Fujino, T. 1975

Reprinted from: CRUSTACEANA, Vol. 28, Part 2, 1975

LEIDEN
E. J. BRILL

Crustaceana 28 (2), 1975. E. J. Brill, Leiden

FUNCHALIA SAGAMIENSIS SP. NOV. FROM CENTRAL JAPAN, WITH DISCUSSION OF THE GENERIC CHARACTERS (DECAPODA, NATANTIA, PENAEIDAE)

BY

TAKAHIRO FUJINO

Zoological Laboratory, Kyushu University, Fukuoka, Japan

The present study is based upon a specimen in the collection of penaeid shrimps gathered in Sagami Bay, central Japan, under the auspices of His Majesty the Emperor of Japan. Because of the peculiar longitudinal keels on the carapace and the scythe-like incisor process of the mandible, this specimen is placed in the genus *Funchalia* Johnson of the subfamily Penaeinae. This genus at present consists of the following five species: *F. woodwardi* Johnson, 1867, *F. villosa* (Bouvier, 1905), *F. danae* Burkenroad, 1940, *F. taaningi* Burkenroad, 1940, and *F. balboae* (Faxon, 1893). These species are all pelagic and mainly distributed in the temperate Atlantic Ocean. Among them none have ever been reported in the North-West Pacific region. The present discovery of *F. sagamiensis* sp. nov. from central Japan, therefore, is a considerable extension of the known distribution of this genus.

The new species resembles the other members of this genus, but is distinguished by some significant morphological differences, namely, lack of exopods on the pereiopods, spines on the telson, and the absence of ischial and basial spines on the first two pereiopods. The significance of these differences is discussed in the present paper. For the inclusion of this species the genus as heretofore defined will need to be emended.

The author would like to thank the staff of the Biological Laboratory of the Imperial Household for allowing him to work with this interesting collection. The author is also greatly indebted to Dr. W. Dall of the Western Australian Marine Research Laboratories for his valuable suggestions and interest and for reading the manuscript. The author's thanks are further extended to Dr. B. F. Kensley of the South African Museum for kindly sending some South African specimens of *Funchalia woodwardi* to the author for this study.

Funchalia sagamiensis sp. nov. (figs. 1-3)

Description. — The rostrum is nearly horizontal, with the tip acute and feebly upturned, reaching as far forward as the distal end of the basal antennular segment. It is rather deep proximally and becomes considerably shallower in the distal half. On the dorsal carina of the rostrum there are six small teeth, the

proximal two of which are on the carapace behind the orbit. The hindmost tooth is the epigastric, separated from the posterior orbital margin by a distance equal to one-third the length of the rostrum. The foremost tooth is minute and located on the anterior third of the rostrum. The interval between the dorsal teeth becomes gradually shorter distally. The lower border of the rostrum is unarmed, but provided proximally with a conspicuous fringe of long plumose hairs. The lateral ridge is poorly marked. The postrostral carina is distinct, extending almost to the posterior margin of the carapace. The carapace is shallow in height, about twice as long as the rostrum, and is densely hirsute. The antennal angle terminates in a minute spine which is followed by a well-defined short carina reaching as far backward as the shallow vertically running groove in front of the hepatic spine. The anterior margin ventral to the antennal angle slopes sinuously downwards and backwards to a small branchiostegal spine where a short well-marked carina commences. The hepatic spine is small but distinct, followed by a rather conspicuous longitudinal keel which is divided at about the middle of the carapace into an upper longer and a lower shorter part; the former curves upwards and then becomes nearly horizontal, continuing backward to the anterior lateral carina on the first abdominal pleuron; the lower runs at an oblique angle for a short distance. A very shallow oblique sulcus runs a little below and is parallel to the frontal carina posterior to the hepatic spine.

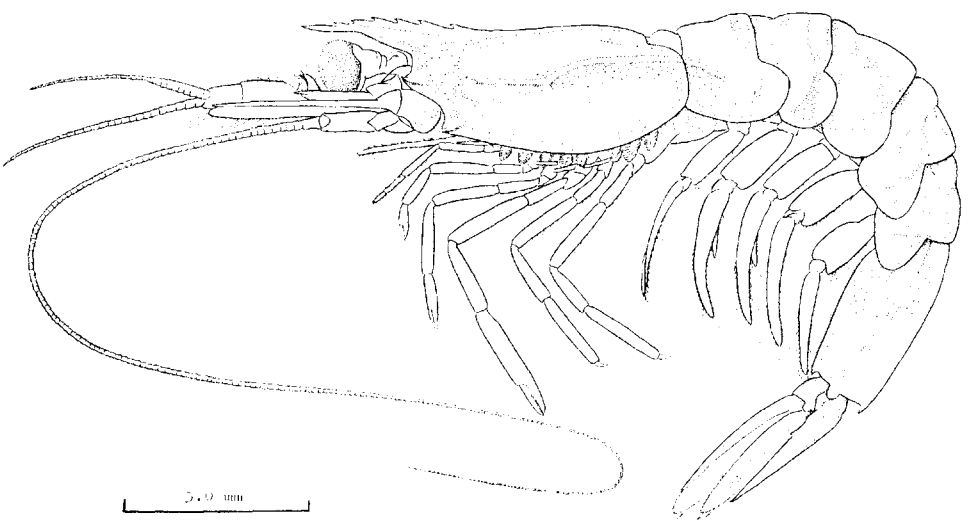

Fig. 1. *Funchalia sagamiensis* sp. nov., holotype.

The abdomen is slim and compressed. The first three somites are almost smooth dorsally, and the pleura of the first four are broadly rounded. In the fifth somite the pleuron is expanded posteriorly to a round lobe. The sixth somite is strongly compressed and elongate, equal to twice the length of the fifth; both the dorsal

and the ventral borders are slightly convex, tipped posteriorly with a small spinous tooth; midlaterally the posterior margin is produced into a round projection. A faint trace of a dorsal carina is found on the posterior two-thirds of the length of the fourth somite. A sharp dorsal carina runs on both the posterior portion of the fifth somite and the whole length of the sixth somite. There are sinuous or oblique transverse carinae and irregular depressions laterally on the first four somites. Midlaterally rises a well-defined carina which continues from the carapace to the anterior half of the first somite. A marked lateral carina lies on the posterior two-thirds the length of the fourth somite and continues to the end of the sixth. There is another short lower carina which diverges posteriorly from the upper on the sixth somite. Each of the first two abdominal sternites bears a well-developed median subconical spine whose tip is bent anteriorly at the base of the protopod of the pleopod. No particular structure of genital organ is visible.

The telson is slender, somewhat shorter than the sixth abdominal somite. It is markedly sulcate dorsally for its full length, and ends in a triangular median projection. The surface is covered with fine short modified setae which may be observed under high magnification. The lateral margin of the telson is somewhat expanded outwards at the proximal third to form a small lobular angled process, which fits into a shallow excavation at the base of the uropodal endopod. Posterior to this process the margin is fringed with plumose setae. On the lateral margins are two pairs of subterminal small movable and a pair of distal slightly larger immovable spines, the latter fail to reach the tip of the telson. On the subdorsal ridge there is a row of minute spines, which are approximately thirty in number, continuing from near the base to the posterior end of the telson.

The eyes are crowned by a large, hemispherical and thickened cornea, whose anterior surface when extended fails to reach as far as the level of the rostral apex. In the upper aspect the last article of the eye peduncle is subrectangular in outline, with an outer posterior shallow excavation. The next segment is subequal in length to the last article, but is much narrower; the upper surface is distinctly hollowed. The basal segment is divided anteriorly into two obtuse triangular projections which turn inwards.

The basal antennular segment is broad and subrectangular, barely surpassing the rostral apex; the upper surface is considerably excavated proximally for the reception of the eye; distolaterally a well-defined spine is present. The stylocerite is short, compressed and foliaceous, with the tip acute, extending as far forward as the proximal third of the basal segment. The prosartema is well-developed, slender, curved and directed anteriorly, with an obtuse tip reaching about the middle of the basal antennular segment. The second antennular segment is about half as long as the basal, with a marked dorsal carina; the lateral margin is somewhat expanded outwards into a narrow lobe. Both the outer and the inner borders are fringed with long setae. The third segment is depressed, distinctly shorter than the second. The upper and the lower flagella are cylindrical. The upper flagellum

is subequal in length to the three antennular segments combined. The lower flagellum is somewhat longer than the upper.

The basicerite of the antennal peduncle is robust, with a short lateral tooth. The carpocerite is short and stout. The long flagellum measures about one and half times the length of the body. The antennal scale barely reaches the end of the antennular peduncle; the lateral margin is feebly convex, tipped with a distinct tooth which just attains the anterior margin of the lamella; a curved dorsal sulcus runs nearer to the outer lateral margin than to the inner, just reaching the lateral final tooth.

The mouthparts on the right side have been dissected and examined. The incisor process of the mandible is a flattened scythe-like blade, and is to some degree arched; the basal portion is broad and suddenly diminishes distally to the acutely pointed tip; the outer border is gently curved and smooth, while the inner is angled at about the middle and further thinned away to the finely serrated edge. A trace of the molar process appears to be visible as a very obscure thickening, with a bunch of short fine bristles. The mandibular palp is broad, leaf-like and two-segmented; the basal segment is short and trapezoidal, its inner margin is slightly concave, while the outer is convex; the distal segment is much larger than the basal and ovoid in outline. The proximal gnathobasic lacinia of the maxillula is relatively small and directed inwards, bearing several plumose setae marginally. The distal lacinia is much larger than the proximal, slightly widened distally; there are a number of slender spines and many coarse setae on the distal border. A narrow, lamellar and segmented palp is present, it is directed sidewise; the basal segment is much longer and broader than the distal; just near the articulation of both segments there is a distinct spine inside. The maxilla has three narrow lobular endites; the anterior one is somewhat broader than the others. The well-developed palp bears a blunt top, with several minute spines on its inner border. The endite of the first maxilliped is divided by a small notch into an anterior broader and thinner, and a posterior narrower and thicker lobe; the posterior endite is produced proximally to form a round knob. The endopod consists of three segments; the basal segment is somewhat broadened basally and setiferous at the inner margin; the distal segment is somewhat longer and more slender than the penultimate. The exopod is foliaceous, elongate and blunt at the anterior end; thin marginal setae are present. The epipod is broad and rectangular, with both the anterior and the posterior ends narrow and blunt. The dactylus of the second maxilliped is narrow and oval. The propodus is about twice as long as the dactylus. Both these segments are provided with coarse long setae at the inner border. The merus is the longest, one and a half times the length of the propodus. A forked epipod is present. The third maxilliped is slender and pediform. The distal three segments are all subcylindrical. The dactylus tapers distally, it is slightly more than half as long as the propodus. The carpus measures about twice the length of the propodus. The merus is shorter than the carpus. The ischium is slightly longer than the merus. A vestigial claviform epipod is present.

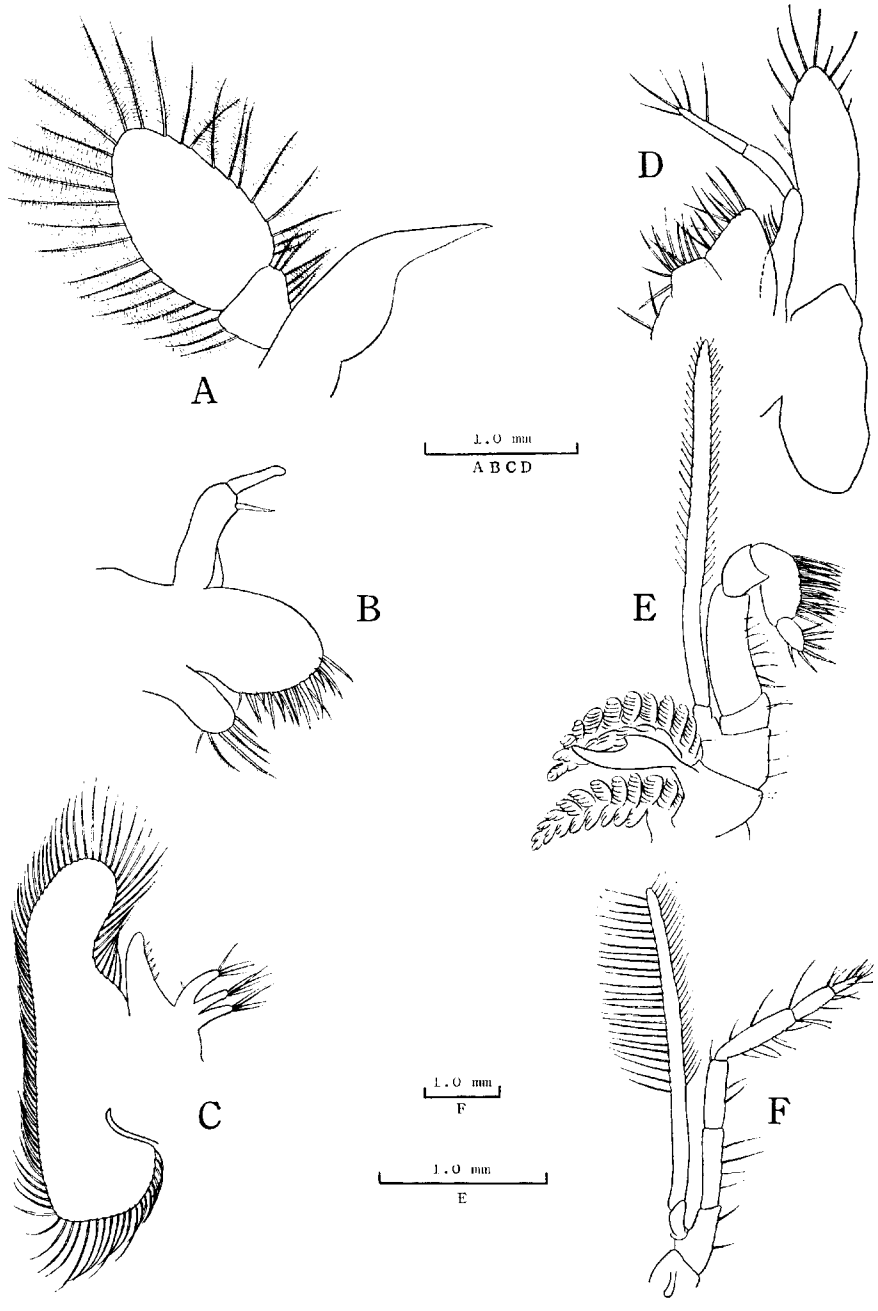

Fig. 2. *Funchalia saganiensis* sp. nov., holotype. A, mandible; B, maxillula; C, maxilla; D, first maxilliped; E, second maxilliped; F, third maxilliped.

The gill formula is tabulated below. The exopods are entirely absent from all the pereiopods. A rudimental arthrobranch is visible on the first maxilliped.

	I	II	III	IV	V	VI	VII	VIII
Pleurobranch			1	1	1	1	1	1
Arthrobranch	r	2	2	2	2	2	1	
Podobranch		1						
Mastigobranch	1	1	1	1	1	1		
Exopod	1	1	1					

The first pereiopods are rather short, nearly reaching the base of the antennal scale. The fingers are short, being half as long as the palmar portion; the cutting edges are finely serrated. The carpus is subequal to the merus in length and longer than the chela, with a row of coarse setae on the posterodistal border. No distinct spine is present on the ischium and the basis. The second pereiopods extend to the tip of the stylocerite. The chela is slender, elongate and cylindrical. The tips of the fingers are curved; on the cutting edges there are some small irregular teeth. The palm is twice as long as the dactylus. The carpus is elongate, longer than the chela, and subequal to the merus in length. Ischial and basial spines are absent. The third pereiopods are large and long, exceeding the distal end of the basal antennular segment by the length of the fingers. The fingers are narrow, with the tips recurved and pointed; five distinct triangular teeth are situated on the cutting edge of the immovable finger; the intervals between these teeth are wide, and the slightly smaller teeth on the movable finger fit into the spaces. The palm is elongate, cylindrical and a little less than twice as long as the fingers. The carpus is subequal to the palm in length. The merus is one and a half times the length of the carpus. The merus and the ischium are armed on the posterior border with some small spines. The fourth pereiopods extend to the distal end of the cornea. The dactylus is rather short, conical and gently curved to a sharply pointed tip. The propodus is about five times as long as the dactylus, with the posterior border almost smooth except for some minute spines. The carpus is two-thirds the length of the propodus, armed with a few spines posteriorly. The merus is equal to the propodus in length, the posterior border bearing four distinct spines.

Ventral to the middle of the posterior border of the protopod of the first pleopod there is a small lobular undeveloped endopod.

The uropods are elongate, much longer than the telson. The external margin of the exopod terminates in a large tooth.

Measurements (mm). — Body length, 33.7; carapace length, 7.0; rostrum length, 3.1; telson length, 4.6; length of chela of first pereiopods, 1.1; length of chela of second pereiopods, 1.9; length of chela of third pereiopods, 3.5.

Material examined. — Amadai-ba, Sagami Bay, central Japan, upper layer, Jun. 7, 1950, BLIH No. 543 — 1 specimen (holotype).

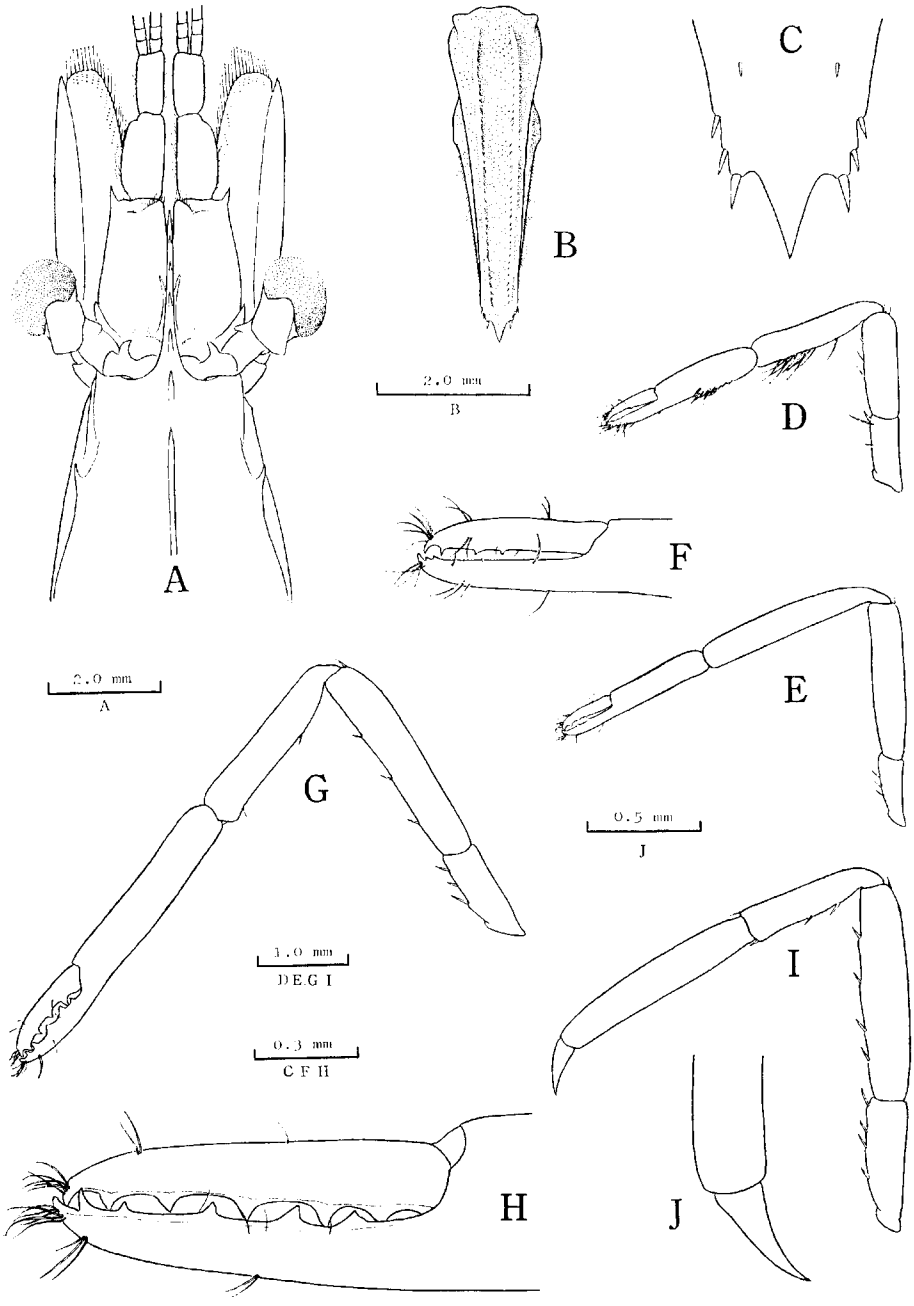

Fig. 3. *Funchalia sagamiensis* sp. nov., holotype. A, anterior part of body in dorsal view; B, telson; C, tip of telson; D, first pereiopod; E, second pereiopod; F, fingers of second pereiopod; G, third pereiopod; H, fingers of third pereiopod; I, fourth pereiopod; J, dactylus of fourth pereiopod.

Systematic position. — The new species *Funchalia sagamiensis* is readily distinguished from all other known forms by the characters already noted above, but appears to have the closest resemblance to *Funchalia woodwardi* Johnson. The latter species was not known from the Indo-Pacific region until Balss (1914) recorded it from the Indian Ocean. However, Gordon & Ingle (1956) suggested that this specimen might better be referred to *F. danae* Burkenroad. Both *Funchalia sagamiensis* and *F. woodwardi* are characterized in the adult by having a hepatic spine on the carapace and a short carina below the long mid-lateral carina on the sixth abdominal somite. *Funchalia sagamiensis*, however, may be readily discriminated from *F. woodwardi* by fewer dorsal rostral teeth, the size and shape of the chelae, the proportional length of each segment of the first three pereiopods, and the form of the dactyli of the last two pereiopods.

Discussion. — The definition of the genus *Funchalia* Johnson as well as the discussion on its relation with the other Penaeinae was first made by Bouvier (1908). Subsequently Burkenroad (1934, 1936) largely revised and emended the generic characters previously accepted, believing that there was a necessity for establishing a new subgenus *Pelagopenaeus* for *Funchalia balboae* (Faxon, 1893). The distinguishing characters between *Funchalia* s. s. and *Pelagopenaeus* listed by him, included rather ill-defined points. Gordon & Ingle (1956) mentioned in this regard that "this difference breaks down, at least in part, since the thelycum of his species *Funchalia danae* resembles that of *Pelagopenaeus*, and as moreover there are so few species in the genus, it seems to us that subgenera are unnecessary." In 1940 Burkenroad described two new species of this genus from the material of the Pacific Oceanographical Expedition, which made a total of five species throughout the world. After that, following Burkenroad (1934, 1936), Barnard (1950) and Dall (1957) each defined this genus, and the latter author gave a key to the species.

The present species *F. sagamiensis*, which is based upon a rather young specimen, as already mentioned, possesses the unique characters diagnostic of *Funchalia* as defined by the above authors, namely, three very characteristic lateral keels running longitudinally on the carapace, a mandible with an elongate scythe-like incisor process, a maxilla with a three-lobed endite, and a prominent lateral keel on both the fifth and the sixth abdominal somites. However, the present species shows three major differences from the definition of this genus.

1) In the present species, as described above, all the pereiopods are completely devoid of exopods, and this character seems to be a most remarkable one. According to Barnard (1950) and Dall (1957), having rudimentary exopods on all the pereiopods is one of the important generic characters of the genus *Funchalia*. *F. woodwardi*, some South African specimens of which were forwarded to the author for the comparison with the present species through the courtesy of Dr. B. F. Kensley, bears small, lamellar and jointed exopods on all the pereiopods, and they decrease gradually in length from anteriorly to posteriorly. The exopod of the

first pereiopod reaches a little beyond the distal end of the ischium, and that of the fifth scarcely extends to the middle of the same segment. Burkenroad (1936), however, happened to report the occurrence of a male adult specimen of *F. balboae* in which the exopod of the fifth pereiopod is completely absent, and a large specimen with a well developed one. In this connection, he noted that "the fifth exopod is delayed in reappearance longer than are the others, in postmysis stages of *Funchalia*."

2) The total absence of spines on both the basis and the ischium of the first two pereiopods. The presence of strong spines was hitherto regarded as a characteristic of the genus. In *F. woodwardi* these spines are rather conspicuous.

3) In all the forms of the genus *Funchalia* previously described there are three pairs of fixed subapical spines on the telson. The telson of *F. woodwardi* terminates posteriorly in a sharply pointed tip, with three pairs of rather well-defined, subequal and fixed spines which are close to each other laterally, and which are separated from the tip by a short distance. In the present species, however, the distal part ends in a triangular projection which is not so sharply pointed as in *F. woodwardi*. Subapically, two pairs of small movable, and a pair of slightly larger fixed spines are present, being situated close to one another.

These facts might suggest the appropriateness of emending the genus by redefining the generic characters for inserting the present seemingly atypical species. One of the peculiarities of *Funchalia*, however, is that characters, which are constant from juvenile to adult in other genera, appear to change during growth. The hepatic spine, the presence or absence of which is one of a great taxonomic importance, for example, is present in juvenile *Funchalia taaningi* Burkenroad, but absent in adult, while in *F. woodwardi* and *F. balboae* this spine persists in the adult. Burkenroad (1936) also pointed out the considerable variation in the number of the rostral spines in *F. villosa* with body size or age. Therefore, it seems not desirable to emend the genus on the basis of one immature specimen, particularly in the genus which changes so much from juvenile to adult. The redefinition of the genus is here to be withheld until more material is available.

There are a few records on the ecology of the genus *Funchalia*. Burkenroad in 1936 regarded this genus as a pelagic one, compared with the genus *Penaeus* a benthonic, littoral or sublittoral one. Gordon & Ingle (1956) recently described *F. woodwardi* from the Outer Hebrides, Great Britain. They quoted in their paper the collector's letter, in which it was noted that the shrimps were shown by echo sounder to be distributed in the deeper layers during the day, while swarming at the surface at night. This record seems very interesting because it revealed both the diurnal migration and abundance of this free-swimming species. The diurnal migration of *Funchalia* is reminiscent of that of *Gennadas* and other deep-water malacostracan crustaceans which were observed and examined to exhibit marked diurnal vertical migration by Waterman et al. (1939). The specimen of the present species was caught in the upper layers, probably in daytime, although the exact

depth is not certain. Dall (1957) inferred from some peculiar morphological characters of *F. villosa* (Bouvier), such as the scythe-like incisor process, talon-like dactyli of the fourth and the fifth pereiopods, the absence of teeth in the gastric mill, and its habit, that *Funchalia* may feed by piercing and sucking the body fluids of some inactive pelagic animals. In the other genera, the molar process of the mandible is usually well developed, with hard flat and well-calcified cutting edges for masticating solid foods.

The species of this genus have been mainly recorded from the temperate Atlantic Ocean. *Funchalia balboae* (Faxon) and *F. villosa* (Bouvier), however, are bioceanic species. The former was known from the American Pacific, as well as from the South Atlantic and the Caribbean Sea. Dall (1957) recorded *F. villosa* from Lord Howe Island, off eastern Australia, adding it to the hitherto known records from the South Atlantic and the Caribbean Seas. Balss (1914, 1925) and Ramadan (1938) recorded *F. woodwardi* from the Indian Ocean. Thus the known distribution of this species is the Mediterranean, North and South Atlantic and South Africa. Gordon & Ingle (1956) doubted this identification and referred the Indian Ocean material to *F. danae*. The discovery of the present species from Sagami Bay, central Japan, therefore, extends the geographical range of the genus *Funchalia* to the North-West Pacific region, where it was previously unknown.

ZUSAMMENFASSUNG

Funchalia sagamiensis sp. nov. (Decapoda Natantia) wurde in der Sagami Bucht entdeckt. Das Material dokumentiert den ersten Fund dieser Gattung in die Nord-West-pazifische Region. Die neue Art unterscheidet sich wesentlich von den anderen Arten der Gattung *Funchalia* durch einige wichtige morphologische Merkmale: (1) die vollständige Abwesenheit der Pereiopoden-Exopodite und des Dorns von Ischium und Basis der ersten zwei Beinpaare; (2) die Anwesenheit von zwei Paaren beweglicher subterminaler Dornen und einem Paar fester terminalen Dornen auf der Spitze des Telsons. Diese Unterschiede werden aus systematischer Sicht erörtert.

REFERENCES

BALSS, H., 1914. Diagnosen neuer Macruren der Valdiviaexpedition. Zool. Anz., **44**: 592-599.

——, 1925. Macrura der Deutschen Tiefsee-Expedition, 2. Natantia, Teil A. Wiss. Ergebn. 'Valdivia' Exped., **20** (5): 217-315, text-figs. 1-75, pls. 20-28.

BARNARD, K. H., 1950. Descriptive catalogue of South African decapod Crustacea. Ann. S. Afri. Mus., **38**: 1-837, figs. 1-154.

BOUVIER, E. L., 1908. Crustacés décapodes (Pénéidés) provenant des campagnes de l'Hirondelle et de la Princesse-Alice (1886-1907). Rés. Camp. sci., Monaco, **33**: 1-122, pls. 1-16.

BURKENROAD, M. D., 1934. The Penaeidae of Louisiana with a discussion of their world relationships. Bull. Amer. Mus. nat. Hist., **68** (2): 61-143, figs. 1-15.

——, 1936. The Aristaeinae, Solenocerinae and pelagic Penaeinae of the Bingham Oceanographic collection. Bull. Bingham oceanogr. Coll., **5** (2): 1-151, figs. 1-71.

——, 1940. Preliminary descriptions of twenty-one new species of pelagic Penaeidea (Crustacea Decapoda) from the Danish Oceanographical Expeditions. Ann. Mag. nat. Hist., (11) **6**: 35-54.

DALL, W., 1957. A revision of the Australian species of Penaeinae (Crustacea Decapoda: Penaeidae). Aust. J. mar. freshw. Res., **8**: 136-231, figs. 1-30.

GORDON, I. & R. W. INGLE, 1956. On a pelagic penaeid prawn, Funchalia woodwardi Johnson, new to the British fauna. J. mar. biol. Ass. U. K., **35**: 475-481, fig. 1.

RAMADAN, M. M., 1938. Crustacea: Penaeidae. John Murray Exped., sci. Rep., **5** (3): 35-76.

WATERMAN, T. H., NUNNEMACHER, R. F., CHACE, F. A., Jr., & G. L. CLARKE, 1939. Diurnal vertical migrations of deep-water plankton. Biol. Bull., Woods Hole, **76**: 256-279, figs. 1-6.

POSTSCRIPT

At the time that the present paper was in press, the author received from Dr. Th. Monod a reprint of his paper (Monod, 1972, Cahiers du Pacifique, 16 : 8-29) on four shrimps from the South Pacific. One of these shrimps, described as *Funchalia* sp., and taken between New Guinea and the Carolines, appears to be identical with *Funchalia sagamiensis* sp. nov.

Received for publication 6 February 1973.