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New Distribution Records of Reptant Decapod Crustacea,  
Including Descriptions of Three New Species of  
*Pagurus*, from the Waters Adjacent to  
British Columbia

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HART, J. F. L. 1971. New distribution records of reptant decapod Crustacea, including descriptions of three new species of *Pagurus*, from the waters adjacent to British Columbia. J. Fish. Res. Bd. Canada 28: 1527-1544.

Three hermit crabs, *Pagurus caurinus*, *P. quaylei*, and *P. stevensae*, from British Columbia are described as new. *Calastacus quinqueseriatus* Rathbun, *Paguristes ulreyi* Schmitt, *Pagurus cavimanus* (Miers), *P. samuelis* (Stimpson), *Parapagurus pilosimanus* Smith, *Munidopsis quadrata* Faxon, and *Chionoecetes tanneri* Rathbun have not been recorded from the area between 48° and 55°N and 123° and 135°W, and also show considerable extensions of the known ranges. Within the confines of the same area, *Callinassa gigas* Dana, *Paguristes turgidus* (Stimpson), *Pagurus cornutus* (Benedict), *P. hemphilli* (Benedict), *Orthopagurus minimus* (Holmes), *Petrolisthes cinctipes* (Randall), *Scleroplax granulata* Rathbun, *Pinnotheres pugetensis* Holmes, *P. taylori* Rathbun, and *Planes marinus* Rathbun are reported with extensions to known ranges. *Pagurus capillatus* (Benedict), *P. tanneri* (Benedict), *Paralomis verrilli* (Benedict), and *Lithodes couesi* Benedict are recorded, apparently for the first time from British Columbia, although known from both north and south of this area.

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Trois nouvelles espèces de pagures, *Pagurus caurinus*, *P. quaylei* et *P. stevensae*, provenant de la Colombie britannique, sont décrites. *Calastacus quinqueseriatus* Rathbun, *Paguristes ulreyi* Schmitt, *Pagurus cavimanus* (Miers), *P. samuelis* (Stimpson), *Parapagurus pilosimanus* Smith, *Munidopsis quadrata* Faxon et *Chionoecetes tanneri* Rathbun n'ont pas encore été signalés dans la zone comprise entre les latitudes 48° et 55° nord et les longitudes 123° et 135° ouest. L'aire de répartition de ces espèces se trouve considérablement agrandie. L'auteur mentionne la présence, dans les mêmes limites, de *Callinassa gigas* Dana, *Paguristes turgidus* (Stimpson), *Pagurus cornutus* (Benedict), *P. hemphilli* (Benedict), *Orthopagurus minimus* (Holmes), *Petrolisthes cinctipes* (Randall), *Scleroplax granulata* Rathbun, *Pinnotheres pugetensis* Holmes, *P. taylori* Rathbun et *Planes marinus* Rathbun en des endroits où ces espèces n'avaient pas encore été signalées. Enfin il rapporte, apparemment pour la première fois, la présence de *Pagurus capillatus* (Benedict), *P. tanneri* (Benedict), *Paralomis verrilli* (Benedict) et *Lithodes couesi* Benedict dans les eaux de la Colombie britannique, bien que ces espèces aient été signalées tant au nord qu'au sud de cette zone.

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WHILE working through collections of reptant decapod Crustacea taken from the waters off British Columbia, I have found a number of species that appear to be undescribed, or that have not been recorded for this area, or that provide northern or southern extensions of the known range. The

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area under study is roughly between 48° and 55°N and 123° and 135°W.

### Descriptions of New Species

Both *Pagurus caurinus* and *P. quaylei*, which are here described as apparently unrecorded in the literature, would appear to belong to the group of *Pagurus* recently designated as "groupe I (groupe *miamensis*)" by Forest and Saint Laurent (1967). Species included in this group have the frontal margin of the carapace obtuse and somewhat protuberant. The eyestalks are subcylindrical and

rather slender and the eye scales are large, with the extremities either uni- or multi-dentate. Chelipeds are very unequal in size and the hands are covered with spiny tubercles and numerous setae. The length of the carapace does not exceed 8 mm. The members of this group are usually found in the lower intertidal or the upper subtidal zones of warm or temperate seas. Some individuals of *P. caurinus* do attain a greater size than the species originally placed in this group and a few of both the species dealt with here have been taken in deeper water (126 m).

The holotypes, all males, of the three new species are deposited in the Provincial Museum of British Columbia and paratypes are to be distributed elsewhere.

Initials are used in the tables of material examined and in the new records for the chief collectors: D. B. Quayle, T. H. Butler, and J. F. L. Hart. In the tables also, the Fisheries Research Board of Canada is designated by FRB and the Allan Hancock Foundation stations Velero III and Velero IV by V-3 and V-4. Subtidal is for collections from less than 10 m depth. Ovigerous females are indicated by ♀♀.

The descriptions of the colouring of the living animals result from examination under magnification and so greater detail of colour pattern may be given than can be easily discerned with the naked eye. The term *stripe* is used to designate a streak of colour running parallel to the longitudinal axis of the body or of the appendage. *Band* refers to a stripe of colour running around or across the body or appendage.

Certain descriptive terms are used to describe the morphology of the hermit crabs. *Shield* refers to the calcified dorsal part of the carapace anterior to the cervical groove. *Seta*, *hair*, or *bristle* are used for the fine cylindrical exoskeletal outgrowths, and are usually pliable, whereas *spine* is rigid and often a corneous process. When a spine is laterally flattened and/or wide, it may be referred to as a *tooth*. Small *knobs* on the surface are often called *granules* when dorsally flattened or rounded, and *tubercles* when the bases are rounded, the tips cone-shaped and sharp-pointed, with or without corneous tips.

Rhizocephalan parasites occurred in less than 5% of each of the three new species examined. The majority of these were of the *Peltogasterella* type and attached to the abdomen. The remainder were of the *Thompsonia* type, which occurred on various parts of the thorax and appendages.

In the figures, magnifications are indicated by lines representing 5 mm in Fig. 1, 8, and 17, and 1 mm in the remaining figures.

### *Pagurus caurinus* n.sp.

Fig. 1-7

*Pagurus setosus* Hart 1940 p. 94 (in part).

*Material examined*—Table 1.

*Description*—Carapace shield subequal in length and width. Surface smooth and almost flat, with some patches of short, stiff setae. Rostrum obtuse, covered

with a tuft of setae and lateral teeth nearly obsolete. No submarginal teeth. Carapace with long soft setae laterally.

Eyestalk long, slender, and slightly constricted medially. Ophthalmic scale with dorsal surface flat and inner margin curved, tip blunt, and large sharp submarginal tooth.

Antennular peduncle subequal or slightly longer than eyestalk.

Antenna setose, with small sharp tooth on base of peduncle, segment 2 with a small sharp tooth on inner side at base of acicle, another on ventral distal margin and a broad lateral projection with the tip cut into 2 or 3 teeth. Acicle curved and decreasing in width distally, setose, and tipped with a stout spine. Segment 3 short: not reaching end of acicle. Segment 4 nearly twice as long as segment 3 and more slender. Flagellum slightly longer than thoracic appendages and bearing tufts of small setae.

Third maxilliped with crista dentata of ischium serrate with corneous teeth, which decrease in size distally. A large accessory tooth medially.

Right cheliped narrow but deep, with many tufts of long setae around bases of tubercles: setae vary in length and degree of plumoseness and tufts consist of 4 or less setae, seldom of equal length. Ischium short, with few if any, flat granules ventrally. Merus subcylindrical in cross section, subequal in length to carpus but narrower. 1, or occasionally 2 in females, large knobs medio-ventrally, and a row of small tubercles on ventral distal margin. Dorsal distal margin with several small teeth. Carpus subequal in width but shorter than chela. Dorsal surface slightly convex and armed on the inner margin with stout spiny tubercles; dorsal surface with small tubercles and tufts of long setae. Chela slightly convex dorsally: inner margin of propodus straight, and outer curved. Lateral margins of palm and fingers bordered with close-set corneous-tipped tubercles with less distinct rows of tubercles on dorsal surface. Tips of fingers corneous and cutting surfaces with flat interlocking teeth.

Left cheliped slender, setose and reaching to base of dactyl of right. Ischium with small granules on ventral ridge, varying considerably in size and number. Merus like that of right, but without any large median knobs ventrally: outer distal ventral margin usually with several spiny tubercles. Carpus narrow, subequal to merus in length and slightly shorter than chela. Chela with additional 2 or 3 rows of smaller tubercles dorsally. Both fingers with a medial row of tubercles. Fingers corneus-tipped and cutting surfaces with combs of short corneous setae.

Walking legs setose, and those of right side subequal in length or longer than right cheliped. Right 2nd pereopod with a number of spiny tubercles on dorsal ridge of carpus. Carpus shorter than subequal propodus and dactylus. Propodus with 2 or 3 spines ventrally. Dactylus with stout spines on ventral margin and on upper inner face, which are conspicuous only in large individuals. Terminates in a stout corneous claw, which is slightly twisted. Third pereopod similar but only one terminal spiny tubercle on carpus. Left pereopods similar but

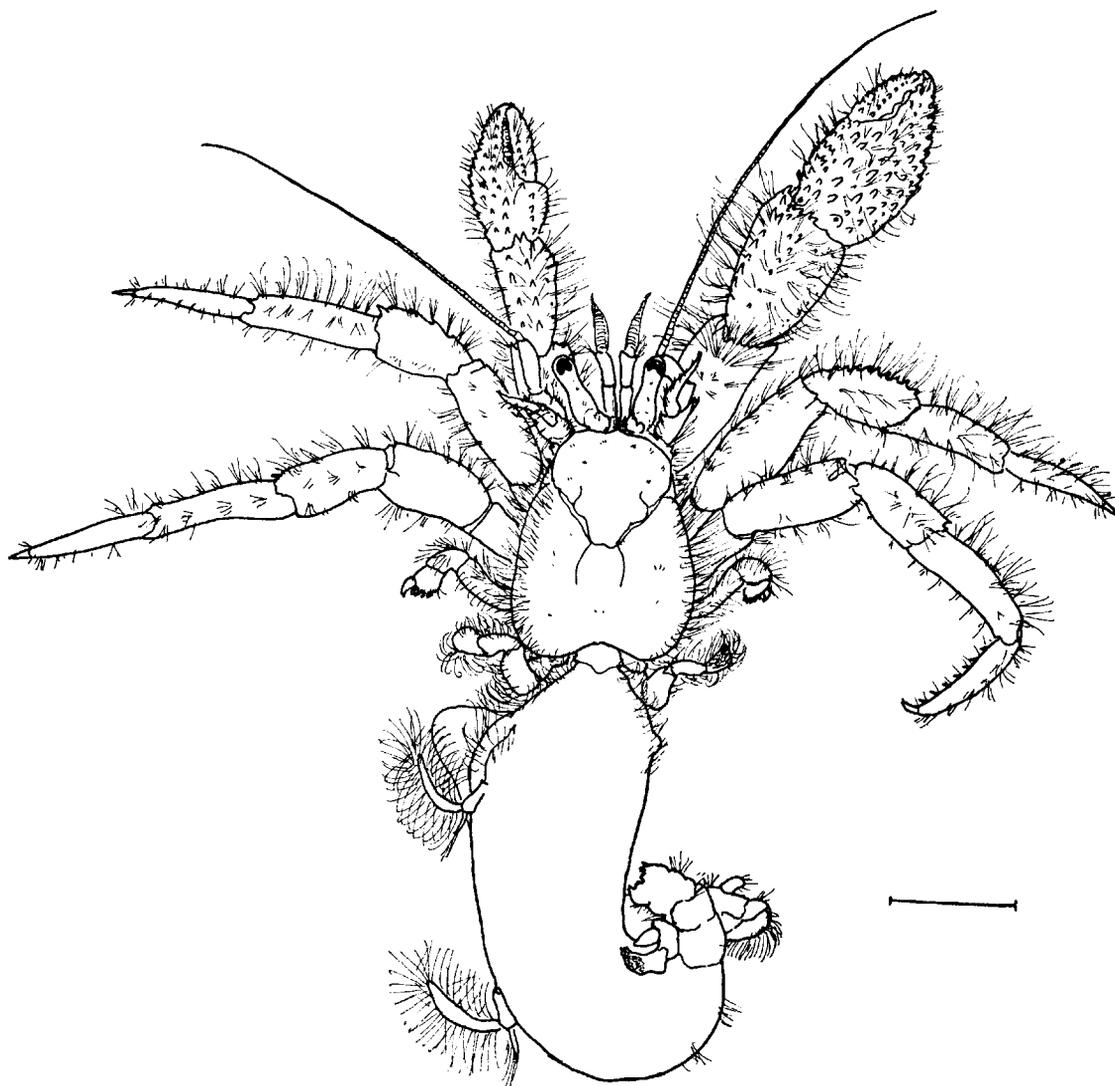


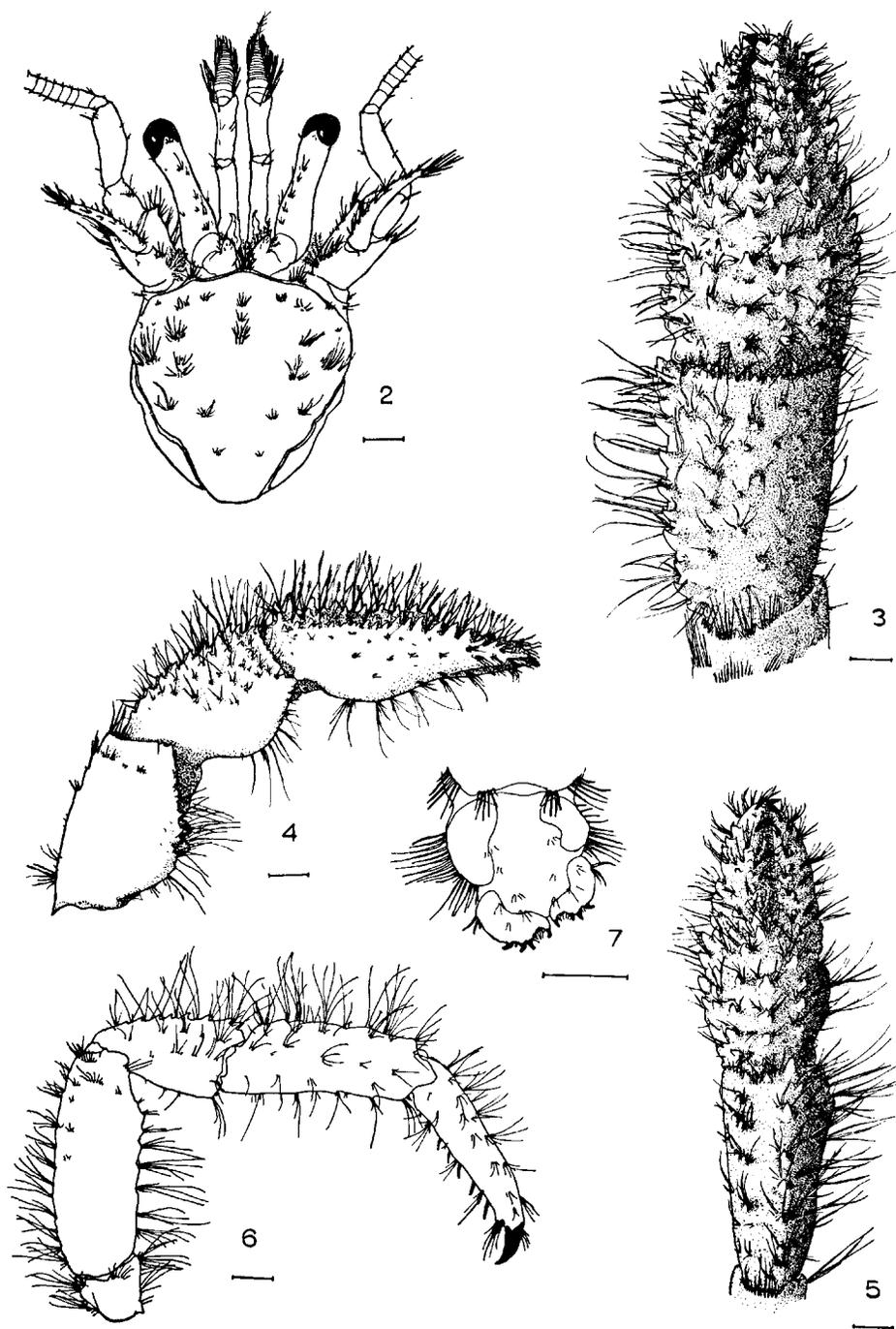
FIG. 1. *Pagurus caurinus* n.sp. Male.

less tubercles on carpus. Fourth and fifth pereiopods very setose.

Telson with anterior and posterior lobes similar in size and shape. Posterior lobes each with 2 or 3 stout curved corneous teeth separated by a concave hiatus from the single large median tooth on either side of the median cleft.

*Colour of living animal*—Carapace a light grey, with longitudinal stripes of purple and a row of light-coloured spots in each stripe. Laterally, red-brown and cream marbling. Abdomen mottled with grey and purple. Peduncle of both pairs of antennae, eyestalks, and third maxillipeds light coloured with greenish brown bands. Cornea of eye covered with yellow chromatophores, except for narrow bands of black. All flagella

orange. Meri of chelipeds a reticulated red-brown and grey, with a dull white or yellowish band on distal part. Carpi of both chelipeds grey-green and red-brown, with tubercles grey based and orange tipped. Chelae light greenish-brown with grey; orange-tipped tubercles and finger tips orange-red. Walking legs with meri red-brown with light spots and a yellowish-white irregular distal band, margined with some orange. Carpus brown with grey spots and median lateral face yellowish. Proximal propodus with a narrow light-coloured band, median part red-brown with grey spots (base of tufts of setae) and distally an opaque white band. Dactylus red-brown with grey spots becoming orange at tip. Claw a translucent brown. The long tan setae mask the colours.



FIGURES 2-7. *Pagurus caurinus* n.sp. Male.

Fig. 2. Shield and head appendages; Fig. 3. Dorsal view, right chela and carpus; Fig. 4. Lateral view, right cheliped; Fig. 5. Left chela and carpus; Fig. 6. Right second pereiopod; Fig. 7. Telson.

TABLE 1. *Pagurus caurinus* n.sp. material examined.

Locality	Depth (m)	Bottom	Date	Station	Sex			Collector
					♂	♀	♀♀	
<i>Alaska</i>								
Kodiak 58°07.8'N, 150°51'W	126	Sand & boulders	31/8/63	FRB 63-74		1		DBQ
<i>British Columbia</i>								
Yakan Pt. 54°05'N, 131°50'W			27/7/63			3		THB
Masset Beach 54°02'N, 132°10'W	Intertidal		6/65		1			DBQ
Naden Harbour 54°01.2'N, 132°40'W	23	Mud & weed	29/5/65	FRB 65-14	5			DBQ
Port Louis 53°42'N, 132°58'W	Subtidal	Gravel	4/6/69		4		2	JFLH
Houston Stewart Chn. 52°15'N, 131°05'W	Subtidal	Gravel	30/5/69		7		1	JFLH
Restless Bay, Drury Inlet 50°57'N, 126°51'W	Intertidal	Rocky	23/6/70		3			JFLH
Cox Is. 50°47'N, 128°40'W	Subtidal	Sand	25/6/70		1		1	JFLH
Entr. Quatsino Sd. 50°25'N, 128°05'W	Subtidal		27/6/70				1	JFLH
Checleset Bay 50°08'N, 127°45.5'W	44	Coarse gravel	28/6/70	FRB 70-53	15	4	3	JFLH
Checleset Bay 50°03'N, 127°39'W	34	Mud & sand	28/6/70	FRB 70-56	1	2	1	JFLH
Esperanza Inlet 49°45.8'N, 126°56'W	10	Rock	30/6/70	FRB 70-67		2	1	JFLH
Nuchatlitz Inlet 49°45'N, 126°59'W	Subtidal		29/6/70		3			JFLH
Sydney Inlet 49°21.5'N, 126°14.7'W	13	Firm clean sand	30/6/70	FRB 70-70		1	3	JFLH
Departure Bay 49°12'N, 123°54'W	73	Rocks & glass sponges	1/6/33		1			JFLH
49°12'N, 123°58'W		"	16/3/33				1	JFLH
Dodd Narrows 49°08'N, 123°58'W	9		27/7/34		8	1	1	JFLH
Frank Is, Cox Bay, Tofino 49°08'N, 125°55'W	Intertidal	Rocky & weed	10/7/60		14	2	1	
			29/7/61		5			
			1/7/65		35	5	22	
			18/8/66		27	9	12	JFLH
Wickaninnish Bay 49°03'N, 125°46'W	Intertidal	Sand	19/8/66			2		JFLH
Mill Bay, Saanich Inlet 48°30'N, 123°25'W	27	Mud	14/2/68		1	1		JFLH
Botanical Gdns., Port Renfrew	Intertidal	Rocks	3/5/69		3			A. D. Carl
48°30'N, 124°25'W	"	"	4/5/58		4	2	1	JFLH
McNeill Bay, Victoria	"	"	20/7/66		1			JFLH

Juveniles and small individuals (shield 1–1.5 mm in length) differ in that they are transparent, with some red or tan pigment. Meri of pereopods are dark red and rest of appendage straw coloured with orange tips. Adult colouring is slowly acquired and when the shield is about 2.5 mm the colour pattern is like the adult but the colour is less intense.

*Size*—Shield length: males 1.4–7 mm, females 1.8–5 mm and ovigerous females 1.8–5 mm.

*Range*—Vicinity of Kodiak, Alaska (58°07.8'N, 150°51'W) to Victoria, B.C. (48°25'N, 123°22'W). Littoral to 126 m.

*Habitat*—Low intertidal in some areas on the west coast of Vancouver Island, where small individuals are at the base of eelgrass or kelp. Larger individuals are found in crevices of rocks or under kelp holdfasts.

*Field recognition*—Orange flagella and tips of pereopods combined with distinct white bands of distal part of propodi of walking legs.

*Notes*—Ovigerous females have been found from March until August. Some of those found in August had freshly extruded eggs, so the breeding season probably lasts for at least 6 months.

There is considerable variation in the amount of setation on the appendages, as well as the type of setae, which vary in length and also in amount of plumosity and in number. Females appear to have “fuzzy” chelae, but as detritus adheres to the plumose setae, it is difficult to judge the degree.

Four species of *Pagurus* found in British Columbia have often been confused. These are *P. kennerlyi* (Stimpson), *P. setosus* (Benedict), *P. capillatus* (Benedict), and *P. caurinus*.

The length of the antennal acicle has been used as a distinguishing character to separate *P. kennerlyi* from *P. setosus* but this character seems to be reliable only when comparing large specimens. Furthermore, a study of a long series of individuals of *P. caurinus* with shield lengths varying from 1.4 to 7 mm has revealed the gradual growth of the acicle: from not reaching as far as the cornea, to exceeding it in length.

The four species under consideration have spiny tubercles and tufts of long setae on the dorsal surface of the right cheliped. The setae may be all naked or some may be plumose. The colour patterns are somewhat similar in preserved specimens.

However, *P. caurinus* can be distinguished immediately from the other three species by the shape of the posterior margin of the telson. In this species the distal part of the telson is emarginate with

three or four large curved teeth on either side of the median cleft, whereas in the others the telson has distally straight margins meeting medially at an angle and armed with numerous straight teeth.

*Pagurus caurinus* differs also from *P. capillatus* and *P. setosus* by the subequal length of the dactyli and propodi of the walking legs, as compared to the more elongate dactyli of the latter two species. It can be separated from *P. kennerlyi* by the proportionate size of the parts of the right cheliped: in *P. caurinus* the carpus is about the same length as the chela, whereas in *P. kennerlyi*, it is only about one-half as long as the chela.

If the colour pattern is still visible, bands of light and dark pigmented segments of the antennal flagella serve to separate *P. kennerlyi* from the others, all of which have unicoloured flagella.

The name “*caurinus*” is derived from the Latin “of the northwest wind, northwestern” (Jaeger 1944).

### *Pagurus quaylei* n.sp.

Fig. 8–16

*Material examined*—Table 2.

*Description*—Carapace shield subequal in length and width and relatively flat. Smooth and shiny with a few tufts of short setae. Tufts of long soft setae laterally and on branchial region. Rostrum and lateral teeth rounded and without submarginal teeth.

Eyestalk cylindrical and elongated. More than one-half length of shield. Cornea slightly wider than stalk. Ophthalmic scales oval, concave dorsally, with one or more marginal teeth.

Antennule peduncle short, reaching slightly past cornea of eye.

Antenna with basal segment armed with 1 lateral tooth. Second segment stout with 1 tooth at base of acicle, 1 on inner-ventral distal border, and 2–5 on lateral projection. Acicle narrow, slightly curved, with sharp tip and setose on inner margin. Third segment short and fourth twice third. Flagellum longer than chelipeds.

Third maxilliped with crista dentata on ischium composed of small corneous teeth diminishing in size distally and 1 large accessory tooth. 1 or 2 teeth on median margin of basis.

Right cheliped relatively stout with stiff setae in tufts around tubercles. Ischium short, with a few tubercles and tufts of setae on inner and outer ventral lateral margins. Merus smooth dorsally with a few tufts of short setae. No teeth on distal dorsal margin. Ventrally rounded, with 1 large median tubercle and a number of smaller tubercles medially and on the distal margins. Carpus subequal in length, but wider than merus. Inner margin armed with a row of large sharp forward-pointing tubercles. Dorsal surface covered with small spiny tubercles in irregular rows and surrounded by tufts of setae.

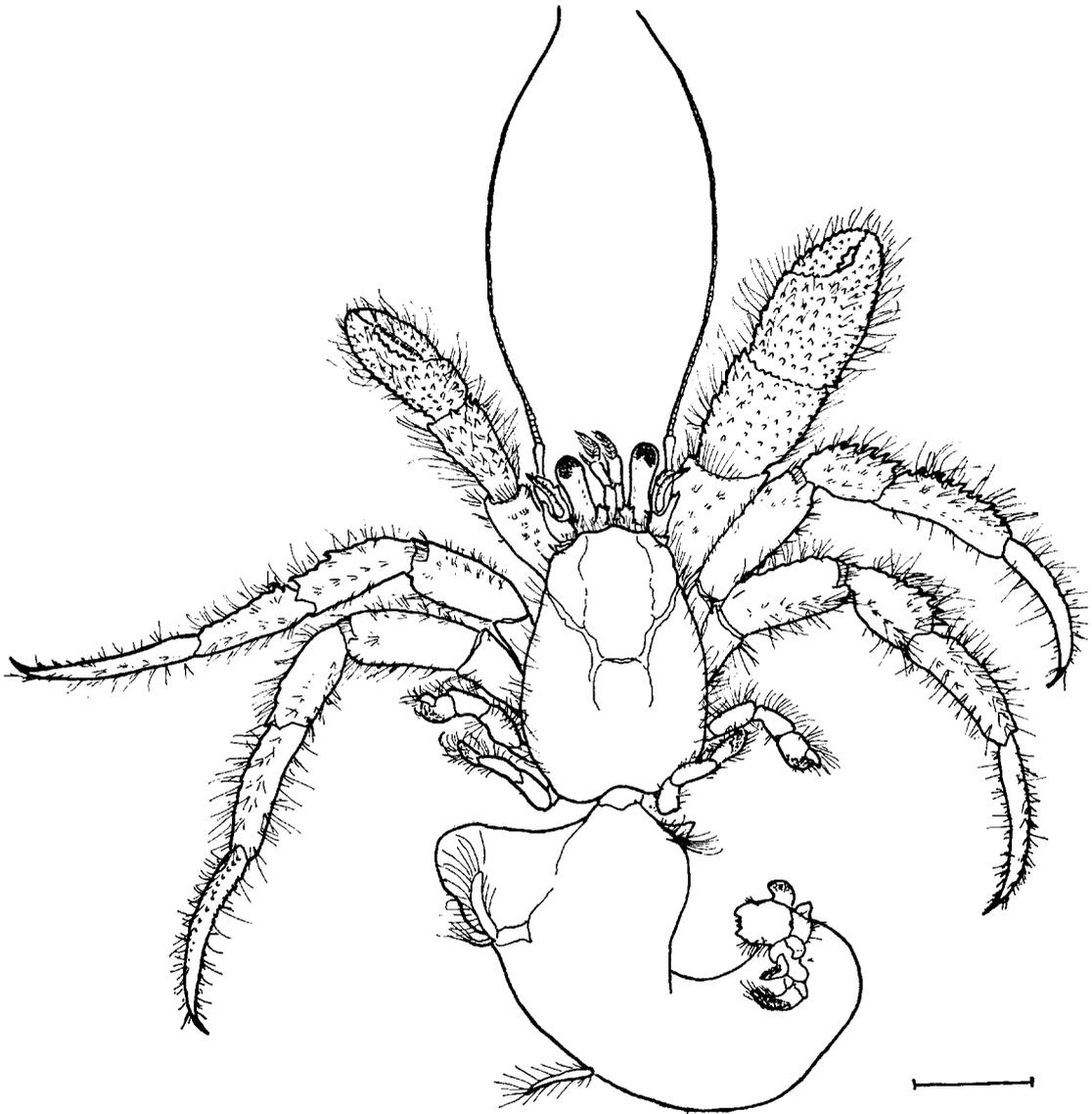
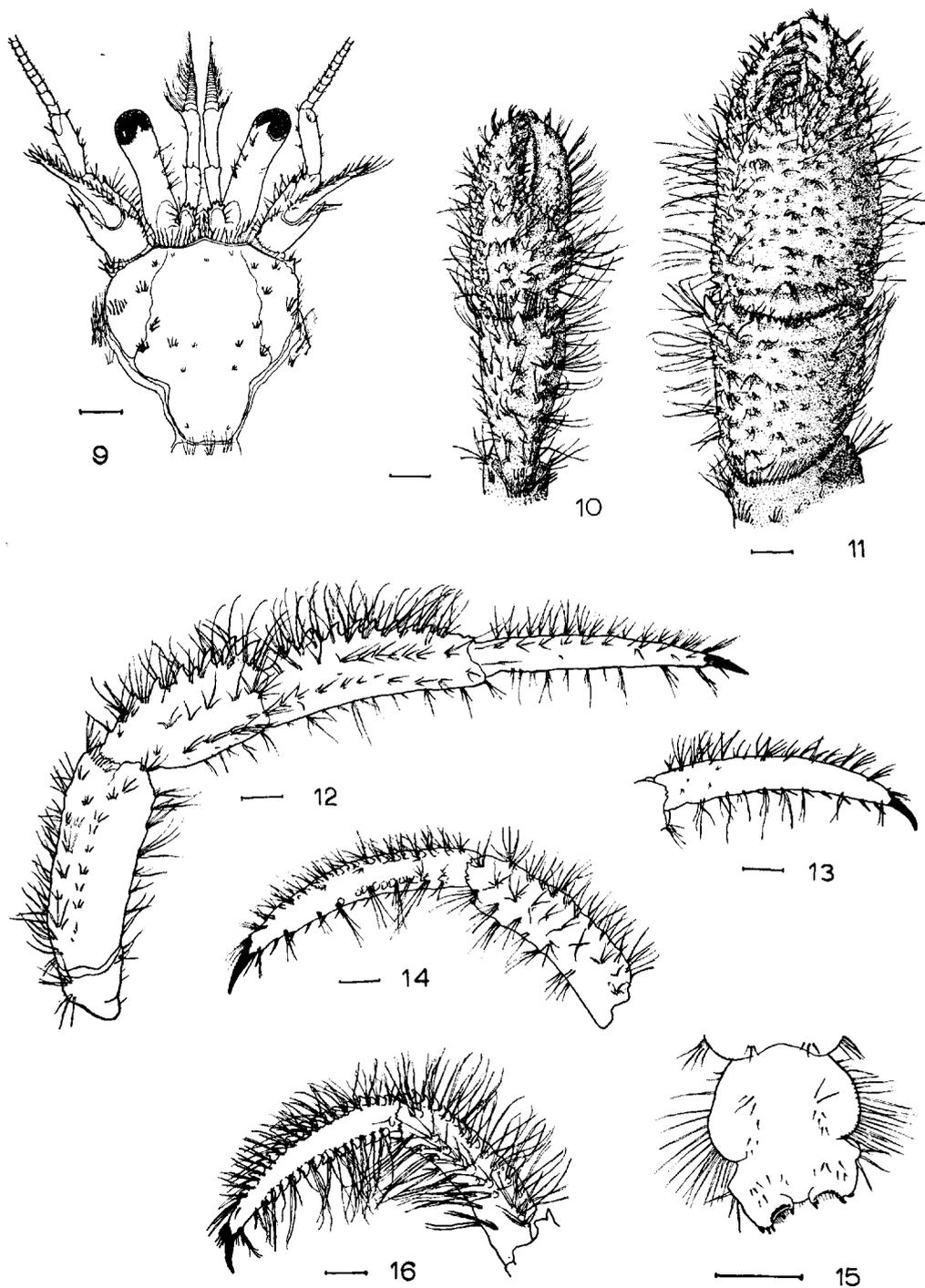


FIG. 8. *Pagurus quaylei* n.sp. Male.

Distal dorsal margins bordered with numerous small tubercles. A few tubercles on ventral distal margin. Chela longer than carpus but subequal in width. Inner margin of propodus straight and outer margin curved. Margins of fingers curved. Palm slightly convex dorsally: covered with tufts of long setae arising between numerous spiny tubercles of varying sizes. More tubercles on inner half and some in rows. Both fingers armed with median and lateral rows of small sharp tubercles. Gape between fingers, with teeth meshing only at distal third. Cutting teeth on fixed finger smaller than those of dactylus and tips of both corneus.

Left cheliped narrow, elongate, and setose. Ischium with a ventral longitudinal ridge armed with small teeth. Merus laterally compressed and narrower dorsally. Few scattered tubercles ventrally. Carpus subequal in length to merus. Many tufts of long setae, especially on inner face. Narrow dorsally, with 2 rows of large spiny tubercles. Chela slightly wider than carpus and somewhat less setose. 2 or 3 rows of spiny tubercles medially, ending between bases of fingers. Smaller spiny tubercles on either side of palm and a crowded semi-double row on each finger dorsally. Fingers elongated; gaping, except at tips. Fixed finger may have small



FIGURES 9-16. *Pagurus quaylei* n.sp. Male.

Fig. 9. Shield and head appendages; Fig. 10. Left chela and carpus; Fig. 11. Right chela and carpus; Fig. 12. Right second pereopod; Fig. 13. Dactylus of right second pereopod to show spines; Fig. 14. Propodus and dactylus of left third pereopod; Fig. 15. Telson; Fig. 16. Propodus and dactylus of left third pereopod of specimen from Santa Cruz Island, California.

TABLE 2. *Pagurus quaylei* n.sp. material examined.

Locality	Depth (m)	Bottom	Date	Station	Sex			Collector
					♂	♀	♀♀	
<i>British Columbia</i>								
Qlawszeet, Stephens Is. 54°13'N, 130°45'W	Subtidal	Gravel	6/6/69		1			JFLH
Frederick Is. 53°56'N, 133°08.5'W	11	Sand & boulders	19/6/62	FRB 62-34	3			DBQ
Port Louis 53°42'N, 132°58'W	Subtidal	Gravel	4/6/69		12		10	JFLH
Checleset Bay 50°03'N, 127°39.8'W	34	Mud & sand	29/6/70	FRB 70-56	1		2	JFLH
Off Kyuquot 49°56.2'N, 127°24'W	34	Firm clean sand	29/6/70	FRB 70-64	1	1	1	JFLH
Nuchatlitz Inlet 49°45.7'N, 126°59'W	14	Firm clean sand	30/6/70	FRB 70-68		1	2	JFLH
Naspart Inlet 49°45'N, 126°51'W	Subtidal		29/6/70		7	1	2	JFLH
Sydney Inlet 49°21.05'N, 126°14.7'W	13	Firm clean sand	30/6/70	FRB 70-70	4		3	JFLH
<i>California</i>								
Entr. Albion River Est., Albion Bay, Mendocina Co.	Dredged		14/7/49	EB-43	1			
Outer Bodega Bay, adj. Doran Spit, Sonoma Co.	7-9		26/7/49	M63-49	13	6	21	L. O. Miles & W. K. Emerson
Outer Bodega Bay	5-9		3/8/49	M68-49	6	1		L. O. Miles & W. K. Emerson
San Luis Obispo Bay, San Luis Obispo Co.	15-26		4/8/38	V-3-885-38	2		3	
S San Miguel Is.	9-27		10/8/38	894-38	4		2	
Becher's Bay, Santa Rosa Is.	18		2/8/38	881-38	1			
N Santa Cruz Is.	97		14/9/38	898-38	1			
W Dutch Harbor, San Nicolas Is.	15-17		23/11/40	1204-40	4			
2½ miles off Port Loma, San Diego Co.	17-24		23/2/41	1243-41	1			
<i>Mexico</i>								
Inside Bahía de San Quintín (San Quintín Bay), Baja California	4.5-8		14/4/51	V-4-2019-51	2	1		

separated teeth on inner margin and scattered tubercles on outer margin. Both fingers with a comb of short corneous setae on cutting surfaces.

Second right pereiopod slender and setose: longer than cheliped. Ischium short, setose. Merus compressed laterally, with dorsal and ventral surfaces narrow. Tufts of short setae. Carpus compressed laterally: inner face flat, outer convex. Dorsal ridge with large

and small spiny tubercles. Propodus with inner face flat, outer convex. Dorsal ridge armed with smaller spiny tubercles than those on carpus. One spine on ventral distal margin. Dactylus slender, twisted at base and longer than propodus. Ventral spines small, claw long and curved.

Third right pereiopod. Ischium only slightly longer than that of second pereiopod. Merus with inner face

flattened, outer convex and dorsal and ventral surface with only ridges. Carpus like that of 2nd, but spiny tubercles smaller and fewer in number. Propodus with tufts of setae and a few flat granules. One spine on distal ventral margin. Dactylus longer than propodus and also than that of second pereiopod.

Left second pereiopod like right with smaller tubercles.

Left third pereiopod. Carpus with one distal spiny tubercle. Propodus with granules or spiny tubercles distally on outer face. Dactylus specialized: outer face with a row of spiny tubercles forming a ridge adjacent to dorsal crest. A similar ridge on lower part of same face. Much variation in degree of armament.

Telson with posterior lobes with lateral margins straight and corneus and armed with 2 or 3 large corneus spines distally. Posterior margin with concave spinulose edge and a large corneus spine on either side of cleft.

*Colour of living animal*—Shield dark red with a few brown spots and covered with a fine reticulation of pink with some yellow and orange medially. Light spots on dark brown of lateral part of carapace. Red at junction of shield and posterior carapace, which is pinkish-brown with poorly defined light blue stripes. Abdomen purplish-red with scattered yellow chromatophores. Tail fan orange and brown mottled. Antennule pale brown with scarlet chromatophores distally on second and third segments of peduncle: flagella translucent with orange at base of aesthetes. Antennal peduncle with first to third segments light brown, with red patches and some opaque white spots; fourth segment translucent mottled with dark brown. Flagellum translucent and banded with dark brown on certain segments: the pattern is irregular and made up of some all dark segments, others with two patches of dark brown on either side and the remainder without colour. Opaque white dots on clear segments, which occur every third or fourth segment. These disappear upon death. Eyestalk pale brown with red-brown and white chromatophores in interrupted stripes. Cornea black with brilliant silver chromatophores covering the surface except for 2 circular bands that curve over the distal part. Third maxillipeds greenish-brown with opaque white patches on distal part of each segment.

Right cheliped: ischium with patches of brown, merus dark brown or mahogany with spots of lighter colour and a white or pale brown band distally, carpus mottled grey or greenish-brown with pale grey spots and tubercles, hand with grey and white tubercles surrounded by reticulated greenish-brown to base of fingers, which are white except for a small brown streak medially on base of fixed finger. Left cheliped similar except that distal part of carpus is white and a tinge of grey-blue on distal part of palm. Walking legs: ischium with a few patches of brown, merus with band of red-brown, distal part of opaque grey-white, with a narrow band of mahogany and a wider band of pale yellow. Carpus grey-white and cream with 3 distinct dark red-brown stripes on outer surface, but none on inner surface. Propodus with 3 rows of grey spots separating four stripes of dark brown on the outer surface and 1 medial stripe on inner surface, none of which reach past the

middle or last quarter of the segment, which is white with a yellow tinge distally. Dactylus with a dark grey patch proximally on a cream base, with 1 red-brown stripe dorsally on proximal half, and 1 red stripe on each lateral face medially, which reach almost to the brown claw. Fourth and fifth pereiopods red-brown with yellow rasps.

There is a tendency in preserved animals for the browns to become pink or red and the stripes less distinct.

*Size*—Shield length: males 1.0–4.3 mm, ovigerous females 1.1–3.7 mm.

*Range*—Qlawdzeet, Stephens Island, B.C., 54°13'N, 130°45'W to Bahía de San Quintín (San Quentin Bay), Baja California, Veleró IV stn. 2014–51. 2–97 m.

*Habitat*—Shallow water in gravelled areas.

*Field characters*—The banded flagella, dark stripes and white bands on carpi, propodi and dactyli of walking legs.

*Notes*—Ovigerous females were taken in British Columbia from June 4 to August 20, and in California from July 26 to August 10. Specimens from the group of islands off shore from Santa Barbara, California, are much more setose and more heavily armed with spiny tubercles and teeth but otherwise are similar morphologically.

The number of teeth on the eyescales varies from 1 to 5, and in any combination in any one individual. Over half of the specimens examined, of both sexes and all sizes, have 2 teeth on each scale. Of the remainder one or both scales had only 1 tooth in specimens of less than 2 mm shield length. 3, 4, or 5 teeth on the scales occurred in those of 1.5 mm to the largest of 4.3 mm shield length. A number of individuals have been kept alive in the laboratory and in some of these the number of teeth has increased. It would seem to require about three moults for the additional tooth to become subequal in size to the others. The extra teeth are apparently only produced on the inner margins.

Males kept in the laboratory for nearly 2 years have increased the length of the shield less than 0.1 mm per ecdysis, which occurred at intervals of 8–10 weeks. Growth of females was at an even slower rate, due possibly to the effects of egg production.

This is a very active hermit crab. It inhabits relatively small shells, which it can raise off the bottom and so move quickly over the surface and scale small rocks with ease. As this species seems to prefer subtidal gravelly areas, this agility would be of an advantage in such a habitat.

The rather striking modifications of the propodus and dactylus of the left third pereiopod of *P. quaylei* is not unique among the hermit crabs of the northeastern Pacific area. There is variation in the degree of modification in both individuals as well as in different species. Many *P. beringanus* (Benedict) have similar spiny tubercles on the propodus and dactylus, as do *P. hemphilli* (Benedict), *P. hirsutiusculus* (Dana), and *P. samuelis* (Stimpson). In these species the occurrence is less common than in *P. quaylei* and the tubercles are often fewer in number and less pointed. The advantages of this rather specialized modification of the pereiopod is not obvious. As all of these species are unusually active and inhabit rocky area, either in the surf zone or in the upper subtidal area, they are thus subjected to considerable buffeting, which could cause the animals to lose their grip on the substrate and to be turned upside down. The speed with which they are able to right themselves and to again cling is therefore of importance to their existence. The tip of the left third pereiopod would seem to be a crucial part of this process and thus the surfaces roughened by extra spiny tubercles might facilitate the speed or efficiency of the action.

This species is named for Daniel B. Quayle, whose knowledge of the marine invertebrates and their distribution in the northeastern Pacific is outstanding.

### *Pagurus stevensae* n.sp.

Fig. 17-22

*Pagurus brandti* Stevens 1925 p. 285-286 fig. 7. Hart 1940 p. 93. Bakus 1966 p. 427.

*Material examined*—Table 3.

*Description*—Carapace shield subequal in length and width in small specimens but slightly longer than wide in large. Smooth surface with tufts of short setae. Rostrum obtuse, rarely pointed, and little advanced beyond broad lateral teeth, each of which has a small curved submarginal tooth. Soft plumose setae on lateral carapace.

Eyestalk long and slender, slightly constricted medially, and more than half width of shield. Cornea slightly wider than base of stalk. Scales somewhat triangular with large submarginal tooth.

Antennular peduncle reaching beyond eyes.

Antenna with minute lateral tooth on basal segment of peduncle. Second segment with 1 tooth on inner distal point, 1 at base of acicle and 1 short stout outer process with 2-7 teeth distally. Setose acicle curved, decreasing in width distally, and terminating in a sharp pointed tip, which barely reaches cornea in small individuals but may surpass it in large. Third segment of peduncle

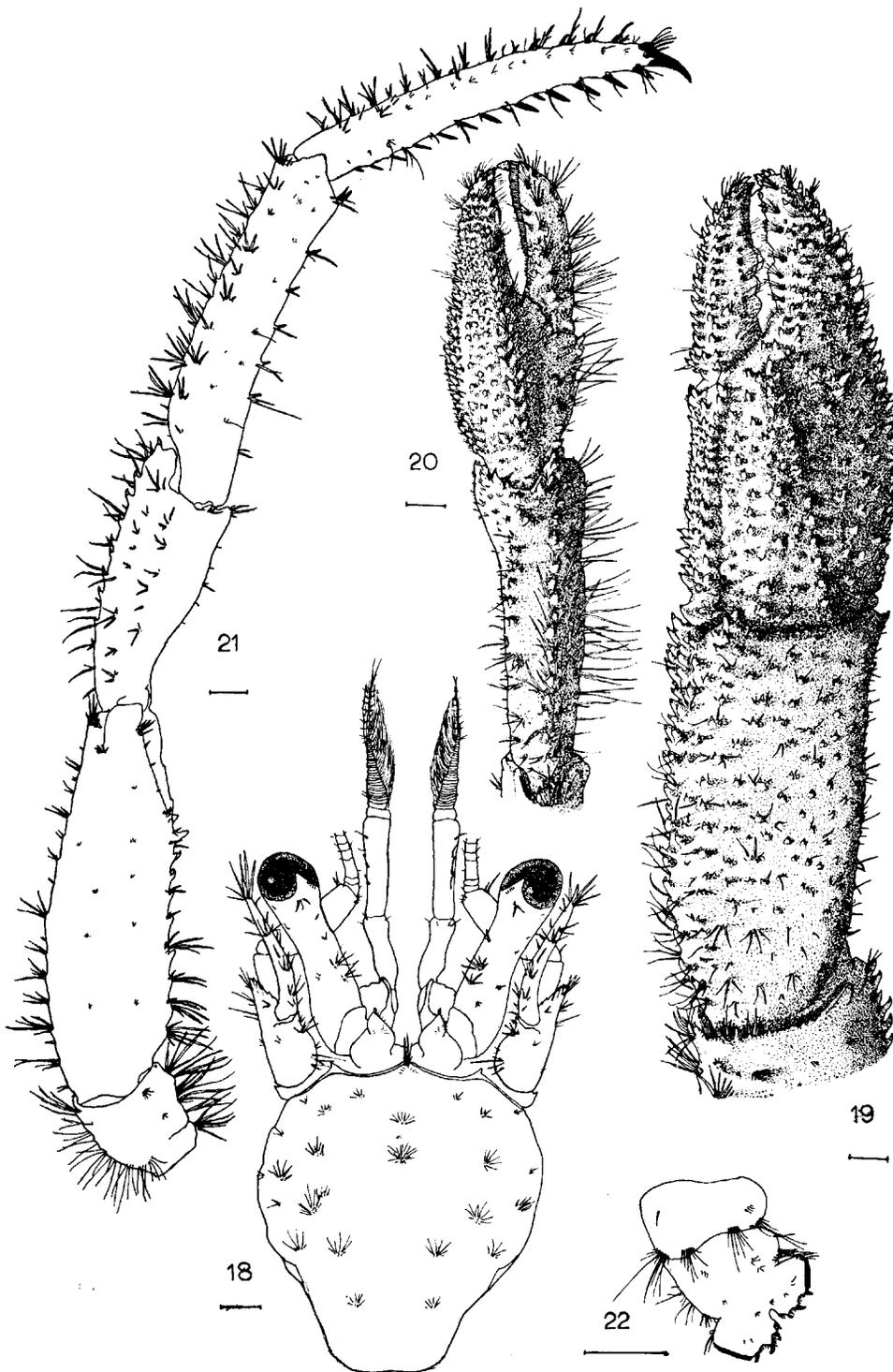
short, and fourth flattened and slender. Peduncles of antennule and antenna subequal in length. Flagellum may be longer than right cheliped.

Third maxilliped with 3-4 teeth on inner margin of basis. Ischium with a series of small corneus teeth, crista dentata, plus 1 accessory tooth medially. Merus with 0-2 spiny tubercles on ventral surface.

Right cheliped elongate and narrow dorsally. Ischium with spiny tubercles scattered on inner ventral margin. Merus with spiny tubercles on ventral lateral margins and a few medially. Lateral face slightly convex and inner face setose. Distal dorsal surface with flat setose ridges and margin cut into 3-7 teeth. Carpus subequal or longer than merus, bulbous ventrally and lateral faces flat. Inner dorsal margin with several rows of stout corneus-tipped tubercles. A concentration of small tubercles on outer margin but not placed in clearly defined rows. Width of distal carpus equal to less than half length in large individuals but often half or slightly more in small. Distal dorsal margin armed with spiny tubercles. Chela with outer margin of palm curved and inner almost straight. A broad ridge covered with many spiny tubercles on inner dorsal surface. An inverted elongated V-shaped raised area delineated with spiny tubercles on mid-dorsal palm and separated from inner ridge by a sparsely tuberculated groove. Outer slightly convex side with numerous small spiny tubercles and tufts of short setae. Outer margin of chela outlined with a row of large spiny tubercles, with corneus tips sharp and upturned, especially on fixed finger. Fingers flat, with scattered tubercles on fixed finger and rows of closely set spiny tubercles on dactyl. Cutting surfaces with broad flat teeth.

Left cheliped ischium with serrated ventral ridge. Merus with ventral margins armed with large spiny tubercles, dorsal surface narrow and armed with setose ridges. 1-2 teeth on distal dorsal margin. Carpus with scattered spiny granules and fine setae on ventral and outer faces; somewhat swollen distally. Mid-dorsal area narrow and bordered on either side with a row of spiny tubercles; inner face setose. Chela with outer margin curved and outer face oblique and slightly convex: covered with many small spiny tubercles and granules. A median crest with 2 rows of spiny corneus-tipped tubercles (inner row larger); tubercles alternate and point in opposite directions and decrease in size distally disappearing at middle of fixed finger. Inner face smooth, with groove adjacent to crest and inner margin with 1 or 2 rows of small spiny tubercles. Dactylus with scattered granules. Fingers with cutting surface armed with short stout corneus setae and tips corneus.

Walking legs long and slender, laterally compressed, dorsally setose with tufts of short setae. Right second pereiopod with short ischium. Merus with ventral margin serrate. Carpus short with a dorsal crest of spiny tubercles. Propodus slightly shorter than dactylus, with small spines on ventral margin. Dactylus with a row of long spines ventrally and dorsally a double row of small spines, which are more obvious in large individuals. Left second pereiopod similar to right. Third pereiopod with ischium longer than that of second, but whole limb subequal in length. Only 1 tooth or none on



FIGURES 18-22. *Pagurus stevensae* n.sp. Male.

Fig. 18. Shield and head appendages. Fig. 19. Right chela and carpus; Fig. 20. Left chela and carpus; Fig. 21. Right second pereiopod. Fig. 22. Telson.

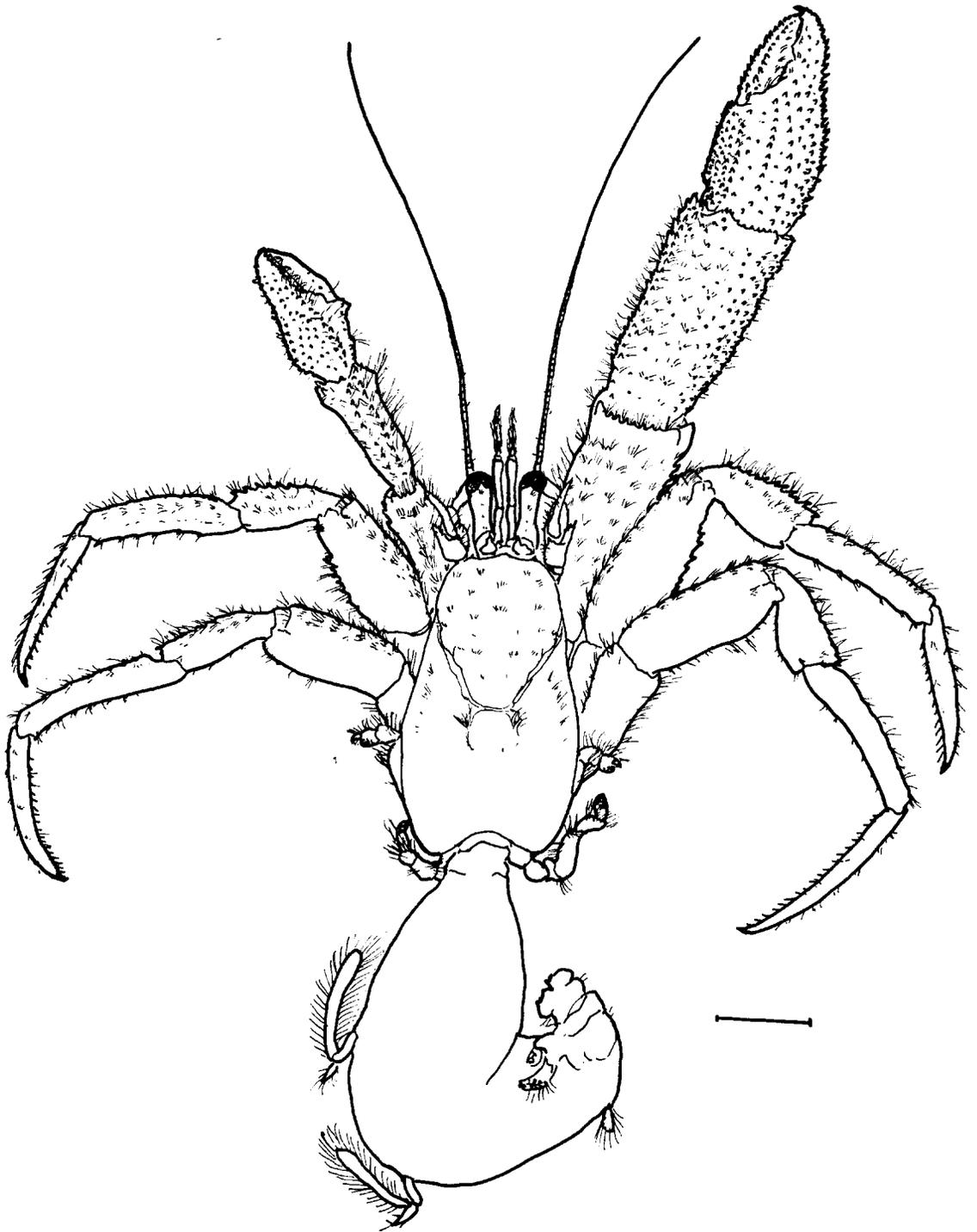


FIG. 17. *Pagurus stevensae* n.sp. Male.



distal ventral part of merus. Carpus with small spiny tubercle on upper distal tip, with or without small tubercles on mid-dorsal ridge. Ventral spines on propodus, minute. Dactylus similar to that of second but with 2 extra rows of small spines on anterior face. Dactylus longer than propodus.

Telson with posterior lateral lobes large and usually wider than anterior lobes. The protuberant proximal part of posterior lobe subrectangular, with lateral posterior margin a narrow corneus plate, and posterior curved margin bearing 4 large curved corneus spines: the outer separated from the 3 equidistant inner by a greater hiatus. Median cleft short and narrow.

*Colour of living animal*—Shield white with red and tan reticulations; lateral areas yellow and posterior part of carapace and abdomen like shield. Some red spots scattered over surface. Tail-fan white with tan mottling. Segments of peduncle of antennule with median scarlet bands, flagella with orange base to aesthetes. Peduncle of antenna pale orange with red patches and flagellum reddish translucent. Eystalk pale orange with red interrupted stripes, cornea with green and yellow surface chromatophores. Maxilliped red with white bands at junctions of segments.

Chelipeds pinkish-brown with dark red spiny tubercles and with scattered small red spots, fingers pale pink. Walking legs with ischium white with red reticulations, merus similar but with two lighter patches medially, carpus dark red-brown with lighter patches medio-laterally, propodus with a dark red stripe dorsally and one ventrally and an orange stripe midlaterally on light yellow base, dactyl with a red-brown band proximally and thin red or orange stripes, dorsally, ventrally, and midlaterally on light base with interrupted rows of red spots above median stripe.

Small individuals are usually more brilliant in colouring than large, scarlet and orange being replaced in large specimens by an overall tan. In preserved material the colour is more drab, although the small red spots seem to persist.

*Size*—Length of shield: males 1.0–11 mm, and females 1.6–9 mm (ovigerous females 2.2–9 mm).

*Range*—Dixon Entrance, B.C., 54°12.9'N, 132°57.3'W, to San Juan Archipelago, Puget Sound, Washington (Stevens 1925). 13–198 m.

*Habitat*—On mud, sand, or gravel bottom. Often occupy living sponges, *Suberites ficus* (Johnston). These sponges are usually tan, and often have red, orange, or pink blotches. The original shell would appear to be absorbed by the sponge but the cavity is retained and increased as necessary with the growth of the crab.

*Field characters*—In large specimens, the right cheliped, with its elongate carpus and no distinct white band on the distal merus, plus the scattered small red spots and the dactyli of the walking legs with a row of

small red spots above the dark stripe, serve to distinguish this species from *P. dalli* (Benedict). The brilliant colour of small individuals and the dactyl spots are distinctive.

*Notes*—Ovigerous females have been taken in January off Malcolm Island and in June in Dixon Entrance.

There are at least four allied species of *Pagurus* found in the northeastern Pacific and in the Arctic, whose validity as distinct species has been the subject of considerable controversy. To date, only two of these have been found in British Columbia: *P. dalli* (Benedict) and *P. stevensae*. The latter has been recorded as *P. brandti* by Stevens (1925), Hart (1940), Bakus (1966), and synonymized by Makarov (1938) as *P. pubescens* Kröyer. I have examined specimens of *P. pubescens* from the Canadian Eastern Arctic and a syntype of Benedict's *P. brandti*. Both *P. dalli* and *P. stevensae* differ from these two species in a number of features, but the most easily diagnosed difference is in the size and shape of the eyes and eystalks. In the latter two species the eystalk is elongate, equal to or more than one-half the width of the shield, and the cornea is little, if any, wider than the diameter of the stalk. The eystalks of *P. brandti* and *P. pubescens* are short, equal to one-half or less than the width of the shield, and the diameter of the cornea is much greater than the diameter of the eystalk. The proportionate size and shape of the eyes and eystalks would seem to be a consistent character for both large and small individuals.

*Pagurus stevensae* can be distinguished from *P. dalli* by the shape and armature of the carpus of the major cheliped. The dorsal surface of the carpus of *P. stevensae* is elongate: in large individuals twice as long as wide, with subparallel margins, the outer one of which is roughly marked with small tubercles. The carpus of *P. dalli* is not particularly elongate, increases in width distally, and the outer margin is clearly marked by a distinct row of large spiny tubercles. The telson of *P. stevensae* has the distal lobes wider than the proximal and the margins are angled, whereas the lobes of the telson of *P. dalli* are subequal in width and the margins of the distal ones are rounded. The living animals differ in colour: *P. stevensae* is an overall pinkish brown, red, or orange with scattered small red spots, which are characteristically in a row on the upper half of the dactyls of the second and third pereopods, whereas *P. dalli* is an overall brown with opaque white bands on the distal part of the meri of the first three pairs of pereopods.

This species is named for the late Belle A. Stevens, of Seattle, Washington, whose enthusiasm for the

taxonomy of the decapod Crustacea of the Puget Sound area inspired all of us who knew her.

### New Records and Extensions of Range of Species in the Area Between 48° and 55°N and 123° and 135°W

#### *Calastacus quinqueseriatatus* Rathbun 1902

FRB stn 64-213, west of Queen Charlotte Sound, 50°54.5'N, 130°06'W, Sept. 11, 1964, 2200 m, mud, 1 female, damaged. DBQ.

The collection of this specimen is a northern and eastern extension of known localities, as well as from a greater depth. The previous northern record of the eastern Pacific is off Point Sur, California (36°20'N) from 1220 m, and the southern off San Nicholas Is., California, 293-2013 m (Schmitt 1921). The nearest western record is from the Okhotsk Sea, 288-1150 m (Vinogradov 1947).

#### *Callianassa gigas* Dana 1851

Wainwright Basin, 54°15'N, 130°20'W, Aug. 4, 1967, 2 males (immature). M. Waldichuk. Inside Sandspit Bar, Line #3, 26 m, Sept. 14, 1960, 1 dried specimen. DBQ.

The paucity of specimens of this species collected in British Columbia is probably due to the difficulties of collection from burrows in sticky mud of the lower intertidal or subtidal. Wainwright Basin, near Prince Rupert, is much farther north than Boundary Bay. The southern known limit is San Quentin Bay, Lower California (Stevens 1928). This species has been taken from 26 m as reported above and from 48-51 m dredged from northeast of Orcas Island, Puget Sound, Washington, 48°42.8'N, 122°49'W, July 24, 1964, by P. L. Illg.

#### *Paguristes turgidus* (Stimpson 1857)

FRB stn. 71-66, Dixon Entrance, 54°36.0'N, 132°08.0'W, 157 m. Sept. 22, 1971, 1 female. JFLH. This is a northern extension from Rennell Sound, Queen Charlotte Is. (Hart 1940). The recorded southern limit is San Diego, California (Schmitt 1921).

#### *Paguristes ulreyi* Schmitt 1921

Frederick Island, 53°56'N, 133°08.3'W, littoral, in rocky crevices, June 3, 1969, 6 males, 11 females. JFLH. The previously known northern record was Monterey, California, and the southern record by Haig et al. (1970) is the outer Baja California coast, and in Golfo de California as far north as Punta Gorda. To a depth of 56 m (Schmitt 1921).

#### *Pagurus cavimanus* (Miers 1879)

Entrance to Departure Bay, 49°10'N, 123°50'W, 73 m, June 1, 1933, 1 small male. JFLH. This record constitutes a considerable southerly extension of range from the previous record from Juneau, Alaska, 58°18'N, 134°25'W. 35-250 m (Rathbun 1904). The northern and western range is the Bering Sea and Japan (Miers 1879; Yokoya 1933). The collection by

C. Birkeland, by scuba diving, from Cobb Seamount, north rim, 46°44'N, 130°47'W, 37 m, of a large male, is a fascinating record (Birkeland 1971).

#### *Pagurus cornutus* (Benedict 1892).

FRB st. 68-45, west of Barkley Sound, 48°44.5'N, 126°30.3'W, 436 m, rock, Sept. 1968, 2 males, 5 females. DBQ. The previously known southern record was off Queen Charlotte Sound, B.C. (Rathbun 1904). The northern and western known limits are the Bering Sea and the Commander Islands. 160-830 m. (Makarov 1938).

#### *Pagurus hemphilli* (Benedict)

Lucy Island, off Langara Island, 54°10'N, 132°58'W, littoral, June 5, 1969, 6 males, 2 females. JFLH. This is farther north than the previous record of Houston Stewart Channel (Hart 1940). The southern known limit is Monterey, California (Schmitt 1921).

#### *Pagurus samuelis* (Stimpson 1857)

Louie Bay, south side of Nuchatlitz Inlet, Nootka Sound, 49°45'N, 126°50'W, high intertidal, May 28, 1969, 27 males, 29 females (22 ovigerous). JFLH. The occurrence of this species on the west coast of Vancouver Island extends the known range farther north than has been recorded in the literature, with the exception of Rathbun's (1904) report from Sitka, Alaska. However, Schmitt (1921) states that this record was based on a misidentification of *P. hirsutiusculus* (Dana). The known southern limit is Northwest Baja California (Haig et al. 1970). *P. samuelis* is recorded from Japan, but Holmes (1900) questioned this record. I have examined specimens from Japan, identified as this species, but which differ from those found in California, and in British Columbia, both in colour and in form.

#### *Orthopagurus minimus* (Holmes 1900)

FRB stn. 62-34, Frederick Island, 53°56'N, 133°08.7'W, 11 m, sand and boulders, Aug. 1962, 1 female (ovigerous). DBQ. This locality is north of Skidegate, Queen Charlotte Islands (Hart 1940). The southern known limit is San Diego, California, 27-64 m (Schmitt 1921). The western record is Nel'ma Bay, Tartar Strait (Makarov 1938). 11 m is a shallower habitat than previously recorded.

#### *Parapagurus pilosimanus* Smith 1879

FRB stn. 71-45, off Queen Charlotte Islands, 53°02.0'N, 132°51.8'W, 1204 m, mud, Sept. 18, 1971, 1 male, 4 females (ovigerous). JFLH. FRB stn. 64-197, off Vancouver Island, 49°19'N, 127°25.6'W, 1400 m, mud, Sept. 6, 1964, 5 males and 2 females. DBQ. The distribution of this species is world wide in deep water. According to Makarov (1938) it occurs between 210 and 4000 m and to 53°N. In the North Pacific it has been taken from near Kamchatka (52°-42.5'N, 159°03.5'E) (Makarov 1938) but apparently has not been previously recorded from the north-eastern Pacific.

*Petrolisthes cinctipes* (Randall 1839)

Port Louis, Queen Charlotte Islands, 53°42'N, 132°58'W, littoral, between *Mytilus californianus* Conrad on exposed rocks, June 4, 1969. 3 males, 3 females (ovigerous). JFLH. This collection is farther north than the former record of Rose Harbour, Houston Stewart Channel (Hart 1940). The southern known limit is Santa Barbara and offshore Islands. To 54 m (Haig 1960).

*Munidopsis quadrata* Faxon 1893

FRB stn. 71-44, off Queen Charlotte Islands, 53°01.5'N, 132°54.3'W, 1069 m, mud and gravel, Sept. 18, 1971, 1 male, 2 females (1 ovigerous, eggs large). JFLH. This species has been previously recorded off Destruction Island, Washington, and south to Tres Marias Islands, Mexico, from 86 to 1572 m (Rathbun 1904).

*Chionoecetes tanneri* Rathbun 1893

FRB stn. 65-66, west of Englefield Bay, Queen Charlotte Islands, 53°01'N, 132°55'W, 1190 m, mud, Aug. 10, 1965. 14 juveniles. DBQ. The previous northern limit recorded in the literature is Washington, 47°29.3'W and the southern Lower California, 37°17'N, from 50 to 1940 m (Rathbun 1925).

*Scleroplax granulata* Rathbun 1893

Roller Bay, 50°55'N, 127°57'W, littoral, July 22, 1959, 1 juvenile. DBQ. This record from the northern tip of Vancouver Island extends the northern limit of known range from Esperanza Inlet (Hart 1940). The southern known limit is Ensenada, Lower California (Rathbun 1918).

*Pinnotheres pugettensis* Holmes 1900

Spider Anchorage, 51°45'N, 128°05'W, scuba 6 m, Aug. 22, 1969, 1 female from purple-hinged scallop (*Hinnites giganteus* Gray). F. R. Bernard. The collection of this pinnotherid from northern Vancouver Island is an extension of range from the previous northern record of Departure Bay, Vancouver Island (Taylor 1912). The southern limit is Puget Sound (Holmes 1900). Taylor (1912) reported a specimen from *Mya arenaria* Linnaeus but Rathbun (1918) reports tunicates as the only host. *Hinnites* is thus an unrecorded host.

*Pinnotheres taylora* Rathbun 1918

Cape Lazo, 49°40'N, 124°50'W, Feb. 5, 1969, 2 females in *Ascidia paratropa* (Huntsman). THB. FRB 69-4, Quatsino Sound, 50°30.4'N, 127°43.1'W, 38 m, May 29, 1969, 1 female in *Phallusia ceratodes* Huntsman, JFLH. Until recently this species was known only from Departure Bay and Ucluelet, B.C. (Rathbun 1918). It has been recorded from Puget Sound by Pearce (1966) and Lie (1968). The above records extend the known range some distance north on both the east and the west coasts of Vancouver Island.

*Planes marinus* Rathbun 1914

20 miles west of Ucluelet, Vancouver Island, 48°57'N, 125°35'W, May 1963, 2 females from a net-covered Japanese glass float. I. MacAskie. This record is slightly farther north than that reported south of Vancouver Island (Hart 1959). This species has been found from the coast of Oregon, off Baja California, Mexico, Hawaii, New Zealand, and St. Helena Island, South Atlantic (Chace 1966).

## SPECIES NOT PREVIOUSLY RECORDED FOR BRITISH COLUMBIA

*Pagurus capillatus* (Benedict 1892)

Common in shallow water (to 90 m) on muddy bottom, but apparently not previously reported from British Columbia. The distribution is the Arctic Ocean, southward through Bering Strait to Kamchatka and California. 5-439 m (Rathbun 1904). Schmitt (1921) gives the California record as off Santa Cruz, 439 m. Also reported from northern Korea and the Sea of Okhotsk (Makarov 1938).

*Pagurus tanneri* (Benedict 1892)

FRB stn. 68-52, West of Clayoquot Sound, 49°04.5'N, 126°51.5'W, 304 m, boulders, Sept. 1968, 1 male, 1 female. DBQ. FRB stn 76-1-41, La Perouse Bank, 48°45'N, 126°31'W, 580 m, 1967, 15 males, 6 females (3 ovigerous). S. J. Westrheim. There does not seem to be a record in the literature of this species collected in British Columbia. The known range is from Iliuluk Harbor, Unalaska, to off San Simeon Bay, California, 92-1053 m (Rathbun 1904).

*Paralomis verrilli* (Benedict 1894)

FRB stn. 68-29, southwest of Barkley Sound, 48°13'N, 126°18.5'W, 951 m, mud and sand, Sept. 1968, 1 juvenile. DBQ. This species does not seem to have been recorded from this area. The range is from Okhotsk Sea, 450 m (Vinogradov 1947) to off Cortez Bank, California, 1238-1480 m (Rathbun 1904).

*Lithodes couesi* Benedict 1894

FBR stn. 71-65, Dixon Entrance, 54°32.0'N, 132°05.3'W, 258 m, rocks, Sept. 22, 1971, 1 juvenile. JFLH. FRB stn. 71-43, west of Englefield Bay, Queen Charlotte Islands, 53°00.8'N, 132°55.8'W, 1076 m. Sept. 18, 1971, 1 male. JFLH. This species apparently has not been recorded from this area, nor as deep nor as shallow as the specimens obtained in 1971. The range is from the Bering Sea to off San Diego, California, 550-970 m (Schmitt 1921).

## Acknowledgments

The major part of the collections were made by staff members of the Fisheries Research Board of Canada, working from the Biological Station at Nanaimo, B.C. During certain periods between the years 1929 and 1940, during periods in the summers of 1969, 1970, and 1971, I made collections using facilities of this institution. Since 1940, my collecting activities have been off southern

Vancouver Island, including parts of the west coast exposed to the open Pacific.

Originally J. Haig, Allan Hancock Foundation, Los Angeles, California, planned to describe *Pagurus quaylei*, using specimens from California and Mexico, and P. A. McLaughlin, University of Miami, Florida, was to collaborate with me to describe *P. stevensae*. However, due to other commitments, neither have had time to do so; thus, they have kindly suggested that I describe these two forms.

I thank both of these colleagues for their confidence in me and for help and loan of material. I also acknowledge the consideration of staff members of the Biological Station at Nanaimo, who over the years kept my specimen requests in mind and succeeded in capturing so many hoped-for species. I am particularly grateful to D. B. Quayle, T. H. Butler, and F. R. Bernard for making so much reptant decapod material available for me to study. Last, but not least, I want to acknowledge the constant help and encouragement given to me by my late husband, G. C. Carl.

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