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A new species of *Solitariopagurus* Türkay (Decapoda, Anomura, Paguridae) from French Polynesia

by Joseph POUPIN & Patsy A. MCLAUGHLIN

Abstract. — A new species of *Solitariopagurus* is described and illustrated from specimens collected in the deep waters of French Polynesia. *Solitariopagurus triprobolus* sp. nov. is compared with *S. profundus* Türkay, the only other species described in the genus, and with species of potentially related genera that use specialized microhabitats.

Key-words. — Decapoda, Paguridae, *Solitariopagurus triprobolus* sp. nov., French Polynesia.

Une nouvelle espèce de *Solitariopagurus* Türkay (Decapoda, Anomura, Paguridae) de Polynésie française

Résumé. — Une nouvelle espèce de *Solitariopagurus* est décrite et illustrée à partir de matériel profond récolté en Polynésie française. *Solitariopagurus triprobolus* sp. nov. est comparé avec *S. profundus* Türkay, la seule autre espèce du genre, et avec des espèces de genres voisins qui utilisent également des coquilles de bivalves.

Mots-clés. — Decapoda, Paguridae, *Solitariopagurus triprobolus* sp. nov., Polynésie française.

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INTRODUCTION

Solitariopagurus Türkay, 1986 was proposed for a singularly distinctive hermit crab species collected from depths in excess of 1400 m in the Red Sea. In having only 10 pairs of phyllobranch gills, and males lacking all pleopods, TÜRKAY (1986) related the genus to the *Ostraconotus* group of SAINT-LAURENT (1968), particularly to *Ostraconotus* A. Milne Edwards, 1880. The extensive, albeit not complete, calcification of the carapace of *Solitariopagurus* suggested to TÜRKAY (1986) that it might hold an intermediate position between *Ostraconotus* and *Porcellanopagurus* Filhol, 1885 although he was careful not to suggest common ancestry for these taxa. Characteristic of the representatives of all three genera is the marked reduction of the abdomen. *Ostraconotus* clearly is not adapted to utilize a gastropod shell as the majority of hermits do (A. MILNE EDWARDS & BOUVIER 1893), but whether it is entirely free-living as proposed by WOLFF (1961) and RUSSELL (1962) is uncertain. Its laterally compressed, blade-

shaped ambulatory dactyls and paddle-shaped fourth pereopodal dactyls at least suggest a probable swimming ability. *Porcellanopagurus*, in contrast, is known to carry a univalve or bivalve shell over the posterior carapace and abdomen (BORRADAILE 1916). The similarities in the fourth pereopods among species of *Porcellanopagurus* and *Solitariopagurus profundus* Türkay led TÜRKAY (1986) to suggest a similar niche adaptation for his species, although no shells were found with his animals. *Solitariopagurus triprobolus* sp. nov. does utilize bivalve, and occasionally univalve shells. The discovery of this new taxon provides additional insight into the relationships among these highly specialized hermit crabs.

MATERIALS AND METHODS

Deep-water decapods were collected intensively in French Polynesia between 1986 and 1994 by the Service mixte de surveillance radiologique et biologique (SMSRB (1)). Using the research vessel, F. R.V. *Marara*, shrimp traps, with a mesh of 9 mm, were set on the outer slopes of the islands, in depths ranging from 100 to 1000 m. The traps were baited with 0.2-0.6 kg of reef fishes and set at night. More details about the gear and operations are given in POUPIN *et al.* (1990). Although the primary aim of these operations was routine radioecological control of the area, it rapidly became apparent that the fauna was poorly known; many species were new to science and would have to be described. In fact almost no deep-water collections had previously been made in that area, and the cruises of the *Marara* presented the first opportunity to develop a large scale inventory of the deep-sea decapod fauna. As a result of this activity, a preliminary list of the deep-water decapods from French Polynesia has shown that out of a total of 128 species, 40 have been recently described from the catches of the *Marara* (POUPIN 1995). Among this material 47 specimens of a small hermit crab carrying a bivalve shell were caught at depths between 200 and 300 m at several stations. A preliminary identification by J. FOREST and M. DE SAINT-LAURENT (MNHN, laboratoire de Zoologie Arthropodes, Paris) proved that this material belonged to a new species of the genus *Solitariopagurus*. Because of the atypical conformation of the cephalothorax of this taxon both shield and carapace lengths have been measured, as well as carapace width. Shield length (SL) was measured from the tip of the rostrum to the midpoint of the cervical groove; carapace length (CL) was measured from the tip of the rostrum to the midpoint of the posterior carapace. Carapace width (CW) represents the maximum width of the carapace measured just in front of the most posterior lateral carapace spine. Carapace terminology follows that of PILGRIM (1973). The holotype and most paratypes have been deposited in the collections of the Muséum national d'Histoire naturelle, Paris (MNHN). A few paratypes have been deposited in the collections of the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Two pairs of paratypes remains in the personal collection of the junior author (PMcL).

1. Until 1991 known as the Service mixte de contrôle biologique (SMCB).

Solitariopagurus triprobolus sp. nov.
(Figs 1-4)

MATERIAL EXAMINED. — (Collector J. POUPIN): Holotype: ♂ (SL = 9.9 mm; CL = 12.5 mm; CW = 11.5 mm), Austral Islands, Rurutu, st. 341, 22°26.5'S, 151°23.1'W, 300 m, 28 November 1990, in shell of Pectinidae (*Amusium*), MNHN Pg 5232.

Paratypes: Society Island – Maiao st. 174, 17°38.6'S, 150°39.0'W, 330 m, 7 August 1989, 1 ♀ (SL = 8.9 mm; CL = 9.7; CW = 9.3), MNHN Pg 5226.

Austral Islands – Maria (Austral), st. 353, 21°47.6'S, 154°43.1'W, 310 m, 8 December 1990, 1 ♂ (SL = 7.1 mm; CL = 7.5 mm; CW = 7.7 mm), in shell of Veneridae (*Pitar* s. l.), MNHN Pg 5234. – Tubuai, st. 350, 23°20.7'S, 147°32.4'W, 200 m, 5 December 1990, 1 ♂ (SL = 8.3 mm; CL = 9.0 mm; CW = 8.4 mm), in shell of Veneridae (*Pitar* s. l.), MNHN Pg 5233.

Tuamotu Islands – Akiaki, st. 154, 18°32'S, 139°12'W, 260m, 10 June 1989, 2 ♀ (SL = 7.0, 9.7 mm; CL = 8.0 mm, 10.0 mm; CW = 7.8 mm, 10.0 mm), in shells of Pectinidae (*Chlamys* s. l.) and Spondylidae (*Spondylus* sp.), MNHN Pg 5222. – Fangataufa, st. 221, 22°16.0'S, 138°46.0'W, 250 m, 5 December 1989, 2 ♂, 1 ♀ (SL = 5.7-8.2 mm; CL = 6.3-9.3 mm; CW = 6.4-9.0 mm), in shells of Pectinidae (*Amusium*), USNM 270048. – st. 231, 22°12.0'S, 138°45.9'W, 270 m, 21 may 1990, 4 ♂, 1 ♀ (SL = 6.4-9.0 mm; CL = 7.0-9.3; CW = 7.2-9.3 mm), in shells of Veneridae (*Timoclea* and *Pitar*) and Spondylidae, MNHN Pg 5229. – st. 322, 22°12.9'S, 138°43.1'W, 250 m, 23 October 1990, 1 ovigerous ♀ (SL = 5.8 mm; CL = 6.0 mm; CW = 6.0 mm), in shell of Spondylidae (*Spondylus*), MNHN Pg 5231. – Maria (Tuamotu), st. 241, 22°00.9'S, 136°12.5'W, 380 m, 30 May 1990, 2 ♂, 1 ♀ (SL = 7.8-8.0 mm; CL = 9.5-9.9 mm; CW = 9.0-9.5 mm), MNHN Pg 5230. – Mururoa, st. 459, 21°46.70'S, 138°54.69'W, 300 m, 28 November 1994, 3 ♂, 1 ♀, 3 ovigerous ♀ (SL = 7.7-9.5 mm; CL = 8.2-10.4 mm; CW = 7.9-9.9 mm), MNHN Pg 5237, PMcL (2 specimens). – st. 448, 21°48.41'S, 138°48.95'W, 340 m, 18 November 1994, 5 ♂, 1 ♀, 7 ovigerous ♀ (SL = 6.0-10.8 mm; CL = 6.3-11.5 mm; CW = 6.2-10.5 mm), MNHN Pg 5235 and Pg 5236, USNM 270049 (2 specimens). – st. 158, 21°48.5'S, 138°47.7'W, 320 m, 21 June 1989, 1 ♂, 1 ♀ (SL = 8.8, 8.3 mm; CL = 9.3, 8.3 mm; CW = 9.0, 8.1 mm), in shells of Capulidae (*Capulus*) and Pectinidae (*Amusium*), MNHN Pg 5224. – st. 164, 21°47.3'S, 138°55.0'W, 360 m, 25 June 1989, 1 ♂, 1 ovigerous ♀ (SL = 7.8, 7.2 mm; CL = 8.5, 8.0 mm; CW = 8.2, 7.5 mm), in shells of Spondylidae and Pectinidae (*Amusium*), MNHN Pg 5225. – st. 207, 21°46.8'S, 138°52.1'W, 200 m, 28 November 1989, 1 ♂ (SL = 7.6 mm; CL = 8.3 mm; CW = 8.0 mm), MNHN Pg 5227. – st. 210, 21°46.9'S, 138°55.4'W, 210 m, 30 November 1989, 1 ♂ (SL = 7.2 mm; CL = 7.7 mm; CW = 8.0 mm), in shell of Veneridae (*Pitar* s. l.), MNHN Pg 5228. – Vanavana, st. 331, 20°45.7'S, 139°10.1'W, 240 m, 28 October 1989, 1 ♂, 1 ♀ (SL = 7.8, 7.6 mm; CL = 9.4, 8.9 mm; CW = 8.2, 8.2 mm), in shells of Veneridae (*Pitar* s. l.), PMcL. – Gambier Islands (along main reef surrounding 8 Gambier Islands), st. 157, 23°00.6'S, 134°58.6'W, 300 m, 14 June 1989, 1 ♂ (SL = 7.1 mm; CL = 9.0 mm; CW = 9.0 mm), MNHN Pg 5223.

ETYMOLOGY. — From the Greek *treis* meaning three, and *probolos* meaning something projecting, referring to the three prominent projections of the anterior margin of the shield (rostrum and lateral projections) in this species.

DESCRIPTION

Anterior carapace (Figs 1A, 2A) strongly vaulted; shield length consistently shorter than breadth, total carapace length usually slightly longer; anterior margin between rostrum and lateral projections straight or very slightly concave; lateral margins each with prominent spine at anterolateral angle, slightly shorter, simple, weakly serrate, or denticulate spine at midlength and strong, often elongate and slender, spine adjacent to cervical groove; dorsal surface strongly calcified, with transverse row of 4 prominent, blunt or subacute spines proximal to anterior margin and often 1 smaller spine anteriorly in midline near base of rostrum, dorsal surface frequently with additional small tubercles anteriorly and laterally; posterolateral region delineated by "linea d?" of PILGRIM (1973) usually distinctly globular; posterior margin broadly rounded. Linea transversalis present as well calcified, broad rod. Rostrum elongate, usually reaching to distal half of ocular peduncles; slightly upturned, acutely triangular, concave dorsally and

frequently with faint median keel; usually terminating bluntly. Lateral projections acutely triangular; extremely elongate, commonly overreaching rostrum and often reaching beyond base of cornea. Posterior carapace with anterolateral regions developed distolaterally as pair of calcified plates, each armed with 1 or 2 moderately well developed spines and/or projecting laterally as short, spinose process; posterolateral regions distomesially and posteromedian plate distally with weakly to moderately well calcified transverse rod-like area; remainder of posterior carapace membraneous.

Ocular peduncles short, 1/4 to 1/2 length of shield, moderately slender, with slight submedian constriction; cornea usually somewhat dilated, diameter 1/4-1/3 length of peduncle. Ocular acicles (Fig. 2B) small, triangular, terminating subacutely, obscured from dorsal view by base of rostrum; separated basally by basal width of 1 acicle.

Antennular peduncles (Fig. 2C) elongate, overreaching ocular peduncles by length of ultimate and 1/3-3/4 length of penultimate segments. Ultimate segment with 2 or 3 long, plumose and 1 or 2 additional shorter, simple setae on dorsodistal margin. Penultimate segment glabrous. Basal segment with few scattered setae. Epistomial plate well calcified, broad.

Antennal peduncles (Fig. 2D) overreaching ocular peduncles by 1/3-2/3 length of ultimate segment, but appreciably shorter than antennular peduncles; with supernumerary segmentation. Fifth and fourth segments with few scattered, very short setae. Third segment with or without spinule at produced ventrodistal angle. Second segment with dorsolateral distal angle slightly

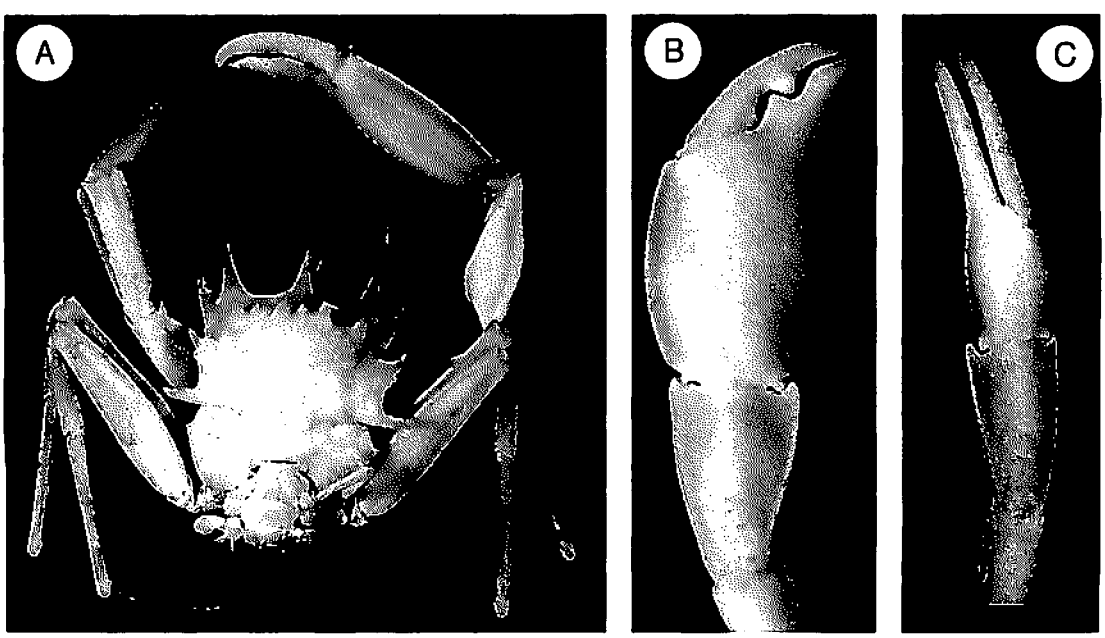

FIG. 1. — *Solitariopagurus triprobolus* sp. nov. A, holotype; B, C, male paratype (SL = 7.8 mm; Vanavana, st. 331). A, whole animal (dorsal view). B, right chela and carpus (dorsal view); C, left cheliped (dorsal view). Magnification : A, 2.4 ×; B, 3,4 ×; C, 3.6 ×.

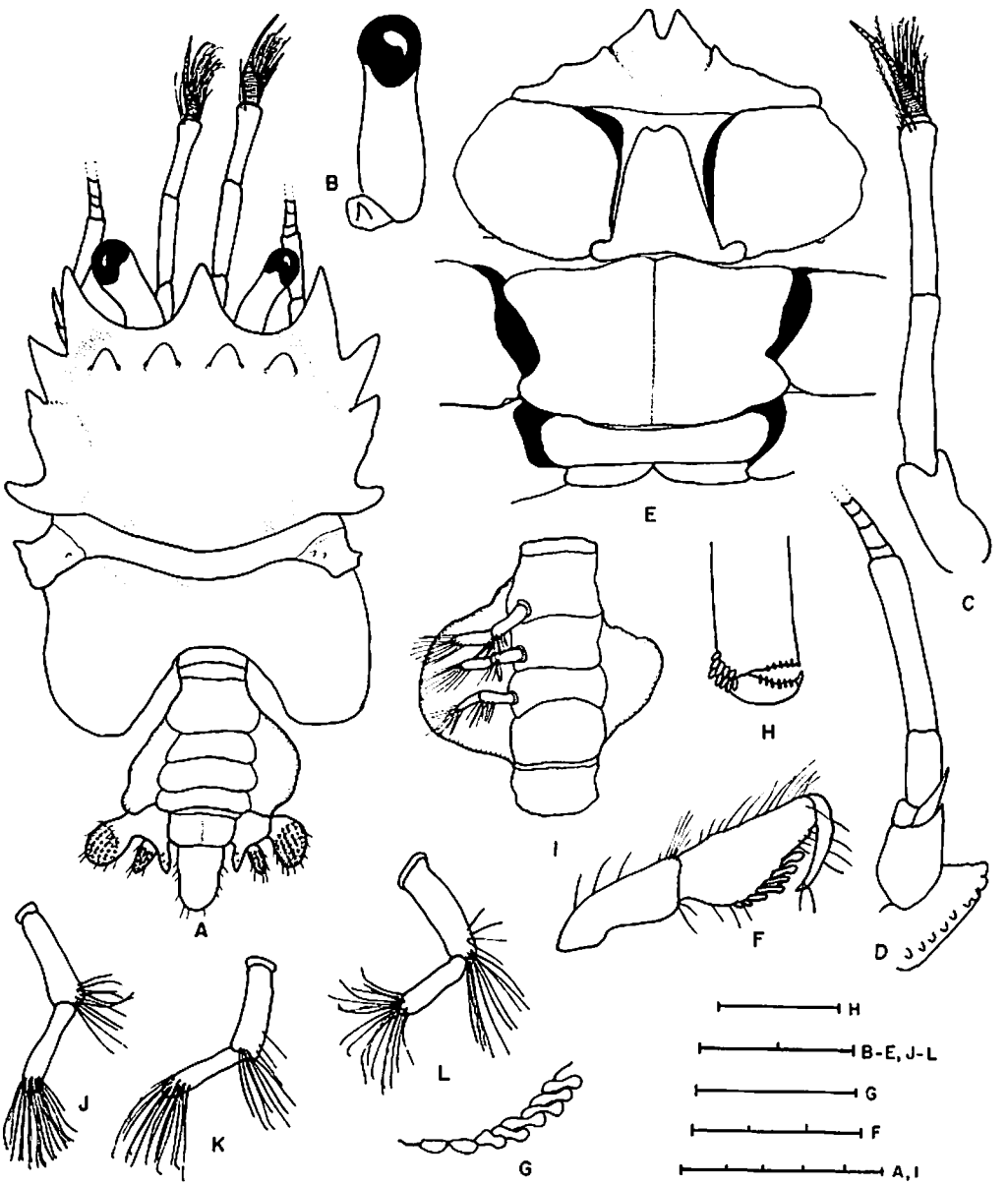

FIG. 2. — *Solitariopagurus triprobolus* sp. nov. A-H, male paratype (SL = 7.8 mm; Vanavana, st. 331); I-L, female paratype (SL = 7.6 mm; Vanavana, st. 331). A, cephalothorax, cephalic appendages, and abdomen (dorsal view); B, right ocular peduncle and ocular acicle; C, right antennule; D, right antenna; E, sternites of third maxilliped, chelipeds, second and third pereopods; F, carpus, propodus and dactyl of right fourth pereopod; G, enlarged propodal rasp of right fourth pereopod; H, dactyl and distal portion of propodus of right fifth pereopod (setae omitted); I, abdomen of female (dorsal view; uropods and telson omitted); J, left second pleopod; K, left third pleopod; L, left fourth pleopod. Scales equal 5.0 mm (A, I); 3.0 mm (F); 2.0 mm (B-E, J-L), and 1.0 mm (G, H).

produced, terminating in small spinule; dorsomesial distal angle unarmed. First segment with row of blunt spines on raised ventrolateral margin. Antennal acicle moderately short, not reaching distal margin of fourth peduncular segment, slightly arcuate, with minute terminal spinule. Antennal flagellum long, overreaching outstretched chelipeds; each, or every other, article with 1 or 2 very short setae.

Maxillule (Fig. 3A) with 1 bristle on weakly developed internal endopodal lobe, external lobe obsolete. Maxilla (Fig. 3B) with broad, relatively short scaphognathite; endopod drawn out distally into elongate spire. First maxilliped (Fig. 3C) with narrow exopod; endopod widely separated from endites. Second maxilliped (Fig. 3D) with transverse row of long, simple setae on dorsal surface of propodus in distal third; ventral and distal margins with few setae. Third maxilliped (Fig. 3E) with basis and ischium distinct; basis with row of tooth-like spines on mesial margin; ischium with crista dentata well developed and 1 accessory tooth, lateral margin with irregular row of small tooth-like spines or tubercles; merus with small spine at dorsodistal margin.

Sternite of third maxillipeds (Fig. 2E) with prominent spiniform process on either side of anterior midline and small auxilliary spinose process laterally. Sternite of chelipeds (Fig. 2E) moderately broad, elongate, with ventral surface concave, terminal margin with shallow to moderately deep median groove. Sternite of second pereopods (Fig. 2E) broad, plate-like, with median longitudinal groove. Sternite of third pereopods (Fig. 2E) narrowly subrectangular.

Right cheliped (Figs 1B, 4A, B) elongate; considerably stronger than left; propodal-carpal articulation perpendicular. Dactyl 2/3-3/4 length of palm; articulating obliquely; cutting edge smooth or serrate, with 2 prominent tooth-like protuberances; terminating in tiny calcareous tip; dorsal surface convex, smooth, minutely granular, or spinulose at least mesially, dorsomesial margin delicately serrate; ventral surface smooth or minutely granular. Palm slightly shorter to slightly longer than carpus; somewhat dorsoventrally compressed; dorsal surface convex, smooth or minutely granular, dorsomesial and dorsolateral margins spinulose or serrate; fixed finger arched; dorsal surface smooth or minutely granular; cutting edge smooth or serrate, with 1 or 2 large tooth-like protuberances; ventral surface of palm granular or faintly tuberculate, with short, obliquely longitudinal row of tubercles distolaterally, extending onto fixed finger at least in proximal half. Carpus slightly longer than merus; trapezoidal (in dorsal view), dorsomesial and dorsolateral distal angles frequently produced as wing-like projections; dorsal surface convex and frequently with scattered small tubercles or spinules, also with median or submedian longitudinal row of tubercles, strongest in proximal half but often difficult to observe in dorsal view, dorsomesial and dorsolateral margins serrate and somewhat elevated; mesial and lateral faces minutely granular or spinulose; ventral surface "hour-glass" in shape, ventromesial and ventrolateral margins each with row of tubercles or blunt spines, strongest proximally. Merus broadly subtriangular; dorsal, mesial and lateral surfaces spinulose or tuberculate; ventromesial and ventrolateral margins each with row of spines, often very prominent in proximal third. Ischium with row of small tubercles or spinules on ventromesial and ventrolateral margins.

Left cheliped (Figs 1C, 4C, D) slender, usually not reaching to base of dactyl of right; dactyl and fixed finger curved ventrally. Dactyl more than twice length of palm; cutting edge with row of corneous teeth; terminating in corneous claw and often slightly over-lapped by fixed finger; dorsal and ventral surfaces unarmed, dorsomesial margin serrate, at least in proximal half, mesial face smooth or weakly tuberculate or spinulose. Palm approximately 2/3 length of

FIG. 3. — *Solitariopagurus triprobolus* sp. nov. Mouthparts (right) from male paratype (SL = 7.8 mm; Vanavana, st. 331). A, maxillule; B, maxilla; C, first maxilliped; D, second maxilliped; E, third maxilliped; F, coxae of male fifth pereopods with sexual tubes; G, telson. Scales equal 2.0 mm (F) and 1.0 mm (A-E, G).

carpus; dorsal surface smooth or minutely granular, dorsomesial and dorsolateral margins serrate and slightly elevated; ventral surface granular or minutely spinulose, with distal longitudinal row of small tubercles extending onto fixed finger, often to distal half; cutting edge of fixed finger with row of small calcareous teeth interspersed with corneous teeth; terminating in corneous claw. Carpus equalling or slightly exceeding length of merus; dorsal surface trapezoidal (dorsal view), frequently with scattered tubercles; dorsomesial and dorsolateral distal angles often produced as wing-like projections, with raised, serrate dorsomesial and dorsolateral margins, midline somewhat elevated and armed with longitudinal row of simple or multidenticulate, spinulose tubercles or small spines, at least proximally, but often difficult to observe in dorsal view; mesial, lateral, and ventral surfaces spinulose, spinules strongest on ventromesial and ventrolateral margins. Merus broadly subtriangular; dorsal, mesial, and lateral faces spinulose or tuberculate, ventromesial and ventrolateral margins each with single, or occasionally double, row of acute spines, often very prominent proximally. Ischium with row of small tubercles or spines on ventromesial and ventrolateral margins.

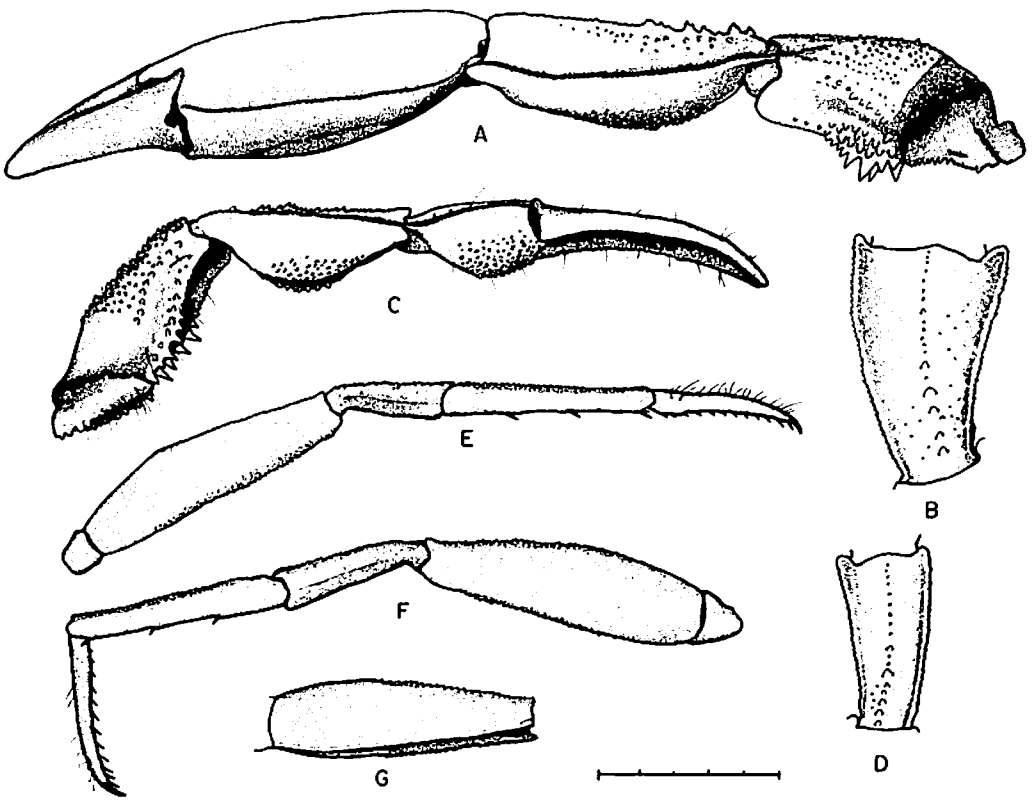

FIG. 4. — *Solitariopagurus triprobolus* sp. nov. A, C, E-G, male paratype (SL = 7.8 mm; Vanavana, st. 331); B, D, male paratype (SL = 9.9 mm; Mururoa, st. 459). A, right cheliped (mesial view); B, carpus of right cheliped (dorsal view); C, left cheliped (mesial view); D, carpus of left cheliped (dorsal view); E, second right pereopod (lateral view); F, third left pereopod (lateral view); G, merus of left third pereopod (mesial view). Scale = 5.0 mm.

Ambulatory legs (Figs 4E-G) long and slender, but usually not overreaching extended right cheliped; generally similar. Dactyls 1/2-2/3 length of propodi; laterally compressed, with slightly curved ventral margins; dorsal margins sometimes minutely serrate proximally, and with row of moderately short setae; mesial and lateral faces with few scattered, short setae; ventral margins with row of 9-17 corneous spines. Propodi 1 and 1/3 to nearly twice length of carpi; dorsal margins serrate; mesial and lateral faces smooth or minutely spinulose; ventral margins each with pair of corneous spines at distal angle and 2, or less frequently 3 or 4, additional moderately to widely-spaced corneous spines. Carpi approximately half or slightly more than half length of meri (third longer than second); dorsal margins smooth or minutely serrate, no distinct spine at distal angle; lateral faces each with median longitudinal ridge and often longitudinal band of minute spinules. Meri 1 and 1/2 to twice breadth (lateral view) of preceding segments; dorsal margins serrate or spinulose, at least in distal half; ventral surfaces oblique (mesial view), ventromesial and ventrolateral margins minutely spinulose. Fourth pereopods (Figs 2F, G) strongly subchelate; propodal rasp consisting of single row of often distally bulbous, corneous scales. Fifth pereopods (Fig. 2H) subchelate, subchela obscured by long setae; propodus with small rasp of corneous scales dorsally.

Males with unequal sexual tubes on coxae of fifth pereopods (Fig. 3F); right approximately twice length of left; each with terminal tuft of long setae and additional distal surface setae. Females with uniramous, unpaired left pleopods on somites 2-4 (Figs 2I-L).

Abdomen (Figs 2A, I) markedly reduced, segmentation clearly delineated dorsally. Tergite of first abdominal somite usually weakly calcified, rod-shaped. Tergites of somites 2-5 broad, chitinous plates. Tergite of sixth somite with weakly to moderately well calcified anterior rod-like and posterior paired rectangular plates. Uropods symmetrical; protopods each with very strong, posteriorly directed spine armed dorsally with 2-4 small spinules; exopods subcircular each with large circular rasp of corneous scales; endopods appreciably smaller, ovate, each with small oval rasp. Telson (Figs 2A, 3G) elongate; transverse suture weakly delineated; terminal margin entire, with rounded external angles.

Color (in life)

Overall generally orange-brown. Ocular peduncles with mesial and lateral longitudinal red stripe. Antennular peduncles with longitudinal red stripe dorsally. Ambulatory legs with 3 continuous or interrupted red stripes on lateral surfaces of meri; carpi often with 1 median longitudinal red stripe on lateral face and 1 on dorsal surface. Eggs of females purplish.

Variation

Solitariopagurus triprobolus exhibits considerable variation in the armature of the shield. As may be seen in the male paratype from Vanavana (Fig. 2A), only four subacute spines are present in the characteristic transverse row behind the anterior margin; however, in the majority of the specimens examined, an additional, smaller spine was observed in the midline anteriorly near the base of the rostrum. The presence of additional small tubercles on dorsal surface of the shield was also quite variable. In the paratype male from Vanavana (Fig. 2A), for example, the surface was virtually smooth, whereas in many specimens, including the holotype (Fig. 1A), numerous small tubercles were present, particularly laterally. Variation was also observed in the strength and acuteness of the rostrum, lateral projections and lateral carapace spines.

DISTRIBUTION

This species is distributed around most of the French Polynesia islands, at depths of 200-380 m. Material has been collected in the Society Islands (Maiao), Austral (Maria, Rurutu, Tubuai), Tuamotu (Akiaki, Fangataufa, Maria, Mururoa, Vanavana), and Gambier Islands. Despite intensive investigations, it has not yet been collected from the Marquesas.

HABITAT

Most shells occupied by *S. triprobolus* sp. nov. belonged to bivalve mollusks of the families Anomiidae, Arcidae, Limidae, Pectinidae, Spondylidae, and Veneridae. Only one individual occupied a univalve gastropod shell of the family Capulidae. The bottom where *S. triprobolus* sp. nov. was found was very rough, which most frequently prevented successful dredging operations. The only elements sampled with a small rectangular dredge were coral rubble. However, the decapods trapped together with *S. triprobolus* were quite diverse, although not abundant. They consisted of Caridea: Pandalidae (*Heterocarpus* and *Plesionika* spp.), Palinura : Scyllaridae (*Scyllarus aurora* Holthuis, 1981), Enoplometopidae (*Hoplometopus gracilipes* de Saint Laurent, 1988); Anomura : Diogenidae (*Bathynarius* sp., *Trizopagurus* sp.), Parapaguridae (*Sympagurus* sp.), Galatheidae (*Munida* spp.); Brachyura : Homolidae (*Paromola* sp.), Portunidae (*Portunus* spp.), and Xanthoidea (*Beuroisia* sp., *Demania* spp., *Epistocavea* sp., *Mathildella* sp., *Meriola* sp.).

AFFINITIES

This new species is clearly assignable to *Solitariopagurus*; nonetheless, *S. triprobolus* differs appreciably from *S. profundus* in several characters, particularly those of the shield. In both species the lateral projections (extraorbital tooth of TÜRKAY 1986) are developed as distinct spines; however, in *S. profundus* they are much smaller than the rostrum, and are directed anterolaterally. In *S. triprobolus* the lateral projections are developed as spines equally as strong or stronger than the rostrum; they are directed anteriorly and frequently overreach the tip of the rostrum. The spines (teeth of TÜRKAY) of the lateral margins are small, and the second frequently only a broad hump in large specimens of *S. profundus*, whereas all three spines are conspicuously developed in *S. triprobolus*. The dorsal surface of the shield is apparently smooth in *S. profundus*, but armed with a transverse row of 4 very prominent blunt spines posterior to the anterior margin in *S. triprobolus*; frequently a smaller, central spine or tubercle is located just anterior to the two median spines. In this species the surface also frequently has numerous additional scattered small tubercles. The posterior carapace is reduced in both species, and in addition to the strongly calcified linea transversalis, both have a pair of calcified lateral plates. These apparently are unarmed in *S. profundus*, but frequently carry 1 or 2 small surface spines and usually also a distinct marginal spine in *S. triprobolus*.

Differences are also evident in the thoracic sternal plates of the two species, albeit not as pronounced. The sternite of the third maxillipeds is appreciably broadened in both species and has a strong pair of spine-like projections on either side of the midline. However, in *S. triprobolus*, the median area is depressed anteriorly, and an additional small projection is developed on either side at the margin of this depression. TÜRKAY (1986) neither described nor illustrated additional

projections on this sternite. In *S. profundus* the sternite of the chelipeds is broadly rounded, whereas in *S. triprobolus* it is elongate, subtriangular, and has a terminal groove or concavity.

TÜRKAY (1986) illustrated all three maxillipeds of *S. profundus*, but described only the crista dentata of the third. He made no mention of the endopod of the maxilla, which in *S. triprobolus* is rather distinctive. As noted in the description, the basally broad endopod is drawn out distally into a somewhat spirelike extension. Among pagurids for which this appendage is described, the endopod of *S. triprobolus* appears most similar to that of *Tisea grandis* Morgan & Forest (as illustrated by MORGAN & FOREST 1991). This type of endopodal development is also reminiscent of that seen in certain members of the palinurid Nephropidae, *e.g., Astacus astacus* (Linnaeus) [BOAS 1880, pl. 3, Fig. 86; HUXLEY 1880, Fig. 47C; SCHMIDT 1915, 217, Fig. 17; as *Astacus fluviatilis* (Linnaeus)], *Homarus gammarus* (Linnaeus) (BOAS 1880, pl. 3, Fig. 85), and *Nephropides caribaeus* Manning) (HOLTHUIS 1974, Fig. 22), and the thalassinid Axiidae, *e.g., Allaxius princeps* (Boas) (BOAS 1880, pl. 3, Fig. 87, as *Axius princeps*). TÜRKAY (1986) illustrated, but did not comment on another character rarely observed in pagurids, namely the denticulate or spinose outer margin of the ischium of the third maxilliped. In *S. triprobolus* this dentition is much stronger than shown for *S. profundus*.

It would appear from TÜRKAY's (1986) description that the meri of the chelipeds are less strongly armed in *S. profundus* than we have found in *S. triprobolus*. The ambulatory legs are long and slender in both species; the ventrodistal margins of the carpi and ventral margins of the propodi are described as being provided with strong, spiniform bristles in *S. profundus*. In *S. triprobolus* the ventrodistal margins of the carpi are unarmed; the propodi are provided with 1 or 2 corneous spinules at the ventrodistal angle and 2-4 rather widely-spaced corneous spinules on the ventral margins. The fourth pereopods have a few more "club-shaped" scales on the propodi in *S. triprobolus* than were described for *S. profundus*. The fifth pereopods are subchelate in both species; however, the distal portion of the propodus carries a small rasp of corneous scales in *S. triprobolus*, that does not appear to be present in *S. profundus*.

DISCUSSION

As previously mentioned, TÜRKAY (1986) pointed out those characters he found to be shared by *Solitariopagurus* and *Ostraconotus*, in particular, the gill number, development of the sternite of the chelipeds, male sexual tube(s), delineation of abdominal tergites, and total loss of male pleopods, but he noted that at least some of these most probably reflected convergent evolution. Similarly, he compared *Solitariopagurus* to *Porcellanopagurus*, but reported fewer commonly shared characters, *e.g.*, comparable regions of calcification of the cephalothorax, lack of highly specialized female fourth pereopods, reduced abdomen, and possible likeness of habitat. TÜRKAY did not mention the striking similarity in cephalothoracic conformation seen in *S. profundus* and species of *Porcellanopagurus*. *Solitariopagurus triprobolus* shares this general conformation; however, the exceptional development of the lateral projections is in marked contrast with these other taxa.

PILGRIM (1973) described the linea transversalis of BOAS (1926) as a narrow uncalcified hinge separating the gastric and cardiac regions of the carapace in *Pagurus bernhardus* (Linnaeus). At least in *S. triprobolus* the linea transversalis appears to be represented by a considerably broader, and completely calcified hinge. A similar, albeit, much narrower and only partially calcified hinge is present in *Porcellanopagurus edwardsi* Filhol, whereas only the more typical uncalcified linea transversalis has been observed in *Ostraconotus spatulipes.*

It is interesting to note that although the posterior carapace of *Ostraconotus* is not appreciably reduced as it is in *Solitariopagurus* and *Porcellanopagurus*, and is calcified throughout, the shield bears certain similarities to *S. triprobolus*. For example, at least in the specimen of *O. spatulipes* that we examined (PMcL collection), the rostrum is better developed than shown by A. MILNE EDWARDS & BOUVIER (1893, pl. 11, Figs 1, 4), but still shorter than the relatively prominent lateral projections. Notwithstanding that the dorsal surface of the shield is completely covered by minute tubercles in *O. spatulipes*, a transverse row of 4 somewhat larger tubercles is present slightly posterior to the anterior margin. A similar, although much more prominent, row is present in *S. triprobolus*.

Females of *Solitariopagurus*, *Porcellanopagurus* and *Ostraconotus* share in the reduction of unpaired pleopods from the typical four of most pagurids to only three, although the number for *Ostraconotus* was incorrectly reported to be four by RUSSELL (1962). In his original description of *Ostraconotus*, A. MILNE EDWARDS (1880) described the unpaired female pleopods as occurring on the left side only. His diagnosis was repeated almost verbatim by A. MILNE EDWARDS & BOUVIER (1893); however, in their legend for the figure of the female pleopods (A. MILNE EDWARDS & BOUVIER 1893, pl. 11, Fig. 17) these are cited as occurring on the right side of the abdomen. The figure itself could represent either side, as just the three pleopods and a small portion of the abdomen are depicted. In the only other detailed account of *Ostraconotus*, DE SAINT-LAURENT (1968) described the paired female gonopores, but made no comment about the pleopods. In our single ovigerous female specimen, the three unpaired pleopods are on the left side of the abdomen. A. MILNE EDWARDS & BOUVIER's (1893) legend, and possibly also their figure, are most probably only an error, as the females of *Ostraconotus* remaining in the Paris collection all have pleopods on the left side (M. DE SAINT-LAURENT pers. comm.). However, the possibility of variability, such as was reported by MAYO (1973) for approximately 20 per cent of *Cancellus* females, should not be ignored.

Just recently another monotypic genus has been described (LEMAITRE & MC LAUGHLIN 1995) that is also clearly related to *Solitariopagurus*. *Alainopagurus*, as represented by its nominal species *A. crosnieri* Lemaitre & McLaughlin, shares more characters with *Solitariopagurus* than do either *Porcellanopagurus* or *Ostraconotus*. These include : 1) exceptionally well calcified shield; 2) reduced posterior carapace with calcified linea transversalis and anterolateral plates; 3) broad thoracic sternal plates, that of the third maxillipeds with prominent median spinose projections separated by deep concavity; 4) ischia of third maxillipeds with denticulate lateral margins; 5) subchelate fourth and fifth pereopods; 6) males with paired sexual tubes and no paired or unpaired pleopods; 7) females with single left gonopore and three unpaired, uniramous left pleopods; 8) reduced abdomen with clearly defined tergites; 9) symmetrical uropods with very well developed exopodal rasps and protopodal posterior spines; 10) use of a bivalve-like habitat. *Alainopagurus* differs from *Solitariopagurus* in having : 1) 11 pairs of gills; 2) well

developed ocular acicles not hidden by the shield; 3) no lateral armament of the shield; 4) endopod of first maxilliped not appreciably removed from the endites.

Solitariopagurus is presently known from two clearly related, but morphologically distinct taxa. *Alainopagurus* and *Ostraconotus* are known only from their nominal species, and the latter not well. Several species of *Porcellanopagurus* have been described, although problems exist with some of the early descriptions (see discussions of FOREST 1951a, b; TÜRKAY 1986). A thorough review of the species of *Porcellanopagurus* and *Ostraconotus* is needed before an accurate assessment of the phylogenetic relationships among these highly specialized hermit crab genera can be made.

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