

11557

A New Genus and Species of Marine Crayfish, *Palibythus magnificus*, and New Records of *Palinurellus* (Decapoda: Palinuridae) from the Pacific Ocean

P. J. F. Davie

Queensland Museum, P.O. Box 300, South Brisbane, Qld 4101, Australia.

Abstract

A new genus and species of marine crayfish, *Palibythus magnificus*, is described from deep water off Western Samoa. *Palibythus* is placed in the Palinuridae, among the 'Stridentes' group of genera, because of the well-developed stridulatory organ. It differs from all other known genera, except *Palinurellus*, by the flat triangular rostrum and the narrow thoracic sternum; *Palinurellus*, however, lacks a stridulatory organ. The relationships of *Palinurellus* are discussed and the Synaxidae is replaced in synonymy with the Palinuridae. *Palinurellus wieneckii* is recorded from New Guinea and Solomon Islands waters for the first time.

Introduction

In June 1989, Mr Bryan Smith of Annie's Seafood Pty Ltd, brought into the Queensland Museum a large crayfish that his company had recently obtained from Western Samoa. It appeared to be a new species of *Palinurellus*, a poorly known genus containing two species, only one of which is found in the Indo-Pacific region. The similarities in overall appearance were very great but the literature at my disposal was inadequate to allow a final decision. Dr L. B. Holthuis of Leiden very kindly sent me a copy of de Man's (1881, 1882b) description and figures of *Palinurellus wieneckii*, but it was only after I received some fine examples of *P. wieneckii* from Beatrice L. Burch of the Bernice P. Bishop Museum in Hawaii, that I realised that the large specimens from Western Samoa were, in fact, very different and had to represent a new genus. This has meant a re-evaluation of the systematic relationships of *Palinurellus*.

Curry (1955) has given a general account of physical geography of Western Samoa and his article shows the extent of reef around the islands. Western Samoa is composed of two main volcanic islands, Savaii and Upolu, between which flow strong currents. According to George (1972), upwelling, causing an area of enrichment, is suspected off the western part of Savaii.

The rock lobster resources of Western Samoa waters were reported by George (1972). He found, after reports and discussions with local fishermen, that only one species, *Panulirus penicillatus*, was present. This certainly suggests that *Palibythus magnificus* has been caught only recently as such a large crayfish would be likely to cause a great deal of interest.

While this paper was awaiting publication, a letter was received from M. de Saint Laurent of the Muséum National D'Histoire Naturelle, Paris. She said that, in about 1980, a French vessel had captured specimens that appeared to be the same as mine from the Tuamotu Archipelago, and she had obtained photographs which she forwarded to me. 'Je n'ai

malheureusement jamais pu obtenir le matériel, qui comprenait plusieurs exemplaires ...' Attempts to re-collect from that area have since been unsuccessful, as have been attempts in Western Samoa.

Abbreviations. c.l. = carapace length; c.b. = carapace breadth. Specimens are housed in the Queensland Museum, Brisbane (QM); the Australian Museum, Sydney (AM); and the Bernice P. Bishop Museum, Hawaii (BPBM).

Palibythus, gen. nov.

Type Species

Palibythus magnificus, sp. nov., by monotypy.

Diagnosis

Lack of strong armature on carapace and abdomen; dorsal covering of small blunt tubercles and felt of short setae; carapace with two short, submedian, post-rostral ridges and deep cervical grooves; broad, flat, triangular rostrum covering ophthalmic somite; well developed stridulatory organ formed by antenna and protruding antennular plate; eyes relatively small, produced laterally, partially covered by rostral plate; abdomen with median carinae, and acutely pointed abdominal pleural plates; thoracic sternum unarmed, lateral margins posteriorly converging; female first abdominal segment with pleopods; first pair of legs stouter than others but of similar form, unarmed except for small distal spine on merus; female fifth leg chelate. Male unknown.

Remarks

This genus differs from all other Palinuridae except *Palinurellus* Von Martens, 1878, by having a broad flat triangular rostrum covering the ophthalmic somite. It differs from *Palinurellus* by having a well developed stridulatory organ formed by the antenna and protruding antennular plate.

Etymology

The name is composed from the first four letters of the family name, Palinuridae, and *bythus*, meaning the depth or bottom of the sea. Gender is masculine.

Palibythus magnificus, sp. nov.

(Figs 1A, B; 3A, C; 4A; 5A)

Material Examined

Holotype. QM W16402, 1♀ (134.3 mm c.l. × 68.5 mm c.b.) off coast of Savaii, Western Samoa, trapped, Annie's Seafoods, 220–275 m, 3 May 1989.

Paratypes. QM W15941, 2♀ (136.9 × 67 mm; 131.4 × 67.5 mm), same data as holotype.

Description

Carapace. Covered by small, blunt tubercles; each tubercle with a semicircle of short setae anteriorly. Rostrum broad, slightly concave side to side, reaching to about level of base of fourth (second free) antennal segment; central triangular, subacute lobe, armed with 2–3 small, blunt accessory spines; strong subacute lateral spines reaching forward to about level of carapace anterolateral spines, with margins a little concave. Two poorly defined but definite, submedian, post-rostral ridges form a backward continuation of lateral margins of rostrum; reach slightly less than half way towards cervical grooves; separated from rostrum proper by deep sulci; each commences with strong subacute tooth; 1 or 2 more prominent tubercles present towards posterior end of each ridge. Orbital margin tuberculate, medio-posteriorly angled, lower margin forming large, triangular, acute spine on much lower plane than rostrum; outer margin of this spine with 1 strong accessory spine and several accessory tubercles. Behind anterolateral spines carapace noticeably constricted, then convex, then constricted again at cervical groove. Margin behind anterolateral spines with 2–3 small subacute spines, largest anteriorly. Cervical sulcus with smooth floor; distinctly incised over

whole length from dorsal surface to buccal frame. Posterolateral carapace convex, unarmed, with ill-defined rounded longitudinal crest visible laterally. Deep transverse groove anterior to posterior margin.

Abdomen. Smooth median carinae present on first to fifth segments; on first, very small and restricted to posterior part. Entire dorsal surface covered, like carapace, in small tubercles and felt of fine setae. First segment with deep transverse groove separating smooth anterior part from tuberculate posterior part of somite; this separation repeated to lesser extent on second segment, but less sharply defined on following segments. First pleural plate with anterior edge pronounced, smooth, convex, ending in single tooth ventro-medially. Second pleural plate with anterior edge less convex; armed with small sharp tubercles; ending in large posteriorly directed tooth; posterior margin with deep, broad, concavity above ventral tooth, and above this, a more-or-less straight row of small sharp tubercles; behind anterior edge a distinct groove meets posterior margin above ventral tooth. Third to fifth pleural plates of similar form; anterior edge concave, armed with row of small tubercles; below frontal concavity ventral margin oblique, straight, with two larger pointed tubercles anteriorly, the whole becoming a large, broad, posteriorly directed tooth; posterior edge with broad, deep concavity with a straight row of pointed tubercles above, as on second segment. Sixth somite without median carina; posterior margin broadly concave until articulation with telson; bearing row of c. 7 sharply pointed denticles, with lateral pair being slightly larger, and a number of smaller accessory granules. Telson unarmed except for pair of sharp posterolateral denticles on hard calcified portion, and 1-2 smaller denticles medially; lateral borders of calcified portion subparallel.

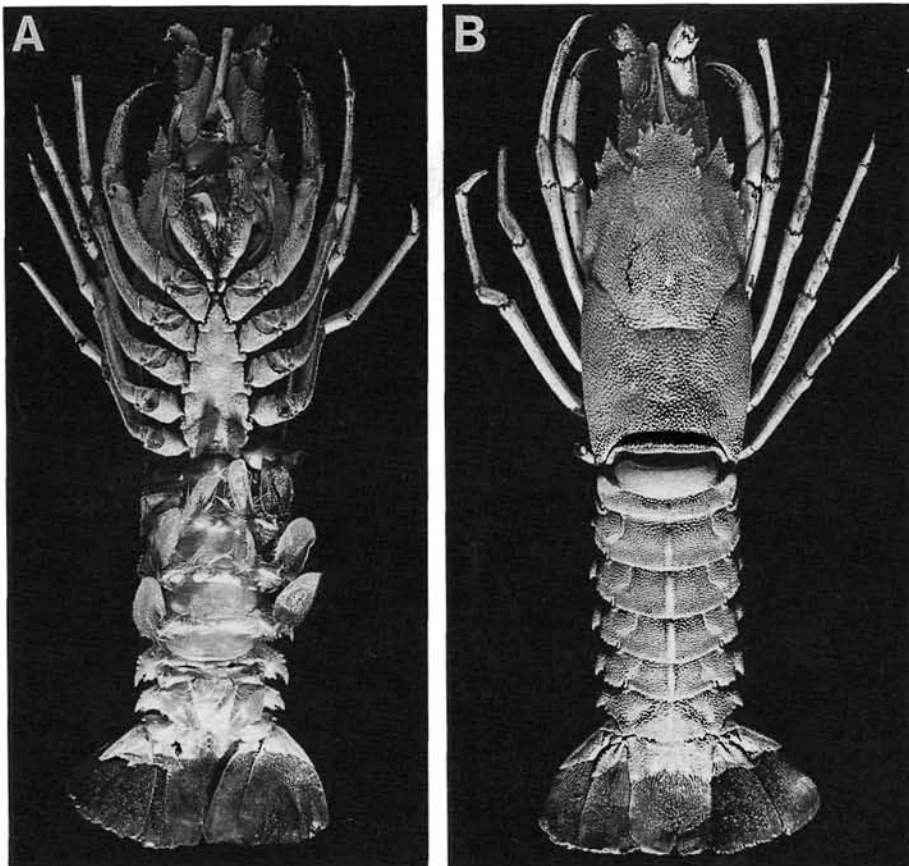


Fig. 1. *Palibythus magnificus*, holotype, c.l. = 134.3 mm. A, ventral view; B, dorsal view.

Eyes relatively small, longer than broad, peduncle medially constricted; cornea rounded, occupying about half length of dorsally visible eyestalk. Eyestalks partially covered by the broad rostral plate.

Antennular plate protruding (as in *Panulirus*), armed with stout pair of lateral spines; lateral ridges bear an oblique, flat, smooth, elongated, stridulating surface, along which slides a broad process from first antennal segment.

Third (first free) antennal segment the longest and armed on outer margin with a few sharp tubercles and 2 small apical spines, one above the other; inner portion with deep narrow sulcus from which arises the stridulatory lobe; inner margin extremely produced anteriorly such that next segment has long, oblique insertion and articulates laterally rather than up and down. Second free antennal segment triangular, armed apically with a number of small spinules, and 2 larger spines on outer distal margin. Third free segment much shorter, subquadrate. Flagellum unknown.

Epistome strongly produced forward, narrowing quickly to a blunt bifid tip; anterior lobes of molars applied laterally along length.

Third maxilliped with basis and ischium fused; inner margins of ischium, merus and distal end of basis, with a series of strong, acute, triangular, dark tipped teeth. Basis/ischium *c.* 2.8 times longer than wide; merus *c.* 2.5–2.6 times longer than wide. Exopod slender, flagellum reaching from just before distal end of ischium to about level of merocarpal joint. Branchial formula is in Table 1. Epipods on all but fifth legs.

Table 1. Branchial formula

Appendage	Maxillipeds			Pereiopods				
	I	II	III	I	II	III	IV	V
Pleurobranchs	—	—	—	—	1	1	1	1
Arthrobranchs	—	1	2	2	2	2	2	—
Podobranchs	—	1	1	1	1	1	1	—

First leg stouter than others but of similar form; all legs unarmed except for small spine on outer distal end of merus just below articulation with carpus; upper distal margin of carpus produced into small rounded lobe. First leg with dactylus *c.* 0.8 times length of propodus (measured along superior margins) and about equal in length to carpus; propodus relatively long, *c.* 3 times longer than wide; merus a little more than 5 times longer than wide.

Last four legs slender and of similar length; dactyli about a half or less length of propodi; merus of second leg slightly more than 8 times width. Dactyl of fifth leg in the female with large accessory hoof-shaped lobe basally forming a chela in conjunction with a similar ventral prolongation of the propodus; dactyl much reduced, only about $\frac{1}{4}$ length of propodus; propodus slender (over 10 times longer than wide), slightly curved.

Thoracic sternum bears a single small spine medially on concave posterior margin; transversely concave; relatively narrow; anteriorly triangular but with a deep sulcus separating a small raised knob lying in the mid-line between the coxae of the third maxillipeds and first pair of legs; margins diverge posteriorly but converge again between coxae of last pair of legs which are still well separated.

Female first abdominal somite with vestigial pleopods; exopod has long narrow blade, endopod is obsolete. Remaining pleopods of similar form with large leaf-shaped exopods and well developed endopods. Endopods most resemble those of *Palinustus* and *Palinurellus*; blade about half width of exopod, nearly as long, subrectangular, *c.* 3.5 times longer than wide; a protuberance on basal part of inner margin bears a slender stylamblys about $\frac{1}{4}$ of length of endopod proper; margins of all segments unarmed except for fine setae.

Distribution

Western Samoa, southwestern Pacific. This species probably extends eastwards to the Tuamotu Archipelago as photographs sent to me by M. de Saint Laurent of a specimen captured from 250–300 m depth in that vicinity are almost definitely of this species.

Palinurellus wieneckii (de Man, 1881)

(Figs 2A, B; 3B, D; 4B; 5B)

Araeosternus wieneckii de Man, 1881: 131.*Araeosternus wieneckeii*.—de Man, 1882a: 1, pls 1, 2.*Palinurellus wienecki*.—de Man, 1882b: 162.*Palinurellus wieneckii*.—Bouvier, 1915: 186, pl. 7, fig. 2.*Palinurellus gundlachi* var. *wieneckeii*.—Holthuis, 1946: 109, 114–15, pl. 11, fig. o; Sakai, 1971: 4, fig. 3.*Palinurellus wieneckii*.—Holthuis, 1966: 261; Baba & Shokita, 1984: 117, fig. 1; Titgen & Fielding, 1986: 294–5.

Synonymy prior to 1966 abbreviated; see Holthuis (1966) for full synonymy.

Material Examined

BPBM S10615, 1♀ (c.l. 67.8 mm), near Puako, Hawaii, 10.7 m, cave along vertical base, 46 m back in, narrow but wide, 16.x.1980, S. Jazwinsky. BPBM S10616, 1♂ (c.l. 69.3 mm), off Kahe Pt, Oahu, 10 m, deep inside a tunnel at night, mid December 1978, S. Jazwinsky. AM P19340, 1♀ (c.l. 31.5 mm), N. end of Kiriwinna (Trobriand) Is., Solomon Sea, Papua New Guinea, poison station,

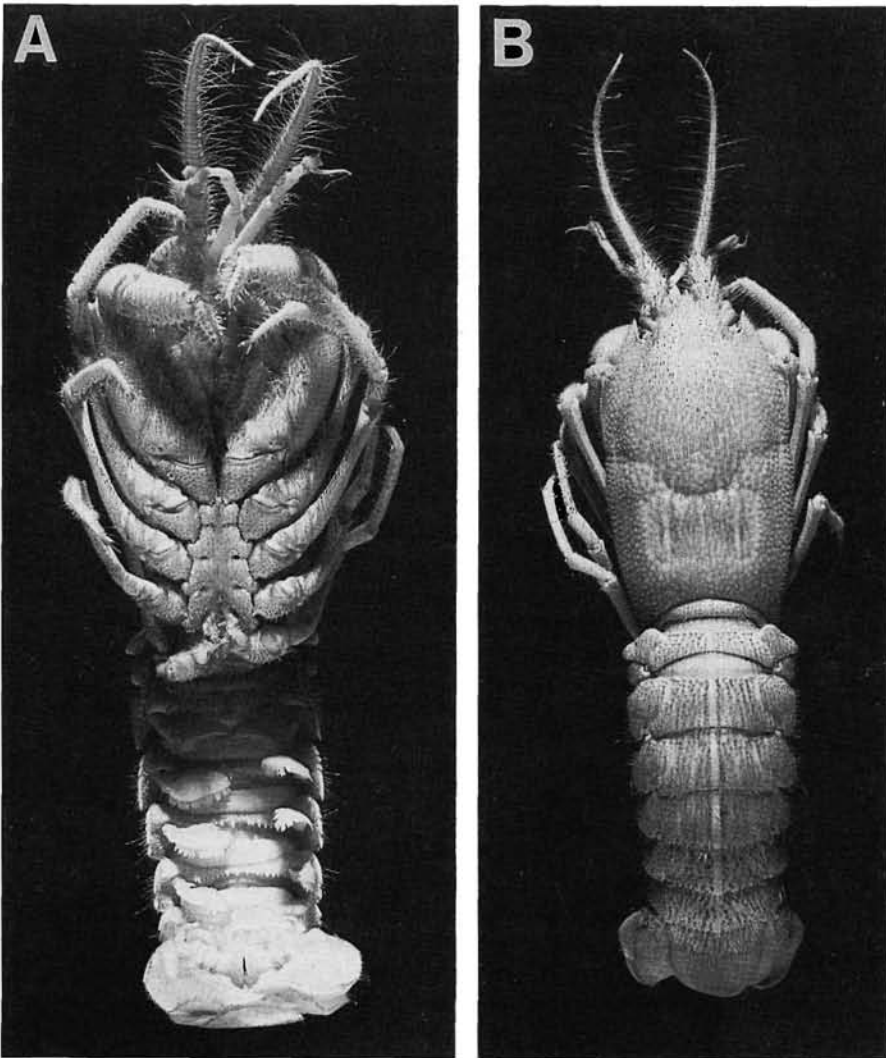


Fig. 2. *Palinurellus wieneckii*, male (BPBM S10616), c.l. = 69.3 mm. A, ventral view; B, dorsal view.

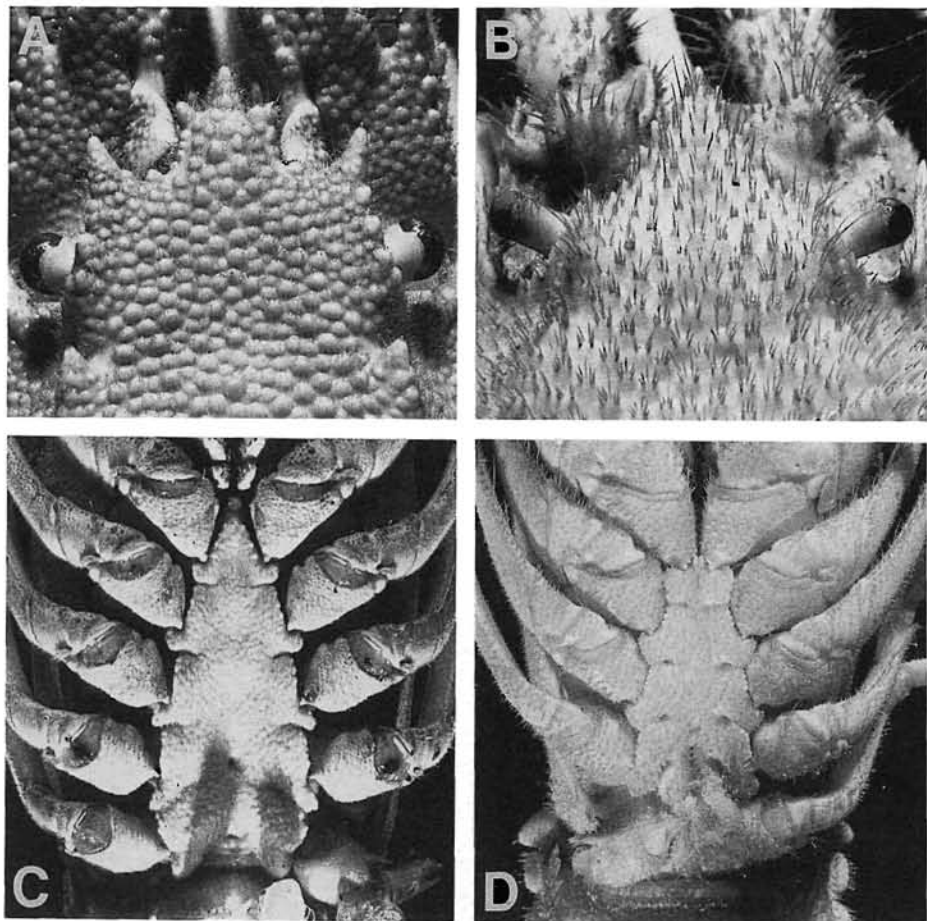


Fig. 3. A, C, *Palibythus magnificus*, holotype. B, D, *Palinurellus wieneckii*, male (BPBM S10616). A, B, enlargement of rostrum; C, D, enlargement of sternum.

7.vi.1970, coll. Collette, Goldman & Palmer. AM P19972, 1♂ (c.l. 40.0 mm), S.W. side of Savo Island, Solomon Islands (N.W. of Guadalcanal), rotenone stn, 5–10 m, amongst coral, 18.vii.1973, B. Goldman.

Remarks

This species has been adequately described by de Man (1881), Holthuis (1946), and Titgen & Fielding (1986). Some additional description is given in the 'Discussion' in this paper. The figures provided here help to illustrate the differences between *Palinurellus* and *Palibythus*. Of the material examined, the two specimens from Hawaii have been previously reported on by Titgen & Fielding (1986). The specimen from New Guinea and that from the Solomon Islands represent new locality records, although they are within the known range.

Distribution

Pulu Tikus, Sumatra (type locality); Mauritius; Danawan Island, N.E. Borneo; Ifaluk Atoll, Caroline Islands; New Caledonia; Ryukyu Islands; ? Durban, South Africa; Hawaiian Islands [see Titgen & Fielding (1986) for authorities]. Now from Trobriand Is., Solomon Sea, and from the Solomon Islands.

Discussion

The narrow thoracic sterna suggest a close relationship between *Palibythus* and *Palinurellus*. De Man (1881) clearly felt this to be an important and unique character when

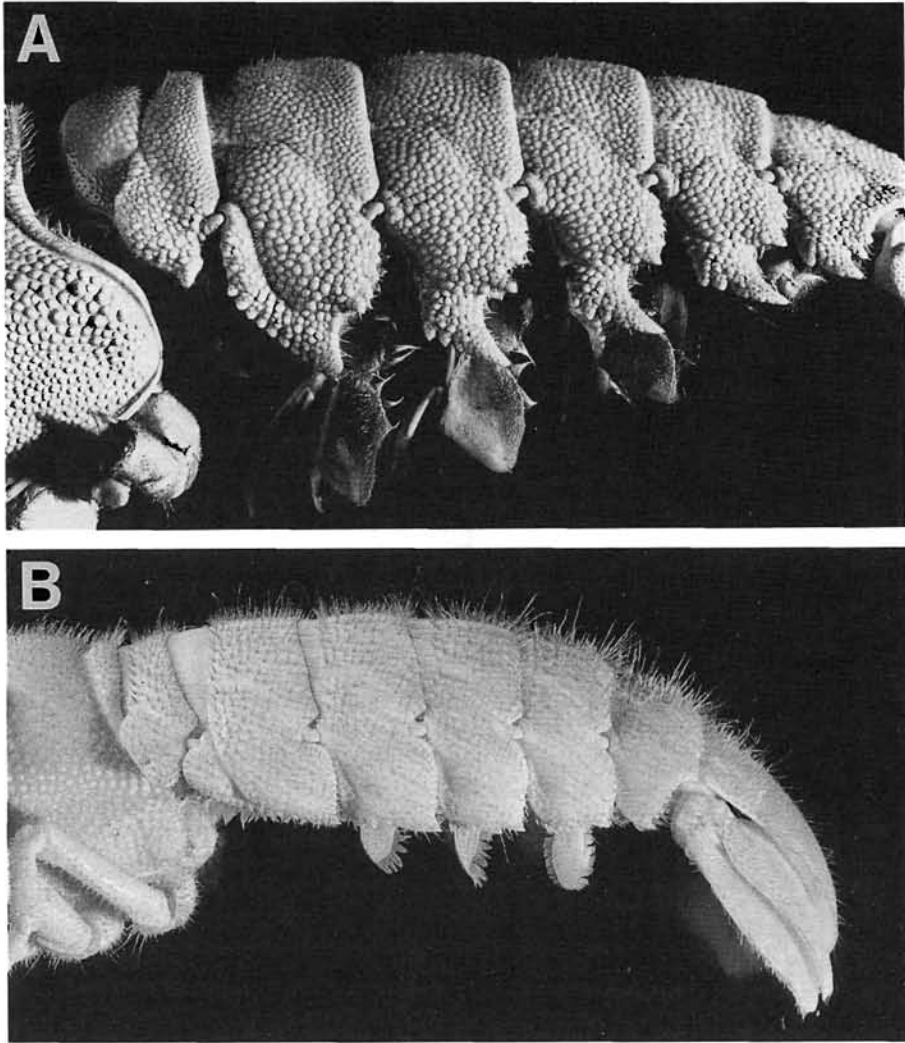


Fig. 4. Lateral views of abdominal terga of: A, *Palibythus magnificus*, holotype; B, *Palinurellus wieneckii*, male (BPBM S10616).

he proposed the generic name *Araeosternus* for what is now known as *Palinurellus wieneckii*. George & Main (1967) considered *Palinurellus* to be in the family Synaxidae Bate, 1881, and away from the evolutionary line of the Palinuridae, and agreed with de Man (1881, 1882a), Bate (1881), and Boas (1882) in this separation. They quoted Bate (1881, p. 226) 'The eyes are those of the Scyllaridae; the second pair of antennae are those of the Palinuridae. The legs are common to both forms, and the carapace belongs to neither. The frontal region resembles neither; and the posterior resembles both, as also does the pleon, whereas the pleopoda are modelled on the type of those of the Scyllaridae, and the tail fan is that of both.' This statement is entirely comparative and without further evidence, is a poor basis for a family definition. Recent authors have used the Synaxidae without further discussion (Bowman & Abele 1982; Schram 1986; Titgen & Fielding 1986).

It has been argued that the Synaxidae and the Palinuridae evolved separately from the Pemphicidae in the early Mesozoic (Glaessner 1960; George & Main 1967). George & Main resurrected the *Silentes* and *Stridentes* within the Palinuridae with the comment that the 'emergence of the *Stridentes* from the pemphicid stock occurred early in the fossil record of the family since the *Stridentes Palaeopalinurus* was already developed in the Jurassic'. 'We consider it most unlikely that dislocation and relocation of the antenna to the

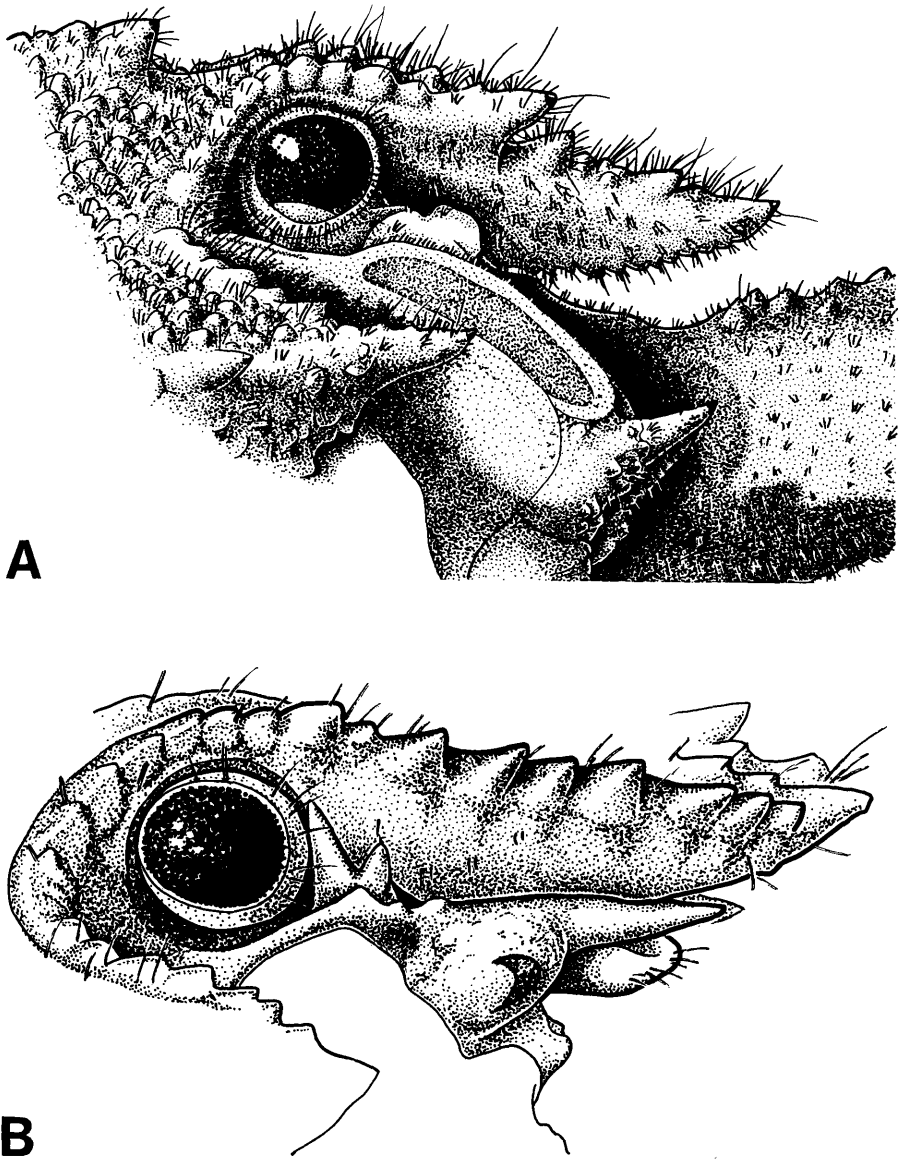


Fig. 5. Lateral view of orbital regions and antennular plates of: A, *Palibythus magnificus*, paratype; B, *Palinurellus wieneckii*, female (AM P19972).

antennular plate has occurred more than once in the history of the family. Our conclusion that the development of a "stridulating line" from a nonstridulating stock is also supported by palaeontological evidence ... which shows that the two lines were present at an early stage of palinurid development' (p. 804).

Palibythus, gen. nov. causes some difficulty in accepting the above hypothesis because of the fact that it has such a strongly developed stridulatory organ and yet in many features appears to be most closely related to *Palinurellus*, a genus without a stridulatory capacity. There is some cause for regarding *Palinurellus* and *Palibythus* as representing a separate family, and yet the argument that such a typical palinurid stridulatory organ could have evolved independently within two families is difficult to accept. The most acceptable action is to put *Palinurellus* back into the Palinuridae and to also include *Palibythus* in this family. Indeed, both *Palibythus* and *Palinurellus* share a number of characters in common with *Projasus*, including the possession of a median carina on the abdominal terga. This carina

is, however, also present to some extent on other palinurids such as species of *Linuparus* and *Puerulus*.

Palinurellus wieneckii, although not having a stridulatory organ, does show the type of structure which could be the forerunner of the stridulatory organ of *Palibythus* and other palinurids (Fig. 5B).

Palinurellus shares in common with *Jasus* and *Projasus* a calcified structure on the median frontal part of the ophthalmic somite. In *Jasus* and *Projasus* this takes the form of a pedate clasping structure which is applied to the sides of the rostrum. In *Palinurellus*, the leading edge of the ophthalmic somite is hidden completely behind the downward, ventrally expanded, keel of the rostrum, and the lateral spines of the antennular plate (see Fig. 5B); the analogue of the clasping structure of *Jasus* and *Projasus* no longer clasps but instead takes the form of lateral spines (sometimes bifid) which project, from within the ocular sockets, laterally in front of the eyestalks. The rostrum is gripped by a long, sharp spine on either side of the keel above the ventral expansion, but these spines arise from the antennular plate, not from the ophthalmic somite, and do not appear to be analogous with any structures in other genera.

Palibythus has a clasping structure on the ophthalmic somite similar to those of *Jasus* and *Projasus*, but it is much reduced and visible only beneath the rostrum where it meets the slight keel on the lower surface of the rostrum.

In a number of features *Palibythus* resembles *Palinustus* [viz. *P. mosambicus* (see Barnard 1950)], particularly in the shape of the endopod of the pleopod of the second abdominal segment (see George & Main 1967) and by the presence of pleopods on the first abdominal segment of the female. Only *Palinustus* and *Palinurellus* (as well as *Palibythus*) are known to have this character amongst the Palinuridae (see Barnard 1950, p. 545).

It would seem that the 'Silentes' genera, *Jasus* and *Projasus*, are strongly removed from *Palinurus* and this has already been concluded by George & Main (1967) and earlier workers (Parker 1883, 1884); however, it is remarkable how superficially similar these three genera are in carapace shape and armature. The supra-ocular horns must have evolved independently as a response to the loss of the rostrum. The rostrum would be lost as a means of gaining greater mobility and forward projection for the enlarged eyes; dorsally projecting supra-ocular spines would therefore be an advantage for ocular protection.

Palinurellus should be considered as a primitive palinurid perhaps started along the lineage that led to the 'Stridentes' genera, or as an early offshoot. *Palibythus* also shows many primitive features suggesting a Pemphicidae ancestor—small eyes, broad flat rostrum, relatively narrow sternum, enlarged stout first legs, etc.—but has the advanced stridulatory apparatus which places it firmly on the mainstream line of the Palinuridae (Stridentes).

Palinurellus wieneckii is a shallow-water reef species living deep within caves, is apparently only nocturnally active, and therefore has been only rarely collected. *Palibythus magnificus*, in contrast, inhabits relatively deeper waters and, although five other palinurid genera are known from depths greater than 100 m, they are represented by comparatively few species (see George & Main 1967). The major marine crayfish radiation has occurred within the genus *Panulirus* (about 19 spp.) in shallow tropical/subtropical waters. George & Main (1967, pp. 808–9) express the opinion that there is 'an evolutionary trend in the Palinuridae from the relatively stable conditions of the deeper waters to the more varied and fluctuating conditions of the shallow waters'. They make the point that: 'Most of the marine fossil deposits have been described from shallow water faunas. Little is known of the ancient faunas which lived in the deeper waters since these are rare in fossil deposits. Perhaps the fossils known today represent specialised shallow water species which died out at that time and the actual ancestors of the modern fauna survived in deeper, cooler waters and were not directly represented in the fossil deposits'. Under this hypothesis, *Palibythus* would represent an ancestral form which has survived in deep water in a remote locality in the Pacific.

This view may, however, be a little too simplistic, and the evolutionary direction within the Palinuroidea may instead have been towards a retreat into deeper waters. For example, *Linuparus* spp. are now considered to be deep-water inhabitants and yet apparently underwent a significant radiation in relatively shallow waters during the Cretaceous and early Tertiary.

Glaessner (1969, p. 425) states, 'The present bathyal decapod fauna comprises, among others, many Penaeidae, Caridea, all living Eryonoidea, some Nephropidae, Lithodidae, Galatheididae, and crabs belonging to the Homolodromiinae (all), Dorippidae, Majidae, Geryonidae, and Retroplumidae. Many of these taxa have fossil representatives in assemblages which indicate shallow-water conditions, particularly Penaeidae, Eryonoidea, . . . Beurlen (28) has shown convincingly that the Eryonoidea and Prosopidae retreated to deep water at the end of the Jurassic; many Nephropidae followed at the end of the Cretaceous, and Geryonidae in the Tertiary. . . . Beurlen has suggested that the cause of these changes of habitat is extensive regressions at critical times, reducing the extent of the shelf seas in which these decapods had flourished. The regression of the Nephropidae, which are abundant Jurassic and Cretaceous fossils and reduced in numbers during the Tertiary, coincides with the increase of Brachyura in the littoral habitat and was probably the result of competition.'

The seemingly 'primitive' forms like *Palinurellus* and *Palibythus* may well have evolved in shallow tropical waters rather than in deeper water which is the logical extension of the arguments of George & Main (1967). The extensive tropical distribution of *Palinurellus wieneckii* reinforces this idea. The unusual habitat of living in caves deep within the reef such that they are probably in continual darkness, may have allowed this species to survive competitive or predatory pressures which caused members of other genera to retreat into deeper water.

Acknowledgments

I am very grateful to Bryan Smith of Annie's Seafood for the donation of specimens of *Palibythus*, and to Beatrice L. Burch of the Bernice P. Bishop Museum, and Penny Berents of the Australian Museum for the loan of specimens of *P. wieneckii*. Dr L. B. Holthuis very kindly sent me copies of figures and descriptions of *P. wieneckii*, and made valuable criticisms on the manuscript. Dr M. de Saint Laurent generously sent colour photographs of a *Palibythus magnificus* from Tuamotu Archipelago, French Polynesia, as well as extra distributional data. Dr Bob Domrow is thanked for his advice on nomenclature. Gary Cranitch took the photographs and Lynette Kirwan typed the manuscript. Finally, I am particularly grateful to Ms Clare Bremner for her wonderful illustrations.

References

- Baba, K. & S. Shokita. 1984. *Palinurellus wieneckii*, a rare species of spiny lobster found in Okinawa-Jima of the Ryukyus (Crustacea: Decapoda: Palinuridae). *Galaxea* 3, 117-18.
- Barnard, K. H. 1950. Descriptive catalogue of South African decapod Crustacea. *Annals of the South African Museum* 38, 1-864.
- Bate, C. S. 1881. On *Synaxes*, a new genus of Crustacea. *Annals and Magazine of Natural History*, series 5, 7, 220-8.
- Boas, J. E. V. 1882. Die Gattung *Synaxes* Sp. Bate. *Zoologische Anzeiger* 1882, 111-14.
- Bouvier, E. L. 1915. Décapodes marcheurs (Reptantia) et stomatopodes recueillis à l'île Maurice par M. Paul Carié. *Bulletin Scientifiques de la France et la Belgique Ser. 7*, 48, 178-318, pls 4-7.
- Bowman, T. E. & L. G. Abele. 1982. Classification of the recent Crustacea. Pp. 1-27 in: 'The Biology of Crustacea'. Vol. 1. (Ed. L. G. Abele.) (Academic Press: New York.) 319 pp.
- Curry, L. 1955. The physical geography of Western Samoa. *New Zealand Geographer* 11(1), 28-52.
- de Man, J. G. 1881. Carcinological studies in the Leyden Museum. No. 1. *Notes of the Leyden Museum* 3, 121-44.
- de Man, J. G. 1882a. On the genus *Araeosternus* de M. *Notes of the Leyden Museum* 4, 161-2.
- de Man, J. G. 1882b. *Araeosternus wieneckei* n.g. n.sp. eene nieuwe vorm in de familie der Loricata. *Tijdschrift voor de Entomologie* 25, 1-6, pls 1, 2.
- George, R. W. & J. R. Grindley, 1964. *Projasus*—a new generic name for Parker's crayfish, *Jasus parkeri* Stebbing (Palinuridae: 'Silentes'). *Journal of the Royal Society of Western Australia* 47(3), 87-90.
- George, R. W. & A. R. Main. 1967. The evolution of spiny lobsters (Palinuridae): a study of evolution in the marine environment. *Evolution* 21, 803-20.
- George, R. W. 1972. 'South Pacific Islands—Rock Lobster Resources.' A report prepared for the South Pacific Islands Fisheries Development Agency. (F.A.O.: Rome.)

- Glaessner, M. F. 1960. The fossil Decapoda Crustacea of New Zealand and the evolution of the Order Decapoda. *New Zealand Department of Scientific and Industrial Research, New Zealand Geological Survey, Paleontological Bulletin* 31, pp. 1-79, 7 pls.
- Glaessner, M. F. 1969. Decapoda. Pp. R399-R533 in: 'Treatise on Invertebrate Palaeontology'. Part R, Arthropoda 4, Volume 2. (Geological Society of America: Boulder, Colorado; University of Kansas Press: Lawrence.)
- Holthuis, L. B. 1946. Biological results of the Snellius Expedition. XIV. The Decapoda Macrura of the Snellius Expedition. I. The Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. *Temminckia* 7, 1-178.
- Holthuis, L. B. 1966. On spiny lobsters of the genera *Palinurellus*, *Linuparus* and *Puerulus* (Crustacea Decapoda, Palinuridae). Pp. 260-78 in: 'Symposium Series of the Marine Biological Association of India'. No. 2. Proceedings of the Symposium on Crustacea, part 1.
- Parker, J. J. 1883. Notes from the Otago University Museum IV.—On the structure of the head in 'Palinurus', with special reference to the classification of the genus. *Nature, Dec. 20* 1883, 189-90.
- Parker, J. J. 1884. On the structure of the head in *Palinurus* with especial reference to the classification of the genus. *Transactions of the New Zealand Institute* 16, 297-307.
- Sakai, T. 1971. Notes from the carcinological fauna of Japan (IV). *Researches on Crustacea* 4/5, 1-19.
- Schram, F. R. 1986. 'Crustacea.' pp. i-xiv, 1-606. (Oxford University Press: Oxford.)
- Titgen, R. H. & A. Fielding. 1986. Occurrence of *Palinurellus wieneckii* (de Man, 1881) in the Hawaiian Islands (Decapoda : Palinura : Synaxidae). *Journal of Crustacean Biology* 6(2), 294-6.