

of sternite of 3rd pereopods subrectangular, narrower in females.

Males with moderately long and slender, left sexual tube, strongly recurved distally, and conical, short, backwardly directed, right sexual tube; pleopods 3 and 4 unequally biramous, pleopod 5 uniramous. Distal protopodal lobe of right uropod less than  $1/2$  length of endopod.

Telson with posterior, asymmetrical lobes, separated by narrow cleft; terminal margins each with 4 short spines.

Colour.— "Il colore in generale e verde sul cefalotorace, specialmente nelle regioni branchiali; l'addome ha un bel colore verde scuro. Le zampe sono di colore ceruleo, percorse da fasce trasverse di colore verde pallido e da fasce longitudinali colour terra di Siena" (Fenzia, 1937: 27). (= Cephalothorax green especially in branchial regions; abdomen a beautiful dark green. Ambulatory legs sky blue with pale-green, transverse bands and ochre-brown, longitudinal stripes.)

Behaviour.— The sexual behaviour of *A. breviaculeatus* has been studied by Hazlett (1968) and Salmon (1983).

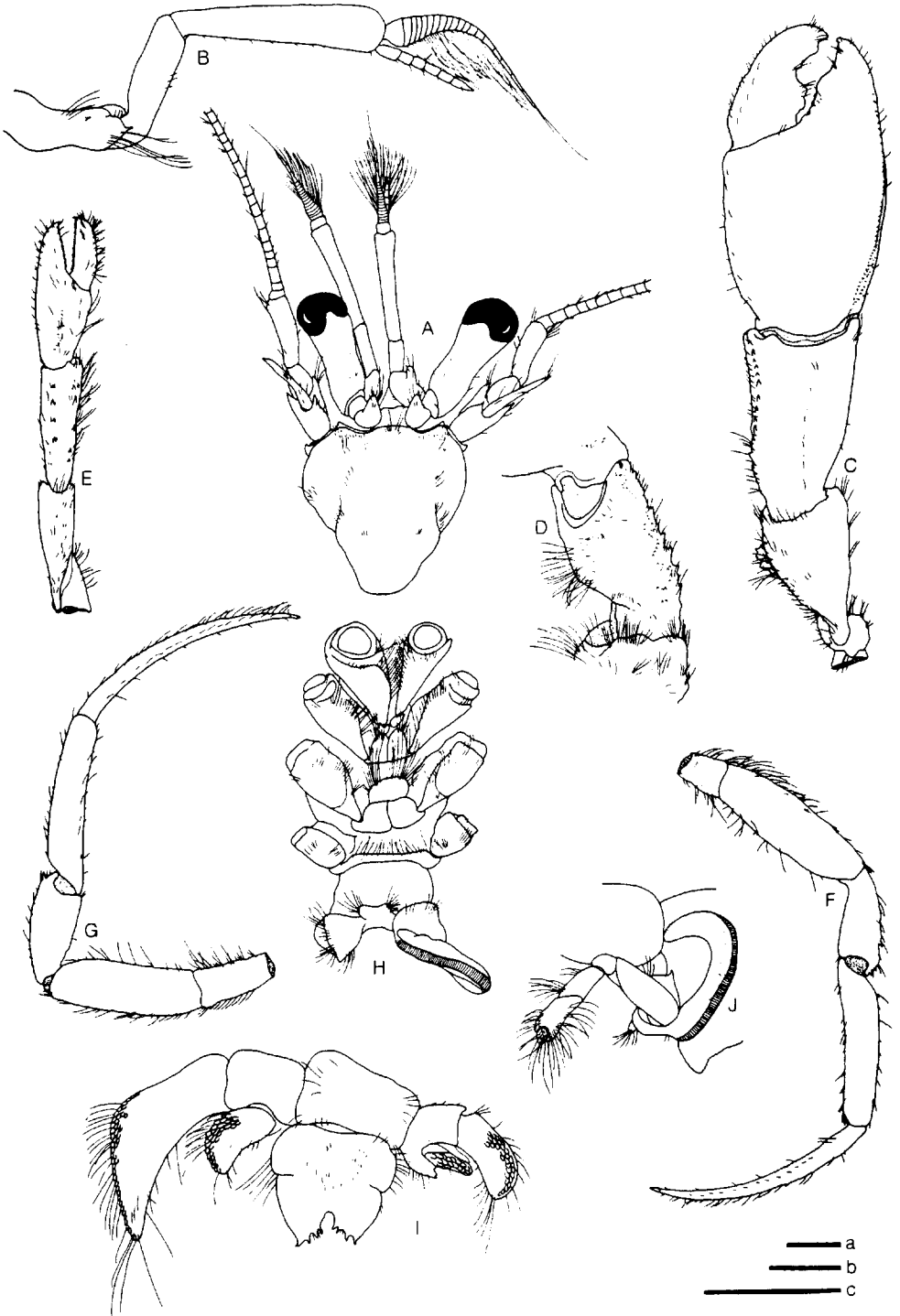
Related organisms.— Fenzia (1937: 27) cited *Nassa mutabilis*, *Turritella*, and *Nassa incrassata* as the gastropod shells occupied by the syntypes of *A. breviaculeatus*. In the present collections the following shells were found inhabited by *A. breviaculeatus*: *Turritella biplicata* (3 specimens, NHRM 12056, 12057 and 12061), naticid (1 specimen, NHRM 12061), *Lunatia guillemini* (1 specimen, NHRM 12057), *Raphitoma purpurea* (Montagu) (1 specimen, RMNH D 1370), *Natica catena* (1 specimen, RMNH D 14877), *Pusia tricolour* (Gmelin) (1 specimen, RMNH D 14879), and 2 unidentified shells (NHRM 12061).

Each of two females of *A. breviaculeatus* (RMNH D 10285 and MMSU "AAK" 1297), each had 6 externae of *Peltogasterella sulcata* (Lilljeborg, 1859) on the abdomen. While there were not apparent external effects of the parasites in one of the specimens, the parasitic infestation changed the normal feminine biramous 2nd pleopods to uniramous in the other. One *Peltogaster paguri* Rathke, 1842, was found attached below pleopod 3 of a male *A. breviaculeatus* (RMNH D 14877), but no external modifications were observed. These comprise the first records of rhizocephalan infestation of *A. breviaculeatus*.

One female of *A. breviaculeatus* (RMNH D 16588) was parasitized by a bopyrid isopod, *Athelges tenuicaudis* Sars, 1899, which did not change any of the presumed secondary sexual characters of the host. It represents the first record of a bopyrid isopod in *A. breviaculeatus*.

One or two folliculinid protozoans type 1 (see section on related organisms for *A. hyndmanni*) per host were attached dorsally to the abdomen (usually near 4th and 5th pleopods) of 9 specimens of *A. breviaculeatus* (MMSU "AAK" stations 1261, 1269-70, 1392 and 1398; RMNH D 14880 and 16588; IRPEM D381; and SMF 13908). These comprise the first records of folliculinids in *A. breviaculeatus*.

Fig. 20. *Anapagurus breviaculeatus* Fenzia, 1937. ♂ (SL = 2.9 mm), 41°29.8'N, 15°59'E, Gulf of Manfredonia, Adriatic Sea, IRPEM-D376: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventromesial view); E, left cheliped (dorsal view); F, left 2nd pereopod (mesial view); G, left 3rd pereopod (mesial view); H, sternum; I, extremity of abdomen, uropods and telson; J, left sexual tube (lateral view). Scales equal 1.0 mm: a: C-G; b: A, H, J; c: B, I.



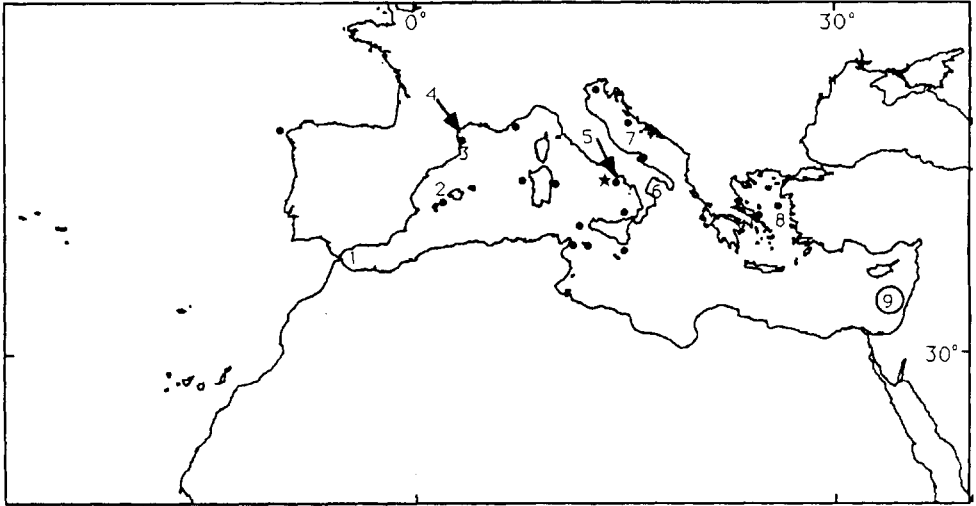


Fig. 21. Distribution of *Anapagurus breviaculeatus* Fenizia, 1937. Star: type locality. Solid circles: based on present records. Numbers: based on previous records (circled number: material examined): 1-García Raso, 1984, 1985; 2-Forest, 1965; 3-Zariquiey Alvarez, 1955; 4-Dechancé, 1962; Guille, 1971; 5-Pike & Williamson, 1958, 1960; Hazlett, 1968; 6-Forest, 1967; 7-Stevcic, 1972; 8-Kocatas, 1981; 9-Holthuis & Gottlieb, 1958.

**Distribution.**— *Anapagurus breviaculeatus* has been collected in the Mediterranean Sea, from the Alboran Basin (García Raso, 1984) to off the coast of Israel. This latter locality is a new record for *A. breviaculeatus*. The ovigerous female in Ría de Arosa, 0.2 km south off Los Mezoz Light, Spain, 42°30.5'N, 08°55.8'W (USNM 121793) is the first record of this species outside of the Mediterranean Sea. Depth range: 0-100 m.

**Affinities.**— As previously indicated, *A. breviaculeatus* appears to be most closely related to *A. pusillus* and *A. alboranensis* spec. nov., but is easily separated by its much longer ocular peduncles and the much longer ultimate antennular segment.

**Remarks.**— In examining the specimens that Bouvier (1922) reported as *A. laevis*, I found that he confounded two distinct taxa. One male from "Princesse Alice II" station 1262 proved to be *A. breviaculeatus* rather than *A. laevis*. Bouvier (1940), in his comparison of *A. breviaculeatus* and *A. laevis*, incorrectly attributed shorter ocular peduncles to *A. breviaculeatus* and added various spines to his figure of this species, stated as having been redrawn from Fenizia's (1937: fig. 17) original illustration. Years later, Zariquiey Alvarez (1968) quoted Bouvier's erroneous statement about the ocular peduncles of *A. breviaculeatus*. As mentioned under *A. laevis*, the specimens reported from the coast of Israel by Holthuis & Gottlieb (1958) as *A. laevis* actually were a composite of *A. breviaculeatus*, *A. longispina*, and *A. adriaticus* spec. nov.

*Anapagurus hendersoni* Barnard, 1947  
(figs. 22, 23)

*Anapagurus pusillus* Henderson, 1888: 74 (in part; see remarks); Alcock, 1905: 187 (in part; listed); Stebbing, 1910: 358; Balss, 1912: 110, 113, 115; Monod, 1932: 487 (in part; listed); Gordan, 1956: 303 (in

part; listed) (not *Anapagurus pusillus* Henderson, 1888).

*Anapagurus hendersoni* Barnard, 1947: 377 (in part; see remarks) (Type locality herein assigned by present lectotype designation: Simon's Bay, False Bay, Cape Province, South Africa, "Challenger", 33 m); 1950: 465 fig. 85: f-g; Gordan, 1956: 302 (listed); Day, Field & Penrith, 1970: 56 (Saldanha Bay, Cape Province, South Africa, 9-82 m); Kensley, 1974: 64 (in part; see remarks); 1978: 252 (in part; see remarks); 1981: 31 (listed).

*Anapagurus laevis*; Forest, 1955: 131 (in part: only specimen collected by "Mercator" 1 mile NE of Island of Dassen), fig. 32, pl. VI: figs. 7, 8].

Material.— Lectotype, herein designated: ♂ [2.2], "Challenger": Simon's Bay, False Bay, Cape Province, South Africa, 33 m, xii. 1873, BMNH 1888: 33; Paralectotypes: 1 ♂ [2.4], "Pieter Faure": off Bird Island Passage, Cape Province, 18 m, 1897, SAM A 1500; 2 ♂♂ [2.0, 2.4], 1 ♀ [2.9], 1 ovig. [2.8], "Pieter Faure": off Cape Natal, W by N, 10 km, 88 m, 1897, SAM A 1501; 7 ♂♂ [1.9-3.5], 2 ovig. [2.3, 3.0], "Pieter Faure": off Umhloti River mouth, Natal, NW ½ W, 24 km, 183 m, 1897, SAM A 1502; 1 ovig. [2.2], "Pieter Faure": off Cape Natal, W by N, 10 km, 99 m, 1897, SAM A 1503. 1 ♂ [2.2], 1 ovig. [2.8], "Valdivia" station 100: Francis Bay, 34°8'S, 24°59'E, 29.x.1898, ZMB 16476; 1 ♂ [3.3], 1 ovig. [2.5], "Th. Mortensen Java-South Africa Expedition" station 24, off Durban, 29°48'30"S, 31°18'E, 226 m, bottom sandy mud, 22.viii.1929, ZMUC; 3 ♂♂ [2.7-3.4], 1 ovig. [2.4], "Th. Mortensen Java-South Africa Expedition" station 31, off Durban, 29°54'25"S, 31°09'45"E, 128 m, bottom of sand and gravel, 29.viii.1929, ZMUC; 1 ♂ [2.4], 1 ovig. [2.1], "Th. Mortensen Java-South Africa Expedition" station 60, 2 ¼ miles off Cape Point, False Bay, 57 m, sandy bottom, 19.xii.1929, ZMUC; 2 ♀♀ [1.1, 1.7], "Th. Mortensen Java-South Africa Expedition" station 72, Chapmans Bay, 53 m, sandy bottom, 20.xii.1929, ZMUC; 1 ovig. [2.3], "Mercator" (11th cruise), 1 mile N.E. of Island of Dassen, 33-37 m, 15.i.1937, MNHN 511; 1 ♀ [3.1], "University of Cape Town Ecological Survey" station F8 653 B, 34°07.5'S, 18°31'E, 27.5 m, 22.ii.1947, collector H. Boschma, RMNH D 34771; 10 ♂♂ [2.4-4.4], 2 ♀♀ [2.7, 3.3], 2 ovig. [2.0, 3.7], UCT Ecol. Survey, False Bay, 34°08'S, 18°31.5'E, 27-28 m, 22.ii.1947, SAM 758A.

Diagnosis.— Shield usually as long as broad, with tufts of moderately long setae. Rostrum equaling in length lateral projections. Lateral projections with short submarginal spine.

Ocular peduncles approximately ½ length of shield, with corneae moderately dilated. Ocular acicles roundly triangular, slightly expanded mesially, with strong acute submarginal spine. Interocular plate unarmed.

Antennular peduncles exceeding distal margin of corneae approximately ¾ length of ultimate segment. Ultimate segment exceeding length of penultimate segment by ¼ to ⅓ own length, with dorsolateral row of short setae and laterodistal fringe of setae composed of 1 long and few short setae; ventral margin with row of tufts of long setae.

Antennal peduncles exceeding distal margin of corneae by approximately ½ length of ultimate segment. Antennal acicles not reaching corneae distally.

Right cheliped with narrow chela. Dactyl ⅔ to ¾ length of palm, with irregular rows of spinules on dorsomesial margin and tufts of long setae. Palm approximately ⅔ length of carpus, dorsomesial margin with irregular rows of spinules; dorsal surface somewhat convex with scattered spinules and with short, high spinose ridge near dorsomesial margin proximally; dorsolateral margin with row of closely spaced, acute, erect spines increasing in size toward fixed finger, progressively decreasing on fixed finger and becoming obsolete near claw; dorsoproximal margin with well-developed, mesial, spinulose lobe and weakly developed lateral lobe; mesial face with well-developed ridge on proximal half; all surfaces with numerous tufts of moderately long, occasionally short setae; ventroproximal margin with

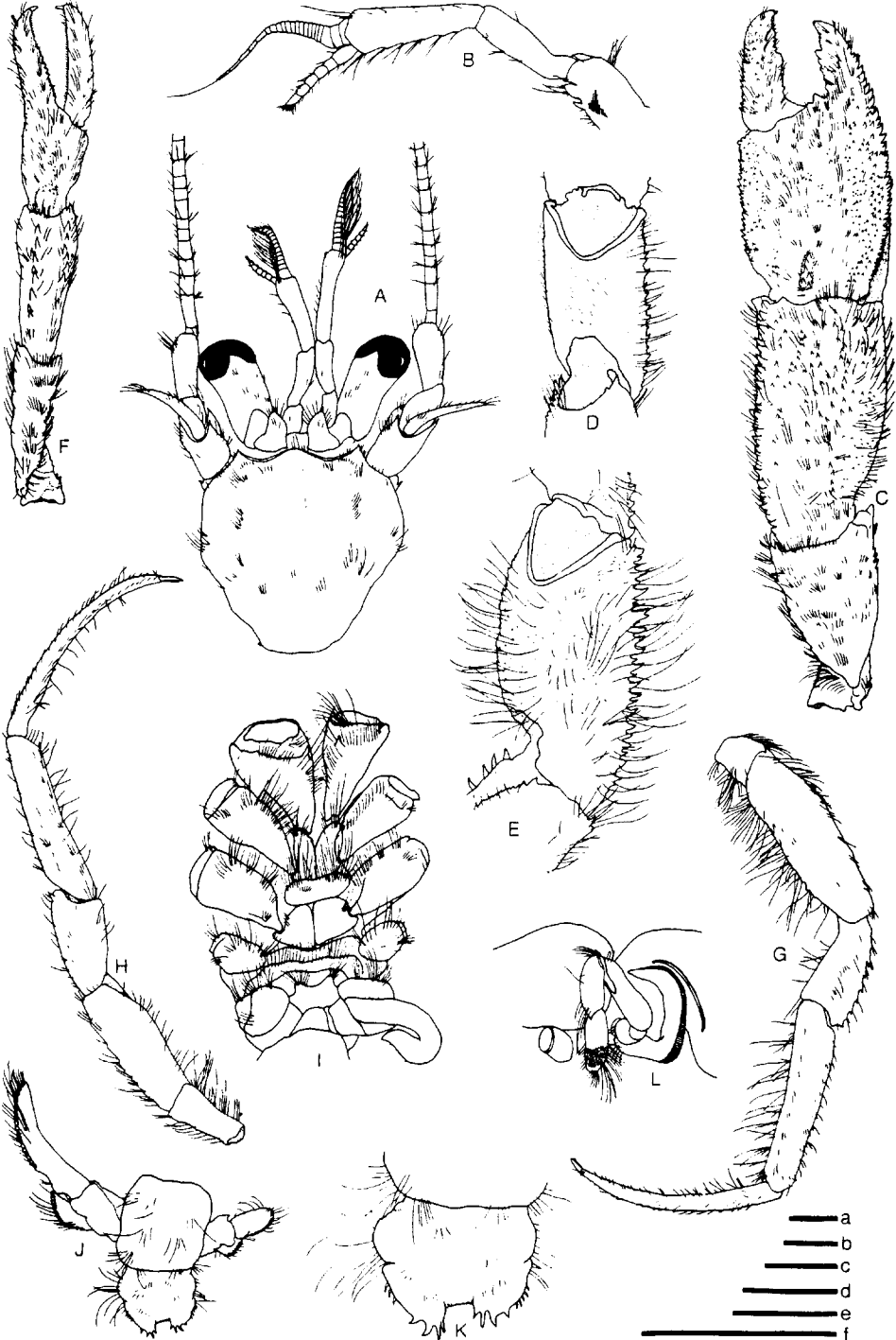
slightly developed median, subrectangular sinus flanked by 2 irregular, slightly calcified sinuses, left sinus larger than right. Carpus exceeding merus by  $\frac{1}{3}$  own length; dorsomesial margin with closely spaced, acute, erect, occasionally bifid, spines of diverse sizes; dorsomesial distal angle produced into a subtriangular structure, with a concave surface and a more raised ventral side; dorsodistal margin with strong, triangular projection adjacent to dorsomesial distal angle, projection set at approximately  $45^\circ$  angle to longitudinal axis of carpus; dorsal surface slightly depressed, with numerous spinules and numerous tufts of short setae; dorsolateral margin with irregular rows of acute spinules; dorsolateral distal angle produced into small, subcircular lobe; mesial face compressed with spinules more numerous ventrally and numerous tufts of long setae; ventromesial margin subcircular in mesial view; ventral surface with numerous spinules and tufts of long setae; long ventral length between deep, subtriangular, ventrodistal margin and shallow subcircular ventroproximal margin; lateral face convex with spinules and numerous tufts of short setae. Merus with dorsal margin with row of moderately long setae terminating in partially obscured, strong spine; ventromesial margin with low, spinulose protuberance on proximal half and row of spinules terminating in 1 or 2 strong spines on distal; ventrolateral margin with row of 3 to 6 strong spines; ventral surface with numerous spinules and tufts of long setae. Ischium with 1 spinule on ventrolateral margin partly covered by short setae; ventromesial margin with row of spinules and tufts of long setae. Coxae of chelipeds with ventrolateral distal angle unarmed.

Dactyl of left cheliped smooth but with tufts of moderately long stiff setae. Dorsomesial and dorsolateral margins of carpus, each with row of 8 to 12 strong, closely spaced spines.

Ambulatory legs with dactyls exceeding propodi by approximately  $\frac{1}{4}$  own length, with dorsomesial row of closely spaced, short, stiff setae; mesial faces each with 2 rows of tufts of long, stiff setae, one near dorsal margin and other close to ventral margin; lateral faces each with median row of short stiff setae, and row of tufts of long setae near ventral margin; ventral margins unarmed but each with 1 distal stiff seta, nearly equaling length of claw. Propodi exceeding carpi by  $\frac{1}{3}$  to  $\frac{1}{2}$  own length; dorsal surfaces each with numerous tufts of short, stiff setae; mesial faces each with median row of tufts of short setae and row of numerous tufts of long setae near ventral margin; ventromesial distal angle with 1 or 2 short, corneous spines partly obscured by moderately long, stiff setae. Carpi  $\frac{1}{2}$  to  $\frac{3}{4}$  length of meri; dorsal surfaces each with row of 2-7 short spines (2nd) or 1 short distal spine (3rd) and row of tufts of short, stiff setae. Ventral margins of merus with row of spinules (2nd) or unarmed (3rd), and tufts of long setae. Lobes of sternite of 2nd pereopods unarmed, expanded laterodistally. Anterior lobe of sternite of 3rd pereopods subrectangular to rectangular; anterior margin with numerous tufts of long setae.

A-K

Fig. 22. *Anapagurus hendersoni* Barnard, 1947. ♂ (SL = 3.4 mm), 34°08'S, 18°31.5'E, False Bay, South Africa, SAM-758A: A, shield and cephalic appendages; B, left antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventral view); E, carpus of same (ventromesial view); F, left cheliped (dorsal view); G, right 2nd pereopod (lateral view); H, left 3rd pereopod (mesial view); I, sternum; J, extremity of abdomen, uropods and telson; K, telson. L: ♂ (SL = 3.3 mm), Th. Mortensen Java-South Africa Expedition, station 24, 29°48'30"S, 31°18'E, off Durban, South Africa, ZMUC: left sexual tube (lateral view). Scales equal 1.0 mm: a: F-H; b: E; c: A, C, D, I, L; d: J; e: B; f: K.



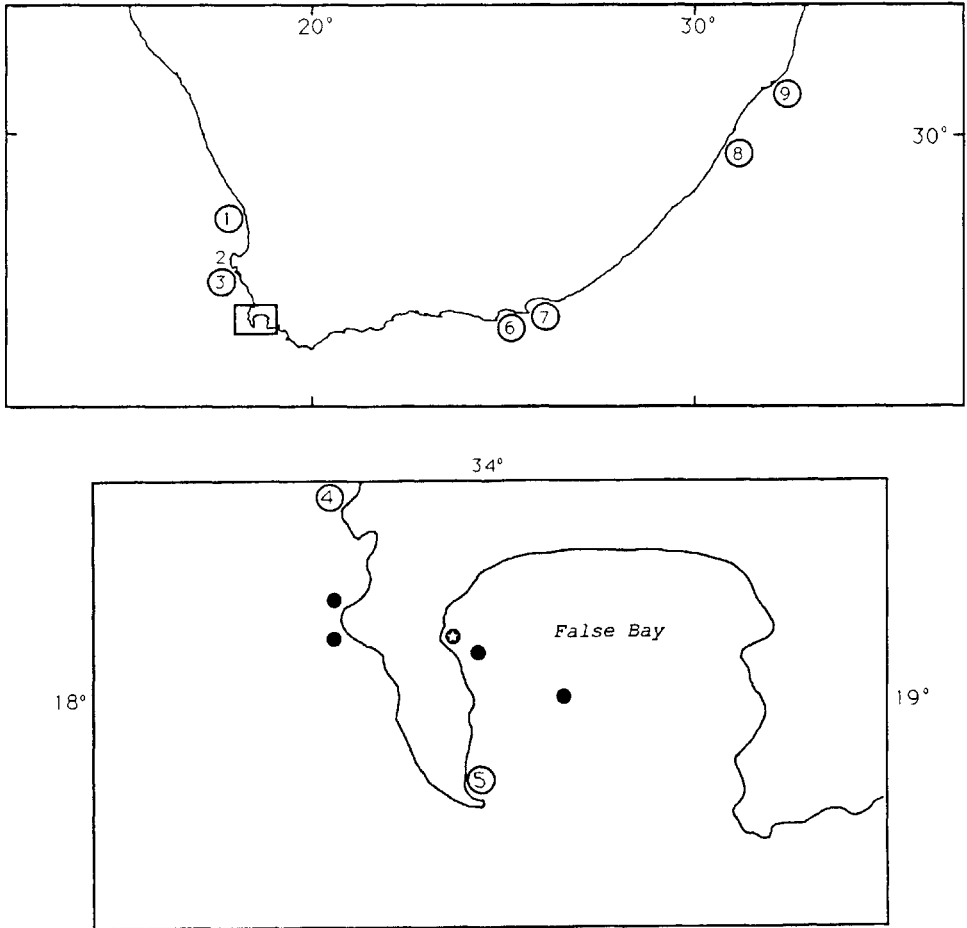


Fig. 23. Distribution of *Anapagurus hendersoni* Barnard, 1947. Circled star: type locality, material examined. Solid circles: based on present records. Numbers: based on previous records (circled numbers: material examined): 1, 8, 9-Kensley, 1974; 2-Day *et al.*, 1970; 3-Forest, 1955; 4, 5, 7, 8, 9-Barnard, 1950; 5, 8-Kensley, 1978; 6-Balss, 1912.

Males with well-developed, left sexual tube, recurved upward to exterior and short, backwardly directed, right sexual tube; pleopods 3 and 4 unequally biramous, pleopod 5 uniramous. Distal protopodal lobe of right uropod subequaling length of endopod.

Telson with slightly asymmetrical posterior lobes, separated by wide, deep cleft; terminal margins each with 3 or 4 strong spines; lateral margins with 1-4 spinules.

Colour.— "Carapace anteriorly pale pinkish, 4th joints [meri] of chelipeds and legs with pale brownish transverse markings, 6th joints [propodi] of legs violaceous, eyes black, ova scarlet" (Barnard, 1950: 466).

Related organisms.— The lectotype was found inhabiting the shell of the gastropod *Trochus benzi* Krauss (Henderson, 1888: 74).

A female of *A. hendersoni* (RMNH D 34771) is the host for the holotype of the rhizocephalan, *Peltogaster contortus* Boschma; no external modification caused by this parasite was observed.

Distribution.— *A. hendersoni* apparently is an endemic South African species; it has been collected from Saldanha Bay, Cape Province on the west coast to off Cape Natal, Natal Province on the east coast. Depth range: 9-226 m.

Affinities.— The dense pilosity of *A. hendersoni* is very similar to that of *A. chiroacanthus*, but the former taxon can be easily distinguished from the latter and other congeners by the stronger armature of its chelipeds and telson, and by the almost parallel lateral margins of the sternal lobes of the 2nd pereopods.

Remarks.— Among the specimens used by Henderson (1888) in his description of *A. pusillus*, he included "with some hesitation" a male collected in Simon's Bay, South Africa. Furthermore, plate VII, figure 7 of the same paper is herein questionably referred to *A. laevis* (Bell, 1846). Alcock (1905) and Monod (1939) subsequently simply listed *A. pusillus* without reference to the questionable specimen. Stebbing (1910) in his catalogue of South African Crustacea clearly referred the Simon's Bay specimen to *A. pusillus*.

Barnard in 1947, briefly described *A. hendersoni* based on Henderson's Simon's Bay specimen and additional South African material collected from Table Bay to Natal. In 1950 the same author more fully described and illustrated the species. Examination of the syntypes of *A. hendersoni* has shown that Barnard confounded two distinct species as *A. hendersoni*; the lack of the sexual tube in one male specimen (SAM A 8225) originally included in the Barnard's type series shows that it is neither conspecific nor congeneric with *A. hendersoni*. In his list of type specimens of decapod crustaceans in the collections of the South African Museum, Kensley (1974) simply listed all of Barnard's (1947) material. Kensley (1978) in his records of *A. hendersoni* collected at station 31 by the Th. Mortensen Java-South Africa Expedition, included an ovigerous female that represents an unidentified species of *Pagurus*.

Having examined the specimen from the "Mercator" expedition collected 1 mile NE of Dassen Island, I found that its assignment to *A. laevis* by Forest (1955) was incorrect. This specimen represents *A. hendersoni*.

*Anapagurus wolffi* Forest, 1961  
(figs. 24, 25)

*Anapagurus wolffi* Forest, 1961: 241-246, figs. 7, 11, 15, 19 (type locality: "Atlantide" station 60, 5°06'N, 9°34'W, 78 m, bottom of sand and silt).

*Anapagurus laevis*; Forest, 1961: 239 (in part; see remarks).

*Anapagurus curvidactylus*; Forest, 1961: 241 (in part; see remarks).

Material.— Holotype: ♂ [1.0], "Atlantide" station 60, 5°06'N, 9°34'W, off Liberia, 78 m, bottom of sand and silt, 9.i.1946, ZMUC; Paratypes: 1 ovig. [0.9], data as for holotype; 1 ♀ [0.9], "Atlantide" station 49, 7°29'N, 13°38'W, off Sierra Leone, 74-79 m, bottom of muddy sand, 30.xii.1945, ZMUC. 1 ovig. [0.9], "Atlantide" station 49, 7°29'N, 13°38'W, off Sierra Leone, 74-79 m, bottom of muddy sand, 30.xii.1945, ZMUC; 1 ♂ [0.8], "Atlantide" station 51, 7°14'N, 12°57'W, off Sierra Leone, 108 m, sandy bottom, 31.xii.1945, ZMUC; 1 ovig. [1.0], "Atlantide" station 58, 5°50'N, 10°31'W, 95 m, bottom of muddy sand, 8.i.1946, ZMUC.



Diagnosis.— Shield broader than long. Rostrum slightly exceeding unarmed lateral projections.

Ocular peduncles subequal to length of shield; with corneae moderately dilated. Ocular acicles equilaterally triangular, with short submarginal spine. Interocular plate unarmed.

Antennular peduncles exceeding distal margin of corneae approximately  $\frac{3}{4}$  length of ultimate segment. Ultimate antennular segment exceeding length of penultimate segment by approximately  $\frac{1}{2}$  own length; dorsolateral margin of ultimate segment with 1 short seta on distal half and 1 moderately long seta distally; basal segment with dorsomesial distal spine.

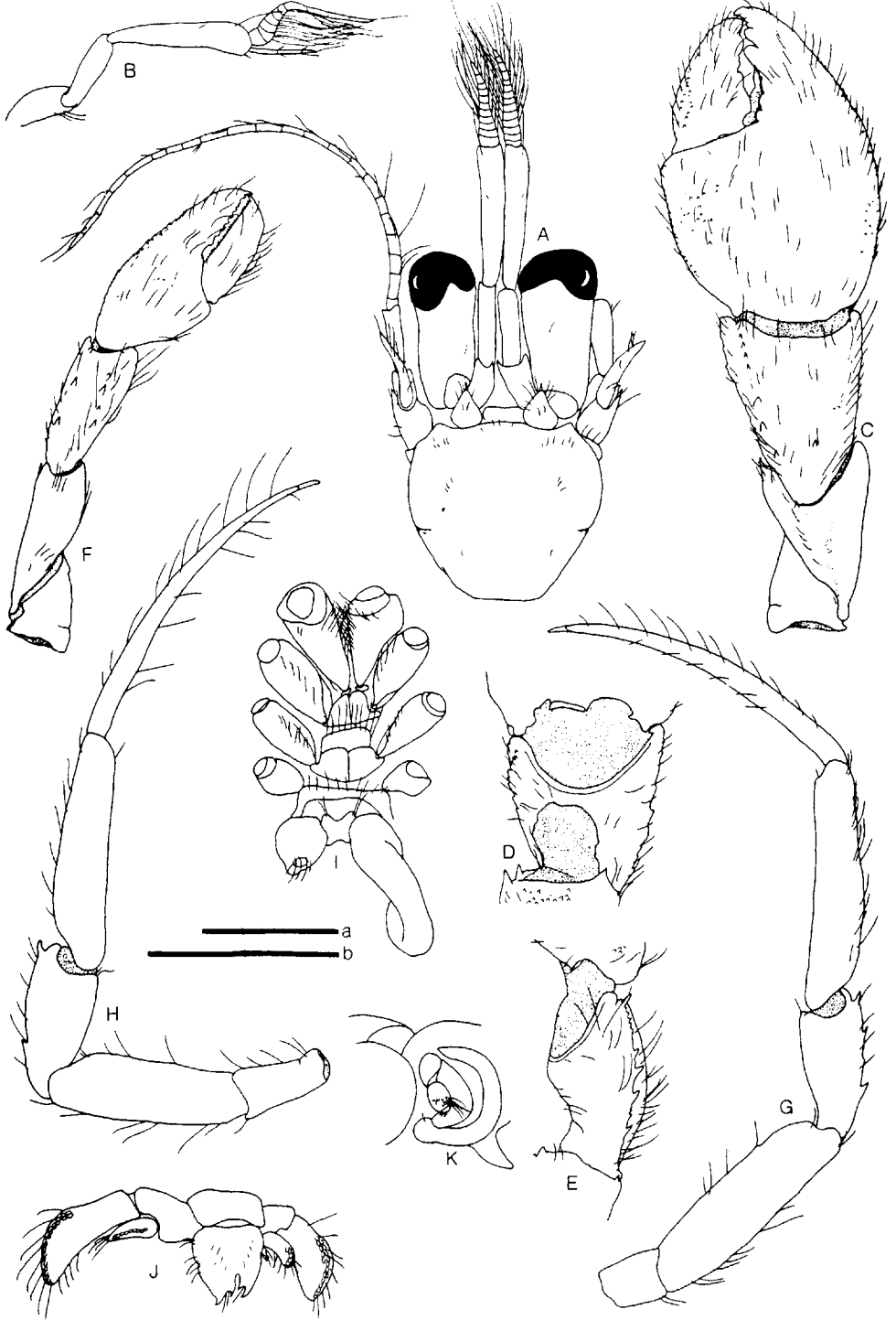
Antennal peduncles reaching proximal margin of corneae. Antennal acicles unarmed, reaching proximal half of corneae; laterodistal margin of first segment unarmed.

Right cheliped with moderately broad chela; distal half of fingers with longitudinal hiatus. Dactyl approximately  $\frac{3}{4}$  length of palm, with tufts of moderately long setae; with granules on mesial surface and near dorsomesial margin. Palm equal to length of carpus, with row of spinules on dorsomesial margin; dorsal surface somewhat convex with scattered tufts of moderately long setae, with spinules near mesial and lateral margins, lacking ridge near dorsomesial margin proximally; dorsolateral margin with row of spinules extending onto fixed finger and becoming obsolete near claw; dorsoproximal margin with weakly developed mesial and lateral lobes; mesial face with vestigial ridge on proximal half; ventroproximal margin with almost obsolete median sinus flanked by 2 slightly calcified sinuses, right sinus larger than left. Carpus exceeding length of merus approximately  $\frac{1}{4}$  own length; dorsomesial margin with 4 or 5 acute spines interspersed with spinules; dorsomesial distal angle produced into small lobe; dorsodistal margin with vestigial projection adjacent to dorsomesial distal angle; dorsolateral margin with 1 acute spine in distal half; lateral face unarmed but with tufts of moderately long setae; ventromesial margin obtusely triangular in mesial view; ventral surface granular and with tufts of long setae; very short ventral length between very deep, subcircular ventrodistal and ventroproximal margins. Dorsal margin of merus with small distal spine; ventromesial margin with acute distal spine; ventrolateral margin with row of spinules and 2 acute distal spines; ventral surface with spinules. Coxae of chelipeds with ventrolateral distal angle unarmed.

Dactyl of left cheliped smooth but with tufts of moderately long setae. Dorsomesial and dorsolateral margins of carpus, each with 3 or 4 strong, widely spaced spines.

Dactyls of ambulatory legs exceeding propodi by approximately  $\frac{1}{4}$  own length; dorsomesial and ventromesial margins of dactyls, each with widely spaced, moderately long setae. Propodi exceeding carpi  $\frac{1}{2}$  to  $\frac{2}{3}$  own length, each with 1 short ven-

Fig. 24. *Anapagurus wolffi* Forest, 1961. Holotype ♂ (SL = 1.0 mm), "Atlantide" station 60, 5°06'N, 9°34'W, ZMUC: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventral view); E, carpus of same (ventromesial view); F, left cheliped (dorsal view); G, right 2nd pereopod (mesial view); H, left 3rd pereopod (mesial view); I, sternum; J, extremity of abdomen, uropods and telson; K, left sexual tube (lateral view). Scales equal 1.0 mm: a: K; b: A-J.



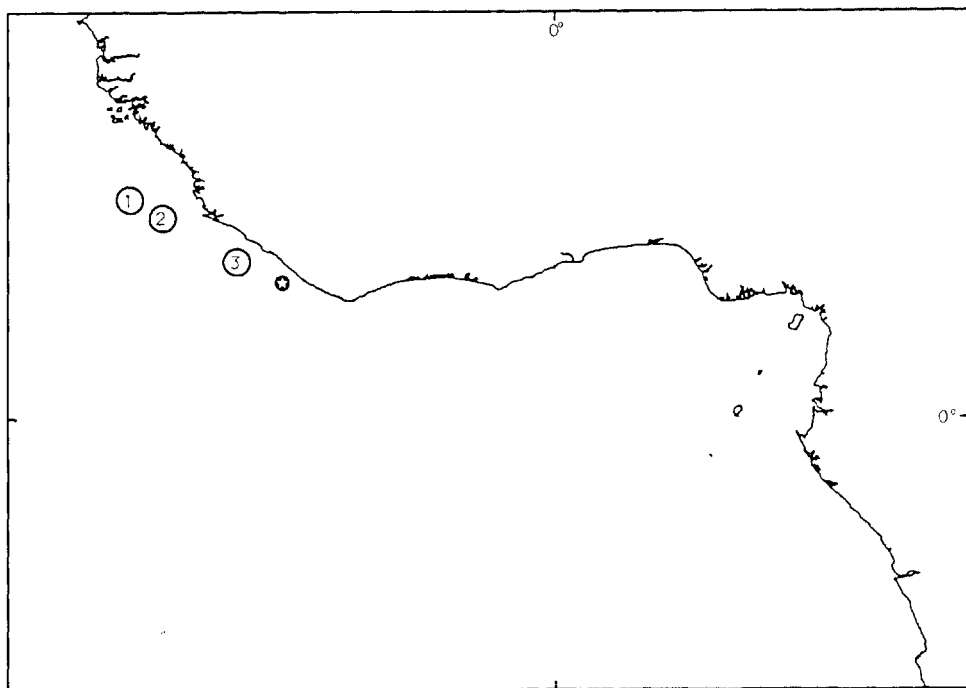


Fig. 25. Distribution of *Anapagurus wolffi* Forest, 1961. Circled star: type locality, material examined. Circled numbers: based on previous records, material examined: Forest, 1961: 1 as *A. wolffi* and *A. laevis*; 2, 3 as *A. curvidactylus*.

tromesial distal seta. Carpi approximately  $\frac{2}{3}$  length of meri; dorsal margins with 3 or 4 widely spaced spines (2nd) or 1 proximal and 1 distal spine (3rd). Meri unarmed but each with widely spaced tufts of moderately long setae. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods subrectangular, slightly skewed.

Males with moderately long, left sexual tube. Coxa of 5th right pereopod with ventral gonopore distally. Pleopods 3 to 5 unequally biramous. Distal protopodal lobe of right uropod less than  $\frac{1}{2}$  length of endopod.

Telson with posterior asymmetrical lobes, separated by narrow cleft; terminal margins each with 2 strong spines and tufts of moderately long, submarginal, stiff setae; lateral margins unarmed but each with moderately long setae.

Colour.— Unknown.

Related organisms.— “Les deux individus de la (“Atlantide”) station 60 étaient logés dans des fragments cylindriques de tubes de *Dentalium*” (Forest, 1961).

Distribution.— *Anapagurus wolffi* has been collected in western African waters off the coasts of Sierra Leone and Liberia. Depth range: 74–108 m.

Affinities.— Forest (1961) observed that *A. wolffi* and *A. chiroacanthus* shared a number of characters, i.e., the aspect of the anterior part of the body, the outline and thickness of the right chela, and the appearance of the ambulatory legs. However *A.*

*wolffi* is easily distinguished, not only from *A. chiroacanthus* but also from the other congeners, in having: the shortest antennal peduncles (last segment barely reaching cornea proximally); the unarmed lateral projections of shield, laterodistal margin of 1st antennal segment, and ventromesial distal angle of propodal 2nd pereopods; the absence of a ridge near the dorsomesial margin of the palm proximally; and the shortest ventral carpal length of the right cheliped.

Remarks.— Forest (1961) described *A. wolffi* from specimens collected by the Danish Expedition to the coasts of tropical west Africa. During my examination of the "Atlantide" collection, I found that one ovigerous female, previously identified as *A. laevis* (station 49), and one male and one ovigerous female (stations 51 and 58) doubtfully identified as *A. curvoidactylus*, were conspecific with *A. wolffi*.

*Anapagurus petiti* Dechancé & Forest, 1962  
(figs. 26, 27)

*Anapagurus bicorniger*; Fenizia, 1937: 33, 34 (in part; see remarks), 35, 36, figs. 23, 25, 26; Zariquiey Alvarez, 1946: 122, 123; 1955: 402.

*Anapagurus petiti* Dechancé & Forest, 1962: 297-299, figs. 2, 6-8, 10, 12 (in part; see remarks) (type locality: Banyuls-sur-Mer, Cap l'Abeille; 12-15 m); Zariquiey Alvarez, 1968: 259, 260, fig. 90q (in part; see remarks); Guille, 1971: 102, 105, 119, 123; Stevcic, 1972: 102, 103; Kocatas, 1981: 162; García Raso: 1982: 504, fig. 3; Williamson, 1982: 92; Ingle, 1985: 764 (listed).

SPECIES N.1: Pike & Williamson, 1960: 531-533, fig. 10.

Material.— Holotype: ♂ (carapace length= 4.5 mm), Banyuls-sur-Mer, Cap l'Abeille, France, 12-15 m, v.1958, collector M. Dechancé (MNHN); not examined. **Mediterranean Sea: Off the Balearic Islands:** Formentera: 1 ovig. [3.0], 45.7 m, 1871, collector F. Söderlund, NHRM 12056; 6 ♂♂ [1.5-2.3], 2 ♀♀ [1.7, 2.1], 2 ovig. [2.2], 54.9 m, 1871, collector F. Söderlund, NHRM 12057; 1 ♂ [1.9], 1 ovig. [2.6], 64 m, 1871, collector F. Söderlund, NHRM 12058; 1 ovig. [3.0], 73.2 m, 1871, collector F. Söderlund, NHRM 12059; 1 ♂ [2.8], 2 ovig. [2.3, 2.5], 91.4 m, 1871, collector F. Söderlund, NHRM 12060; San Antonio, Ibiza: 1 ♂ [2.8], 45.7 m, 1871, collector A. Lindahl, NHRM 6965; 4 ♂♂ [1.8-2.8], 1 ♀ [2.0], 45.7 m, 1871, collector F. Söderlund, NHRM 12061. **Bahía de Cadaqués:** 2 ♂♂ [1.7, 1.9], 4 ♀♀ [1.6-2.1], viii.1954, collector R. Zariquiey Alvarez, MNHN 1536; 1 ♂ [1.4], 45 m, 1.viii.1957, collectors L.B. Holthuis & R. Zariquiey Alvarez, RMNH D; 6 ♂♂ [1.3-2.6], 30-40 m, gross sand, 27.vii to 2.viii.1961, collector L.B. Holthuis, RMNH D 16559; 1 ♀ [1.7], 20 m, bottom of sand and silt covered with *Posidonia*, 28.vii.1961, collector L.B. Holthuis, RMNH D 16562; 1 ♂ [2.1], 1 ♀ [1.7], 30-40 m, 31.vii.1961, collector L.B. Holthuis, RMNH D 16561; 2 ♂♂ [2.2, 3.3], 2 ♀♀ [1.7, 1.8], 30 m, 1.viii.1961, collector L.B. Holthuis, RMNH D 16560. **Off Monaco:** 1 ♂ [2.5], 1 ♀ [2.8], 1 ovig. [1.8], 15 m, 17.iii.1909, MOM 382512. **Off Roquebrune-Cap-Martin:** 1 ovig. [2.3], 30-50 m, bottom of silt covered with *Posidonia*, 5.iv.1951, collector H. Nouvel, RMNH D. **Off Sorì:** 1 ♂ [3.7], 1 ovig. [1.8], 18.3 m, ix.1887, collector H. Théel, NHRM 6942; 1 ♂ [2.3], 36.6-54.9 m, coraline bottom, 3.x.1887, collector E. Théel, SMNH 13178. **Gulf of Naples:** 1 ♂ [3.0], sandy bottom, 25.vii.1959, collector R. Bott, SMF 2551; 3 ovig. [2.9-3.3], MSNM 1867. **Off SW of Lampedusa:** 1 ♂ [2.5], "AAK" station 1313, 35°17.2'N, 12°04, 5'E, 53 m, sandy bottom covered with *Udotea*, 17.ix.1979, collector V.V. Murina, MMSU. **Golfo di Taranto:** 1 ♂ [3.4], station 199, 27 m, 4.viii.1966, collector A. Vatova, RMNH D 23605. **Adriatic Sea:** 1 ♀ [1.4], off Rovinj, 28 m, 13.ix.1983, SMF 12100; 2 ovig. [2.4, 3.0], off Split, 30-35 m, sandy bottom, 20.iii.1932, collector S. Bock, NHRM 13564; 1 ♂ [2.6], off Split, 30-35 m, sandy bottom, 5.iv.1932, collector S. Bock, NHRM 13953.

Diagnosis.— Shield broader than long. Rostrum slightly exceeded by lateral projections. Lateral projections with short submarginal spine. Ocular peduncles approximately  $\frac{2}{3}$  length of shield; with corneae moderately dilated.

Ocular acicles broadly subovate, with short submarginal spine. Interocular plate with 2 chitinous spines usually overreaching proximal half of ocular acicles.

Antennular peduncles exceeding distal margin of corneae approximately  $\frac{2}{3}$  length of ultimate segment. Ultimate antennular segment exceeding length of penultimate segment by approximately  $\frac{1}{2}$  own length, with dorsolateral row of short setae interspersed with moderately long setae; ventral margin with row of very short setae; basal segment with laterodistal and dorsodistal spines.

Antennal peduncles exceeding distal margin of corneae by approximately  $\frac{1}{2}$  length of ultimate segment. Antennal acicles unarmed, usually reaching proximal half of ocular peduncles.

Right cheliped with moderately narrow chela. Dactyl  $\frac{1}{2}$  to  $\frac{2}{3}$  length of palm, with tufts of moderately long setae and scattered granules on mesial surface and dorsal surface near dorsomesial margin. Palm slightly longer than carpus; dorsomesial margin with well-developed ridge on proximal half with row of spinules and moderately long setae; dorsal surface somewhat convex, with scattered tufts of short setae, with very low, serrate ridge near dorsomesial margin proximally; dorsolateral margin with row of moderately long setae; dorsoproximal margin with weakly developed mesial and lateral lobes; ventroproximal margin with median subquadrate sinus. Carpus approximately  $\frac{3}{4}$  length of merus; dorsomesial margin with 3 or 4 widely spaced, long spines interspersed with spinules; dorsomesial distal angle produced into concave, semicircular structure; dorsodistal margin with weak, triangular projection adjacent to dorsomesial angle; dorsolateral margin with row of 3 or 4 widely spaced, long spines; distal half of lateral face usually with 2 widely spaced, long spines; ventromesial margin subcircular in mesial view; ventral surface with tufts of long setae; very short ventral length between deep, subtriangular ventrodistal margin and deep subcircular ventroproximal margin. Ventromesial margin of merus with tubercles or spines in males; dorsal margin with 2 spinules distally. Coxae of chelipeds with ventrolateral distal angle unarmed.

Dactyl of left cheliped smooth but with tufts of moderately long, stiff setae. Dorsomesial and dorsolateral margins of carpus, each with row of 5 to 8 strong, closely spaced spines.

Dactyls of ambulatory legs exceeding propodi by approximately  $\frac{1}{4}$  own length, with dorsomesial row of closely spaced, moderately long setae and ventromesial row of widely spaced, short setae. Propodi exceeding carpi  $\frac{2}{3}$  own length; ventromesial distal angle with 5 to 10 spines (2nd, males), 1 or 2 spinules (2nd, females; 3rd, males) or unarmed (3rd, females); dorsal margin of carpi each with 1 proximal and 1 distal spines; meri with 2, occasionally 3 widely spaced spinules on dorsal margin, and 1 spinule (2nd) or unarmed (3rd) on distal third ventrally. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods semicircular.

Males with moderately long, left sexual tube and conical, short, backwardly

Fig. 26. *Anapagurus petiti* Dechancé & Forest, 1962. ♂ (SL = 3.0 mm), Gulf of Naples, Italy, FNMS 2551: A, shield and cephalic appendages, B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventromesial view); E, left cheliped (dorsal view); F, left 2nd pereopod (mesial view); G, left 3rd pereopod (mesial view); H, sternum; I, extremity of abdomen, uropods and telson; J, left sexual tube (lateral view). Scales equal 1.0 mm: a: A, C-H, J; b: B, I.



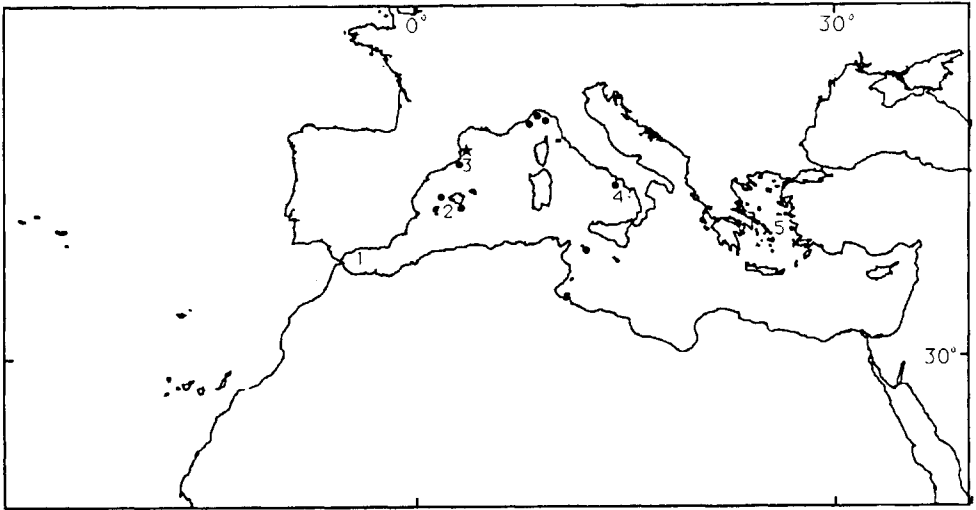


Fig. 27. Distribution of *Anapagurus petiti* Dechancé & Forest, 1962. Star: type locality. Solid circles: based on present records. Numbers: based on previous records: 1-García Raso, 1982; 2, 3-Zariquiey Alvarez, 1968; 3-Zariquiey Alvarez, 1946, 1955 (as *A. bicorniger*); 4-Fenizia, 1937 (as *A. bicorniger*); 5-Kocatas, 1981.

directed, right sexual tube; pleopods 3 and 4 unequally biramous, pleopod 5 uniramous. Distal protopodal lobe of right uropod approximately  $\frac{1}{2}$  length of endopod.

Telson with posterior, asymmetrical lobes, separated by wide, median cleft; terminal margins each with 3 or 4 short spines.

Colour.— Unknown.

Related organisms.— One female of *A. petiti* (NHRM 12057) was found in a shell of *Turritella biplicata* covered by hydroids, foraminiferans and serpulid polychaetes; another female (RMNH D 16560) was inhabiting the shell of a naticid completely covered by colonial hydroids.

Folliculinid protozoans type 1 (see section on related organisms for *A. hyndmani*) were found dorsally on the posterior carapace and abdomen of 5 specimens of *A. petiti* (MOM 382512; and NHRM 12057, 12060 and 13953). These protozoans ranged in number from 1 to 5 specimens per host. This is the first recorded folliculinid association with *Anapagurus petiti*.

Distribution.— *Anapagurus petiti* has been found in the Mediterranean Sea, from off Málaga, Spain (García Raso, 1982) to off Turkey, in the Aegean Sea (Kocatas, 1981). Depth range: 10 to 92 m.

Affinities.— The 2 widely spaced, strong spines on distal half of lateral face of carpus of right cheliped immediately distinguish *A. petiti* from other members of *Anapagurus*. As earlier discussed *A. petiti* is most closely related to *A. bicorniger*, however, *A. petiti* is easily distinguished from the latter species by the much broader subcircular ocular acicles, the longer interocular plate spines, the much shorter and unarmed antennal acicles, the less numerous but stronger carpal spines of the right cheliped, and the less numerous and shorter ventral setae of the dactyls of the ambulatory legs.

Remarks.— As previously indicated (see remarks under *A. bicorniger*), Dechancé & Forest (1962) were correct in their assumption that Fenizia (1937) had confounded two taxa under the name *A. bicorniger*. Balss's (1926) description and illustration pertain only to *A. bicorniger*. Zariquiey Alvarez's (1968) report of *A. bicorniger* pertained only to *A. petiti*.

In their description of *A. petiti*, Dechancé & Forest (1962) compared its adult and glaucothoe stages with those of *A. bicorniger*. These authors further stated that the larval and young stages assigned to SPECIES N.I by Pike & Williamson (1960) belong to their new taxon.

*Anapagurus alboranensis* spec. nov.  
(figs. 28-30)

Material.— Holotype: ♂ [1.8], Alboran Sea, off Málaga, Spain, 35-43 m, 1979, collector J.E. García-Raso, UMDZ; Paratypes: **Mediterranean Sea: Alboran Sea:** 2 ♂♂ [2.4, 2.9], 2 ovig. [2.2, 3.4], data as for holotype. **Balearic Sea:** 1 ♂ [2.8], off San Antonio, Ibiza, Balearic Islands, 45.7 m, 1871, collector F. Söderlund, NHRM 4540; 1 ♂ [1.9], off Formentera, Balearic Islands, 64 m, 1871 collector F. Söderlund, NHRM 4539. **Ligurian Sea:** 1 ♂ [2.0], "Princesse Alice II" station 040, off Beaulieu, France, 30 m, 1907, MOM 382511; 1 ♂ [2.3], off Sori, Italy, 36.6-54.9 m, coralline bottom, 3.x.1887, collector E. Théel, NHRM 4541. **Tyrrhenian Sea:** 1 ♂ [2.4], off Naples, Italy, MSNM 1869; **Strait of Sicily:** 1 ♂ [2.6], "AAK" station 1400, 37°28.1'N, 12°13.5'E, 65 m, sandy bottom with living and dead corals, 8.ix.1980, collectors V.V. Murina & V.D. Tchukhtchin, MMSU. **Adriatic Sea:** 1 ♂ [1.8], 43°30'N, 13°48'E, 20 m, 18.x.1972, collector C. Frogliia, IRPEM D382; 1 ♂ [1.6], 1 ♀ [1.1], off Rovinj, Yugoslavia, 30 m, 2.vi.1962, RMNH D 19367; 1 ♂ [2.4], off Rovinj, Yugoslavia, 3.viii.1981, collector Exk. Uni Frankfurt, SMF 11086; 1 ♂ [2.1], 2 ovig. [2.0], "F.B. Burin", off Rovinj, Yugoslavia, 31 m, 18.ix.1987, collector Baumkurre, SMF 21920; 2 ♂♂ [1.5, 1.8], "F.B. Burin", off Rovinj, Yugoslavia, 30 m, 18.ix.1987, collector Baumkurre, SMF 21922; 1 ♂ [2.3], "F.B. Burin", off Rovinj, Yugoslavia, 31 m, 18.ix.1987, collector Baumkurre, SMF 21921; 1 ♂ [1.7], off Istrian Peninsula, Yugoslavia, 9.ix.1974, collector M. Türkay, SMF 7007; 1 ♂ [1.9], 1 ♀ [1.7], "Sixten Bock", off Split, Yugoslavia, 30-35 m, bottom of sand and shells, 5.iv.1932, NHRM 4542; 1 ♂ [1.6], "Sixten Bock", off Split, Yugoslavia, 30-35 m, bottom of sand and shells, iii.1932, NHRM 4543. **Northeastern Atlantic:** 1 ♂ [1.7], off Sanlúcar de Barrameda, SW Spain, 1975, collector E. Comanescu, SMF 7870.

Description.— Shield slightly longer than broad. Rostrum slightly overreaching lateral projections. Lateral projections with short submarginal spine.

Ocular peduncles approximately  $\frac{2}{3}$  length of shield; with corneae slightly dilated; dorsomesial face with 1-3 stiff setae distally. Ocular acicles roundly triangular, with submarginal spine, separated basally by approximately basal width of 1 acicle. Interocular plate unarmed.

Antennular peduncles overreaching ocular peduncles by  $\frac{2}{3}$  to  $\frac{3}{4}$  length of ultimate segment. Ultimate segment exceeding length of penultimate segment by approximately  $\frac{1}{2}$  own length; dorsolateral margin glabrous or with row of tufts of very short setae and laterodistal pair of setae composed of 1 long and 1 short seta; ventral margin with row of tufts of short setae. Basal segment with lateromedial and laterodistal spines.

Antennal peduncles overreaching distal margin of corneae by approximately  $\frac{1}{2}$  length of ultimate segment. Fifth and fourth segments with few, stiff setae. Third segment with small, ventrolateral distal spine obscured by long stiff setae. Second segment with dorsolateral distal angle produced, terminating in strong, bifid spine; dor-

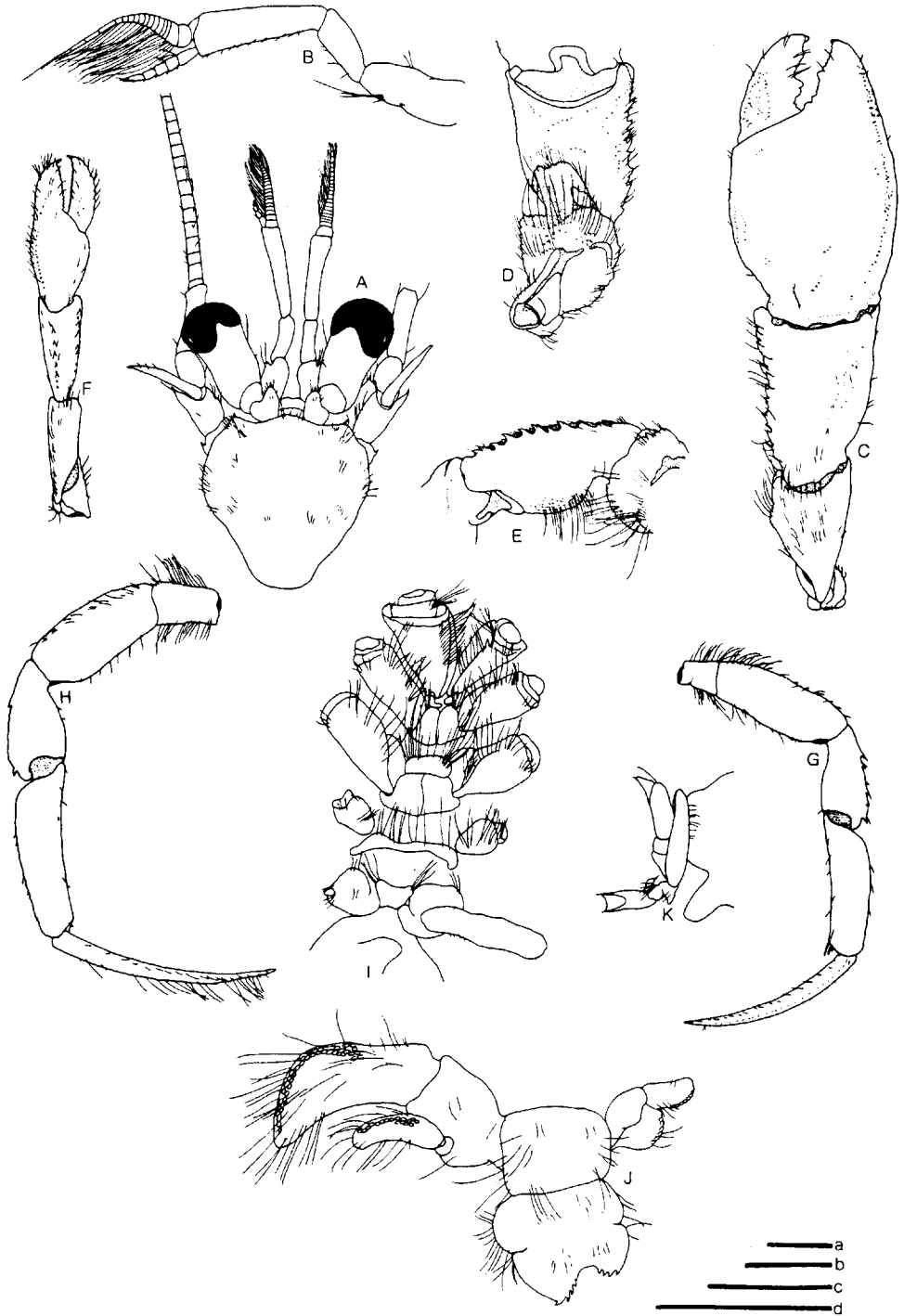


somesial distal angle with strong spine. First segment with small spine at laterodistal margin; ventromesial angle produced, with 2 or 3 small spines laterally. Antennal acicles slightly arcuate, reaching to proximal half of corneae; dorsomesial margin with row of tufts of stiff setae; terminating in small spine. Antennal flagella long, reaching dactyl of right cheliped proximally; dorsoventrally flattened, with 1-4 short (less than 1 article in length) setae on both lateral and mesial distal angles of each article.

Maxillule with stiff bristle on moderately well-developed, internal endopodal lobe, external lobe not developed; epipod produced and with tufts of long setae. Maxilla with endopod overreaching scaphognathite. First maxilliped with endopod approximately  $\frac{1}{2}$  length of exopod. Third maxilliped with long spine on dorsodistal meral margin. Sternite of 3rd maxillipeds with shallow median cleft.

Right cheliped with dactyl  $\frac{2}{5}$  to  $\frac{2}{3}$  length of palm; cutting edge with (proximal to distal) 2 or 3 short, calcareous teeth, 3 prominent, calcareous teeth in triangular arrangement, 2 or 3 short, calcareous teeth, 1 prominent, calcareous tooth, and 3 or 4 short, calcareous teeth interspersed with corneous teeth; terminating in small corneous claw; dorsal surface slightly elevated in midline; all surface granulose and with tufts of long setae; granules more numerous and larger on dorsomesial margin. Palm slightly longer than carpus, somewhat inflated dorsoventrally; dorsal surface slightly convex, with scattered granules and tufts of short setae, and short, low granulose ridge near dorsomesial margin proximally; dorsomesial margin with somewhat prominent ridge proximally and row of closely spaced granules and tufts of short setae; dorsoproximal margin with well-developed lobes, laterally and mesially (mesial lobe usually larger); dorsolateral margin with row of closely spaced granules extending onto fixed finger; ventroproximal margin with median, skewed, subquadrate sinus; all surfaces with scattered granules and tufts of short setae; cutting edge of fixed finger with 2 proximal rows of calcareous teeth, converging to form single row of 1 large and several small, calcareous teeth interspersed with corneous teeth distally; terminating in short, corneous claw; all surfaces of fixed finger with granules (more numerous on lateral face) and scattered tufts of setae (longer and more numerous on ventral face). Carpus exceeding merus by  $\frac{3}{4}$  own length; dorsomesial margin with irregular row of closely spaced, occasionally widely spaced, acute spines and tufts of stiff setae; dorsomesial distal angle produced into large, subrectangular structure, with concave distal margin; dorsodistal margin with a roundish, triangular projection adjacent to dorsomesial distal angle; dorsolateral margin with 1 acute spine in distal half; dorsolateral distal angle produced into small lobe; lateral face unarmed; dorsomesial margin subcircular in mesial view; ventral surface with numerous closely spaced granules and very long, stiff setae; moderately long ventral length between shallow subcircular ventrodistal margin and deep, subcircular ventroproximal margin; all other surfaces granulose and with scattered, short setae.

Fig. 28. *Anapagurus alboranensis* spec. nov. ♂ (SL = 2.4 mm), off Naples, Italy, MSNM 1869: A, shield and cephalic appendages; B, left antennule (lateral view); C, right cheliped (dorsal view); D, carpus and merus of same (ventromesial view); E, carpus of same (mesial view); F, left cheliped (dorsal view); G, left 2nd pereopod (mesial view); H, right 3rd pereopod (mesial view); I, sternum; J, extremity of abdomen, uropods and telson; K, left sexual tube (lateral view). Scales equal 1.0 mm: a: C-H, K; b: A, I; c: B; d: J.



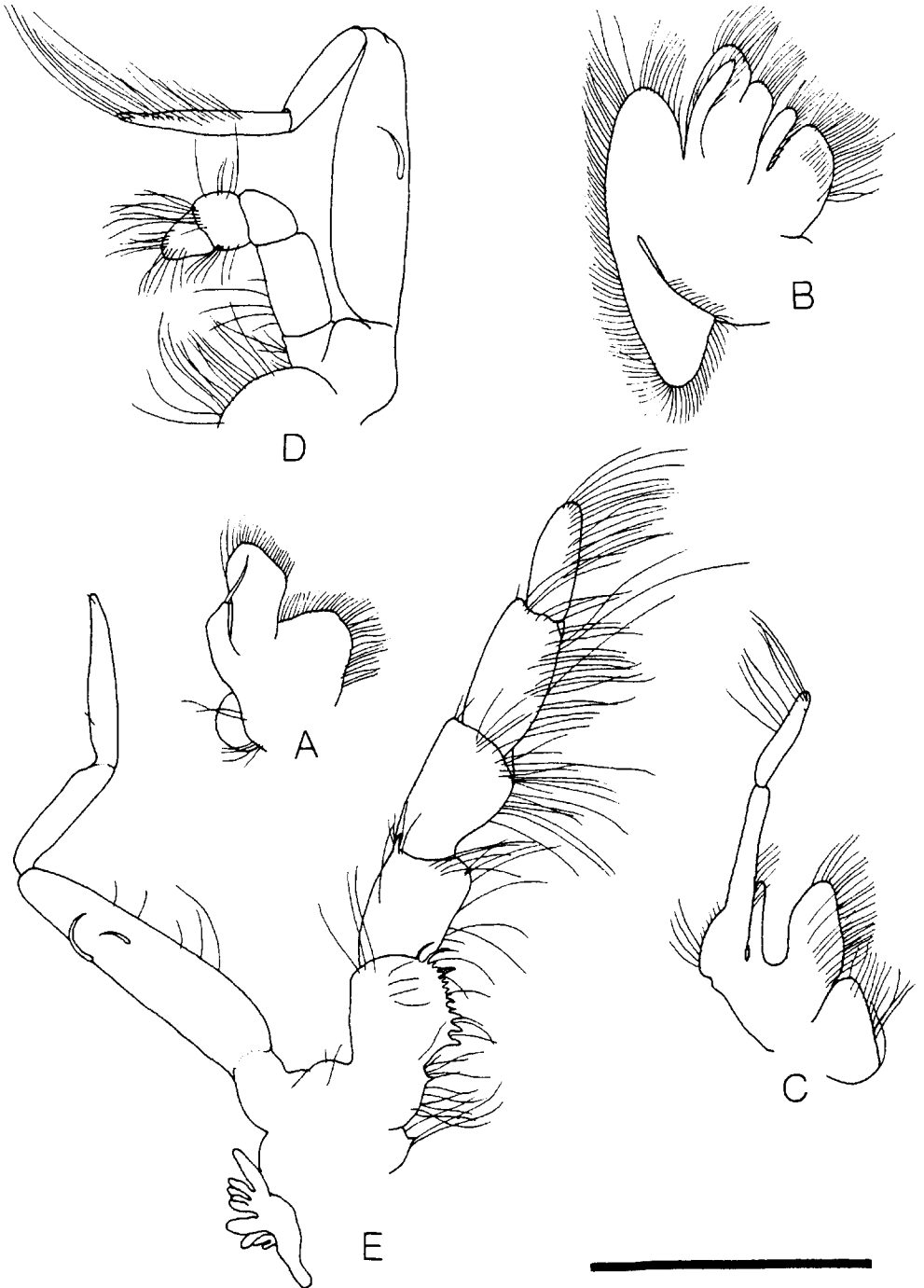


Fig. 29. *Anapagurus alboranensis* spec. nov. ♂ (SL = 2.4 mm), off Naples, Italy, MSNM 1869: left mouthparts: A, maxillule (internal view); B, maxilla (internal view); C, 1st maxilliped (internal view); D, 2nd maxilliped (external view); E, 3rd maxilliped (internal view). Scale equals 1.0 mm.

Merus inflated dorsoventrally; dorsal margin with row of long stiff setae, terminating in partially obscured, acute spine; ventrolateral margin with 2-5 acute spines increasing in size distally; ventromesial margin usually with short spine (small specimens) or 1 short spine and 2 additional spinules (large specimens), and spinulose protuberance; ventral surface with numerous tubercles and tufts of very long, stiff setae completely covering posterior carpal arthrodistal membrane. Ischium with 1 spinule on ventrolateral margin partly covered by tufts of long, stiff setae; ventromesial margin with row of spinules and stiff setae; dorsodistal angle with short protuberance partly obscured by long, stiff setae. Ventromesial margin of coxa with long setae and strong, acute spine at distal angle; ventrolateral distal angle unarmed.

Left cheliped, reaching distal half of palm of right. Dactyl approximately equaling length of palm; terminating in acute, corneous claw; cutting edge with row of corneous teeth; all surfaces with scattered granules and tufts of long, stiff setae. Palm slightly shorter than carpus, somewhat inflated ventrally and laterally; dorsolateral margin with closely spaced granules extending onto fixed finger; dorsal surface with very low, granulose ridge near dorsomesial margin proximally; all surfaces with scattered granules and long stiff setae; fixed finger with granulose dorsal and lateral surfaces, ventral surface smooth, with scattered tufts of long setae on all faces; cutting edge of fixed finger with row of corneous teeth interspersed with calcareous teeth, terminating in acute corneous claw. Carpus slightly shorter than merus, inflated ventrally; dorsomesial margin with 3 to 5 acute spines interspersed with spinules; dorsomesial distal angle produced into moderately large, subrectangular structure; dorsolateral margin with 2 to 5 acute spines interspersed with spinules; dorsolateral distal angle produced into moderately large lobe; dorsal surface with tufts of long, stiff setae. Dorsal margin of merus with tufts of long, stiff setae; ventrolateral margin with 2 to 5 long, acute spines; ventromesial margin with slightly developed spinulose protuberance and 1 short distal spine; ventral face granulose and with scattered tufts of long, stiff setae. Ischium with ventromesial row of spinules, occasionally unarmed, and long, stiff setae; dorsodistal angle with short protuberance partly obscured by long, stiff setae. Coxa with long setae on ventromesial margin and single, strong, acute spine at distal angle; ventrolateral distal angle unarmed.

Dactyls of ambulatory legs exceeding propodi by approximately  $\frac{1}{4}$  own length; dorsal margins each with row of moderately long, widely spaced, stiff setae, more numerous and closely spaced on distal half (3rd); mesial faces each with row of closely spaced, stiff setae near ventral margin; lateral faces with row of widely spaced setae near ventral margin. Propodi exceeding carpi  $\frac{1}{2}$  to  $\frac{2}{3}$  own length; dorsal surfaces each with row of tufts of moderately short, stiff setae; mesial and lateral faces each with row of short setae near ventral margin; ventromesial distal angle with 2, occasionally 1, corneous spine (2nd) or unarmed (3rd). Carpi approximately  $\frac{2}{3}$  length of meri; dorsal surfaces each with row of 2 to 7 spines (2nd) or 1 to 2, commonly 2, spines (3rd), and row of tufts of short, stiff setae; ventral surfaces with scattered, short setae. Ventrolateral margins of meri with one spinule on distal half (2nd) or unarmed (3rd), and row of tufts of short setae; dorsal surfaces usually unarmed or with 1 spinule on proximal third (left 2nd) and row of tufts of short, stiff setae. Ischia with tufts of long, stiff setae on dorsal and ventral margins. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods

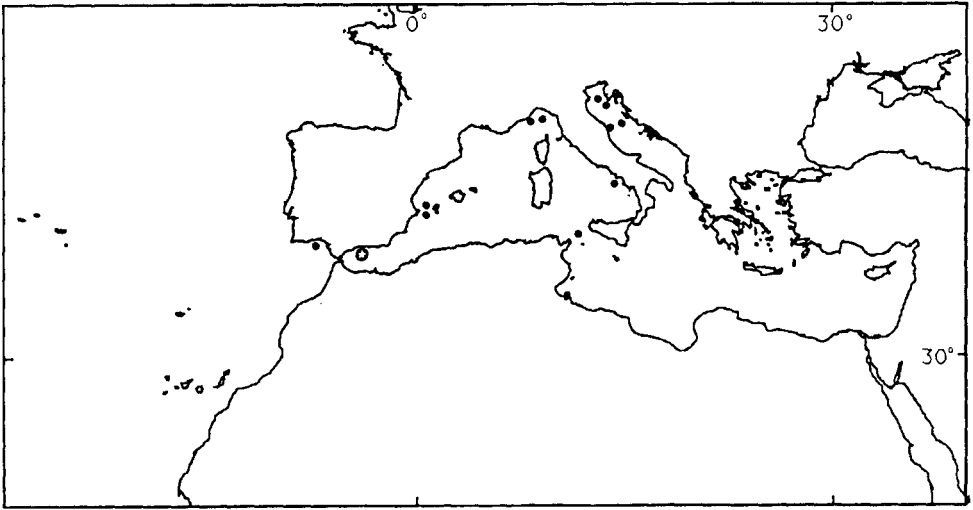


Fig. 30. Distribution of *Anapagurus alboranensis* spec. nov. Circled star: type locality. Solid circles: based on paratypic material.

subrectangular; anterior margin with long setae.

Males with left sexual tube directed diagonally toward exterior, then recurved upward to level of coxa. Coxa of 5th right pereopod with short sexual tube downwardly directed, partly covered with tufts of long, stiff setae. Pleopods 3 and 4 unequally biramous; pleopod 5 uniramous. Distal protopodal lobe of right uropod approximately  $1/2$  length of endopod.

Terminal margins of telson each with 4 closely spaced, short spines; lateral margins each with 1 spinule or bristle and long setae; dorsal surface with scattered, short setae.

Colour.— Unknown.

Etymology.— Named in reference to the type locality, the Alboran Sea.

Related organisms.— A male of *A. alboranensis* spec. nov. (MOM 382511) was found inhabiting the gastropod shell of *Buccinum humphreysianum*.

On 3 specimens of *A. alboranensis* spec. nov. collected in the Adriatic Sea, off Split, Yugoslavia (SMF), there were 1-4 folliculinid protozoans type 1 (see section on related organisms for *A. hyndmanni*) per host; tests were cemented to the abdomen dorso-distally and to the shield; no external modification caused by these symbionts was observed. Each of two males from the type locality had 3 folliculinid protozoans type 2 (see section on related organisms for *A. hyndmanni*) attached to their abdomens. This parasitic infestation apparently changed a secondary sex character of one of the hosts, i.e., the feminization of the pleopods.

Distribution.— *Anapagurus alboranensis* spec. nov. has been collected in the Mediterranean Sea, from the Alboran Sea to the Adriatic Sea. Outside the Mediterranean Sea, this species was found off Sanlúcar de Barrameda, southwest Spain. Depth range: 30-65 m.

Affinities.— As formerly noted (see section on affinities for *A. pusillus*), *A. alboranensis*

*nensis* spec. nov. resembles *A. pusillus* and *A. breviaculeatus* in the general appearance of the chelipeds and ambulatory legs. The new species can be distinguished by the presence of a spinule or bristle on the lateral margin of the posterior lobes of the telson, a shorter left sexual tube, and, at least from *A. breviaculeatus*, by the shorter ocular peduncles and the much shorter ultimate antennular segment.

*Anapagurus adriaticus* spec. nov.

(figs. 31-33)

*Anapagurus laevis*; Holthuis & Gottlieb, 1958: 72 (in part; see remarks) [not *Anapagurus laevis* (Bell, 1846)].

Material.— Holotype: ♂ [3.0], 42°27.7'N, 15°48'E, off Isole Tremiti, Adriatic Sea, 83 m, 9.vii.1972, collector C. Froglija, RMNH D 42360. Paratypes: **Mediterranean Sea: Balearic Sea:** 5 ♂♂ [1.3-2.8], 2 ♀♀ [1.4, 2.4], 8 ovig. [1.9-2.4], "AAK" station 1246, 40°14.5'N, 1°09.2'E, 110 m, bottom of clayed sand with fragmented shells, 9.iv.1978, collectors V.V. Murina & V.D. Tchukhtchin, MMSU; 5 ♂♂ [1.7-2.4], 1 ♀ [1.9], 4 ovig. [1.6-2.1], "AAK" station 1247, 40°26.2'N, 1°09.2'E, 90 m, bottom of clayed sand, 9.iv.1978, collectors V.V. Murina & V.D. Tchukhtchin, MMSU; 1 ♂ [3.3], off Formentera, Balearic Islands, 91.4 m, 1871, collector F. Söderlund, NHRM 4538; 6 ♂♂ [2.2-3.1], 2 ♀♀ [1.9, 2.4], "AAK" station 1192 (129), 40°03.3'N, 0°56.1'E, 105 m, bottom of sand and fragmented shells, 2.vi.1974, collector V.V. Murina, MMSU. **Ligurian Sea:** 1 ♂ [4.4], "Hirondelle II" station 3680, SW off Pointe Carqueirane, near Toulon, France, 60-80 m, 20.iv.1915, MOM 382510; 1 ♂ [2.7], 1 ovig. [2.6], "E. Gilat" station 15, off Roquebrune-Cap Martin, SE France, 72-80 m, 30.vii.1903, RMNH D 20257. **Off W Sardinia:** 1 ♂ [2.2], from 38°50.8'N, 8°27.2'E to 38°54.7'N, 8°28.5'E, 67-80 m, 20.ix.1973, collectors C. Froglija & G. Orel. **Tyrrhenian Sea:** 1 ♀ [3.1], 1 ovig. [3.0], off Naples, MCSN 1868; 1 ♂ [3.1], off Naples, MSNM 1869; 1 ♀ [3.2], from 38°07.1'N, 12°50.8'E to 38°06.2'N, 12°55.6'E, Golfo di Castellammare, NW Sicily, 350-480 m, 16.vi.1974, collectors R.B. Manning & C. Froglija, IRPEM D393. **Strait of Sicily:** 1 ♂ [1.9], "AAK" station 1265, 35°27.0'N, 11°30.3'E, 70 m, clayed sand bottom, 26.iv.1978, collector V.V. Murina, MMSU; 1 ♂ [2.8], "AAK" station 1392, 35°30.7'N, 12°01.2'E, 72 m, sandy bottom with *Lithothamnium*, 3.ix.1980, collectors V.V. Murina & V.D. Tchukhtchin, MMSU; 2 ♂♂ [1.8, 2.0], "AAK" station 1393, 37°04.5'N, 12°06.0'E, 110 m, clayed sand bottom, 6.ix.1980, collectors V.V. Murina & V.D. Tchukhtchin, MMSU. **Adriatic Sea:** 4 ♂♂ [2.1-3.1], 1 ovig. [2.6], 42°27.7'N, 15°48.0'E, off Isole Tremiti, 83 m, 9.vii.1972, IRPEM D537; 1 ♂ [1.9], 1 ♀ [2.7], 42°53'N, 14°32'E, 145 m, 5.x.1972, collector C. Froglija, USNM; 1 ♂ [2.6], 42°34'N, 15°50'E, 130 m, 4.v.1972, collector C. Froglija, IRPEM D375; 1 ovig. [2.9], 44°02.9'N, 13°46.3'E, 67 m, 11.viii. 1975, collector C. Froglija, USNM; 1 ♂ [3.4], 1 ovig. [2.9], 43°05'N, 14°20'E, 100 m, 8.vii.1985, collector C. Froglija IRPEM D613; 1 ovig. [4.0], off San Benedetto, 85 m, 5.v.1972, collector C. Froglija, UMML 32: 5819; 1 ♂ [3.4], 1 ♀ [3.8], 1 ovig. [3.6], 43°40'N, 14°13'E, 78 m, 27.iv.1972, IRPEM D156; 1 ♂ [2.4], 42°53'N, 14°34'E, 140 m, 10.x.1972, IRPEM D370; 1 ovig. [3.6], 43°59'N, 13°50'E, 73 m, 11. x.1973, CF 88. **Off Israel:** 1 ♂ [2.0], station 6-5 (b), Haifa Bay, 79 m, 5.iv.1955, collector Gottlieb, RMNH D 13742. **Southeastern Atlantic:** 1 ♂ [2.5], "John Elliott Pillsbury" station 45, 5°05'N, 4°04.5'W, Gulf of Guinea, 342-346 m, 30.v.1964, USNM 259325.

Description.— Shield approximately as long as broad. Rostrum equaling lateral projections. Lateral projections with strong submarginal spine.

Ocular peduncles approximately  $\frac{2}{3}$  length of shield; with corneae slightly dilated; dorsomesial face with 1-3 stiff setae distally. Ocular acicles roundly triangular, terminating in acute submarginal spine; dorsal surface concave and with row of short setae and moderately long submarginal setae on both lateral and mesial borders; separated basally by approximately basal width of 1 acicle. Interocular plate unarmed.

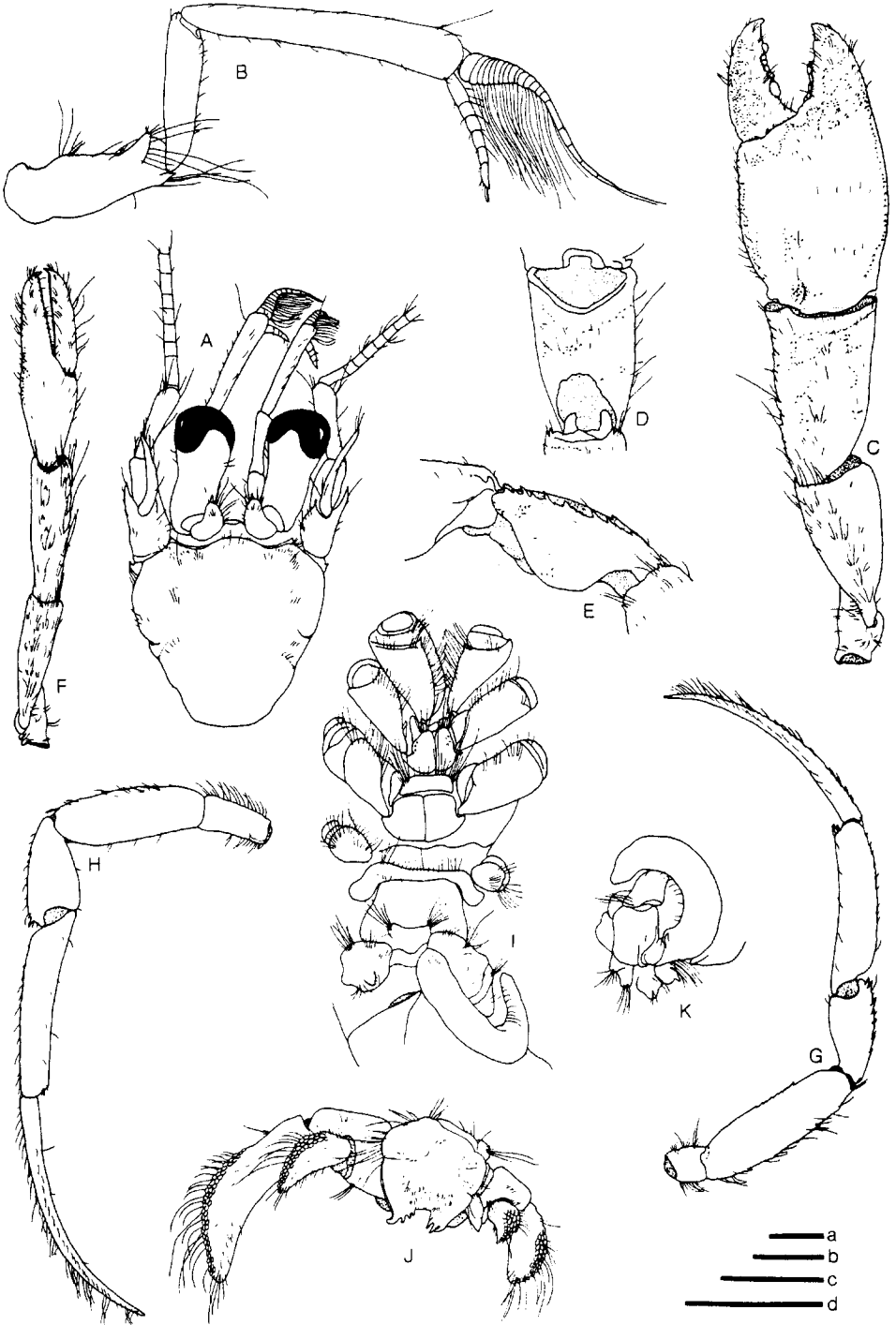
Antennular peduncles overreaching ocular peduncles by approximately entire length of ultimate segment. Ultimate segment exceeding length of penultimate segment by more than  $\frac{1}{2}$  own length, with dorsolateral row of very short setae and laterodistal pair of setae, 1 long and 1 short; ventral margin with row of tufts of very short setae. Basal segment with lateromedial and laterodistal spines.

Antennal peduncles overreaching corneae distally by approximately  $\frac{1}{2}$  length of ultimate segment. Fifth and fourth segments with few, long, stiff setae. Third segment with moderately long, ventrolateral distal spine obscured by long, stiff setae. Second segment with dorsolateral distal angle produced, terminating in strong, bifid spine; dorsomesial distal angle with strong spine. First segment with small spine at laterodistal margin, ventromesial angle produced and with 2 or 3 small spines laterally. Antennal acicles slightly arcuate, terminating in small spine; usually reaching corneae distally; dorsomesial margin with row of tufts of stiff setae. Antennal flagella nearly reaching tip of right cheliped; dorsoventrally flattened, with 1-3 short (less than 1 article in length) setae on both lateral and mesial distal angles of each article, and 2 long (1 or 2 articles in length) setae every 2 to 4 articles on proximal half.

Maxillule with stiff bristle on moderately well-developed, internal endopodal lobe, external lobe slightly developed; epipod produced and with tufts of long setae. Maxilla with endopod overreaching scaphognathite by  $\frac{1}{2}$  own length. First maxilliped with endopod approximately  $\frac{1}{2}$  length of exopod; flagellum distinctly 3-segmented distally. Third maxilliped with long spine on dorsodistal meral margin; carpus with short spine on dorsodistal meral margin. Sternite of 3rd maxillipeds with shallow median cleft and long setae.

Right cheliped with dactyl approximately  $\frac{2}{3}$  length of palm; cutting edge with 3 proximal, prominent, calcareous teeth in triangular arrangement and short, calcareous teeth interspersed with corneous teeth distally; terminating in small, corneous claw, slightly overlapped by fixed finger; dorsal surface slightly elevated in midline; all surfaces granular and with tufts of long setae, granules more numerous and larger on dorsomesial margin. Palm slightly longer than carpus, somewhat inflated dorsoventrally; dorsal surface slightly convex, and with long, low spinulose ridge near dorsomesial margin proximally; dorsomesial margin with prominent ridge on proximal half, with row of closely spaced granules and tufts of short setae; dorsoproximal margin with well-developed lobes, laterally and mesially (mesial lobe larger and with acute spine); dorsolateral margin with row of closely spaced granules extending onto fixed finger; ventroproximal margin with median, subrectangular sinus; all surfaces with scattered granules and tufts of short setae; cutting edge of fixed finger with 2 proximal rows of calcareous teeth, converging to single row of 1 prominent and several small, calcareous teeth interspersed with corneous teeth distally; terminating in short corneous claw; all surfaces of fixed finger with granules and tufts of moderately long setae. Carpus slightly exceeding length of merus; dorsomesial margin with irregular row of closely spaced, acute spines and tufts of stiff setae; dorso-

Fig. 31. *Anapagurus adriaticus* spec. nov. ♂ (SL = 3.4 mm), 43°05'N, 14°20'E, IRPEM-D 613: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventral view); E, carpus of same (mesial view); F, left cheliped (dorsal view); G, right 2nd pereopod (mesial view); H, right 3rd pereopod (mesial view); I, sternum; J, uropods and telson; K, left sexual tube (lateral view). Scales equal 1.0 mm: a: C-H; b: A, I, K; c: J; d: B.



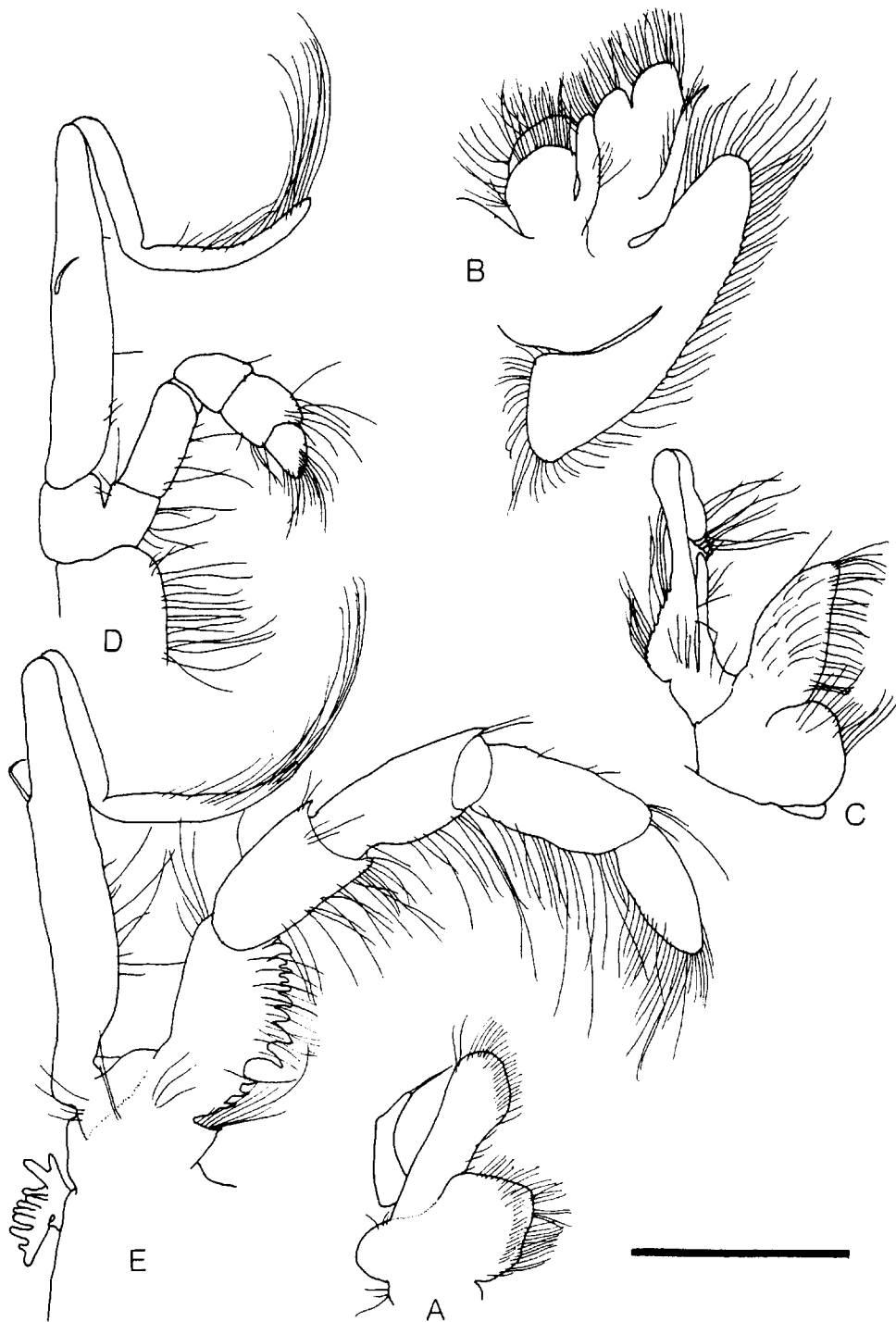


mesial distal angle produced into moderately large lobe with more raised, granular ventral side; dorsodistal margin with acute, triangular projection adjacent to dorsomesial distal angle; dorsolateral margin with irregular row of short spines and 1 larger, acute spine on distal half; dorsolateral distal angle produced into small lobe; ventromesial margin truncate in mesial view; ventral surface inflated, with few granules and tufts of short setae; moderately long ventral length between shallow, subtriangular, ventrodistal margin and deep, subcircular, ventroproximal margin; mesial surface slightly compressed, smooth; all other surfaces with granules and scattered, short setae. Dorsal margin of merus with row of long, stiff setae and acute distal spine partially obscured by tufts of long, stiff setae; ventrolateral margin with 2 or 3 acute spines strongest distally; ventromesial margin usually with 1 or 2 short spines, males occasionally with vestigial, spinulose protuberance; ventral surface with numerous spinules and tufts of short, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by long, stiff setae; ventromesial margin with row of spinules and stiff setae; dorsodistal angle with short protuberance and short stiff setae. Coxa with long setae on ventromesial margin and single, strong, acute spine at distal angle; ventrolateral distal angle unarmed.

Left cheliped almost reaching base of dactyl of right. Dactyl slightly exceeding length of palm; terminating in acute corneous claw overlapped by claw of fixed finger; cutting edge with row of corneous teeth; proximal half with scattered granules, or short spinules in large specimens dorsally and mesially; all surfaces with tufts of long, stiff setae. Palm approximately  $\frac{2}{3}$  length of carpus, somewhat inflated ventrally; dorsolateral margin with closely spaced granules (spinules in large specimens) extending onto fixed finger; dorsal surface with very low, spinulose ridge near dorsomesial margin proximally; all surfaces with scattered granules, or spinules in large specimens, and long, stiff setae; fixed finger with scattered granules on dorsal and lateral surfaces, ventral surface smooth, with scattered tufts of long setae on all faces; cutting edge of fixed finger with row of corneous teeth interspersed with calcareous teeth; terminating in acute, corneous claw. Carpus approximately equaling length of merus, slightly inflated ventrally; dorsomesial margin with 4 to 9 acute spines, dorsomesial distal angle produced into acute subtriangular lobe; dorsolateral margin with 4 to 8 acute spines, dorsolateral distal angle produced into acute subtriangular lobe; dorsal surface with tufts of long, stiff setae. Dorsal margin of merus with tufts of long, stiff setae; ventrolateral margin with 2 or 3, occasionally 4 or 5, acute (or short) spines; ventromesial margin with 1 short spine; ventral face granular, or spinulose in large specimens, and with scattered tufts of long, stiff setae. Ischium with row of spinules and long, stiff setae on ventromesial margin; ventrolateral margin with 1 spinule partly covered by long, stiff setae; dorsodistal angle with short protuberance partly obscured by long, stiff setae. Coxa with long setae on ventromesial margin and single short spine at distal angle; ventrolateral distal angle unarmed.

Second and 3rd pereopods overreaching right cheliped. Dactyls exceeding propodi by approximately  $\frac{1}{3}$  own length; dorsal margins each with row of moderately

Fig. 32. *Anapagurus adriaticus* spec. nov. ♂ (SL = 3.4 mm), 43°05'N, 14°20'E, IRPEM-D 613: right mouthparts: A, maxilluledele (external view); B, maxilla (internal view); C, 1st maxilliped (external view); D, 2nd maxilliped (external view); E, 3rd maxilliped (external view). Scale equals 1.0 mm.



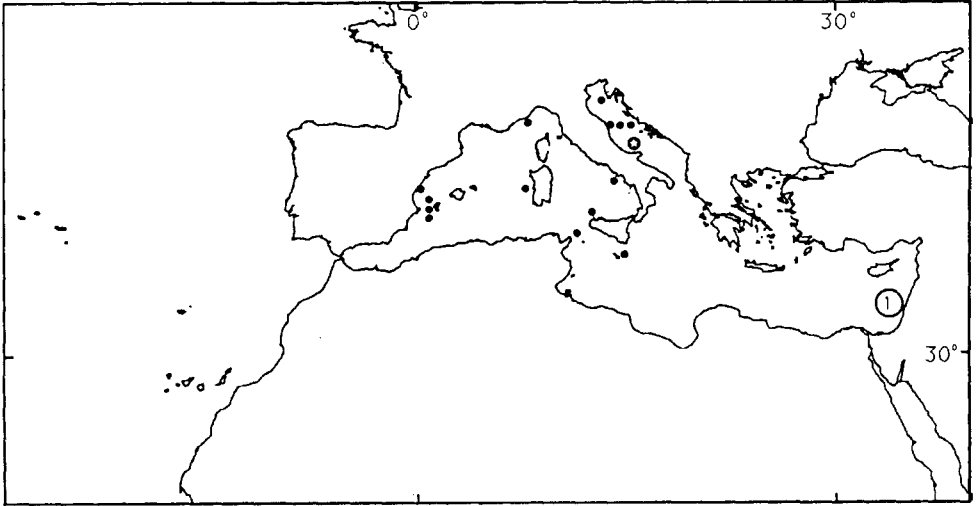


Fig. 33. Distribution of *Anapagurus adriaticus* spec. nov. Circled star: type locality. Solid circles: based on paratypic material. Circled number 1: based on previous record, material examined: Holthuis & Gottlieb, 1958 (as *A. laevis*).

long, closely spaced, stiff setae; mesial faces each with row of short, closely spaced, stiff setae near ventral margin; lateral faces with row of few, widely spaced setae near dorsal and ventral margins. Propodi exceeding carpi approximately  $\frac{1}{3}$  own length; dorsal surfaces serrate, each with row of tufts of moderately short, stiff setae; mesial and lateral faces each with row of few, widely spaced, short setae near ventral margin; ventromesial distal angle with 1 to 4 moderately long, corneous spines (2nd), 1 short, corneous spine or occasionally unarmed (3rd). Carpi approximately  $\frac{2}{3}$  length of meri; dorsal surface with row of 4 to 9 spines (2nd) or with serrate margin and 1 proximal and 1 distal, corneous spine (3rd), and row of tufts of short, stiff setae; lateral and ventral surfaces with scattered short setae. Ventrolateral margins of meri serrate, with 1 spinule on distal half (2nd) or unarmed (3rd) and row of tufts of short setae; dorsal surfaces serrate and with spinule in proximal and distal thirds (2nd) or with 1 spinule in distal third (3rd), and row of tufts of short, stiff setae. Ischia with tufts of short, stiff setae on dorsal and ventral margins. Lobes of sternite of 2nd pereopods rounded distally, unarmed or with row of spinules on lateral margins in large specimens. Anterior lobe of sternite of 3rd pereopods subrectangular, anterior margin with long setae.

Males with well-developed, left sexual tube directed diagonally toward exterior and recurved upward to level of coxa. Coxa of 5th right pereopod with short sexual tube directed backward and partly covered with tufts of long, stiff setae. Pleopods 3 and 4 unequally biramous, pleopod 5 uniramous. Distal protopodal lobe of right uropod approximately  $\frac{1}{2}$  length of endopod.

Terminal margins of telson each with 4 closely spaced spines on terminal margins, decreasing in size mesially; lateral margins unarmed but each with tufts of long setae; dorsal surface with scattered, short setae.

Colour.— Unknown.

Etymology.— The species name refers to the type locality, off Isole Tremiti, Adriatic Sea.

Related organisms.— In the present study specimens of *A. adriaticus* spec. nov. have been found in shells of *Turritella biplicata* (4 specimens, MMSU "AAK" stations 1247 and 1192-129); *Natica acyonix* Marche Marchad (2 specimens, UMML; and MMSU "AAK" station 1192-129); *Trophonopsis muricatus* (Montagu) (2 specimens, MMSU "AAK" station 1192-129; and NHRM 12060); *Taranais moerchi* (Malm) (1 specimen, MMSU "AAK" station 1192-129); and *Cantharidus striatus* (Linnaeus) (1 specimen, MMSU "AAK" station 1214-169).

There is no external evidence of symbionts in any of the specimens examined.

Distribution.— *Anapagurus adriaticus* spec. nov. has been collected in the Mediterranean Sea from the Balearic Sea to off the coast of Israel. One male collected in the Gulf of Guinea is the only record of this new species outside the Mediterranean Sea. Depth range: 30-480 m; most frequently found in depths of 65 to 110 m.

Affinities.— As earlier discussed, *A. adriaticus* spec. nov. and *A. laevis* share the overall appearance and armature but the new species is distinguished by its much narrower shield; less dilated corneae; the roundly triangular ocular acicles, with no expanded mesial margins; and the armed, distally rounded lobes of the sternite of the 2nd pereopods in large specimens.

Remarks.— As previously stated, Holthuis & Gottlieb (1958) questionably assigned to *A. laevis* specimens collected off the coast of Israel. Examination of these specimens has shown that, except for one male from Haifa Bay that actually is *A. adriaticus* spec. nov., the others belong to *A. breaviaculeatus*.

*Anapagurus vossi* spec. nov.  
(figs. 34-36)

*Anapagurus laevis*; Forest, 1961 : 239 (in part; see remarks) [not *Anapagurus laevis* (Bell, 1846)], not figs. 8, 12, 16 (= *Anapagurus atlantidii* spec. nov.).

Material.— Holotype: ♂ [1.0], "John Elliott Pillsbury" station 24, off Ghana, Africa, from 4°56'N, 0°47.5'W to 4°56'N, 0°50'W, 35-37 m, 28.v.1964, collector UMML, MCZ Crustacea No. 13337. Paratypes: 1 ♂ [1.2], "Atlantide" station 154, off Portuguese Guinea, Africa, 11°54'N, 17°14'W, 55-80 m, bluish mud bottom, 17.iv.1946, ZMUC; 1 ovig. [1.0], "Atlantide" station 153, off French Guinea, Africa, 10°49'N, 16°39'W, 42 m, bottom of gray sand, 16.iv.1946, ZMUC; 1 ovig. [1.2], "Atlantide" station 49, off Sierra Leone, Africa, 7°29'N, 13°38'W, 74-79 m, muddy sand bottom, 30.xii.1945, ZMUC; 2 ♂♂ [0.9, 1.0] [found in the stomach of *Arnoglossus imperialis* (Rafinesque, 1810)], "Atlantide" station 70, off Gold Coast, Africa, 4°50'N, 2°49'W, 65 m, bottom of mud and bryozoans, 15.i.1946, ZMUC; 2 ♂♂ [1.4, 1.5], 1 ovig. [1.2], "John Elliott Pillsbury" station 68, off Liberia, Africa, from 4°23'N, 8°05.5'W to 4°24'N, 8°07.5'W, 70 m, 3.vi.1964, USNM 259326; 1.5 ♂ [1.5], "John Elliott Pillsbury" station 68, off Liberia, Africa, from 4°23'N, 8°05.5'W to 4°24'N, 8°07.5'W, 70 m, 3.vi.1964, UMML 32: 5820; 1 ♂ [1.4], "Atlantide" station 123, off Gabon, 2°03'S, 9°05'E, 49-50 m, bottom of mud, shells and corals, 5.iii.1946, ZMUC.

Description.— Shield broader than long. Rostrum equaling lateral projections. Lateral projections with short submarginal spine.

Ocular peduncles approximately  $\frac{3}{4}$  length of shield; with corneae strongly dilat-

ed; dorsomesial face with 1-3 stiff setae. Ocular acicles with mesial margins more strongly expanded than lateral margins; terminating in acute submarginal spine; dorsal surface concave and with few, short setae, long submarginal setae on both lateral and mesial borders; separated basally by approximately basal width of 1 acicle. Interocular plate unarmed.

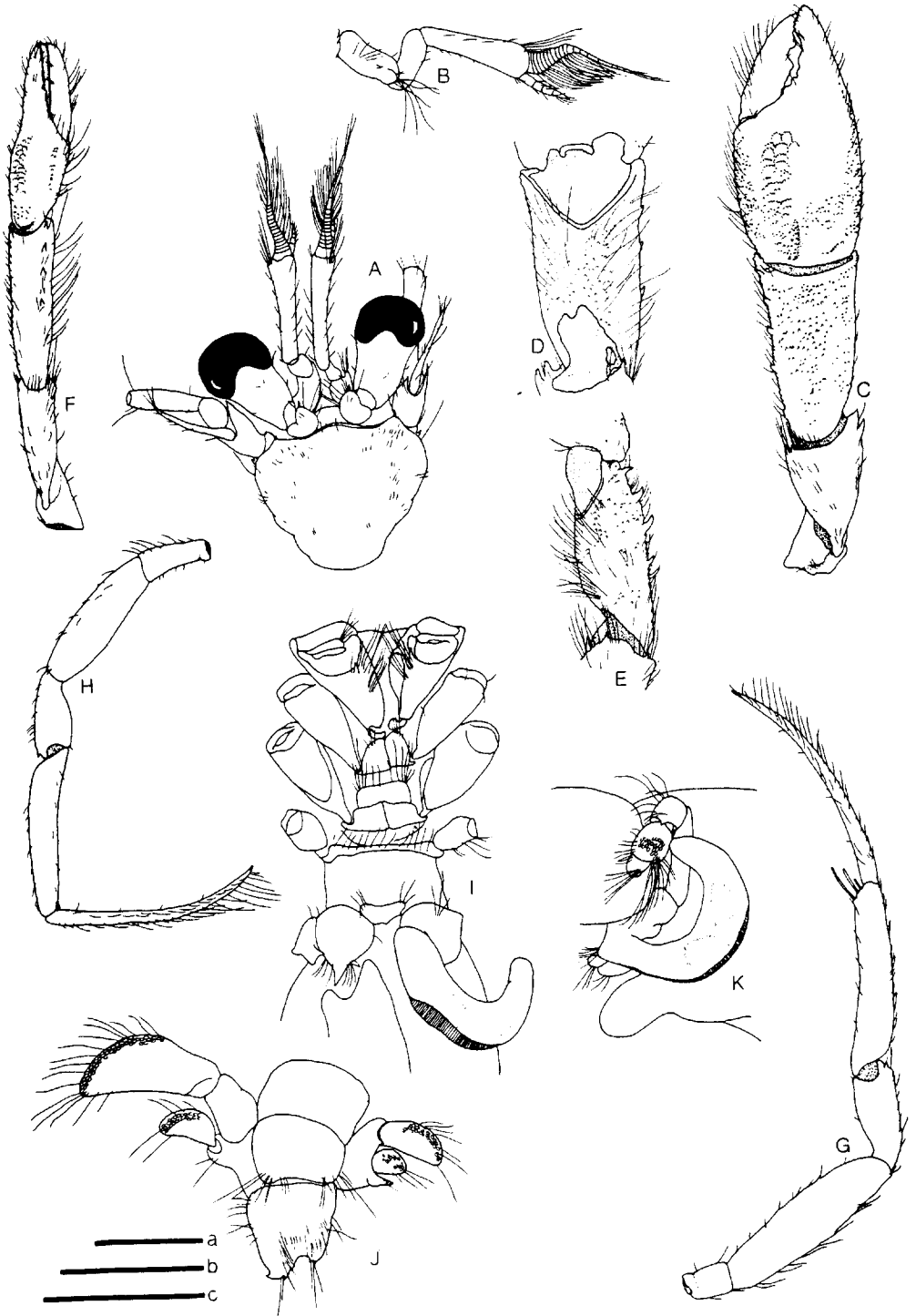
Antennular peduncles overreaching ocular peduncles by approximately entire length of ultimate segment. Ultimate segment exceeding length of penultimate segment by approximately  $\frac{1}{2}$  own length; with dorsolateral row of short setae and laterodistal tuft of 5-7 long setae decreasing in size laterally; dorsomesial margin with row of short setae; ventral margin with row of tufts of very short setae. Basal segment unarmed but with tufts of moderately long setae.

Antennal peduncles overreaching corneae distally by approximately  $\frac{1}{3}$  length of ultimate segment. Fifth and fourth segments with few long stiff setae. Third segment with short ventrolateral distal spine obscured by long stiff setae. Second segment with dorsolateral distal angle produced, terminating in single, strong spine; dorsomesial distal angle with moderately long spine. First segment with short spine at laterodistal margin; ventromesial angle produced, with 2 or 3 small spines laterally. Antennal acicles slightly arcuate, usually reaching corneae distally; dorsomesial margin with row of tufts of stiff setae; terminating in small spine. Antennal flagella nearly reaching dactyl of right cheliped proximally; dorsoventrally flattened, with 1-3 short (less than 1 article in length) setae on both lateral and mesial distal angles of each article and 2 moderately long (1 article in length) setae every 2 to 4 articles.

Maxillular endopod with stiff seta distally, no internal and external lobes. Maxilla with endopod overreaching scaphognathite by  $\frac{1}{4}$  own length. First maxilliped with endopod approximately  $\frac{1}{2}$  length of exopod. Dorsodistal margin of carpus and propodus of third maxilliped, each with very short spine; basis with 3 acute spines; mesial margin of exopod with 1 or 2 moderately long setae. Sternite of 3rd maxillipeds with shallow median cleft and long setae.

Right cheliped with dactyl approximately subequal to length of palm; cutting edge with 3 prominent, proximal, calcareous teeth in triangular arrangement and several shorter distal teeth distributed as follows: 3 or 4 short, calcareous teeth, 1 prominent, calcareous tooth and several very short calcareous teeth interspersed with corneous teeth; terminating in small, corneous claw, slightly overlapped by fixed finger; mesial face granular and with tufts of long setae; all other surfaces smooth but, also with tufts of long setae. Palm slightly shorter than carpus, somewhat inflated dorsoventrally; dorsal surface slightly convex, with long low spinulose ridge near dorsomesial margin proximally; dorsomesial margin with slightly developed ridge on proximal half and various rows of closely spaced granules; dorsoproximal margin with weakly developed lobes, laterally and mesially; dorsolateral margin well delimited, with row of closely spaced granules extending to fixed finger;

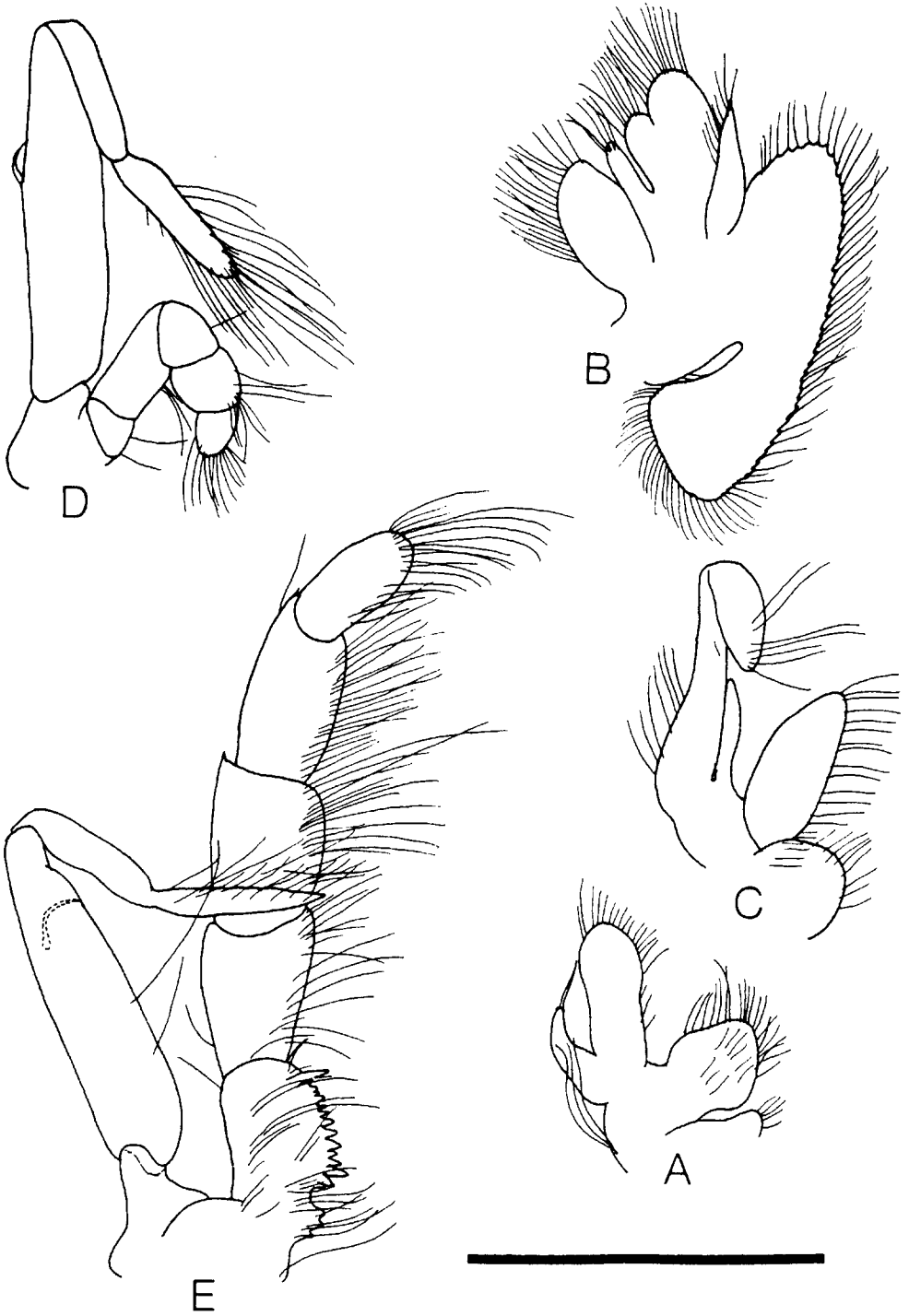
Fig. 34. *Anapagurus vossi* spec. nov. ♂ (SL = 1.5 mm), "John Elliot Pillsbury" station 68, from 4°23'N, 8°05.5'W to 4°24'N, 8°07.5'W, USNM: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventral view); E, carpus of same (ventromesial view); F, left cheliped (dorsal view); G, right 2nd pereopod (mesial view); H, right 3rd pereopod (mesial view); I, sternum; J, extremity of abdomen, uropods and telson; K, left sexual tube (lateral view). Scales equal 1.0 mm: a: A-H; b: I, K; c: J.



ventroproximal margin with median, low subrectangular sinus flanked by 2 slightly calcified sinuses, right subcircular sinus larger and deeper than the left; lateral and mesial faces with scattered granules; ventral surface smooth; all surfaces with scattered tufts of short setae; cutting edge of fixed finger with 2 proximal rows of calcareous teeth converging to single row of 1 prominent and several small calcareous teeth interspersed with corneous teeth distally; terminating in short, corneous claw; all surfaces of fixed finger with tufts of long setae. Carpus approximately equaling length of merus; distal half of dorsomesial margin with 4 strong, acute spines interspersed with spinules, distal spine above dorsomesial distal lobe distinctly directed upward, dorsomesial distal angle produced into moderately large, concave structure, more extended forward ventrally than dorsally; dorsodistal margin with weak triangular projection adjacent to dorsomesial angle; dorsolateral margin with row of spinules and 1 short spine on proximal third; dorsolateral distal angle produced into a structure similar to, but approximately half the size of the dorsomesial distal structure; ventromesial margin subcircular in mesial view; ventral surface inflated with numerous granules and tufts of long setae; short ventral length between subtriangular ventrodistal margin and subcircular ventroproximal margin; mesial surface slightly compressed, granular, with numerous tufts of long, stiff setae; ventral surface granular, with numerous tufts of long stiff setae; dorsal and lateral surfaces granular, with scattered tufts of short setae. Merus with row of long, stiff setae on dorsal margin and partially obscured short, distal spine; ventrolateral margin usually with 2 widely spaced, strong, acute spines, occasionally with 5 closely spaced, acute spines increasing in size distally; ventromesial margin usually with 1 short spine, and a low granular protuberance; ventral surface with numerous granules and tufts of short, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by short, stiff setae; ventromesial margin unarmed, but with row of moderately long, stiff setae. Coxa with ventromesial margin with long setae and strong acute spine at distal angle; ventrolateral distal angle unarmed.

Left cheliped usually overreaching base of dactyl of right. Dactyl slightly exceeding length of palm; terminating in acute corneous claw overlapped by claw of fixed finger; cutting edge with row of corneous teeth; all surfaces smooth, but with tufts of long, stiff setae. Palm approximately  $\frac{2}{3}$  length of carpus, somewhat inflated ventrally; dorsolateral margin abruptly curving and narrowing at base of fixed finger, well-delimited by closely spaced granules extending into fixed finger; dorsal surface granular with very low, wide granular median ridge proximally and with scattered tufts of short setae; all other surfaces granular, with tufts of setae, short on lateral face, long on ventral and mesial faces; fixed finger with scattered granules on dorsal and lateral surfaces, ventral surface smooth, with scattered tufts of long setae on all faces; cutting edge of fixed finger with row of corneous teeth interspersed with calcareous teeth, terminating in acute, corneous claw. Carpus exceeding merus by approximately  $\frac{1}{4}$  own length, slightly inflated ventrally; dorsomesial margin with 4 or 5 acute spines and tufts of long setae, dorsomesial distal angle produced into subcircular

Fig. 35. *Anapagurus vossi* spec. nov. ♂ (SL = 1.5 mm), "Pillsbury" station 68, from 4°23'N, 8°05.5'W to 4°24'N, 8°07.5'W, USNM: right mouthparts: A, maxillule (external view); B, maxilla (internal view); C, 1st maxilliped (external view); D, 2nd maxilliped (external view); E, 3rd maxilliped (external view). Scale equals 1.0 mm.





lobe; dorsolateral margin with numerous, closely spaced acute spines of diverse sizes and tufts of long setae, dorsolateral distal angle produced into subtriangular lobe; dorsal surface somewhat depressed, glabrous. Merus with tufts of long, stiff setae on dorsal margin; ventrolateral margin with 2 widely spaced, strong, acute spines; ventromesial margin with 1 short spine; ventral face granular and with scattered tufts of long, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by short, stiff setae; ventromesial margin unarmed, but with row of moderately long stiff setae. Coxa with ventromesial margin with long setae and strong, acute spine at distal angle; ventrolateral distal angle unarmed.

Second and 3rd pereopods overreaching right cheliped. Dactyls exceeding propodi by approximately  $\frac{1}{4}$  own length; dorsal margins each with row of long, closely spaced, stiff setae; mesial faces each with row of short, closely spaced, stiff setae near ventral margin; lateral faces each with row of few widely spaced setae near dorsal and ventral margins. Propodi exceeding carpi  $\frac{1}{3}$  to  $\frac{1}{2}$  own length; dorsal surfaces each with row of tufts of short, stiff setae; mesial and lateral faces each with row of few widely spaced, short setae near ventral margin; ventromesial distal angle with corneous spines, 3 or 4 long (2nd pereopods, males), 2 short (2nd pereopods, females), 1 or 2 very short (3rd pereopods, both sexes). Carpi approximately  $\frac{1}{2}$  length of meri; dorsal margins each with 1 proximal and 1 distal spine and row of tufts of short, stiff setae; lateral and ventral surfaces each with scattered, short setae. Ventrolateral margins of meri each with row of tufts of short, stiff setae, 1 spinule on distal half (2nd) or unarmed (3rd); dorsal surfaces unarmed, but with row of tufts of short, stiff setae. Ischia with tufts of short, stiff setae on dorsal and ventral margins. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods subrectangular, anterior margin with long setae.

Males with relatively short and broad, left sexual tube recurved upward to level of coxa of 5th pereopod. Coxa of 5th right pereopod with well-developed, short sexual tube backwardly directed, partly covered with tufts of long, stiff setae. Pleopod 3 unequally biramous; pleopods 4 and 5 uniramous. Right distal protopodal lobe overreaching  $\frac{1}{2}$  length of uropodal endopod.

Terminal margins of telson with 2 or 3 unequal, widely spaced spines and long, submarginal, stiff setae; lateral margins unarmed but each with tufts of long setae; distal half of dorsal surface heavily setose.

Colour.— Unknown.

Etymology.— This species is named for the late Dr. Gilbert L. Voss in recognition for his guidance, moral support and friendship throughout my graduate studies.

Related organisms.— Two males of *A. vossi* spec. nov., inhabiting the gastropod shells of *Nassa semistriata* Brocchi, were found in the stomach of a bothid fish, *Arnoglossus imperialis*. There is no external evidence of symbionts in any of the specimens examined.

Distribution.— Specimens of *A. vossi* spec. nov. were collected off the tropical western coast of Africa from Portuguese Guinea to Gabon. Depth range: 35–80 m.

Affinities.— As earlier discussed (see section on affinities for *A. laevis*), *A. vossi* spec. nov. shares a number of characters with *A. laevis* and *A. congolensis* spec. nov. *Anapagurus vossi* spec. nov. can be distinguished from the latter two taxa by the ultimate antennular segment with a laterodistal tuft of five to seven long setae, the right

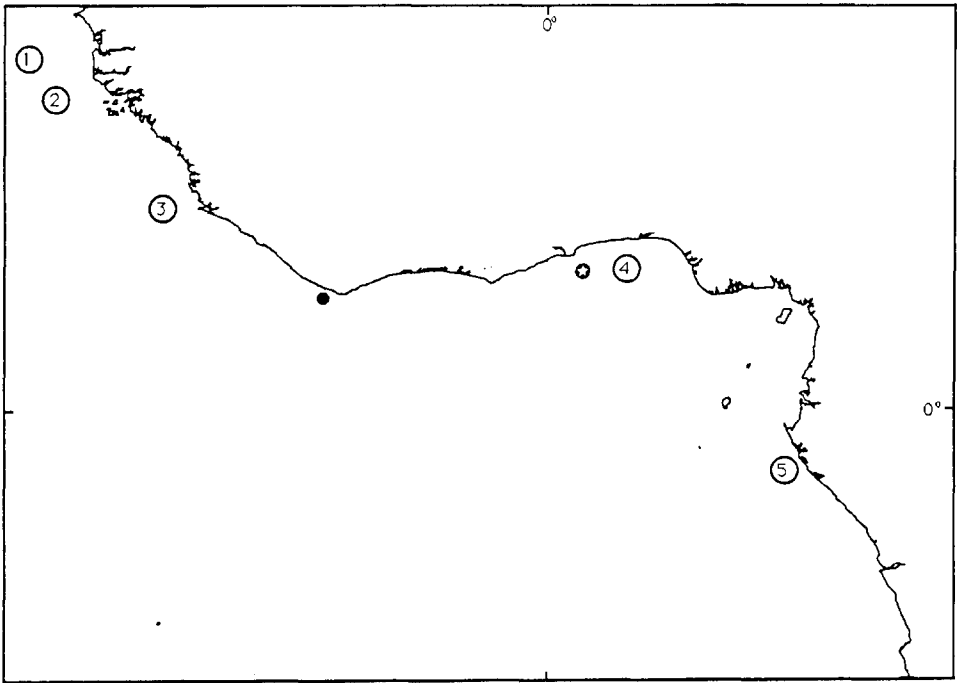


Fig. 36. Distribution of *Anapagurus vossi* spec. nov. Circled star: type locality. Solid circle: based on present record. Circled numbers: based on previous records, material examined: Forest, 1961 (as *A. laevis*).

cheliped with a carpal, dorsomesial, distal spine upwardly directed, the distal armature of the telson with long, submarginal, stiff setae, and in males the relatively shorter and thicker, left sexual tube, and much longer and more conical, right sexual tube.

Remarks.— As previously stated, Forest (1961) reported several specimens collected by the "Atlantide" off the tropical western coast of Africa as *A. laevis*. From my examination of these specimens I have concluded that none represent this taxon, but rather represent three different taxa, *A. wolffi*, *A. vossi* spec. nov., and *A. atlantidii* spec. nov.

R.W. Ingle (personal communication, 1991) is going to describe a presumably new species of *Anapagurus* from Adventure Bank, Mediterranean that appears to have many features of *A. vossi* spec. nov. It has particularly noticeably broadened corneae, but differs in having one or more spines on the lower meral margin of the third pereopod, a dorso-distal carpal and meral spine on the third maxilliped endopod, and the propodal palm of the right cheliped being much broader and with small scattered granules (tubercles). In addition, Ingle's specimens have a different setal armature of the antennule first peduncular segment.

*Anapagurus atlantidii* spec. nov.  
(figs. 37-39)

*Anapagurus laevis*; Forest, 1961: 239 (in part; see remarks), figs. 8, 12, 16 [not *Anapagurus laevis* (Bell, 1846)].

Material.— Holotype: ♂ [0.9], "Atlantide" station 146, off French Guinea, Africa, 9°27'N, 14°48'W, 50 m, bottom of shells and foraminiferans, 13.iv.1946, ZMUC; Paratypes: 1 ♂ [0.9], 3 ovig. [1.3-1.5], same data as holotype; 1 ♂ [1.0], "Atlantide" station 145, off French Guinea, Africa 9°20'N, 14°15'W, 32 m, 13.iv.1946; ZMUC.

Description.— Shield broader than long. Rostrum slightly overreaching lateral projections. Lateral projections with short submarginal spine.

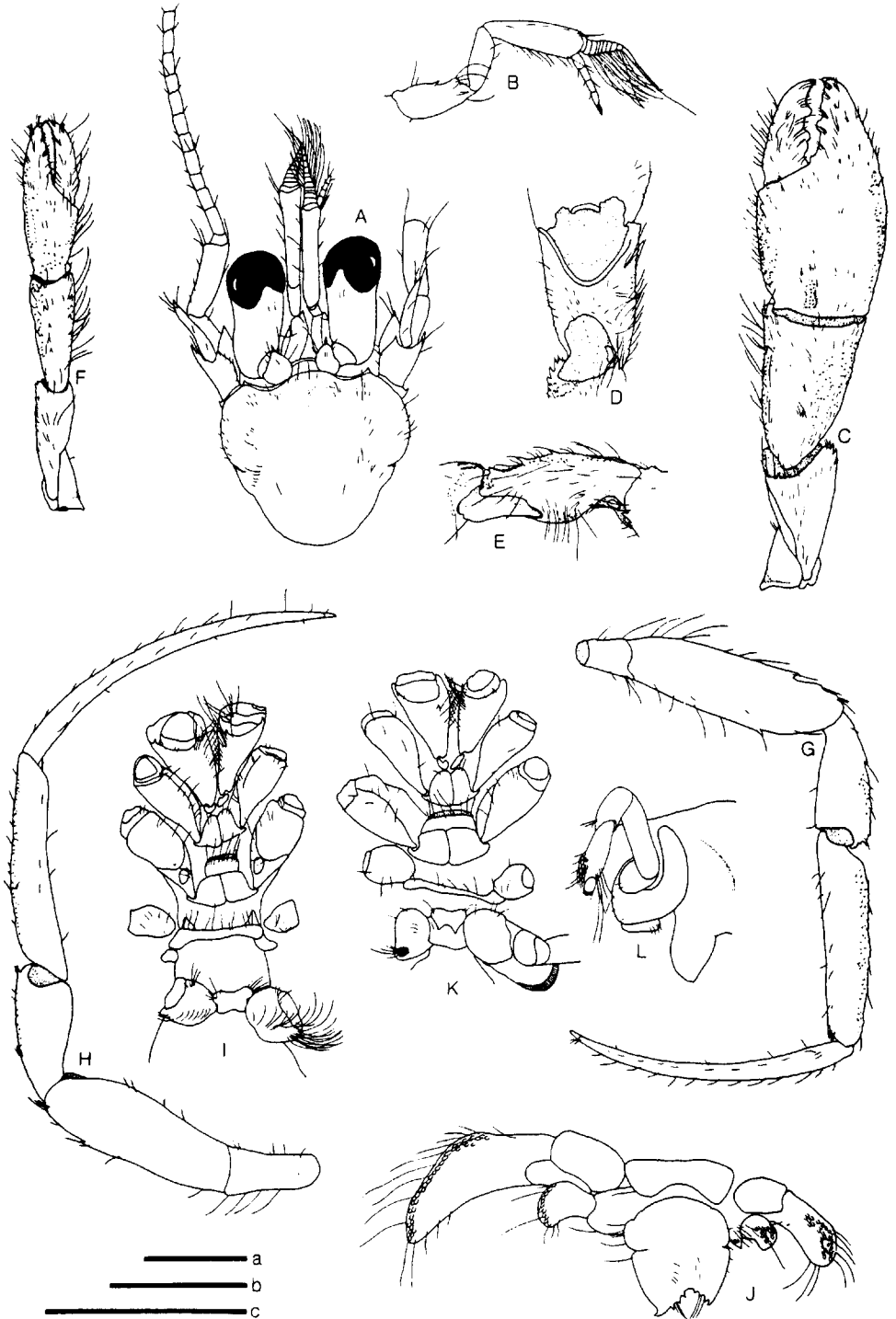
Ocular peduncles approximately  $\frac{3}{4}$  length of shield; with corneae moderately dilated; dorsomesial face with 1 or 2 short, stiff setae. Ocular acicles roundly triangular, terminating in acute submarginal spine; dorsal surface concave and with few short setae, long submarginal setae on both lateral and mesial borders; separated basally by approximately basal width of 1 acicle. Interocular plate unarmed.

Antennular peduncles overreaching ocular peduncles by approximately entire length of ultimate segment. Ultimate segment exceeding length of penultimate segment by approximately  $\frac{1}{3}$  own length, with dorsolateral row of short setae and laterodistal set of 2 or 3 long setae; dorsomesial margin with row of short setae; ventral margin with row of tufts of moderately long setae. Basal segment with short lateromedial spine.

Antennal peduncles overreaching corneae distally by approximately  $\frac{1}{4}$  length of ultimate segment. Fifth and fourth segments with few long, stiff setae. Third segment with short, ventrolateral, distal spine obscured by long, stiff setae. Second segment with dorsolateral distal angle produced, terminating in strong, bifid spine; dorsomesial distal angle with moderately strong spine. First segment with small spine at laterodistal margin; ventromesial angle produced and with 2 or 3 small spines laterally. Antennal acicles slightly arcuate, terminating in small spine; usually reaching proximal half of corneae, dorsomesial margin with row of tufts of stiff setae. Antennal flagella usually overreaching tip of right cheliped; dorsoventrally flattened, with 1-3 short (less than 1 article in length) setae on both lateral and mesial distal angles of each article and 2 moderately long (equal to or more than 1 article in length) setae every 2 to 4 articles.

Maxillular endopod with stiff seta distally, no internal and external lobes. Maxilla with endopod slightly overreaching scaphognathite. First maxilliped with endopod approximately  $\frac{1}{2}$  length of exopod. Dorsodistal margin of merus of third maxilliped with short spine; basis with 3 acute spines; mesial margin of exopod with 1 or 2

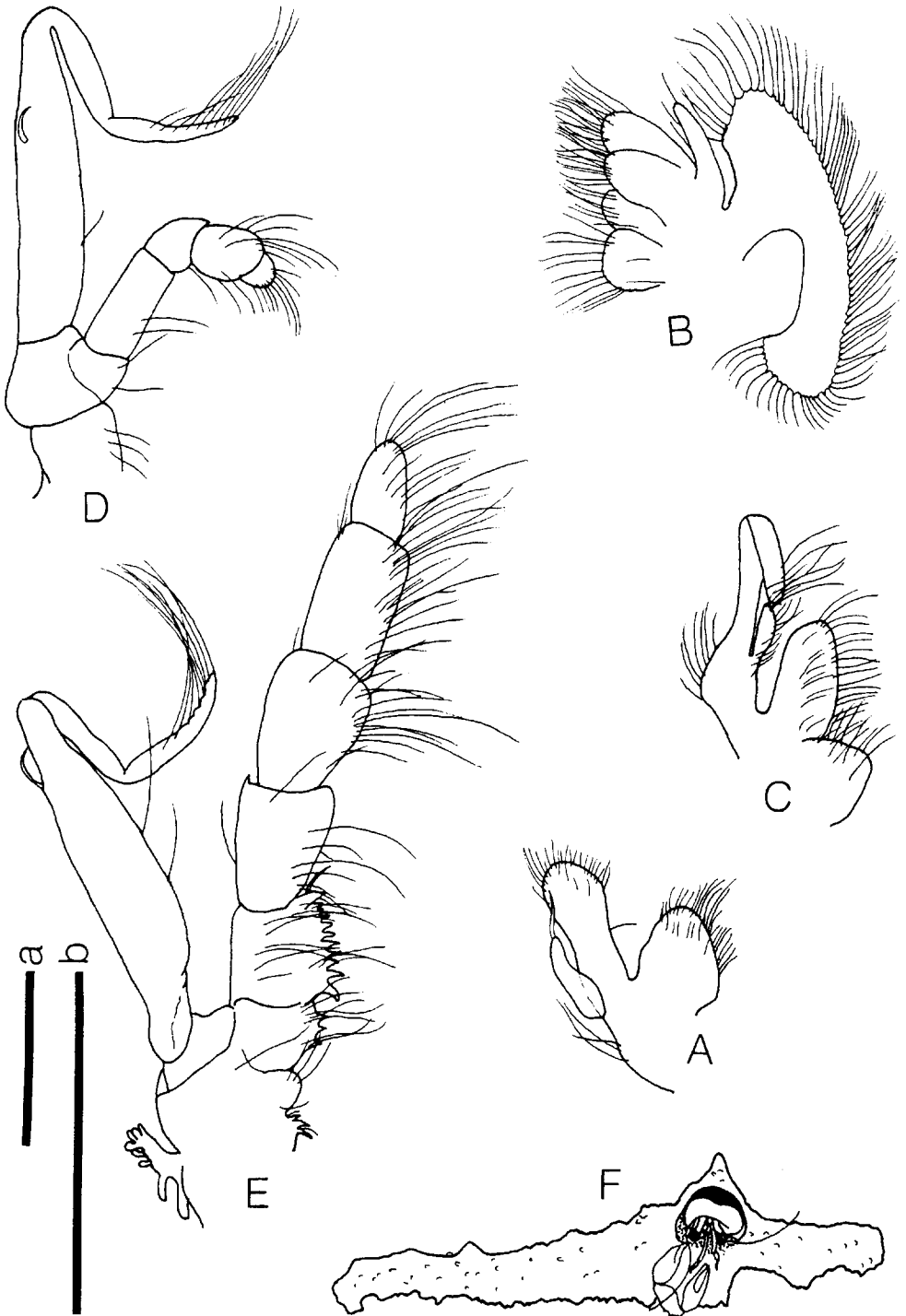
Fig. 37. *Anapagurus atlantidii* spec. nov. A-J: ovig. (SL = 1.5 mm), "Atlantide" station 146, 9°27'N, 14°48'W, ZMUC: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventral view); E, carpus of same (ventromesial view); F, left cheliped (dorsal view); G, left 2nd pereopod (mesial view); H, left 3rd pereopod (mesial view); I, sternum; J, extremity of abdomen, uropods and telson. K, L: holotype ♂ (SL = 0.9 mm), "Atlantide" station 146, 9°27'N, 14°48'W, ZMUC: K, sternum; L, left sexual tube (lateral view). Scales equal 1.0 mm: a: C-F; b: A, B, G-I; c: J-L.



moderately long setae. Sternite of 3rd maxillipeds with shallow, median cleft and long setae.

Right cheliped with dactyl subequal to length of palm; cutting edge with 3 prominent, proximal, calcareous teeth in triangular arrangement and several, shorter, distal teeth distributed as follows: 2 or 3 short, calcareous teeth, 1 prominent, calcareous tooth and several, very short, calcareous teeth interspersed with corneous teeth; terminating in small, corneous claw; slightly overlapped by fixed finger; mesial face granular and with tufts of long, stiff setae; all other surfaces smooth but with tufts of long setae. Palm subequal to length of carpus, somewhat inflated dorsoventrally; dorsal surface slightly convex, with very small granules and long, low spinulose ridge near dorsomesial margin proximally; dorsomesial margin with slightly developed ridge on proximal half and row of closely spaced granules and tufts of short setae; dorsoproximal margin with well-developed mesial lobe and weakly developed lateral lobe; dorsolateral margin well delimited by row of closely spaced spinules extending onto fixed finger; ventroproximal margin with median, low subrectangular sinus flanked by 2 slightly calcified sinuses, right subcircular sinus larger and deeper than left; lateral and mesial faces with closely spaced granules; ventral surface with very small granules; mesial surface with tufts of long setae, all other surfaces with scattered tufts of short setae; cutting edge of fixed finger with 2 proximal rows of calcareous teeth converging distally to single row of 1 prominent and several small, calcareous teeth interspersed with corneous teeth; terminating in short corneous claw; all surfaces of fixed finger with tufts of long setae. Carpus approximately equaling length of merus; dorsomesial margin with widely spaced long, stiff setae, and 3 or 4 long spines on distal half increasing in size distally, distalmost spine upwardly directed; dorsomesial distal angle produced into concave, subrectangular structure; dorsodistal margin with weak, triangular projection adjacent to dorsomesial distal angle; dorsolateral margin with row of spinules and widely spaced, moderately long, stiff setae, 1 short, acute spine on proximal third; dorsolateral distal angle produced into small lobe; mesial surface slightly compressed, granular, with numerous tufts of long, stiff setae; ventromesial margin conical in mesial view; ventral surface inflated, granular and with numerous tufts of long, stiff setae, except for a glabrous, slightly depressed median part; short ventral length between deep, subtriangular, ventrodistal margin and deep subcircular ventroproximal margin; dorsal surface slightly depressed, with scattered granules and tufts of short setae; lateral surface somewhat convex, granular and with scattered tufts of short setae. Merus with row of long stiff setae on dorsal margin and partially obscured, short, acute distal spine; ventrolateral margin with 3 or 4 acute spines; ventromesial margin usually with 1 acute spine, and low, spinulose protuberance; ventral surface with numerous granules and tufts of short, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by short, stiff setae; ventromesial margin unarmed, but with row of moderately long, stiff setae. Coxa with 1 spinule on ventrolateral distal angle; ven-

Fig. 38. *Anapagurus atlantidii* spec. nov. A-E: ovig. (SL = 1.5 mm), "Atlantide" station 146, 9°27'N, 14°48'W, ZMUC: right mouthparts: A, maxillule (external view); B, maxilla (internal view); C, 1st maxilliped (external view); D, 2nd maxilliped (external view); E, 3rd maxilliped (external view). F. ovig. (SL=1.3 mm), "Atlantide" station 146, 9°27'N, 14°48'W, ZMUC: specimen in a gastropod shell completely encrusted by a colonial bryozoan. Scales equal 1.0 mm: a: F; b: A-E.



tromesial margin with tufts of moderately long, stiff setae, partly covering 1 short spine at distal angle; ventrolateral distal angle unarmed.

Left cheliped reaching distal fifth of palm of right. Dactyl exceeding palm by approximately  $\frac{1}{4}$  own length; terminating in acute corneous claw overlapped by claw of fixed finger; cutting edge with row of corneous teeth; all surfaces with scattered spinules and tufts of long, stiff setae. Palm approximately  $\frac{2}{3}$  length of carpus, somewhat inflated ventrally; dorsolateral margin well delimited by closely spaced spinules extending onto fixed finger; dorsal surface with spinules, more numerous on proximal half and with scattered tufts of short setae; very low, wide, spinulose median ridge proximally; dorsoproximal margin flanked by well-developed mesial lobe and poorly developed lateral lobe; dorsomesial margin with row of closely spaced spinules and tufts of moderately long, stiff setae; lateral surface spinulose and with scattered tufts of short setae; mesial and ventral surfaces smooth but with tufts of long, stiff setae; fixed finger with scattered spinules on dorsal and lateral surfaces, ventral surface smooth; scattered tufts of long setae on all faces; cutting edge of fixed finger with row of corneous teeth interspersed with calcareous teeth, terminating in acute, corneous claw. Carpus subequal to length of merus, slightly inflated ventrally; dorsomesial margin with 4 or 5 acute spines interspersed with spinules and tufts of long setae, dorsomesial distal angle produced into subcircular lobe; dorsolateral margin with 4 or 5 widely spaced, acute spines interspersed with spinules and tufts of long setae, dorsolateral distal angle produced into subtriangular lobe; dorsal surface somewhat depressed, glabrous. Merus with tufts of long, stiff setae on dorsal margin; ventrolateral margin with 2 closely spaced, strong, acute spines; ventromesial margin with 1 short spine; ventral face spinulose and with scattered tufts of long, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by short, stiff setae; ventromesial margin unarmed, but with row of moderately long, stiff setae. Coxa with 1 spinule on ventrolateral distal angle; ventromesial margin with tufts of moderately long, stiff setae and 1 short, acute spine at distal angle; ventrolateral distal angle unarmed.

Second and 3rd pereopods overreaching right cheliped. Dactyls exceeding propodi by approximately  $\frac{1}{3}$  own length; dorsal margins each with row of moderately long, widely spaced, stiff setae; mesial faces each with row of short, widely spaced, stiff setae near ventral margin; lateral faces each with row of few widely spaced setae near dorsal and ventral margins. Propodi exceeding carpi approximately  $\frac{1}{3}$  own length; dorsal surfaces spinulose, each with row of widely spaced, short, stiff setae; mesial and lateral faces each with row of few, widely spaced, short setae near ventral margin; ventromesial distal angle with 1 corneous spine (2nd) or unarmed (3rd). Carpi approximately  $\frac{2}{3}$  length of meri; dorsal margin each with 2 or 3 spines interspersed with spinules (2nd) or granular and with 1 dorsodistal spine (3rd), lateral and mesial faces glabrous; ventral surfaces each with scattered short setae. Ventrolateral margins of meri each with row of tufts of short setae, 2nd serrate and with 1 spinule on distal half, 3rd unarmed; dorsal surface with row of tufts of short, stiff setae and 1 short spine on distal half. Ischia with tufts of short, stiff setae on dorsal and ventral margins. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods subtrapezoidal to subrectangular, anterior margin with long setae.

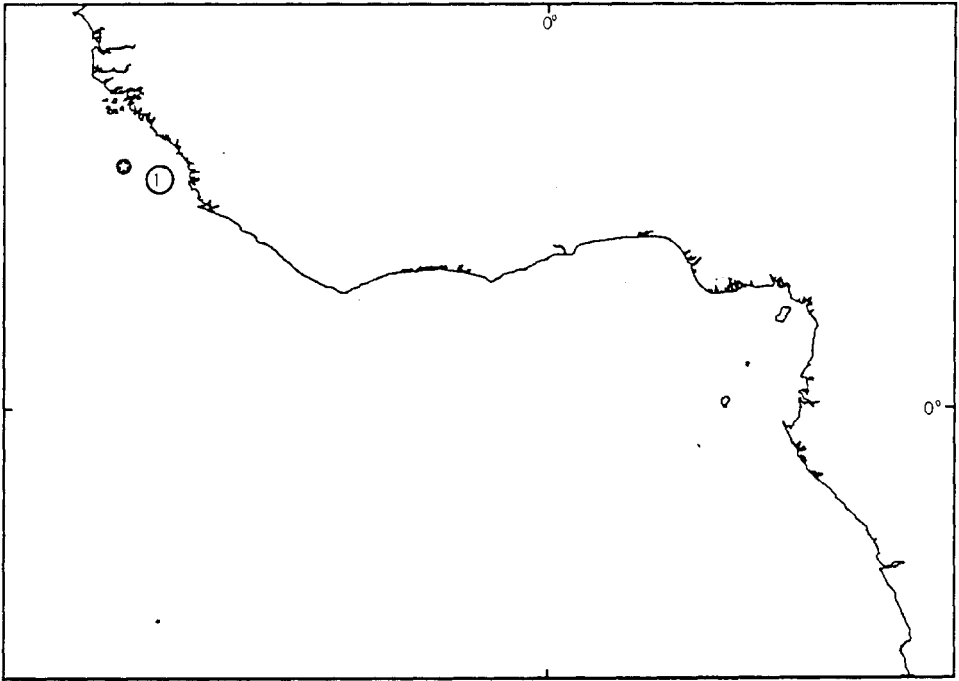


Fig. 39. Distribution of *Anapagurus atlantidii* spec. nov. Circled star: type locality. Circled number 1: based on previous record, material examined: Forest, 1961 (as *A. laevis*).

Males with relatively short and broad, left sexual tube recurved upward to level of coxa of 5th pereopod. Coxa of 5th right pereopod with gonopore partly obscured by tufts of long setae. Three uniramous pleopods. Right distal protopodal lobe approximately  $1/2$  length of uropodal endopod.

Terminal margins of telson with 4 subequal, closely spaced spines and tufts of moderately long, submarginal, stiff setae; lateral margins unarmed but each with moderately long setae; distal half of dorsal surface with scattered short setae.

Colour.— Unknown.

Etymology.— This species is named for the research vessel "Atlantide" in recognition of its marine investigations off the West African coast that provided the specimens for the species description.

Related organisms.— One of the ovigerous females of *A. atlantidii* spec. nov. collected at station 146 by the "Atlantide" (ZMUC) was found inhabiting a gastropod shell completely encrusted by an unidentified colony of bryozoan, similar to the association previously reported in this paper for *A. curvidactylus*.

Distribution.— Specimens of *A. atlantidii* spec. nov. have been collected only in tropical waters off the coast of French Guinea, Africa. Depth range: 32-50 m.

Affinities.— The presence of ventrolateral, distal, coxal spines on the chelipeds in *A. atlantidii* spec. nov. is shared with *A. hyndmanni* and *A. curvidactylus*, however, the new species can be easily distinguished from the other two taxa by its right cheliped with a palmar, spinulose ridge near its dorsomesial margin proximally, its carpal



dorsomesial row of spines with a distalmost spine directed upward, and its much shorter ventral carpal length.

Remarks.— During his study of the "Atlantide" collections, Forest (1961), as previously noted, confounded three taxa under the name *Anapagurus laevis*. The specimens collected at stations 145 and 146 by the "Atlantide" are herein assigned to the new taxon, *A. atlantidii* spec. nov.

*Anapagurus congolensis* spec. nov.  
(figs. 40-42)

*Anapagurus laevis*; Forest, 1955: 131 (in part; see remarks) [Not *Anapagurus laevis* (Bell, 1846)].

Material.— Holotype: ♂ [2.3], "Mbizi" station 172, 30 miles SW off Pointe Noire, Congo, Africa, 5°15'S, 11°29'E, 225-240 m, bottom of sand and silt, 2.iv.1949, IRSNB-IG-16.808; Paratypes: 1 ♂ [2.9], "Mbizi" station 9, 26 miles WSW off Moita Seca, Congo, Africa, 6°21'S, 11°53'12"E, 100 m, bottom of sand, silt and brown coral, 4-5.viii.1948, IRSNB-IG-16.808; 4 ♂ [2.2-2.8], "Mbizi" station 10, 42 miles SW off Moita Seca, Congo, Africa, from 6°28'42"S, 11°36'30"E to 6°16'30"S, 11°45'E, 125 m, bottom of brown sandy silt, 5-6.viii.1948, IRSNB-IG-16.808; 8 ♂ [1.9-3.3], 3 ♀ [2.2-2.3], 2 ovig. [1.8, 2.3], "Mbizi" station 166, 35 miles W by S off Pointe Noire, Congo, Africa, 4°57'S, 11°16'E, 170 m, bottom of sand and silt, 28.iii.1949, IRSNB-IG-16.808; 2 ♂ [2.6, 3.4], 1 ovig. [2.6], "Mbizi" station 171, 32 miles W off Pointe Noire, Congo, Africa, 4°48'S, 11°30'E, 135 m, bottom of green sand and silt, 1-2.iv.1949, IRSNB-IG-16.808; 1 ♂ [2.6], "Mbizi" station 172, 30 miles SW off Pointe Noire, Congo, Africa, 5°15'S, 11°29'E, 225-240 m, bottom of sand and silt, 2.iv.1949, IRSNB-IG-16.808.

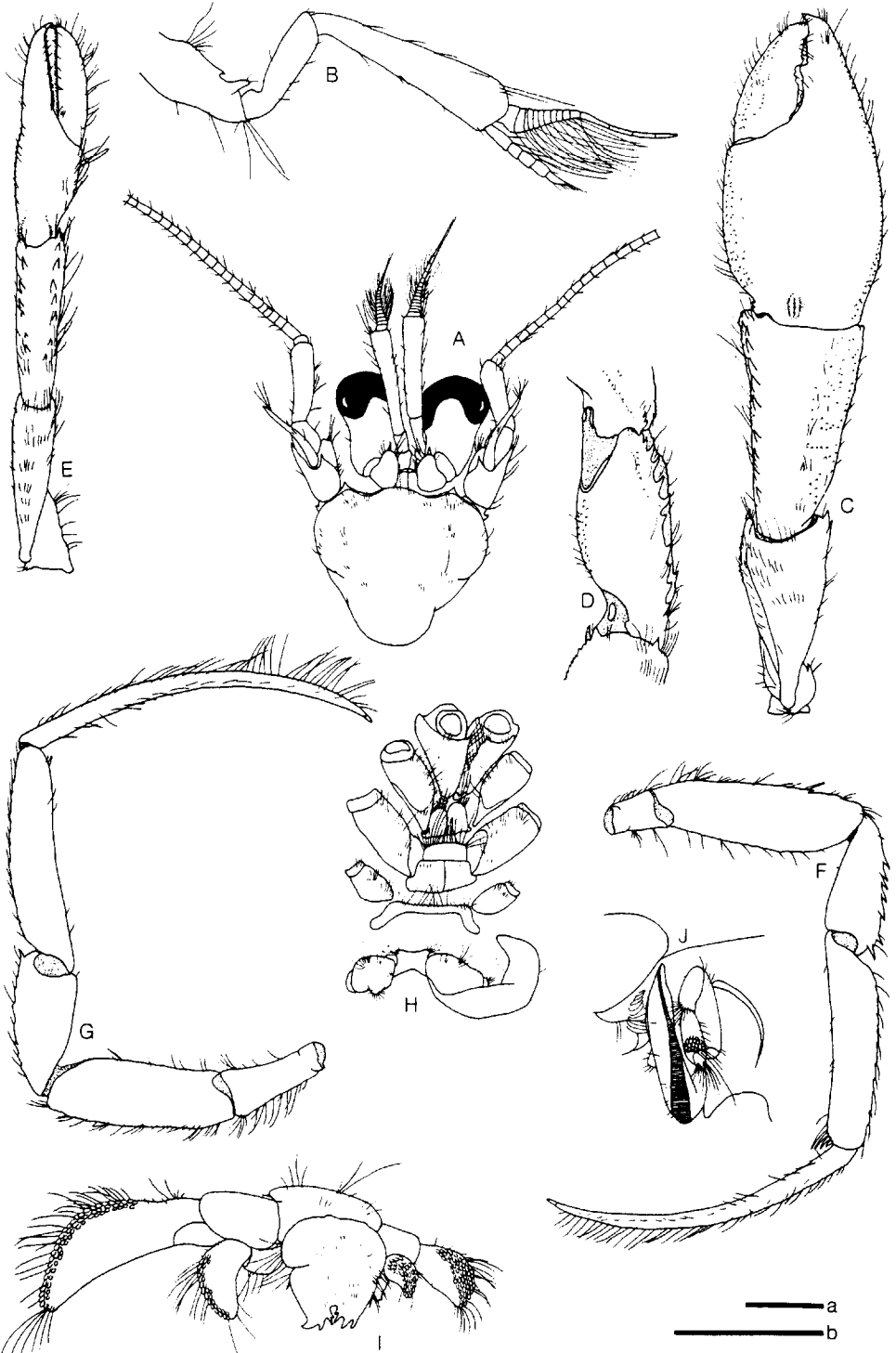
Description.— Shield broader than long. Rostrum slightly overreached by lateral projections. Lateral projections with short submarginal spine.

Ocular peduncles approximately  $\frac{2}{3}$  length of shield; with corneae moderately dilated; dorsomesial face with 1 or 2 short, stiff setae. Ocular acicles roundly triangular, terminating in acute submarginal spine; dorsal surface concave and with few short setae; with long submarginal setae on both lateral and mesial borders; separated basally by slightly less than basal width of 1 acicle. Interocular plate unarmed.

Antennular peduncles overreaching ocular peduncles by approximately  $\frac{3}{4}$  length of ultimate segment. Ultimate segment exceeding length of penultimate segment by approximately  $\frac{1}{2}$  own length, with dorsolateral row of moderately long setae and laterodistal tuft of 2 or 3 long setae; dorsomesial margin with row of short setae; ventral margin with row of tufts of very short setae. Basal segment with short lateromedial and laterodistal spines.

Antennal peduncles overreaching distal margin of corneae by approximately  $\frac{1}{4}$  length of ultimate segment. Fifth and fourth segment with few, long, stiff setae. Third segment with short, ventrolateral, distal spine obscured by long, stiff setae. Second segment with dorsolateral distal angle produced, terminating in strong, bifid spine; dorsomesial distal angle with moderately strong spine. First segment with small

Fig. 40. *Anapagurus congolensis* spec. nov. ♂ (SL = 2.6 mm), "Mbizi" station 172, 5°15'S, 11°29'E, IRSNB-IG-16.808: A, shield and cephalic appendages; B, right antennule (lateral view); C, right cheliped (dorsal view); D, carpus of same (ventromesial view); E, left cheliped (dorsal view); F, left 2nd pereopod (mesial view); G, left 3rd pereopod (mesial view); H, sternum; I, extremity of abdomen, uropods and telson; J, left sexual tube (lateral view). Scales equal 1.0 mm: a: A, C-H; b: B, I, J.

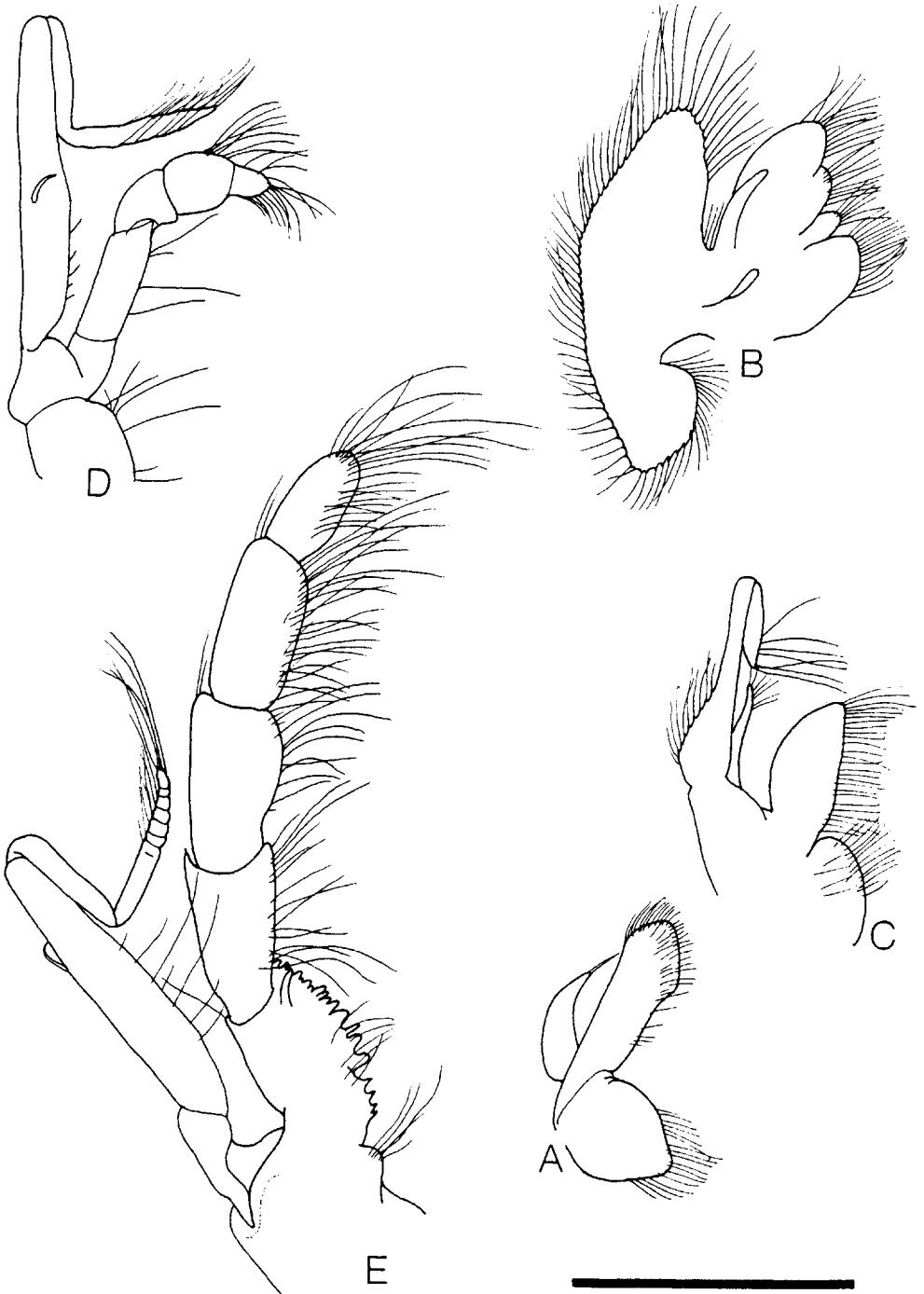


spine at laterodistal margin; ventromesial angle produced and with 2 or 3 small spines laterally. Antennal acicles slightly arcuate, terminating in small spine; usually not reaching corneae distally, dorsomesial margin with row of tufts of stiff setae. Antennal flagella usually overreaching tips of walking legs; dorsoventrally flattened, with 1-3 short (less than 1 article in length) setae on both lateral and mesial distal angles of each article, and 2 moderately long (1 article in length) setae every 2 to 4 articles.

Maxillular endopod with distal, stiff bristle, lacking internal and external lobes. Maxilla with endopod not reaching scaphognathite distally. First maxilliped with endopod approximately  $\frac{1}{2}$  length of exopod. Dorsodistal margin of merus of third maxilliped with short spine; basis unarmed; mesial margin of exopod with numerous moderately long setae. Sternite of 3rd maxillipeds with shallow median cleft and long setae.

Right cheliped with dactyl subequal to length of palm; cutting edge with 3 prominent, proximal, calcareous teeth in triangular arrangement, and several shorter, distal teeth distributed as follows: 2 or 3 short, calcareous teeth, 1 prominent, calcareous tooth and several very short, calcareous teeth interspersed with corneous teeth; terminating in small, corneous claw; slightly overlapped by fixed finger; mesial face granular and with tufts of moderately long, stiff setae; all other surfaces smooth but with tufts of moderately long setae. Palm approximately  $\frac{3}{4}$  length of carpus, somewhat inflated dorsoventrally; dorsomesial margin with row of closely spaced spinules and tufts of short setae; dorsal surface slightly convex with very small granules, with long, low spinulose ridge near dorsomesial margin proximally; dorsolateral margin well delimited by row of closely spaced spinules extending onto fixed finger; dorsoproximal margin with well-developed mesial lobe armed with 2 or 3 spinules and weakly developed lateral lobe; mesial face with slightly developed ridge on proximal half; ventroproximal margin with median, low subrectangular sinus flanked by 2 small, slightly calcified sinuses; lateral and mesial faces with closely spaced spinules; ventral surface with very small granules; mesial surface with tufts of moderately long setae, all other surfaces with scattered tufts of short setae; cutting edge of fixed finger with 2 proximal rows of calcareous teeth converging to single row of 1 prominent and several small, calcareous teeth interspersed with corneous teeth distally; terminating in short corneous claw; all surfaces of fixed finger with tufts of moderately long setae. Carpus approximately  $\frac{1}{4}$  longer than merus; dorsomesial margin with 8 to 12 closely spaced spines increasing in size distally except for 2 most distal, smaller spines; dorsomesial distal angle produced into concave, subrectangular structure with more raised ventral side; dorsodistal margin with strong triangular projection adjacent to dorsomesial distal angle; dorsal surface slightly depressed, with scattered spinules and tufts of short setae; dorsolateral margin with row of spinules and 1 acute spine on proximal third and with moderately long, stiff setae; dorsolateral distal angle produced into small lobe; ventromesial margin subcircular in mesial view; ventral surface inflated, spinulose and with tufts of short, stiff

Fig. 41. *Anapagurus congolensis* spec. nov. ♂ (SL = 2.6 mm). "Mbizi" station 172, 5°15'S, 11°29'E, IRSNB-IG-16.808: mouthparts (right, external view): A, maxillule; B, maxilla; C, 1st maxilliped; D, 2nd maxilliped; E, 3rd maxilliped. Scale equals 1.0 mm.



setae; moderately long ventral length between deep, subtriangular ventrodistal margin and subcircular ventroproximal margin; mesial surface slightly compressed, spinulose, with moderately long, stiff setae; lateral surface somewhat convex, spinulose and with scattered tufts of short setae. Dorsal margin of merus with row of moderately long, stiff setae partly covering 1 strong distal spine; ventrolateral margin with row of spinules and 2 strong distal spines; ventromesial margin usually with 1 strong spine and low spinulose protuberance; ventral surface with numerous spinules and tufts of short, stiff setae. Ischium with 1 spinule on ventrolateral margin partly covered by short, stiff setae; ventromesial margin with row of spinules and moderately long, stiff setae. Ventromesial margin of coxa with tufts of moderately long, stiff setae, partly covering 1 strong spine at distal angle; ventrolateral distal angle unarmed.

Left cheliped reaching distal fifth of palm of right. Dactyl exceeding palm by approximately  $\frac{1}{5}$  own length; terminating in acute corneous claw overlapped by claw of fixed finger; cutting edge with row of corneous teeth; all surfaces with scattered spinules and tufts of long, stiff setae. Palm  $\frac{1}{2}$  to  $\frac{2}{3}$  length of carpus, somewhat inflated ventrally; dorsolateral margin well delimited by closely spaced spinules extending onto fixed finger; dorsal surface with spinules (more numerous on proximal half) and scattered tufts of short setae; a very low, wide, spinulose median ridge proximally; dorsoproximal margin flanked by weakly developed mesial and lateral lobes; dorsomesial margin with row of closely spaced spinules and tufts of moderately long, stiff setae; lateral surface spinulose and with scattered tufts of short setae; mesial surface spinulose and with tufts of moderately long, stiff setae; ventral surface smooth but with tufts of moderately long, stiff setae; fixed finger with scattered spinules on dorsal and lateral surfaces, ventral surface smooth, with scattered tufts of long setae on all faces; cutting edge of fixed finger with row of corneous teeth interspersed with calcareous teeth, terminating in acute, corneous claw. Carpus subequal to length of merus, slightly inflated ventrally; dorsomesial margin with 4 to 6 acute spines interspersed with spinules and tufts of moderately long setae, dorsomesial distal angle produced into subcircular lobe; dorsolateral margin with 7 to 9 strong, acute spines and tufts of long setae, dorsolateral distal angle produced into subcircular lobe; dorsal surface somewhat depressed, glabrous. Dorsal margin of merus with tufts of moderately long, stiff setae; ventrolateral margin with row of spinules on proximal half and 2 widely spaced, strong spines on distal half; ventromesial margin with 1 strong spine; ventral face spinulose and with scattered tufts of moderately long, stiff setae. Ischium with ventromesial margin serrate and row of moderately long, stiff setae. Coxa with ventromesial margin with tufts of moderately long, stiff setae and 1 acute spine at distal angle; ventrolateral distal angle unarmed.

Second and 3rd pereopods overreaching right cheliped. Dactyls exceeding propodi by approximately  $\frac{1}{4}$  own length; dorsal margins each with row of long, closely spaced, stiff setae near ventral margin; lateral faces with row of few widely spaced setae near dorsal and ventral margins. Propodi exceeding carpi approximately  $\frac{1}{3}$  own length; dorsal surfaces smooth, each with row of closely spaced, short, stiff setae; mesial and lateral faces each with row of few, widely spaced, short setae near ventral margin; ventromesial distal angle with corneous spines, 3 or 4 moderately long (2nd, males), 2 short (2nd, females), 1 very short (3rd, both sexes), and tufts of

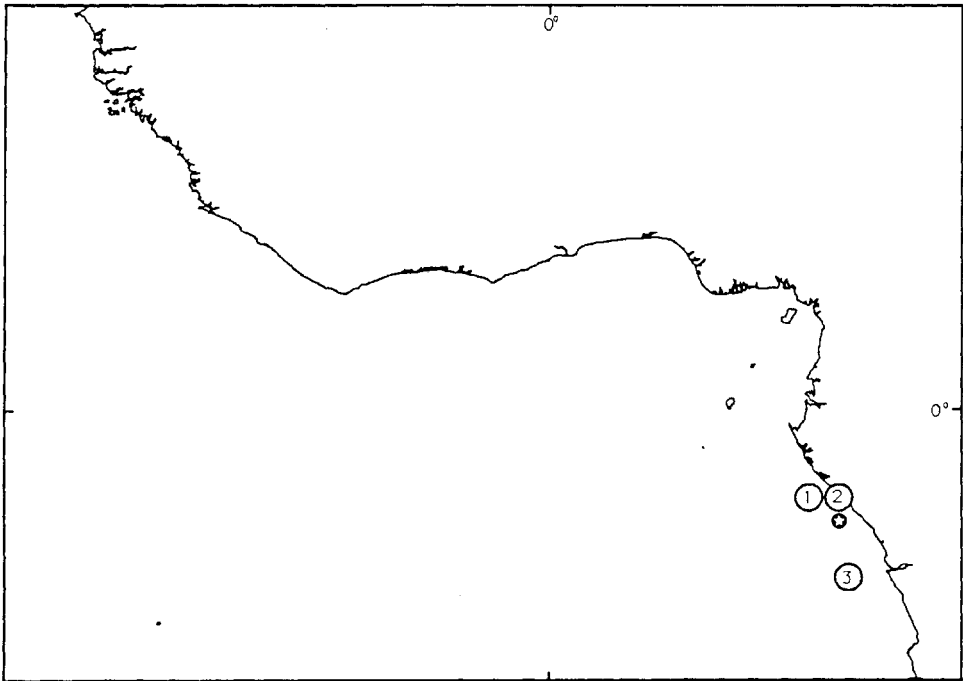


Fig. 42. Distribution of *Anapagurus congolensis* spec. nov. Circled star: type locality. Circled numbers: based on previous records, material examined: Forest, 1955 (as *A. laevis*).

short, stiff setae. Carpi approximately  $\frac{2}{3}$  length of meri; dorsal surface with row of 5 to 8 spines (2nd) or serrate margin flanked by 1 proximal and 1 distal spines (3rd); lateral, mesial and ventral faces glabrous. Ventrolateral margin of meri serrate (2nd) or unarmed (3rd) and row of tufts of short setae; dorsal surface with 1 short spine on distal half (2nd) or unarmed (3rd) and row of tufts of short, stiff setae. Ischia with tufts of short, stiff setae on dorsal and ventral margins. Lobes of sternite of 2nd pereopods unarmed, distally rounded. Anterior lobe of sternite of 3rd pereopods subrectangular; anterior margin with long setae.

Males with relatively short and broad, left sexual tube recurved upward to level of coxa of 5th pereopod. Coxa of 5th right pereopod with gonopore partly obscured by tufts of short setae. Pleopods 3 and 4 unequally biramous; pleopod 5 uniramous. Distal protopodal lobe of right uropod subequal to length of endopod.

Terminal margins of telson with 4 subequal, closely spaced spines; lateral margins each with 1 spinule and moderately long setae; dorsal surface with scattered short setae.

Colour.— Unknown.

Etymology.— The species name refers to the type locality, off Pointe Noire, Congo, Africa.

Related organisms.— There is no external evidence of symbionts in any of the specimens examined.

Distribution.— All the specimens of *A. congolensis* spec. nov. were collected by the Belgian MBIZI expedition along the tropical western coast of Africa, from off Pointe Noire to Moita Seca. Depth range: 100-240 m.

Affinities.— As previously discussed (see section on affinities for *A. laevis*), *A. congolensis* spec. nov. is closely allied to *A. laevis* and *A. vossi* spec. nov. *Anapagurus congolensis* spec. nov. can be separated from *A. laevis* by: the former's roundly ocular acicles with unexpanded mesial margins; the right cheliped with carpal dorsomesial spines increasing in size distally except for the two most distal smaller spines; the lobes of the sternite of the 2nd pereopods being distally rounded; and in males, the ventromesial distal angle of the propodus of the 2nd pereopods with three or four moderately long spines (see section on affinities for *A. vossi* spec. nov.).

Remarks.— Among the hermit crabs collected during the expeditions of the "Mbizi" and "Mercator" along the southwestern coast of Africa, Forest (1955) illustrated and discussed specimens that he ascribed to *A. laevis*. From my reexamination of this material, I have determined that the specimens from the "Mbizi" expedition represent the new species herein described as *A. congolensis* spec. nov.. The single specimen from the "Mercator" expedition, I have assigned to *A. hendersoni*.

### Biogeography

Horizontal distribution.— Most species of *Anapagurus* have an eastern Atlantic distribution and only two have been found elsewhere. Although Briggs (1974) in his book, *Marine Zoogeography*, placed considerable emphasis on the fishes, the general distributional patterns proposed by him appear to coincide well with those of other marine animals, and especially with those of *Anapagurus*. Following his classification of zoogeographical regions I propose five distributional groupings of species.

(1) Boreal-warm temperate-tropical species. One species, *A. chiroacanthus* (Fig. 7) is well adapted to three different zoogeographical regions of the eastern Atlantic, the boreal or cold temperate, the warm temperate and the tropical. It has the broadest horizontal distribution, occurring between ca 63°N, off the western coast of Norway, and ca 16°N off the Cape Verde Islands. The species has an east-west northern distribution that includes the Azores and extends into the eastern Mediterranean Sea.

(2) Boreal-warm temperate species. Two species of *Anapagurus* are distributed in two distinct regions of the eastern Atlantic, the boreal or cold temperate and the warm temperate: *A. laevis* (Fig. 3) and *A. hyndmanni* (Fig. 5). *Anapagurus laevis* has been collected between ca 63°N, off the western coast of Norway, and ca 20°N, off the coast of Mauritania. In the Mediterranean, *A. laevis* is apparently restricted to the western part. The distribution of *A. hyndmanni* from the British Isles and the Faeroe Islands to the south coast of Spain in the Mediterranean Sea, between ca 62°N and 36°N, appears to be more restricted than that of *A. laevis*.

(3) Warm temperate species. Nine species of *Anapagurus* are known to occur in three well-separated warm temperate regions: a) Mediterranean-Atlantic: *A. adriaticus* spec. nov. (Fig. 33) and *A. petiti* (Fig. 27) are restricted to the Mediterranean, occurring in both the eastern and western sectors; *A. pusillus* (Fig. 9) has been found only outside the Mediterranean Sea in the Azores, Canary Islands and off the south coast of Portugal; *A. bicorniger* (Fig. 15), *A. longispina* (Fig. 17), *A. breviaculeatus* (Fig. 21) and *A. alboranensis* spec. nov. (Fig. 30) are distributed in the Mediterranean, as

well as, in the eastern Atlantic; b) Southern African: *A. hendersoni* (Fig. 23), an apparently South African endemic species has been recorded from Saldanha Bay on the Atlantic west coast to off Cape Natal on the eastern coast in the Indian Ocean. Kensley (1981) summarized several studies of the Plio-Pleistocene molluscan fauna of the western coast of South Africa indicating that a more tropical, warm-water fauna dominated up to the last interglacial in a region which is today considered cold temperate. Apparently *A. hendersoni* is a relict of this tropical fauna that may have survived in well-protected warmer water basins such as Saldanha Bay and False Bay; and c) Japan: *A. japonicus* (Fig. 11), a possibly endemic Japanese species has been collected off the Islands of Honshu, Shikoku and Kyushu. The Uraga Strait, its type locality, is its northernmost record. Ekman (1967) called this region, the "Japanese Mediterranean" because of certain faunal similarities with the Mediterranean.

(4) Warm temperate-tropical species. One species, *A. curvidactylus* (Fig. 13) is broadly distributed in the eastern Atlantic from warm temperate waters off the northwestern coast of Spain to tropical waters of Angola, between ca 43°N and 10°S.

(5) Tropical species. Five species of *Anapagurus* are presumably restricted to two tropical regions widely separated by Africa: a) Eastern Atlantic: four species of *Anapagurus* have similar distributions in tropical African waters: *A. wolffi* (Fig. 25), *A. vossi* spec. nov. (Fig. 36), *A. atlantidii* spec. nov. (Fig. 39) and *A. congolensis* spec. nov. (Fig. 42); and b) Indo-West Pacific: *A. bonnierii* (Fig. 19) that has been collected in three localities: the Red Sea, the Persian Gulf, and off Pulau Saparua, Indonesia.

Vertical distribution (Fig. 43).— Although most species of *Anapagurus* are commonly found on the continental shelf between the intertidal area and about 200 m, some, including *A. longispina*, *A. hendersoni*, *A. adriaticus* spec. nov., *A. congolensis* spec. nov., and *A. laevis*, also occur on the continental slope extending beyond 200 m to depths as great as 1262 m. *Anapagurus laevis* has the broadest bathymetric distribution (4.6 to 1262 m) in the genus *Anapagurus*, and extends to the greatest depth.

Though *A. hyndmanni*, *A. chiroacanthus*, *A. pusillus*, and *A. curvidactylus* have been collected in the intertidal zone; *A. bonnierii* is known to have the shallowest depth range of all recognized species of *Anapagurus*, 5 to 15 m.

#### *Forestopagurus* gen. nov.

*Anapagurus*; Forest, 1966: 162 (in part).

Type species.— *Anapagurus drachi* Forest, 1966. Gender masculine.

Diagnosis.— Carapace with pterygostomial plate somewhat more calcified than remainder of branchiostegite. Posterior carapace also with noticeably calcified plates delimited by cervical groove, lineae anomurica and transversalis, and by cardiobranchialis and cardiac sulci. Anterior margin of shield slightly produced, rounded. Lateral projections with short submarginal spine. Corneae dilated. Ocular acicles ovate, terminating in small marginal spine. Interocular plate unarmed. Antennal peduncles with supernumerary segmentation, acicle well developed. Maxillule with stiff bristle on moderately well-developed internal endopodal lobe; external lobe absent. Third maxilliped with accessory tooth on well-developed crista dentata. Sternite of third maxillipeds convex and without median cleft. Eleven pairs of phyllobranchiae. Chelipeds markedly unequal; dactyls opening in horizontal plane. Anterior lobe of ster-



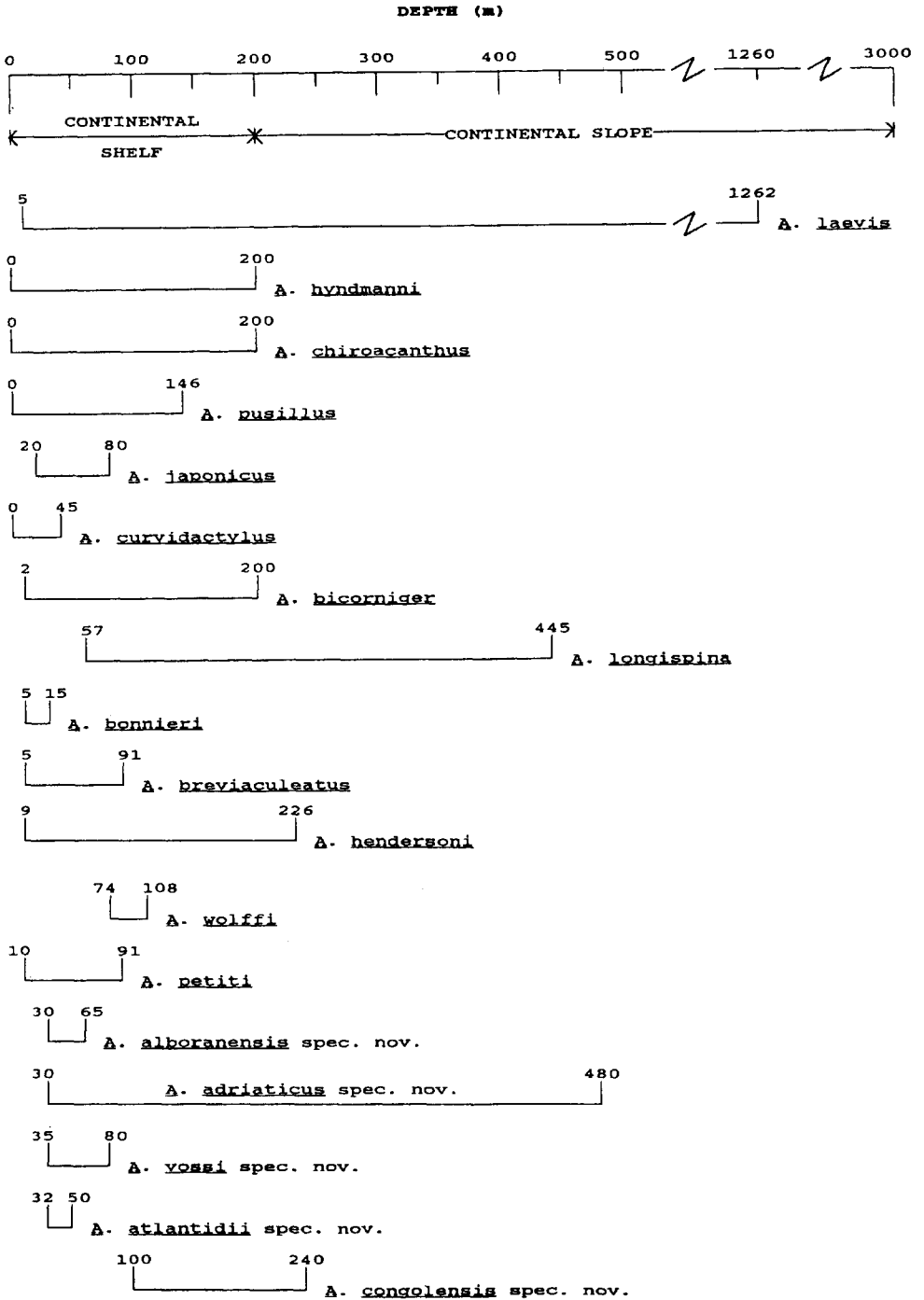


Fig. 43. Bathymetric distribution of *Anapagurus* species. The horizontal lines indicate the depth range for each species. Depth zones of the ocean floor are after Briggs (1974).

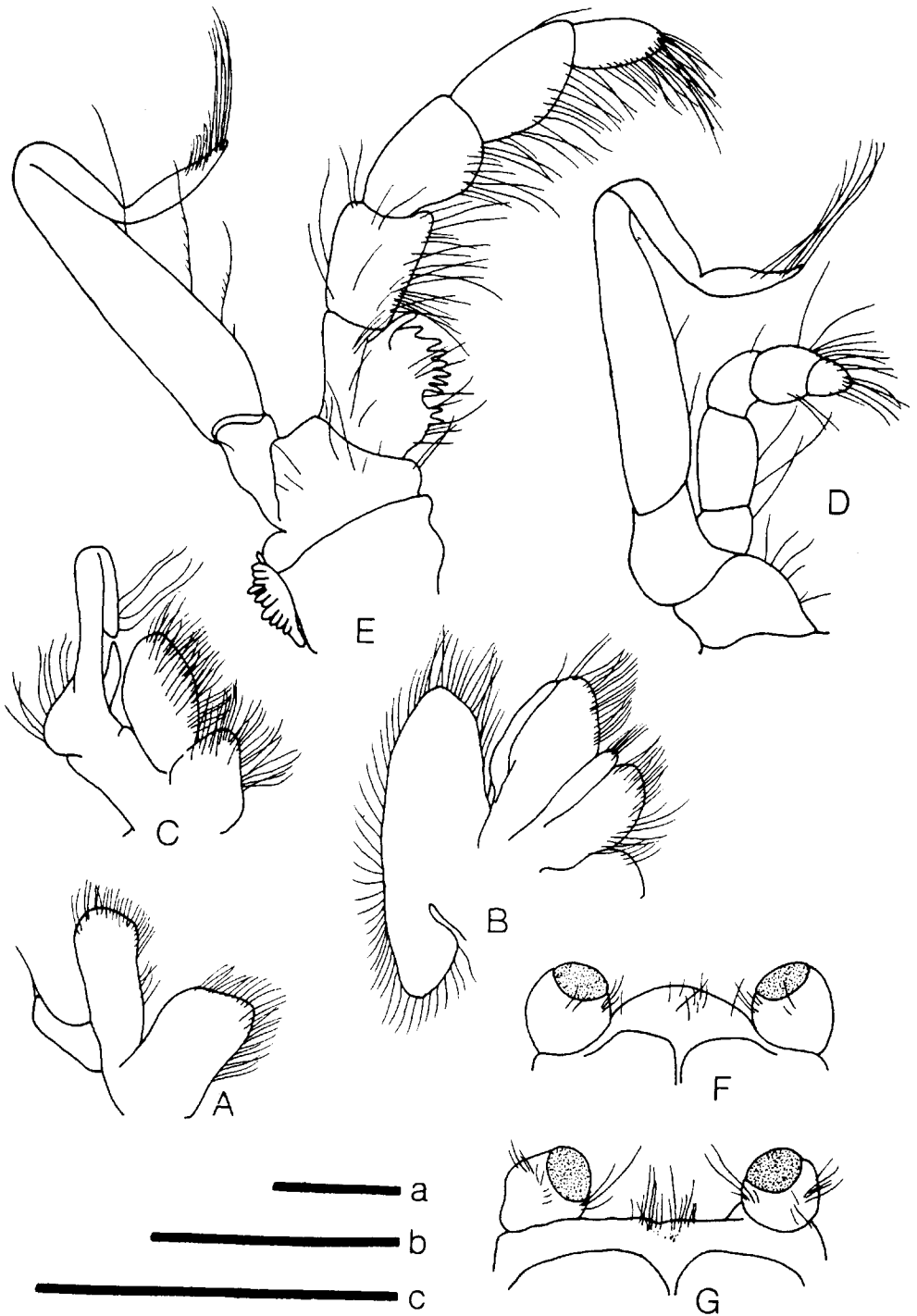


Fig. 44. *Forestopagurus drachi* (Forest, 1966). A-F: ovig. (SL = 1.6 mm), "Calypso" station 94, 1°38'25"N, 7°22'05"E, MNHN 1791. *Anapagurus laevis* (Bell, 1846). G: ♂ (SL = 3.8 mm), off Málaga, Spain, UMDZ. A-E: mouth parts (right, external view): A, maxillule; B, maxilla; C, 1st maxilliped; D, 2nd maxilliped.

nite of third pereopods unarmed. Propodal rasp of fourth pereopods with single row of closely-spaced corneous scales. Sternite of fifth pereopods with two closely-spaced lobes. In males, coxa of right fifth pereopod with gonopore partly covered by tufts of long setae; coxa of left pereopod somewhat enlarged and with moderately long, curved sexual tube; without paired or unpaired pleopods. Females with paired gonopores; three unpaired biramous pleopods, pl<sub>2</sub>-pl<sub>4</sub>. Uropods asymmetrical. Telson with transverse suture; terminal margin entire, unarmed.

**Etymology.**— This genus is named for Dr Jacques Forest, a major contributor to our knowledge of hermit crabs, and who, as curator of the Musée National d'Histoire Naturelle (Paris), made the specimens available.

**Distribution.**— Off Principe Island, Africa; 31 m.

**Remarks.**— Forest (1966) described *A. drachi* from the Gulf of Guinea, and with "reservation and perhaps provisionally" included the species in the genus *Anapagurus*. From my examinations of the paratypes of *A. drachi* and the extensive collections of *Anapagurus* used in the present revision I have confirmed his doubts. All pleopods are lacking in the male paratype and the fifth left pleopod is wanting in the female paratypes. Other differences that set this species apart from *Anapagurus* include the unarmed telson which lacks a median cleft, the convex anterior margin of the sternite of the third maxillipeds without median cleft, ~~the convex anterior margin of the sternite of the third maxillipeds without median cleft,~~ the moderately long curved left sexual tube, and the noticeably calcified regions of the branchiostegites and the posterior carapace.

Pleopod loss in males is not restricted to *Forestopagurus*. Within the genus *Pagurus*, males of *P. prideaux* Leach, 1815, lack unpaired pleopods. A similar condition is reported for species of *Porcellanopagurus*, *Paguritta*, and *Ostraconotus*. As in *F. drachi*, females of these taxa have their pleopod number reduced to three. The evolutionary mechanism responsible for this loss is unknown.

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Note (added in proof).— In a recent work by Ray Ingle (1993, *Hermit Crabs of the Northeastern Atlantic Ocean and Mediterranean Sea: an illustrated key*. Chapman & Hall Identification Guide 4: 1-vi, 1-495.— London) the description of *Anapagurus smythii* spec. nov., collected in Adventure Bank, Mediterranean Sea (37°20'N, 12°10'E, 168 m), increased the number of species of *Anapagurus* to 19.

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## Index

<i>acantholepis</i> , <i>Micropagurus</i> .....	4, 8
<i>Acanthopagurus</i> .....	4
<i>Acanthopagurus dubius</i> .....	4
<i>acutus</i> , <i>Anapagurus</i> .....	3, 4, 11
<i>adriaticus</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 19, 21, 72, 91, 97, 116, 117
<i>alboranensis</i> , <i>Anapagurus</i> .....	3, 4, 5, 13, 42, 66, 72, 85, 90, 116
<i>Anapagurides</i> .....	10
<i>Anapagurus adriaticus</i> .....	3, 4, 5, 12, 19, 21, 72, 91, 97, 116, 117
<i>Anapagurus acutus</i> .....	3, 4, 11
<i>Anapagurus alboranensis</i> .....	3, 4, 5, 13, 42, 66, 72, 85, 90, 116
<i>Anapagurus atlantidii</i> .....	3, 4, 5, 12, 14, 22, 97, 103, 104, 109, 110, 117
<i>Anapagurus australiensis</i> .....	4
<i>Anapagurus bicorniger</i> .....	3, 4, 5, 8, 12, 53, 56, 57, 58, 81, 84, 85, 116
<i>Anapagurus bonnieri</i> .....	3, 4, 5, 10, 13, 63, 64, 66, 117
<i>Anapagurus Bonnier</i> .....	63
<i>Anapagurus breviaculatus</i> .....	67
<i>Anapagurus breviaculeatus</i> .....	3, 4, 5, 13, 21, 42, 66, 67, 70, 72, 91, 116
<i>Anapagurus brevicarpus</i> .....	3, 4, 30, 37, 39
<i>Anapagurus chiracanthus</i> .....	30
<i>Anapagurus chiroacanthus</i> .....	3, 5, 12, 29, 30, 36, 37, 39, 47, 77, 80, 81, 116, 117
<i>Anapagurus chiroacanthus</i> var. <i>cristatus</i> .....	30, 36
<i>Anapagurus chiroacanthus</i> var. <i>gracilis</i> .....	30
<i>Anapagurus congolensis</i> .....	3, 4, 5, 13, 14, 19, 22, 102, 110, 116, 117
<i>Anapagurus curvidactylus</i> .....	3, 4, 5, 12, 23, 29, 48, 51, 53, 77, 81, 109, 117
<i>Anapagurus curvidactylus</i> var.? .....	48
<i>Anapagurus drachi</i> .....	3, 4, 5, 117, 120
<i>Anapagurus?</i> <i>dubius</i> .....	4
<i>Anapagurus ferrugineus</i> .....	34
<i>Anapagurus hendersoni</i> .....	3, 4, 5, 12, 14, 22, 39, 40, 43, 72, 73, 77, 116, 117
<i>Anapagurus hyndmani</i> .....	23
<i>Anapagurus hyndmanni</i> .....	3, 4, 5, 12, 22, 23, 27, 29, 37, 48, 51, 53, 56, 70, 84, 90, 109, 116, 117
<i>Anapagurus Hyndmanni</i> .....	22, 29
<i>Anapagurus japonicus</i> .....	3, 4, 5, 10, 12, 37, 39, 44, 46, 47, 48, 117
<i>Anapagurus japonicus</i> .....	44
<i>Anapagurus laevis</i> ... 3, 5, 13, 14, 18, 19, 21, 22, 24, 40, 43, 58, 60, 62, 66, 72, 73, 77, 81, 91, 97, 102, 104, 116	
<i>Anapagurus laevis</i> var. <i>longispina</i> .....	4, 58, 60, 62
<i>Anapagurus levis</i> .....	14
<i>Anapagurus longispina</i> .....	3, 4, 5, 12, 21, 22, 40, 43, 58, 60, 62, 72, 116, 117
<i>Anapagurus marginatus</i> .....	3, 4, 11
<i>Anapagurus petiti</i> .....	4, 5, 8, 11, 53, 57, 58, 81, 84, 85, 116
<i>Anapagurus polynesiensis</i> .....	4
<i>Anapagurus pusillus</i> .....	3, 4, 5, 13, 40, 42, 43, 47, 64, 72, 73, 77, 90, 91, 116, 117
<i>Anapagurus pusillus</i> var. <i>japonica</i> .....	4, 44
<i>Anapagurus pusillus</i> var. <i>japonicus</i> .....	44
<i>Anapagurus</i> sp. ....	64, 66
<i>Anapagurus vossi</i> .....	3, 4, 5, 12, 14, 19, 22, 97, 102, 103, 116, 117
<i>Anapagurus wolffi</i> .....	4, 5, 12, 14, 22, 53, 77, 80, 81, 103, 117
<i>australiensis</i> , <i>Anapagurus</i> .....	4
<i>bicorniger</i> , <i>Anapagurus</i> .....	3, 4, 5, 8, 12, 53, 56, 57, 58, 81, 84, 85, 116
<i>bonnieri</i> , <i>Anapagurus</i> .....	3, 4, 5, 10, 13, 63, 64, 66, 117
<i>Bonnier</i> , <i>Anapagurus</i> .....	63
<i>breviaculatus</i> , <i>Anapagurus</i> .....	67

<i>breviaculeatus</i> , <i>Anapagurus</i> .....	3, 4, 5, 13, 21, 42, 66, 67, 70, 72, 91, 116
<i>brevicarpus</i> , <i>Anapagurus</i> .....	3, 4, 30, 37, 39
<i>chiracanthus</i> , <i>Anapagurus</i> .....	30
<i>chiroacanthus</i> , <i>Anapagurus</i> .....	3, 5, 12, 29, 30, 36, 37, 39, 47, 77, 80, 81, 116, 117
<i>chiroacanthus</i> var. <i>cristatus</i> , <i>Anapagurus</i> .....	30, 36
<i>chiroacanthus</i> var. <i>gracilis</i> , <i>Anapagurus</i> .....	30
<i>congolensis</i> , <i>Anapagurus</i> .....	3, 4, 5, 13, 14, 19, 22, 102, 110, 116, 117
<i>curvidactylus</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 23, 29, 48, 51, 53, 77, 81, 109, 117
<i>curvidactylus</i> var.?, <i>Anapagurus</i> .....	48
<i>drachi</i> , <i>Anapagurus</i> .....	3, 4, 5, 117, 120
<i>dubius</i> , <i>Acanthopagurus</i> .....	4
<i>dubius</i> , <i>Anapagurus</i> ? .....	4
<i>Enneobranchus</i> .....	10
<i>Eupagurus chiroacanthus</i> .....	30
<i>Eupagurus hyndmanni</i> .....	23
<i>Eupagurus Hyndmanni</i> .....	22
<i>Eupagurus laevis</i> .....	13, 21
<i>Forestopagurus</i> .....	3, 4, 6, 11, 117, 120
<i>ferrugineus</i> , <i>Anapagurus</i> .....	34
<i>hendersoni</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 14, 22, 39, 40, 43, 72, 73, 77, 116, 117
<i>hyndmani</i> , <i>Anapagurus</i> .....	23
<i>hyndmanni</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 22, 23, 27, 29, 37, 48, 51, 53, 56, 70, 84, 90, 109, 116, 117
<i>Hyndmanni</i> , <i>Anapagurus</i> .....	22, 29
<i>Iridopagurus</i> .....	10
<i>japonicus</i> , <i>Anapagurus</i> .....	3, 4, 5, 10, 12, 37, 39, 44, 46, 47, 48, 117
<i>japonisus</i> , <i>Anapagurus</i> .....	44
<i>laevis</i> , <i>Anapagurus</i> .....	3, 5, 13, 14, 18, 19, 21, 22, 24, 40, 43, 58, 60, 62, 66, 72, 73, 77, 81, 91, 97, 102, 104, 116
<i>laevis</i> var. <i>longispina</i> , <i>Anapagurus</i> .....	4, 58, 60, 62
<i>laevis</i> , <i>Anapagurus</i> .....	14
<i>longispina</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 21, 22, 40, 43, 58, 60, 62, 72, 116, 117
<i>marginatus</i> , <i>Anapagurus</i> .....	3, 4, 11
<i>Micropagurus</i> .....	10
<i>Micropagurus acantholepis</i> .....	4, 8
<i>Micropagurus polynesiensis</i> .....	4
<i>Nematopaguroides</i> .....	11
<i>Ostraconotus</i> .....	120
<i>Paguritta</i> .....	120
<i>Pagurus</i> .....	4, 43, 77, 120
<i>Pagurus bernhardus</i> .....	24
<i>Pagurus chiracanthus</i> .....	30
<i>Pagurus chiroacanthus</i> .....	4, 29, 30, 37, 39
<i>Pagurus cuanensis</i> .....	21, 39
<i>Pagurus ferrugineus</i> .....	4, 11, 29, 34, 37, 39
<i>Pagurus hyndmanni</i> .....	21
<i>Pagurus Hyndmanni</i> .....	22
<i>Pagurus laevis</i> .....	4, 8, 13, 21, 39
<i>Pagurus moluccensis</i> .....	8
<i>Pagurus prideaux</i> .....	120
<i>Pagurus pubescens</i> .....	39
<i>Pagurus pubescentulus</i> .....	21
<i>Pagurus thomsoni</i> .....	39
<i>Pagurus ulidianus</i> .....	21
<i>polynesiensis</i> , <i>Anapagurus</i> .....	4
<i>Porcellanopagurus</i> .....	120

<i>pusillus</i> , <i>Anapagurus</i> .....	3, 4, 5, 13, 40, 42, 43, 47, 64, 72, 73, 77, 90, 91, 116, 117
<i>pusillus</i> var. <i>japonica</i> , <i>Anapagurus</i> .....	4, 44
<i>pusillus</i> var. <i>japonicus</i> , <i>Anapagurus</i> .....	44
<i>Pygmaeopagurus</i> .....	10
<i>Pygmaeopagurus hadrochirus</i> .....	10
<i>Spiropagurus</i> .....	4, 8, 10, 11, 21, 39
<i>Spiropagurus chiroacanthus</i> .....	30
<i>Spiropagurus</i> ( <i>Anapagurus</i> ) <i>chiroacanthus</i> .....	11, 29
<i>Spiropagurus Hyndmanni</i> .....	22
<i>Spiropagurus laevis</i> .....	13
sp., <i>Anapagurus</i> .....	64, 66
SPECIES N.1 .....	81
<i>vossi</i> , <i>Anapagurus</i> .....	3, 4, 5, 12, 14, 19, 22, 97, 102, 103, 116, 117
<i>wolffi</i> , <i>Anapagurus</i> .....	4, 5, 12, 14, 22, 53, 77, 80, 81, 103, 117

## Instructions to authors

Two zoological journals dealing with taxonomy, phylogeny and biogeography are published by the Nationaal Natuurhistorisch Museum, Leiden: *Zoologische Mededelingen* (publications of less than 40 pages) and *Zoologische Verhandelingen* (publications of more than 40 pages). Papers in the Dutch language are published in the *Zoologische Bijdragen*. Large monographs may be published separately. Papers should be the result of research projects of the Nationaal Natuurhistorisch Museum or should be based entirely or for an important part on material in its collections.

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