Wasmer 1989

JOURNAL OF NATURAL HISTORY, 1989, 23, 475–485

Supplementary description of *Funchalia taaningi* Burkenroad, 1940 (Crustacea, Decapoda, Penaeidae) from the Central Pacific Ocean and a new record of *F. villosa* (Bouvier, 1905) from the Eastern Indian Ocean

ROBERT A. WASMER

Biology Department, Columbia Union College, Takoma Park, Maryland 20912 USA

(*Accepted 12 August 1988*)

The pelagic penaeid shrimp *Funchalia taaningi* Burkenroad, 1940 is redescribed based on specimens collected mainly in the central Pacific Ocean. The petasma of the male is illustrated for the first time. The distribution of the species is extended into the eastern Indian Ocean based on a female collected in 1964 during the International Indian Ocean Expedition. Two males of *Funchalia villosa* (Bouvier, 1905), also collected during the International Indian Ocean Expedition, are recorded from the eastern Indian Ocean, extending the known distribution of this species.

KEYWORDS: Crustacea, Penaeidae, *Funchalia taaningi*, *Funchalia villosa*, Central Pacific Ocean, Eastern Indian Ocean.

Introduction

In 1940, M. D. Burkenroad published a preliminary description of the penaeid shrimp *Funchalia taaningi* from material collected by the Danish Oceanographic Expeditions. The holotype, a female with a carapace length of 16·2 mm, was taken north of Madagascar in the Indian Ocean (*Dana* station 3920 III, 1°06′N, 62° 25′E). Burkenroad's specimens are apparently lost, not being found by A. A. Racek among the vast material from the *Dana* and *Galathea* expeditions when it was later entrusted to him for detailed revision (personal communication, 25 April 1972). The species has rarely been collected since its original description. Hayashi (1983) and Crosnier (1985) published figures of the thelycum from specimens taken off Japan and Madagascar, respectively, which agree with Burkenroad's preliminary description of that structure of the holotype of *F. tanningi*. Baba *et al.* (1986) described and illustrated with a colour photograph the same specimen described by Hayashi (1983). Kikuchi and Omori (1985) dealt with the vertical distribution of the species (as *F. villosa*) off Japan, while Kikuchi and Nemoto (1986) included the species in a list of the pelagic shrimps from the western North Pacific.

Among specimens I obtained in 1970 from what is now the Southwest Fisheries Center of the National Marine Fisheries Service in Honolulu for my doctoral research on the taxonomy and zoogeography of pelagic shrimps in the Pacific Ocean north of 20°N (Wasmer, 1972) were ten identified specimens of *F. taaningi*. These specimens were collected in 1954 and 1955 during cruises of the research vessels *John R. Manning*

0022–2933/89 $5·00

and *Hugh M. Smith* (King and Iversen, 1962). I identified two additional specimens (Wasmer, 1972) from midwater trawl samples collected in the North Pacific by the R/V *Yaquina* of Oregon State University during YALOC–66 (R/V *Yaquina* Long Cruise, 1966). I was recently able to examine additional specimens of *F. taaningi*. Ken-Ichi Hayashi of the Shimonoseki University of Fisheries, Shimonoseki, Japan, kindly provided three specimens identified as *F. tanningi* collected from the eastern Indian Ocean in 1964 by the Japanese R/V *Koyo Maru* during the International Indian Ocean Expedition (two of these specimens, as discussed below, proved to be *Funchalia villosa*). Alan Crosnier of the Muséum National d'Histoire Naturelle in Paris graciously provided 51 specimens of *F. taaningi* collected from the equatorial Pacific north of the Marquesas Islands during the French CARIDE cruises during 1968 and 1969.

In view of the paucity of previously reported specimens of *F. taaningi*, and since the male has not been adequately described and illustrated, I feel that it is desirable to present a supplementary description of the species based on the material at hand. Because no nomenclatural question is at stake, and since the type-locality of the species is so far removed from the area of capture of most of the specimens discussed here, and since Burkenroad's material may yet reappear, I choose not to name a neotype of *F. taaningi*

The following abbreviations are used: Cl. for postorbital carapace length; JRM–22 for R/V *John R. Manning* Cruise 22; HMS–27 for R/V *Hugh M. Smith* Cruise 27; HMS–30 for R/V *Hugh M. Smith* Cruise 30; IIOE for International Indian Ocean Expedition of R/V *Koyo Maru*; IKMT for Issacs-Kidd midwater trawl; MP for Muséum National d'Histoire, Paris; MPS for multiple plankton sampler; Sta. for station number; USNM for National Museum of Natural History, Smithsonian Institution, Washington, D.C.; and YALOC–66 for R/V *Yaquina* Long Cruise, 1966. The specimens loaned by Ken-Ichi Hayashi of the Shimonoseki University of Fisheries are deposited in the collections of that institution. All other specimens are deposited in the National Museum of Natural History, Smithsonian Institution (USNM) or the Muséum National d'Histoire Naturelle, Paris (MP).

Systematics

PENAEIDAE

Genus ***Funchalia*** Johnson, 1867

The genus *Funchalia* was established by Johnson (1867) with the type-species *F. woodwardi*. Grippa (1976, 1987) reviewed the status of the genus and elevated to full generic rank the subgenus *Pelagopenaeus* established by Burkenroad (1934, 1936) for *Funchalia balboae* (Faxon, 1893). *Funchalia* differs from *Pelagopenaeus* in a number of morphological characters (Grippa, 1987), including the following: the absence of ventral rostral teeth, an asymmetrical petasma, a much longer incisor process on the mandible, a much larger mandibular palp, the presence of an antennal spine, markedly dimorphic dactyli of third maxillipeds, unsulcated dorsal carinae on abdominal somites, uropods much longer than telson, and a superior antennular flagellum which is but little longer than the inferior antennular flagellum.

Grippa (1976) included the presence of a diaeresis on the uropods of *Pelagopenaeus* and its absence in *Funchalia*, and a glabrous integument in *Pelagopenaeus* and a villous integument in *Funchalia* as additional characters separating the two genera. These

characters are not useful. Grippa (1987) does not mention the first and retracts the second. A diaeresis is present on all the specimens of *Funchalia* examined in this study.

The genus *Funchalia* contains five species: *F. woodwardi* Johnson, 1867; *F. villosa* (Bouvier, 1905); *F. danae* Burkenroad, 1940; *F. taaningi* Burkenroad, 1940; and the somewhat enigmatic *F. sagamiensis* Fujino, 1975, still only known from a single juvenile specimen (Grippa, 1987).

Funchalia taaningi Burkenroad, 1940
(Figs 1, 2A, B, D–F, 3)

Synonymy

Funchalia taaningi Burkenroad, 1940: 36; Anderson and Lindner, 1945: 303 (in key); Dall, 1957: 163 (in key); King and Iversen, 1962: tables 12, 17–19, appendix tables 5, 7, 8; Grippa 1976: 129 (in key), 130 ff (discussion); Hayashi, 1983: 34, figs 45, 46; Crosnier, 1985: 871, figs 14d–e; Baba *et al.*, 1986: 59 (Japanese text), 239 (English text), colour plate 16; Kikuchi and Nemoto, 1986: table 1; Grippa, 1987: 84, 85; Krygier and Wasmer, 1988: 54 (in list), table 1.

?*Funchalia* sp., Monod, 1973: 8.

Funchalia villosa, Kikuchi and Omori, 1985: table 2.

Material examined. JRM–22: Sta. 8, 19 Sept 1954, 20:10–21:15 h, 33°16′N, 159°54′W, IKMT, 100–0 m, 1 male, Cl. 15·0 mm, 1 impregnated female, Cl. 18·0 mm (USNM 211470). HMS–27: Sta. 25, 1 Feb 1955, 19:35·5–20:41 h, 29°65·3′N, 179°28·5′E, IKMT, 100–0 m, 1 impregnated female, Cl. 23·0 mm (USNM 211471); Sta. 40, 8 Feb 1955, 19:11·5–20:10 h, 29°36·1′N–172°42·5′W, IKMT, 100–0 m, 1 juvenile male, Cl. 9·0 mm (USNM 211472); Sta. 65, 18 Feb 1955, 19:30–20:29 hrs., 30°36′N, 59°19·5′W, IKMT, 100–0 m, 2 males, Cl. 13·0 mm (USNM 211473). HMS–30: Sta. 12, 19 July 1955, 19:36–20:45 h, 27°11′N, 170°54′W, IKMT, 100–0 m, 1 impregnated female, Cl. 18·0 mm (USNM 211474); Sta. 60, 8 Aug 1955, 21:04–22:10 h, 30°08′N, 171°48′W, IKMT, 100–0 m, 1 male, Cl. 10·0 mm (USNM 211475); Sta. 63, 9 Aug 1955, 21:01–22:01 h, 29°54′N, 168°32′W, IKMT, 100–0 m, 1 unsexed juvenile, Cl. 7·0 mm (USNM 211476); Sta. 65, 10 Aug 1955, 20:48–21:48 h, 29°59′N, 164°49′W, IKMT, 100–0 m, 1 impregnated female, Cl. 16·0 m (USNM 211477). IIOE: Sta. 14, 3 Jan 1964, 20:11–21:19 h, 12°23·8′S, 99°35·3′E, IKMT: 1 female, Cl. 17·5 mm. YALOC–66: Sta. 823, 31 May 1966, 10:15–18:55 h, 22°43·2′N, 158°55·9′W, MPS, 2600–0 m: 1 male, Cl. 15·0 mm, 1 impregnated female Cl. 16·0 mm (USNM 211478). CARIDE I: Sta. 46, 25 Sept 1968, 15:19 h, 0°21′N, 139°39′W, IKMT, 630–0 m: 1 male, Cl. 17·0 mm, 4 impregnated females, Cl. 16·9–17·9 mm (MP–Na 10013); Sta. 47, 25 Sept 1968, 17:57 h, 0°21′N, 139°48′W, IKMT, 530–0 m: 8 males, Cl. 14·9–17·1 mm, 6 impregnated females, Cl. 14·0–19·9 mm (USNM 240163); Sta. 54, 26 Sept 1968, 20:35 h, 0°03′N, 141°19′W, IKMT, 290–0 m: 5 males, Cl. 16·5–16·9 mm, 4 impregnated females, Cl. 16·0–18·4 mm (MP–Na 10015); Sta. 80, 1 Oct 1968, 11:51 h, 0°14′S, 147°17′W, IKMT, 440–0 m: 1 male, Cl. 14·7 mm, 2 females, Cl. 12·2 and 12·5 mm (USNM 240158), 3 males, Cl. 15·2–16·4 mm, 4 females (3 impregnated), Cl. 16·2–17·3 mm (USNM 240159); Sta. 81A, 1 Oct 1968, 15:44 h, 0°05′S, 147°28′W, IKMT, 600–0 m; 3 males, Cl. 15·1–17·3 mm, 4 impregnated females, Cl. 17·1–18·4 mm (USNM 240157); Sta. 101, 4 Oct 1968, 20:23 h, 0°04′S, 150°47′W, IKMT, 730–0 m: 1 male, Cl. 16·4 mm (USNM 240156). CARIDE 4: Sta. 127, 6 Jul 1969, 08:42 h, 0°10′N, 151°59′W, IKMT, 560–0 m: 1 male, Cl. 16·5 mm (USNM 240162). CARIDE 5: Sta. 218, 25 Sept 1969, 21:28 h, 0°00′, 139°50′W, IKMT, 140–0 m: 1

juvenile male, Cl. 8·5 mm, 1 male, Cl. 17·6 mm (USNM 240161); Sta. 226, 26 Sept 1969, 00:30 h, 0°00, 139°57′W, IKMT, 300–0 m: 1 male, Cl. 12·8 mm (USNM 240155); Sta. 229, 26 Sept 1969, 01:52 h, 0°00, 139°57′W, IKMT, 150–0 m: 1 female, Cl. 17·6 mm (USNM 240160).

Description. Integument thin, but not membranous. Carapace, abdomen, antennal scales, uropods, and telson of most specimens densely covered with elongate, needle-like integumental scales, each attached by small stalk with expanded base; scales easily removed by abrasion, leaving pattern of small pores in integument where stalks were attached. Scales generally oriented anteriorly on anterior half of body, posteriorly on posterior half, and ventrally on pleurae of abdominal somites. Higher magnification shows scales to be armed laterally with varying number of small setae in single row, base of stalk with central opening appearing to be continuous with pore in integument and perhaps with an internal cavity running most of length of scale, no evidence of external opening distally.

Rostrum (Fig. 1) reaching to just beyond cornea, tip acute and directed anteroventrad; adrostral carina weak; dorsal carina with 5 or 6 teeth, followed by epigastric tooth, first rostral tooth proper lying behind level of orbital margin; interval between teeth becoming shorter anteriorly; postrostral carina weak, extending almost to posterior margin of carapace; ventral margin of rostrum lacking teeth.

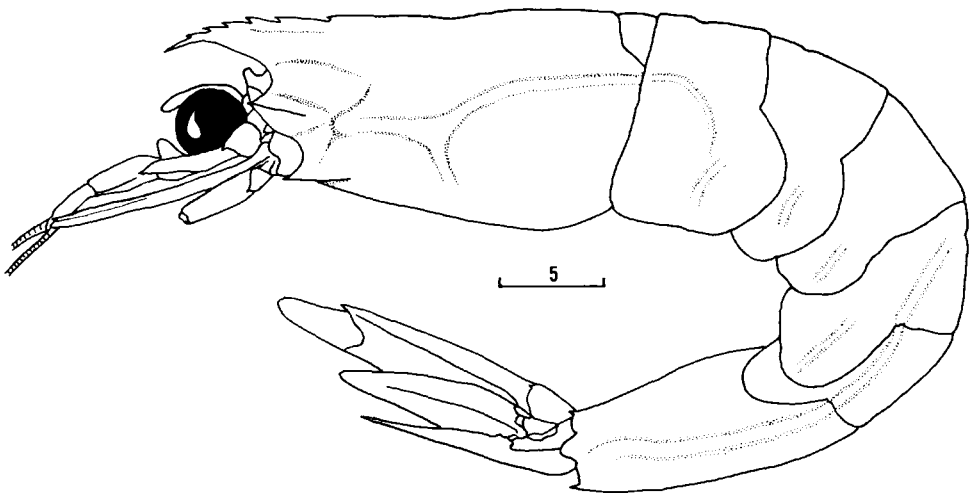

FIG. 1. *Funchalia taaningi* Burkenroad. ♂, Cl. 15·0 mm, YALOC–66 Station 823. Carapace and abdomen (pubescence not shown). Scale in mm.

Orbital angle absent; antennal spine small, well-defined antennal carina and orbito-antennal sulcus extending posteriorly to short shallow vertical sulcus in front of hepatic spine or unarmed hepatic prominence. Gastrofrontal sulcus weak, running from orbital margin toward weak cervical sulcus. Anterior margin of carapace ventral to antennal spine curving sinuously downward and posteriorly, then anteriorly to well-developed pterygostomian spine without definite point of demarcation between margin and spine; strong carina extending posteriorly from pterygostomian spine to level below hepatic spine or prominence. Anterior margin of carapace ventral to pterygostomian spine sloping posteriorly (Fig. 2A). Hepatic spine present only on

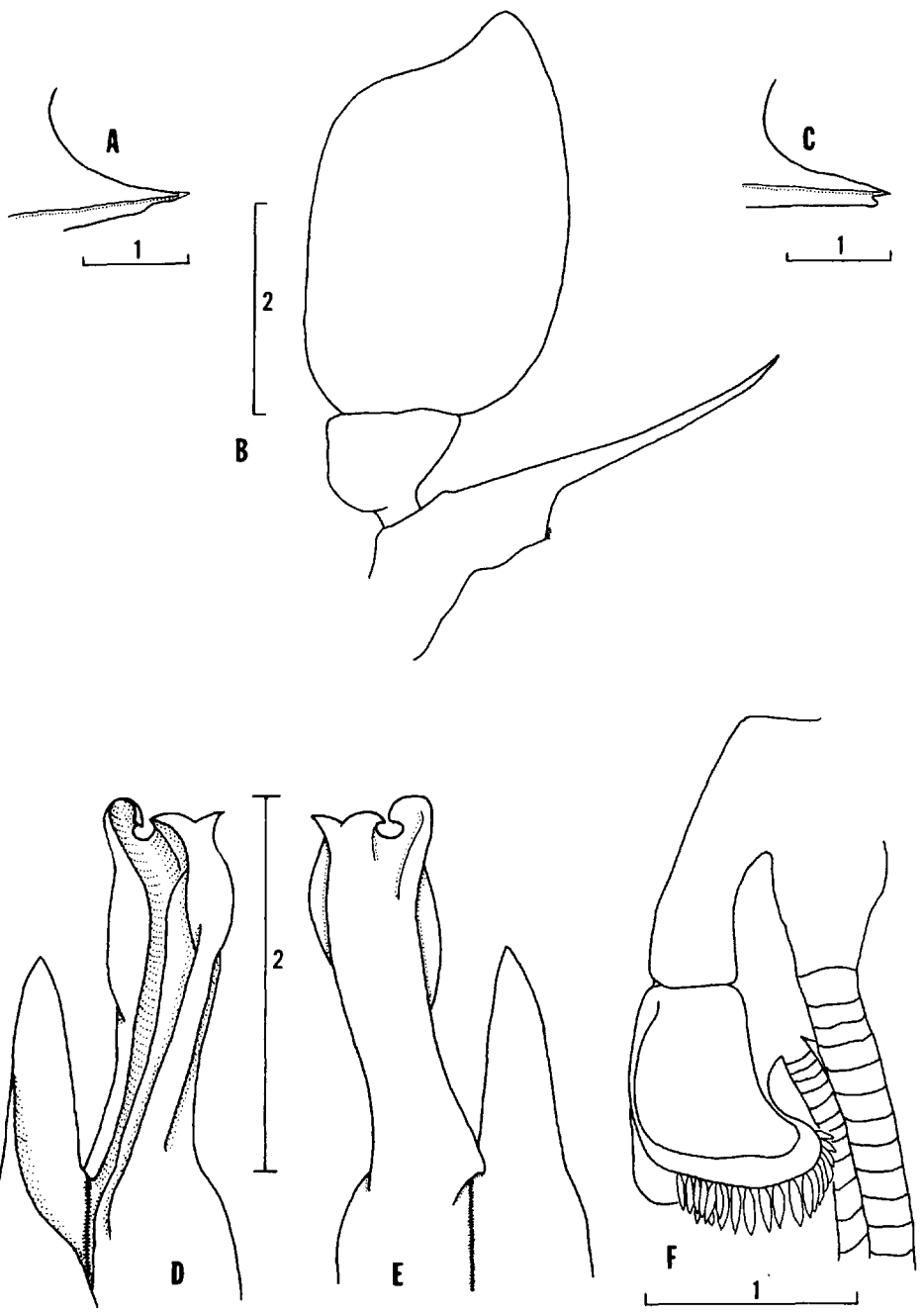

FIG. 2. A: *Funchalia taaningi* Burkenroad. ♀. Cl. 18·0 mm, HMS–30 Station 12; B, F: *Funchalia taaningi* Burkenroad. ♂, Cl. 15·0 mm, YALOC–66 Station 823; C: *Funchalia villosa* (Bouvier). ♂, Cl. 16·5 mm, R/V *Koyo Maru*, IIOE Station 19; D, E: *Fuchalia taaningi* Burkenroad. ♂, Cl. 17·1 mm, CARIDE Station 47. A, C. Right anteroventral margin of carapace below pterygostomian spine; B. Right mandible, extensor (ventral) view; D–E. Distal portion of petasma, posterior and anterior views; F. Left appendix masculina, mesial view. Scales in mm.

specimens with carapace length of 10·0 mm or less, completely absent on larger specimens, which bear only hepatic prominence. Shallow sulcus running obliquely downward from hepatic prominence toward pterygostomian carina, faint trace of cervical sulcus extending obliquely upward from hepatic prominence. Horizontal hepatic carina dividing into dorsal and ventral branches near middle of carapace; dorsal, longer branch merging dorsally with anterior part of horizontal branchiocardiac carina, continuing to posterior edge of carapace; ventral, shorter carina extending posteroventral at oblique angle.

Abdominal somites 1–3 dorsally smooth, dorsal carina present on posterior 2/3 of somite 4 and on entire length of somites 5 and 6, that on somite 6 ending in small tooth. Abdominal somite 6 laterally compressed, twice length of somite 5. Anterior half of tergite on somite 1 with midlateral carina beginning at level of posterior end of branchiocardiac carina, curving strongly ventrally; pleurae of somites 1–4 with vertical carinae; somites 4–6 bearing continuous tergal carinae, that on somite 4 running obliquely ventrally from dorsum. Abdominal sternites 1 and 2 with well-developed lamelliform midline projection between pleopods. Telson about $\frac{3}{4}$ length of abdominal somite 6, dorsally sulcate along entire length; telson tapering posteriorly, forming triangular projection with 3 large fixed subapical spines; edges of telson proximal to large spines with series of smaller spines difficult to distinguish from scales covering surface of telson. Mesial ramus of uropod extending beyond telson, but not as far as to level of strong tooth on lateral margin of lateral ramus of uropod. Latter bearing diaeresis.

Superior antennular flagellum about as long as carapace; inferior antennular flagellum slightly shorter than superior. Antennal flagellum extremely long, totalling about 19 cm at a carapace length of 23·0 mm; flagellum divided into proximal nonsetose and distal setose parts, with setose portion bearing paired plumose setae which arch upward toward each other, between which, at various intervals of annuli, single straight plumose setae project upward.

Mandible (Fig. 2B) with molar process obsolete, represented by slight thickening, with group of short, heavy setae; incisor process elongate and scythe-like, basal portion broad and flattened, narrowing distally to acute tip, lying transversely behind labrum, reaching to opposite branchiostegite; mandibular palp with 2 broad and leaf-like segments, distal margin of segment 2 somewhat concave, with mesial margin longer than lateral margin. Maxilliped 3 slender and pediform; dactylus sexually dimorphic, spatulate in males, subcylindrical in females; dactylus and propodus together longer than carpus.

Pereopod 1 with strong spine on distoventral part of basis and ischium, 3 to 5 strong spines on posterior distal margin of merus; posterior distal margin of carpus with dense group of short serrate setae; fingers of chela abut 1·5 times as long as palm of propodus. Perepod 2 with strong spine on distoventral part of basis and ischium, posterior margin of merus with series of strong spines; fingers of chela slightly longer than palm of propodus. Chela of pereopod 3 4·4 mm long on specimen of 9·0 mm carapace length to 4·8 mm long on specimen of 16·0 mm carapace length. Dactylus of pereopods 4 and 5 curved and slender, more than 2/3 length of propodus in adults, proportionally much shorter in juvenile specimens.

Petasma of adult male (Fig. 2D,E) reaching forward as far as coxae of pereopod 4. Endopods of petasma asymmetrical, either right or left longer than the other, shorter one with simple grooved, spatulate apex; apex of longer endopod deeply grooved, curving dorsally, bifurcate at apex; midlateral margin of distal part of longer endopod

without triangular projection. Appendix masculina (Fig. 2F) subrectangular, distal margin flared and with marginal row of flattened setae.

Thelycum of adult female (Fig. 3) with large tooth-like median ridge on last thoracic sternite (XIV) between fifth pereopods posterior to receptacular depression; ridges forming lateral boundary of receptacular depression straight posteriorly. Large, anteriorly directed tongue-like central plate on penultimate thoracic sternite (XIII), deeply excavated posteriorly, forming anterior boundary of receptacular depression.

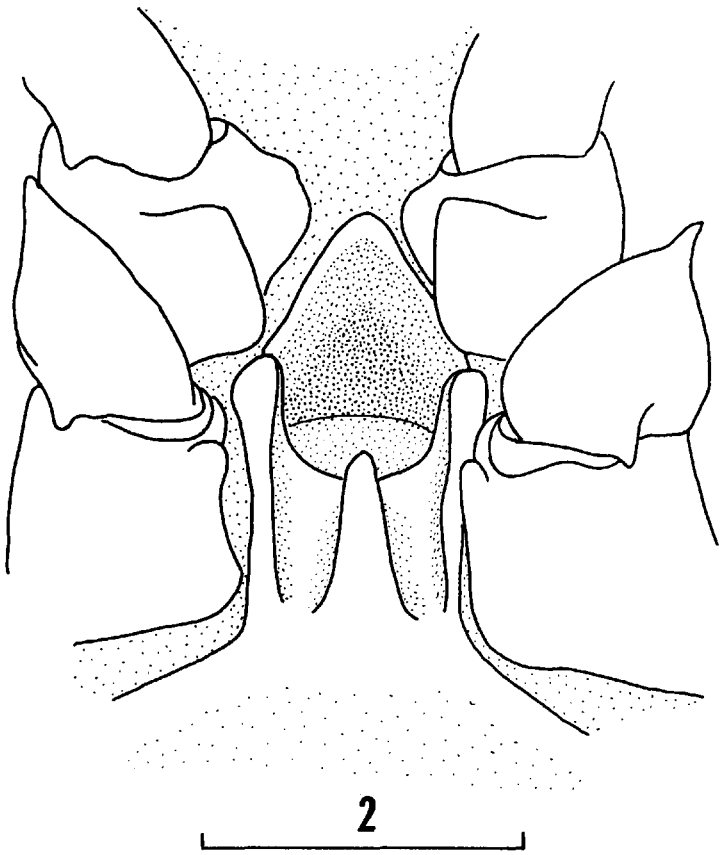

FIG. 3. *Funchalia taaningi* Burkenroad. ♀, Cl. 16·0 mm, YALOC–66 Station 823. Thelycum, spermatophoric mass removed, ventral view (setae not shown). Scale in mm.

Remarks. Burkenroad (1940) stated that *F. taaningi* is very nearly related to *F. villosa* (Bouvier, 1905). The specimens described here are in agreement with the characters used by Burkenroad (1940) to distinguish *F. taaningi* from *F. villosa*: rostrum with 5+1 to 6+1 dorsal teeth and unarmed ventral edge; hepatic spine present on juveniles but absent on adults; anterior margin of carapace ventral to the pterygostomian spine sloping posteriorly rather than vertically or even anteriorly as in adults of *F. villosa*; greater length of the chela on third pereopod compared to that of *F. villosa* of similar carapace length; absence of small triangular projection on mid-lateral margin of distal part of longer petasmal endopod; and presence of a large tooth-like median ridge posterior to receptacular depression of thelycum and straight ridges forming the posterior lateral boundary of thelycal depression.

The needle-like scales covering the integument of *F. taaningi* are reminiscent of the flattened scales present on the integument of the oplophorid genera *Acanthephyra* and *Systellaspis* and several species of pandalids (Mauchline *et al.*, 1977; Chace, 1985). Although the scales on *F. taaningi* differ in shape from those on the other genera, their peculiar orientation on the surfaces they cover, and the presence of a pore through the integument at the site of each scale suggests that the scales on *F. taaningi* may serve some sensory function similar to that suggested by Mauchline *et al.* (1977) for the scales on the integuent of some other species of pelagic shrimps.

The extremely long antennal flagellum of *F. taaningi* is in agreement with that described by Foxton (1969) for other members of the genus. In *Funchalia*, as well as in perhaps all the species of *Bentheogennema, Gennadas, Acetes, Petalidium, Sergestes*, and *Sergia*, (Foxton, 1969; Wasmer, 1974; Krygier and Wasmer, 1975; Denton and Gray, 1985), the arched setae on the distal portion of the flagellum form a tubular arrangement surrounding single straight setae spaced along the length of the 'tube'. The straight setae function as mechanoreceptors providing the shrimp with a sensory system capable of responding to external sources of vibration in the surrounding water (Denton and Gray, 1985).'

Distribution. F. tanningi has been recorded with certainty from the western Indian Ocean (Burkenroad, 1940; Crosnier, 1985), the central Pacific from near the equator to 33°N (King and Iversen, 1962; Wasmer, 1972), and the northwestern Pacific off Japan (Hayashi, 1983; Kikuchi and Omori, 1985, as *F. villosa*; Baba *et al.*, 1986; Kikuchi and Nemoto, 1986). The specimens from the French CARIDE cruises were taken from the same general area as some of those recorded by King and Iversen (1962). The specimen of *F. taaningi* from IIOE Sta. 14 extends the known distribution of the species into the eastern Indian Ocean. It is possible that the specimen of *Funchalia* collected between New Caledonia and the Carolines, identified by Monod (1972) simply as *Funchalia* sp., and the specimen of *F. sagamiensis* from Japan, which according to Fujina (1975: 210) appears to be identical with Monod's specimen, both represent juveniles of *F. taaningi* as suggested by Grippa (1976). However, in spite of Fujino's statement that the two specimens appear to be identical, Monod's figures (1972: figs 15, 17) indicate the presence of strong distoventral spines on the basis and ischium of the first and second pereopods of the specimen of *Funchalia* sp., these spines are apparently absent on *F. sagamiensis*. Consequently, the true identity of these juvenile specimens of *Funchalia* must remain uncertain for the present time.

Several members of the genus *Funchalia* (*F. woodwardi* and *F. villosa*) are capable of undergoing diurnal vertical migrations of considerable magnitude, being distributed in deeper layers during the day and then moving upwards into surface layers (to less than 40 m depth) at night (Gordon and Ingle, 1956; Foxton, 1970; Miller *et al.*, 1983). *F. taaningi* appears to follow a similar pattern. Kikuchi and Nemoto (1986) placed *F. taaningi* in a group of species in the western North Pacific that are vertical migrants living in the lower mesopelagic zone, with vertical distributions of 240–265 m and 555–594 m at night at two different stations and 483–678 m during the day. King and Iversen (1962: table 18, appendix table 3) recorded specimens of the species from trawls as shallow as 85 m. Thirteen of the 64 specimens dealt with here were taken between 200 m and the surface (10 of the 13 were were taken between 100–0 m) during evening and early night hours (roughly 19:00–01:52 h). The specimens from YALOC–66 Sta. 823 were taken during the day with an Isaacs-Kidd midwater trawl modified with an open-closing cod-end unit called a multiple plankton sampler (Pearcy and Hubbard, 1964) to sample the intervals of 2600–1000 m, 1000–500 m and 500–200 m

during one oblique tow. It is unfortunate that the MPS malfunctioned on this station, sampling continuously through a depth range of 2600–0 m instead of the intended intervals.

The specimen of *F. taaningi* reported by Hayashi (1983) and Baba *et al.* (1986) was taken from the stomach of the fish *Beryx splendens* collected at a depth of 355 m from the Kyushu Palau Ridge off Japan (Hayashi, personal communication, 22 Aug 1986). While there are several reports (Barnard, 1950; Kensley, 1977; Miller *et al.*, 1983) of tunas (*Thunnus* sp.) and hake (*Merluccius* sp.) feeding on *F. woodwardi*, the studies reported by King and Iversen (1962) show that tunas apparently do not feed on *F. taaningi*. Even though the species was taken in trawl collections made to sample the potential forage organisms available as food for tunas in the central Pacific Ocean, no specimens of *F. taaningi* were found in the stomach contents of four species of tunas taken by longline, surface trolling, and pole-and-line fishing.

***Funchalia villosa* (Bouvier, 1905)**

(Fig. 2c)

Restricted Synonymy:

Hemipenaeopsis villosus Bouvier, 1905: 981 (in part).

Funchalia villosa, Burkenroad, 1936: 129; Crosnier, 1985: 869, figs 13a–e, 14b–c; Gore, 1985: 132; Kensley *et al.*, 1987: 281; Grippa, 1987: 80, figs 1C, 2A, 3A, 4B.

Material examined. IIOE Sta. 19, 8 Jan 1964, 18:50–20:01 h, 20°02·2′S, 99°41·5′E, IKMT, 2 males, Cl. 16·5 and 17·5 mm, identified as *F. taaningi*.

Remarks. No detailed description of the species is given here since the specimens agree with the salient features used to distinguish the males of *F. villosa* from those of *F. taaningi*. The petasma of each has a triangular projection near the middle of the lateral edge of the longer endopod, a diagnostic feature of males of *F. villosa* (see Burkenroad, 1940; Dall, 1957: fig. 9B; Grippa, 1976; Kensley, 1977; fig. 8C; Crosnier, 1985: figs. 13b, c). In addition, the anterior margin of the carapace of both specimens slopes anteriorly below the pterygostomian spine (Fig. 2C), as indicated by Burkenroad (1940), to form an anteriorly directed lobe before finally turning posteriorly, and the chelae of the third pereopods are somewhat shorter than those of *F. taaningi* at similar carapace lengths (4·4 mm and 4·3 mm at carapace lengths of 16·5 mm and 17·5 mm, respectively). The integument of both has elongate needle-like scales or shows pores where they were lost by abrasion. Both specimens have spatulate dactylus on the third maxillipeds.

Distribution. F. villosa has been recorded from the Atlantic Ocean (Burkenroad, 1936; Crosnier and Forest, 1973; Crosnier, 1985), the Caribbean (Gore, 1985), the Mediterranean Sea (Casanova, 1976; Casanova and Judkins, 1977), in the South Pacific from near Lord Howe Island and off eastern Australian in the Tasman Sea (Dall, 1957; Griffiths and Brandt, 1983; Kensley, 1987), and in the southwestern Indian Ocean off South Africa (Crosnier, 1985). The specimens of *F. villosa* reported from off Japan by Kikuchi and Omori (1985) instead are *F. taaningi* (Kikuchi, personal communication, 17 Feb 1987). Thus, these two male IIOE specimens extend the known distribution of *F. villosa* into the eastern Indian Ocean.

Acknowledgements

I am grateful to E. C. Jones, then of the Honolulu Laboratory, Southwest Fisheries Center of the National Marine Fisheries Service, W. G. Pearcy of the School of Oceanography, Oregon State University, K. I. Hayashi of the Shimonoseki University

of Fisheries, and A. Crosnier of the Muséum National d'Histoire Naturelle for making available the specimens discussed here. I especially thank Isabel Pérez-Farfante of the Systematics Laboratory, National Marine Fisheries Service, NOAA, National Museum of Natural History, for providing copies of several of the references. Isabel Pérez-Farfante, Brian Kensley of the National Museum of Natural History, Alain Crosnier, Anthony Futcher of Columbia Union College, and an anonymous reviewer read early versions of the manuscript. Their help is gratefully acknowledged.

References

ANDERSON, W. W., and LINDNER, M. J. 1945. A provisional key to the Family Penaeidae with especial reference to American forms. *Transactions of the American Fisheries Society* **43,** 284–319.

BABA, K., HAYASHI, K. I., and TORIYAMA M., 1986. *Decapod crustaceans from continental shelf and slope around Japan.* Tokyo: Japan Fisheries Resource Conservation Association, Tosho Printing Co., Ltd. pp. 467.

BARNARD, H. H. 1950. Descriptive catalogue of South African decapod Crustacea (crabs and shrimps). *Annals of the South African Museum* **38,** 1–837.

BOUVIER E. L. 1905. Sur les Pénéides et les Sténopides recueillis par les expéditions françaices et monegasques dans l'Atlantique oriental. *Comptes Rendus Séances Academie Sciences,* Paris **140,** 980–983.

BURKENROAD, M. D. 1934. The Penaeidea of Louisiana with a discussion of their world relationships. *Bulletin of the American Museum of Natural History* **68,** (2), 61–143.

BURKENROAD, M. D. 1936. The Aristaeinae, Solenocerinae and pelagic Penaeinae of the Bingham Oceanographic Collection: materials for a revision of the oceanic Penaeidae. *Bulletin of the Bingham Oceanographic Collection* **5,** (2), 1–152.

BURKENROAD, M. D. 1940. Preliminary descriptions of twenty-one new species of pelagic Penaeidea (Crustacea Decapoda) from the Danish Ocenographic Expeditions. *Annals and Magazine of Natural History* (11) **6,** 35–54.

CASANOVA, J. P. 1976. Crustacés décapodes pelagiques de la province Atlanto-Méditerranéene – Notes taxonomiques et biogeographiques. *Rapports et Proces-Verbaux des Reunions. Commission internationale pour l'Exploration scientique de la Mer Mediterranée* **23,** (9), 63–64.

CASANOVA, J. P., and JUDKINS, D. C. 1977. Les décapodes pelagiques en Mediterannée. Répartition et secteurs faunistiques. *Rapports et Proces-Verbaux des Reunions. Commission internationale pour l'Exploration scientifiques de la Mer Mediterranée* **24,** (10): 125–127.

CHACE, F. A., Jr. 1985. The caridean shrimps (Crustacea: Decapoda) of the *Albatross* Philippine Expedition, 1907–1910, Part 3: Families Thalassocarididae and Pandalidae. *Smithsonian Contributions to Zoology* **411,** 1–143.

CROSNIER, A. 1985. Crevettes pénéides d'eau profonde récoltées dans l'océan Indien lors des campagnes BENTHEDI, SAFARI I et II, MD 32/RÉUNION. *Bulletin du Muséum national d'Histoire naturelle, Paris, serie 4, Section A. Tome 7, no. 4*: 839–877.

CROSNIER, A., and FOREST, J. 1973. Les crevettes profondes de l'Atlantique orental tropical. *Faune Tropicale (ORSTOM)* **19,** 1–409.

DALL, W. 1957. A revision of the Australian species of Penaeinae (Crustacea Decapoda: Penaeidae). *Australian Journal of Marine and Freshwater Research* **8,** (2), 136–231.

DENTON, D. J., and GRAY, J. 1985. Lateral-line-like antennae of certain of the Penaeidea (Crustacea, Decapoda, Natantia). *Proceedings of the Royal Society of London, series B* **226,** 249–261.

FAXON, W. 1893. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U.S. Fish Commission Steamer 'Albatross' during 1891, Lieut. Commander Z. L. Tanner, U.S.N., Commanding, VI: Preliminary descriptions of new species of Crustacea. *Bulletin of the Museum of Comparative Zoology at Harvard College* **24,** 149–220.

FOXTON, P. 1969. The morphology of the antennal flagellum of certain of the Penaeidea (Decapoda, Natantia). *Crustaceana* **16,** (2), 33–42.

FOXTON, P. 1970. The vertical distribution of pelagic decapods (Crustacea, Natantia) collected on the Sond cruise 1965. II. The Penaeidea and general discussion. *Journal of the Marine Biological Association of the United Kingdom* **50,** 961–1000.

FUJINO, T. 1975. *Funchalia sagamiensis* sp. nov. from central Japan, with discusssion of the generic characters (Decapoda, Natantia, Penaeidae). *Crustaceana* **28,** (2), 200–210.

GORE, R. H. 1985. Abyssobenthic and abyssopelagic penaeoidean shrimp (Families Aristeidae and Penaeidae) from the Venezuela Basin, Caribbean Sea. *Crustaceana* **49,** (2), 119–138.

GORDON, I., and INGLE, R. W. 1956. On a pelagic penaeid prawn *Funchalia woodwardi* Johnson, new to the British fauna. *Journal of the Marine Biological Association of the United Kingdom* **35,** 475–481.

GRIFFITHS, F. B., and BRANDT S. B., 1983. Distribution of mesopelagic decapod Crustacea in and around a warm-core eddy in the Tasman Sea. *Marine Ecology – Progress Series* **12,** 175–184.

GRIPPA, G. 1976. *Funchalia woodwardi* Johnson, 1867 nelle acque di Sicilia, con osservazione sul genera. *Atti della Societa Italiana di Scienze Naturali del Museo Civico di Storia Naturale di Milano* **117,** (3–4), 117–136.

GRIPPA, G. 1987. A revision of gen. *Pelagopenaeus* Burkenroad, 1934 and *Funchalia* Johnson, 1867 (Crustacea, Decapoda, Penaeidea). *Investigación Pesquera* **51,** (Suppl. 1), 73–85.

HAYASHI, K. I. 1983. Prawns, shrimps and lobsters from Japan (9). Family Penaeidae. Genera *Atypopenaeus* and *Funchalia*. *Aquabiology* **5,** (1), 32–35. (In Japanese).

JOHNSON, J. Y. 1867. Description of a new genus and a new species of macruruous decapod crustaceans belonging to the Penaeidae discovered at Madeira. *Proceedings of the Zoological Society of London 1867*, 895–901.

KENSLEY, B. F. 1977. The South African Museum's *Meiring Naude* cruises. Part 5. Crustacea, Decapoda, Reptantia, and Natantia. *Annals of the South African Museum* **74,** (2), 13–44.

KENSLEY, B. F., TRANTER, H. A., and GRIFFIN, D. J. G. 1987. Deepwater decapod Crustacea from eastern Australia (Penaeidea and Caridea). *Records of the Australian Museum* **39,** (5), 263–331.

KIKUCHI, T., and NEMOTO, T. 1986. List of pelagic shrimps (Crustacea, Decapoda) from the western North Pacific. *Bulletin of the Biogeographical Society of Japan* **41,** (7), 51–59.

KIKUCHI, T., and OMORI, M. 1985. Vertical distribution and migration of oceanic shrimps at two locations off the Pacific coast of Japan. *Deep-Sea Research* **32,** 837–851.

KING, J. E., and IVERSEN, R. T. B. 1962. Midwater trawling for forage organisms in the central Pacific, 1951–1956. *Fishery Bulletin 62* (210), 1–132.

KRYGIER, E. E., and WASMER, R. A. 1975. Description and biology of a new species of pelagic penaeid shrimp, *Bentheogennema burkenroadi*, from the northeastern Pacific. *Fishery Bulletin* **73,** (4), 737–746.

KRYGIER, E. E., and WASMER, R. A. 1988. Zoogeography of pelagic shrimps (Natantia: Penaeidea and Caridea) in the North Pacific Ocean (with synopses and keys to the species of the Subarctic and Transitional Zones. *Bulletin of the Ocean Research Institute, University of Tokyo, No. 26*, (Part 1), 43–98.

MAUCHLINE, J., AIZAWA, Y., ISHIMARU, T., NISHIDA, S., and MARUMO, R. 1977. Integumental sensilla of pelagic decapod crustaceans. *Marine Biology* **43,** 149–155.

MILLER, D. G., AUGUSTYN, C. J., and HAMPTON, I. 1983. An unusual record of the prawn *Funchalia woodwardi* Johnson (Crustacea: Decapoda). *South African Journal of Marine Science* **1,** 175–180.

MONOD, T. 1972. Sur quatre crevettes du Pacifique Sud. *Cahiers du Pacifique* **16,** 7–29.

PEARCY, W. G., and HUBBARD, L. 1964. A modification of the Isaacs-Kidd midwater trawl for sampling at different depth intervals. *Deep-Sea Research* **11,** 263–264.

WASMER R. A. 1972. Zoogeography of pelagic shrimps (Natantia: Penaeidea and Caridea) in the North Pacific Ocean. Ph. D. dissertation, Oregon State University, Corvallis, pp. 232.

WASMER, R. A. 1974. A description of *Petalidium suspiriosum* Burkenroad, 1937 (Decapoda, Natantia). *Crustaceana* **27,** (2), 159–169.