is longer and directed almost laterally, whereas in *M. lauensis* eyespine is smaller and almost directed straightforward. Absence of antennal and anterolateral spine on frontal margin is another character which separates the new species from *M. lauensis*. Furthermore, P2–4 dactyli in *M. laticorpus* are stout with terminal corneous claw strongly curved, whereas in *M. lauensis*, P2–4 dactyli are gradually narrowed distally with terminal corneous claw gently curved. *Mundiopsis laticorpus* also resembles *M. ceratophthalmus* Alcock, 1901 from the Andaman Sea, in the unarmed dorsal surface, absence of epipods on pereiopods and in spooned fingers of chelipeds. However, in Alcock's species, the eyespine is much longer and slender, more than half the length of rostrum and its basal portion relatively narrow and the new species differ in spination of cheliped and walking legs from *M. ceratophthalmus*.

Munidopsis gracilis sp. nov.
(Figure 3 A–I)

Type material

Holotype: 1F, 24.23 mm, (NSMT–Cr 16875) 'Shinkai 6500', dive 6 k # 354, Forecast Vent Field, Mariana Back Arc Basin, 13° 23. 07′ N/145° 55.02′E, 1450 m, 1 December 1996.

Description

Carapace exclusive of rostrum distinctly longer than broader, moderately arched, anterior and posterior cervical groove distinct, transverse depression in anterior part of cardiac region. Rostrum 0.17 times long as carapace length, horizontal, narrow triangular, lateral margin with fine serrations, distinct dorsal carina merging into gastric region. Slightly raised concave frontal margin sweeping to strong antennal spine followed by shorter acute spine adjacent to it, following to strongly spined anterolateral angle. Gastric region somewhat dilated with transverse rugae occasionally feebly tuberculate, often obsolescent but moderate spine on either side of mid-line, lateral to each other variably developed small spines. Anterior branchial region bearing rugae, lateral margin with distinct strong anterior spine followed by 4 successively diminishing lateral spines and scattered moderate tubercles dorsally. Posterior branchial region with a strong lateral spine followed by 1 (right) or 2 (left) spines and rugose with tendency to being transversely continuous across central part of cardiac region. Pterygostomian flap with obliquely interrupted rugae, more distinct posteriorly, anteriorly ending in triangular margin with a slender spine.

Abdomen unarmed, transverse ridge of somites 2 and 3 smooth, preceded by concave trough more distinct on 2nd segment, segments 4, 5 and 6 smooth, posteriomedian margin of the posteriomost segment transverse. Telson divided into 8 plates, length–width ratio 0.80, posterolateral plate markedly convergent with a fringe of long coarse setae.

Eyes small, well exposed, almost round cornea cupped within broad-based movable ocular peduncle extending into a strong and long mesiodorsal spine directed laterally, 0.7 times length of rostrum, ornamented with three or four irregular spines, short lateral spines near base of cornea, accompanied by smaller acute mesioventral spine.

Basal article of antennular peduncle, exclusive of spine, longer than broader, slender dorsolateral carina distally continued into a long spine, dorsal to distolateral spine; separated by a groove bordering inflated lateral surface bearing small tubercles or spines, scalloped ventrodistal margin ending mesially in small but often prominent spine. Antennal peduncle having basal segment with well developed long ventral spine and smaller distolateral spine, 2nd segment with sharp distolateral spine, 3rd segment longer than broader with serrate distal margin, 4th segment with scalloped distal margin.

Third maxilliped, ischium shorter than merus bearing mesial crest armed with finely uniform evenly spaced 20 corneous tipped spines, merus with a few (3 strong) spines along flexor margin and small spine at distodorsal margin, dactyl ending

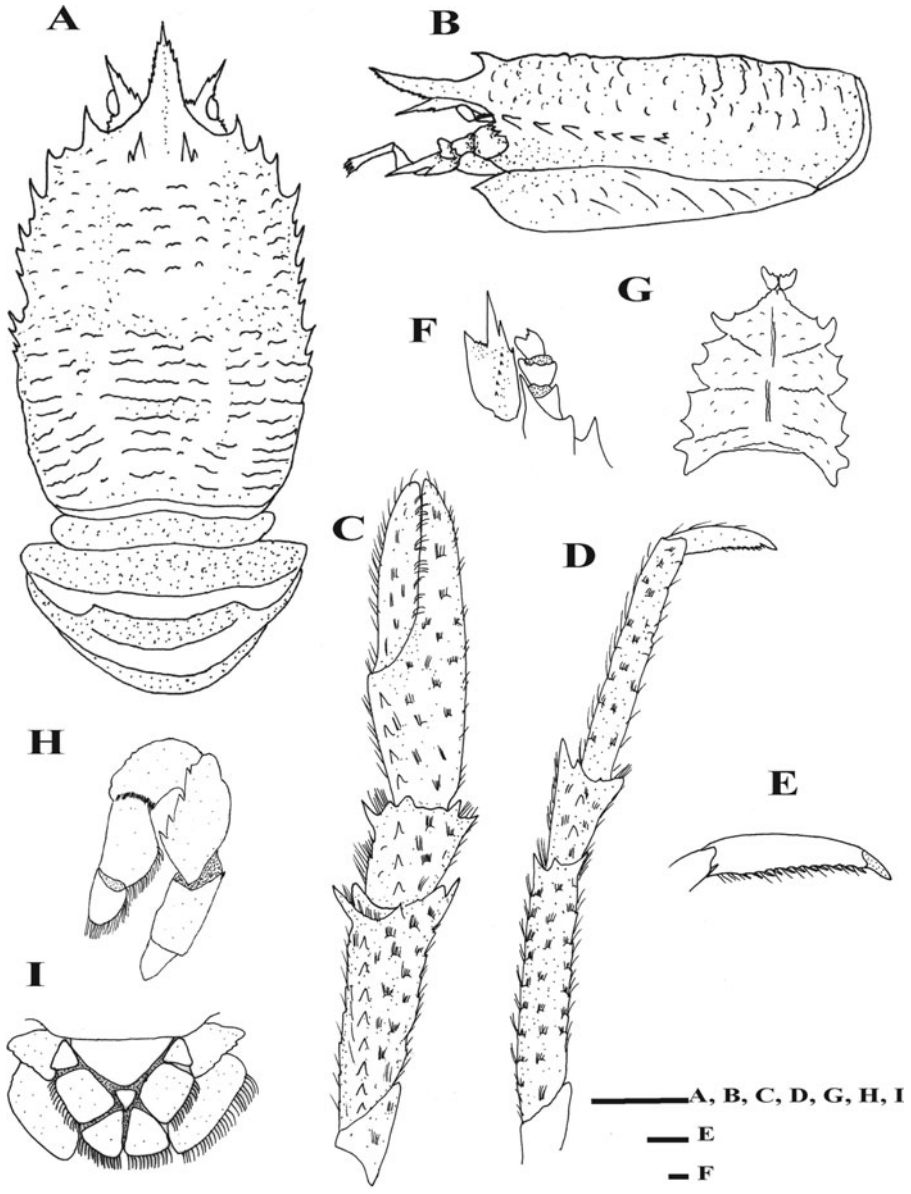

Fig. 3. *Munidopsis gracilis* sp. nov. holotype female. (A) carapace and abdominal segment, dorsal view; (B) lateral view; (C) right P1, lateral; (D) right P2, lateral; (E) dactylus of P2, lateral; (F) antennal peduncle and antennular basal article, ventral; (G) thoracic sternum; (H) endopod of right third maxilliped; and (I) telson. Scale: A, B, C, D, G, H & I = 5 mm; E & F = 2 mm.

in rounded distal margin with brush of setae. Tip of dactylus almost reaching the proximal end of ischium when folded.

Epipods absent from pereiopods.

Chelipeds (P1) with dense setaetion, 1.9 times as long as post-orbital carapace length, with many spines and fewer rugosites tending to arrange in longitudinal tracts. Ischium with mesial row of 5 acute spines and merus exceeding rostrum bearing a row of 8 mesial spines, terminal one being strongest, and 7 spines laterally, carpus with long spines mesially and laterally, palm with 4 spines mesially and laterally with strong tubercles. Fingers somewhat longer than palm with intermeshing teeth, spooned, closely fitting each other when closed.

Pereiopods 2–4 (P2–4) long and slender, P2 reaching almost to tip of P1, P3–4 reaching to base of dactyl on preceding leg. Merus with 6–7 spines mesially and laterally with spiny tubercles, carpi with longitudinal dorsal and lateral rib, each ending in spines, propodus thin with longitudinal and lateral rib with a spine on lateral side, almost 2.2 times as long as dactylus, dactyl slender, acute corneous tip preceded by row of 11 spines on prehensile edge.

Eggs few, principal axis measuring 2.4 × 2.6 mm.

Colour

Carapace and appendages are entirely white, eyes light yellow.

Etymology

From the Latin *gracilis*, slender, in reference to the thin and slender walking legs. The name is considered as a substantive in apposition.

Distribution

Known only from the type locality, Forecast Vent Field, Mariana Back Arc Basin at a depth of 1450 m.

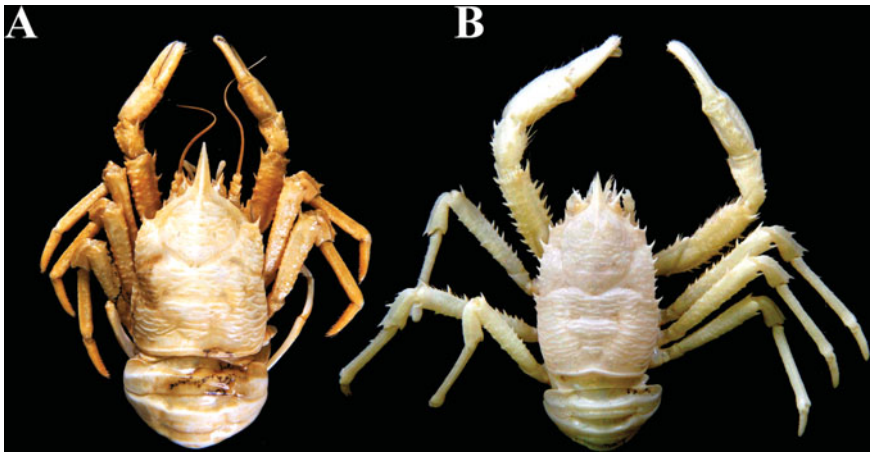

Fig. 4. (A) *Munidopsis laticorpus* sp. nov. holotype female, 31.45 mm; and B. *Munidopsis gracilis* sp. nov. holotype female, 24.23 mm.

Remarks

Munidopsis gracilis sp. nov. strongly resembles *Munidopsis marianica* Williams & Baba, 1989. However, lack of epipods on the chelipeds, shape of rostrum and erectness of eye spines immediately separates *Munidopsis gracilis* from *M. marianica. Munidopsis marianica* features a strongly produced posteriomedian margin of the 6th abdominal somite overreaching its lateral lobes while *Munidopsis gracilis* features a transverse posteriomedian margin of the 6th abdominal somite. The main eyespine of *Munidopsis gracilis* is long almost reaching to 3/4th of rostrum whereas for *M. marianica* it is not so. Furthermore, *Munidopsis gracilis* characterizes a very long rostrum with lateral serrations, whereas these serrations are present only at distal end of rostrum in *M. marianica.* Spination of carapace and absence of epipods on cheliped links *Munidopsis gracilis* to *M. starmer* Baba & de Saint Laurent, 1992. However, both the species can easily be distinguished by length and ornamentation of eyespine, shape of 6th abdominal segment and spination of cheliped and walking legs. *Munidopsis starmer* is characterized by a protruded rounded posterolateral flap of 6th abdominal segment, distinctly overreaching its posteromedian margin, whereas it is transverse in *M. gracilis.* Eyespine is small compared to rostral length in *M. starmer*, whereas eyespine of *Munidopsis gracilis* is long almost reaching to 3/4th of rostrum.

HABITT AND ECOLOGY OF KAIREI FIELD

Chimney complexes characterized Kairei Field, including black smokers, the largest of which was over about 10 m high. Biological communities were distributed in a 40 m by 80 m field around the knolls between depths of 2420 m and 2450 m. Maximum temperature from an active black smoker was 360°C and pH 3.4 (Hashimoto *et al.*, 2001).

Swarms of densely packed shrimps, *Rimicaris kairei* were seen directly in the hot venting chimneys. Crowded beds of actinians, *Marianactis* sp., provannid gastropods *Alviniconcha* sp., bythograeid crabs *Austinograea rodriguezensis*, stalked barnacles *Neolepas* sp., deep-sea mussels *Bathymodiolus marisindicus* and 'scaly foot gastropods' dominated the communities. Zoarcid fish were seen swimming in the vicinity of the chimneys. Moulted exuvia of *Rimicaris kairei* were thickly accumulated in the slope. 5–6 individuals of *Munidopsis* were seen slowly crawling among sea anemones and stalked barnacles in the bare rock. They were found little distant from the chimneys, probably avoiding the predation from bythograeid crabs.

DISCUSSION

Munidopsis comprise an important element of macrofauna of reducing habitats such as hydrothermal vent, cold seep, whale carcass and decomposing wood in deep-sea (Williams & Van Dover, 1983; Williams, 1988; Williams & Baba, 1989; Baba, 2005; Macpherson & Segonzac, 2005; Macpherson, 2007). *Munidopsis laticorpus* sp. nov. becomes the first vent associated *Munidopsis* to be described from Kairei Field, Central Indian Ridge (25° 19.17′ S 70° 02.40′E) and *Munidopsis gracilis* sp. nov., the second from Forecast Vent Field, Mariana Back Arc Basin, west Pacific (13° 23. 07′ N/145° 55.02′E). This increases the number of vent associated *Munidopsis* to 16, including the newly identified undescribed species; three species from Hatoma Knoll, Okinawa Trough and one species from Brothers Seamount, Kermadec Volcanic Arc (Cubelio *et al.*, in press).

Munidopsis exhibits a rather variable pattern of abundance in vent fields. In west Pacific vent sites such as, DESMOS and PACMANUS in Manus Basin, and north-west Eifuku Seamount in Mariana Volcanic Arc, *Munidopsis* are very abundant (Tunnicliffe, 1991; Cubelio *et al.*, 2007), whereas in the vent fields such as Mariana Back Arc Basin and Kairei Field, they are not so abundant. This might be related to the abundance of predators on galatheid crabs. *Munidopsis* seem to be very slow and inactive animals and could be easily preyed upon by predators such as bythograeid crabs. Hence it could be possible that in vent fields, such as Mariana Back Arc Basin and Kairei Field, where the bythograeid crabs are abundant, *Munidopsis* are found to inhabit areas distant from the active venting chimneys, probably avoiding the predation. Environmental conditions also play an important role in controlling the distribution of vent animals (Tunnicliffe, 1991; Van Dover, 2000). In the DESMOS site, pH of the vent fluid is found to be 1.5, which is the lowest to be reported from any vent field (Van Dover, 2000). Most of the vent animals, including the predators

might try to avoid such low pH, but *Munidopsis* are found to be very abundant in the DESMOS site (Tunnicliffe, 1991; Baba & de Saint Laurent, 1992). Presumably they could adapt themselves and survive in these unusual environments. These factors could be one of the reasons for the variable patterns of abundance of vent associated *Munidopsis* in the Pacific and Indian Oceans.

The present description of vent associated *Munidopsis* in the Indian Ocean indicates that *Munidopsis* distribution extends to hydrothermal vents of all the three major oceans. This study supports the evidence of the global distribution of common chemosynthetic genera via the active spreading ridges of the Indian Ocean. In addition to the *Munidopsis gracilis* sp. nov., described herein from Forecast Vent Field, two other species, *M. marianica* and *M. myojinensis* from the north-western Eifuku Seamount, Mariana Volcanic Arc have also been reported. Hence, it could be assumed that there is a very wide distribution of *Munidopsis* between the Back Arc and Volcanic Arc of west Pacific vent fields despite the difference in depth and distance.

Geographical affinities of Kairei, with Pacific and Atlantic vent taxa have been analysed by Van Dover *et al.* (2001) and demonstrated a strong evolutionary link to Pacific vent taxa. Ongoing phylogenetic studies should greatly increase our understanding about the complex evolutionary history and diversity of this group.

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