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AN ANNOTATED CHECKLIST AND KEY TO HERMIT CRABS OF TAMPA BAY, FLORIDA, AND SURROUNDING WATERS

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ABSTRACT Fourteen species of hermit crabs, belonging to 5 genera, were identified from 35 stations in Tampa Bay and adjacent continental shelf waters. Ninety-two samples were taken from the intertidal zone to 15 m with a variety of gear including dip nets, trawls, dredges, and hand collections using SCUBA. *Pagurus maclaughlinae*, *Pagurus longicarpus*, and *Pagurus pollicaris* were distributed throughout the bay. These species were often sympatric, and were commonly found in seagrass beds, sandy substrates, and sand/mud substrates, respectively. *Clibanarius vittatus*, *Pagurus gymnodactylus*, and *Pagurus stimpsoni* inhabited the higher salinity waters of the bay entrance. *Paguristes* sp., *Paguristes hummi*, *Pagurus impressus* and *Petrochirus diogenes* were collected from the lower bay to offshore on hard substrates and sand. *Paguristes puncticeps*, *Paguristes sericeus* and *Pagurus carolinensis* were collected only offshore on hard substrates. The latter species is reported from the Gulf of Mexico for the first time. *Isocheles wurdemanni* appears to be restricted to high energy beaches. An illustrated key as well as information on distribution, reproductive biology, taxonomic problems, symbionts, and coloration are presented.

INTRODUCTION

Tampa Bay, the largest open-water estuary in Florida (Tampa Bay National Estuary Program 1996), supports a rich diversity of invertebrates which often occur in high densities (Simon 1974). However, the hermit crab fauna of this embayment and adjacent waters is poorly known. Although prior to the present study 15 species of hermit crabs were documented from the shallow waters (15 m or less) of the west coast of Florida, only 5 have been recorded from the Tampa Bay area (Table 1). The first species reported was *Pagurus pollicaris* Say, 1817, by Ives (1891) near the entrance of the Manatee River, which flows into Tampa Bay. Over 50 years later, *Paguristes hummi* Wass, 1955, was collected in tidal pools at the mouth of Tampa Bay. Provenzano (1959), in a major taxonomic paper on the shallow-water hermit crabs of Florida, cited only 1 species from the Tampa Bay area, *Pagurus longicarpus* Say, 1817. In the most recently published survey of macroinvertebrates of Tampa Bay, Dragovitch and Kelley (1964) found *Petrochirus diogenes* (Linnaeus, 1758) as well as *Pagurus longicarpus* and *P. pollicaris*. During the next 20 years, several systematic accounts were published on hermit crabs from Florida waters (McLaughlin and Provenzano 1974a, 1974b, McLaughlin 1975, García-Gómez 1982, Lemaitre 1982, Lemaitre et al. 1982), but they included no records from Tampa Bay. McLaughlin and Gore (1988) reported *P. maclaughlinae* García-Gómez, 1982 from Tampa Bay, in a study on the larval development of this species.

The present study was undertaken to assess the species composition and distribution of hermit crabs

inhabiting the Tampa Bay area, and provide an illustrated key as an aid to their identification. In addition, information on reproductive biology, coloration, and taxonomic considerations is included.

MATERIALS AND METHODS

More than 90 samples (over 850 specimens) of hermit crabs were taken at 35 locations in the Tampa Bay, Florida, area to a depth of 15 m (Figure 1). Most collections were made by the authors from 1991-1997; however, additional material was examined from the University of Tampa Invertebrate Collection and the Florida Marine Research Institute, St. Petersburg, Florida. Specimens were collected with a variety of gear types and techniques; these are included in Appendix 1 with the station number (Figure 1), bottom type, temperature, salinity, depth, and species found at each station. Morphological terminology used for identification in the key is given in Figure 2. Unless otherwise noted, illustrations were prepared with the aid of a dissecting microscope and drawing tube.

Synonymies (restricted to primary taxonomic publications), material examined, distribution, and notes on ecological and reproductive biology are provided for each species in the systematic account. For species in which detailed coloration notes are available in the literature, only key color characters have been provided. For the other species listed below, descriptions of coloration for living specimens are reported for the first time, or additional detail is given to supplement existing notes. The material examined is presented in the following

manner: station number: date collected (number of specimens). Ovigerous females are designated with an (o). Collection dates followed by an asterisk indicate specimens borrowed from the Florida Marine Research Institute, St. Petersburg, Florida. Collections dates before 1991 that are not followed by an asterisk are from the University of Tampa Invertebrate Collection. Specimens collected during

the present study are deposited in the University of Tampa Invertebrate Collection except for representative specimens of each species which are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, (catalog number of specimens referred to as *Paguristes* sp. is USNM 265379).

TABLE 1

Hermit crab species reported from the west coast of Florida (Florida/Alabama border south to Cape Sable) to a depth of 15 m. Species records contained in this table were compiled from published literature as indicated. Lemaitre et al. (1982) concluded after a study of the species of the *Provenzanoi* Group, the distribution of *Pagurus annulipes* did not include the west coast of Florida. The authors did not examine Wass' (1955) material, and assigned his material to *Pagurus macLaughlinae*, *P. stimpsoni*, *P. gymnodactylus*, and/or *P. criniticornis*.

	Location	Reference
Family Diogenidae:		
<i>Clibanarius vittatus</i>	Pensacola	Cooley 1978
	St. Joseph Bay	Brooks and Mariscal 1985a
	Sopchoppy	Hazlett 1981
	Alligator Harbor	Wass 1955
	Tampa Bay	Present study
	Little Gasparilla Pass	Ives 1891
<i>Isocheles wurdemanni</i>	Perdido Key	Rakocinski et al. 1996
	St. George Island	Caine 1978
	Alligator Harbor	Wass 1955; Provenzano 1959
	Tampa Bay	Present Study
<i>Paguristes hummi</i>	Perdido Key	Rakocinski et al. 1996
	Pensacola	Cooley 1978
	Dog Island	Sandford 1995
	Alligator Harbor	Wass 1955; Wells 1969
	Clearwater Beach	Provenzano 1959
	Tampa Bay	Wass 1955; Present study
	Sanibel Island	Gunter and Hall 1965
	Marco Island	Provenzano 1959
West Coast of Everglades	Rouse 1970	
<i>Paguristes puncticeps</i>	Northwest Coast of Florida off Tampa Bay	Provenzano 1959 Present study
<i>Paguristes sericeus</i>	off Horseshoe Cove off St. Petersburg Beach off Tampa Bay	Provenzano 1959 Provenzano 1959 Present study
<i>Paguristes tortugae</i>	Marco Island Everglades	Provenzano 1959; McLaughlin and Provenzano 1974a Rouse 1970
<i>Paguristes</i> sp.	Tampa Bay	Present study
<i>Petrochirus diogenes</i>	Pensacola	Cooley 1978
	Alligator Harbor	Wass 1955
	Tampa Bay	Dragovich and Kelley 1964; Present study
	Everglades	Rouse 1970
Family Paguridae:		
<i>Pagurus annulipes</i> ?*	Alligator Harbor	Wass 1955
<i>Pagurus brevidactylus</i>	St. Andrews State Park	McLaughlin 1975
<i>Pagurus carolinensis</i>	off Tampa Bay	Present study

HERMIT CRABS OF TAMPA BAY, FLORIDA

TABLE 1 (CONTINUED)

	Location	Reference
Family Paguridae (continued):		
<i>Pagurus gymnodactylus</i>	Perdido Key	Rakocinski et al. 1996
	Pensacola	Lemaitre 1982
	Cedar Key	Lemaitre 1982
	Anclote Anchorage	Lemaitre 1982
	Tampa Bay	Present study
	Marco Island	Lemaitre 1982
<i>Pagurus impressus</i>	Pensacola	Cooley 1978
	Dog Island	Sandford 1995
	Alligator Harbor	Wass 1955; Wells 1969
	Sea Horse Key	Provenzano 1959
	Clearwater Beach	Provenzano 1959
	Tampa Bay	Benedict 1892 (see Williams 1984); Present study
	Sanibel Island	Provenzano 1959
Everglades	Rouse 1970	
<i>Pagurus longicarpus</i>	Perdido Key	Rakocinski et al. 1996
	Pensacola	Cooley 1978
	St. Joseph Bay	Brooks and Mariscal 1985a
	Dog Island	Sandford 1995
	Alligator Harbor	Wass 1955; Wilber 1989
	Panacea	Wilber and Herrnkind 1982
	Wakulla Beach	Wilber and Herrnkind 1982, 1984; Wilber 1989
	Cedar Key	Provenzano 1959
	Crystal River	Lyons et al. 1971
	Clearwater Beach	Provenzano 1959
	Tampa Bay	Provenzano 1959; Dragovich & Kelley 1964; Present study
	Sanibel Island	Provenzano 1959; Gunter and Hall 1965
	Rookery Bay	Sheridan 1992
Everglades	Rouse 1970	
Cape Sable	Tabb and Manning 1961	
<i>Pagurus maclaughlinae</i>	Crystal River	García-Gómez 1982
	Anclote Anchorage	Lemaitre et al. 1982
	Tampa Bay	McLaughlin and Gore 1988; Present study
	Esterro Bay	García-Gómez 1982
	Rookery Bay	Sheridan 1992
	Everglades	García-Gómez 1982
<i>Pagurus pollicaris</i>	Pensacola	Cooley 1978
	St. Joseph Bay	Brooks and Mariscal 1985a, 1985b
	Dog Island	Sandford 1995
	Alligator Harbor	Wass 1955; Wells 1969
	Panacea	Brooks 1989
	Cedar Key	Provenzano 1959
	Tampa Bay	Ives 1891; Dragovich and Kelley 1964; Present study
	Lemon Bay	Provenzano 1959
	Little Gasparilla Pass	Provenzano 1959
	Charlotte Harbor	Provenzano 1959
	Sanibel Island	Provenzano 1959; Gunter and Hall 1965
	Rookery Bay	Sheridan 1992
Everglades	Rouse 1970	
<i>Pagurus stimpsoni</i>	Anclote Anchorage	Lemaitre et al. 1982
	Tampa Bay	Present study
<i>Iridopagurus caribbensis</i>	off Panama City	Williams 1984

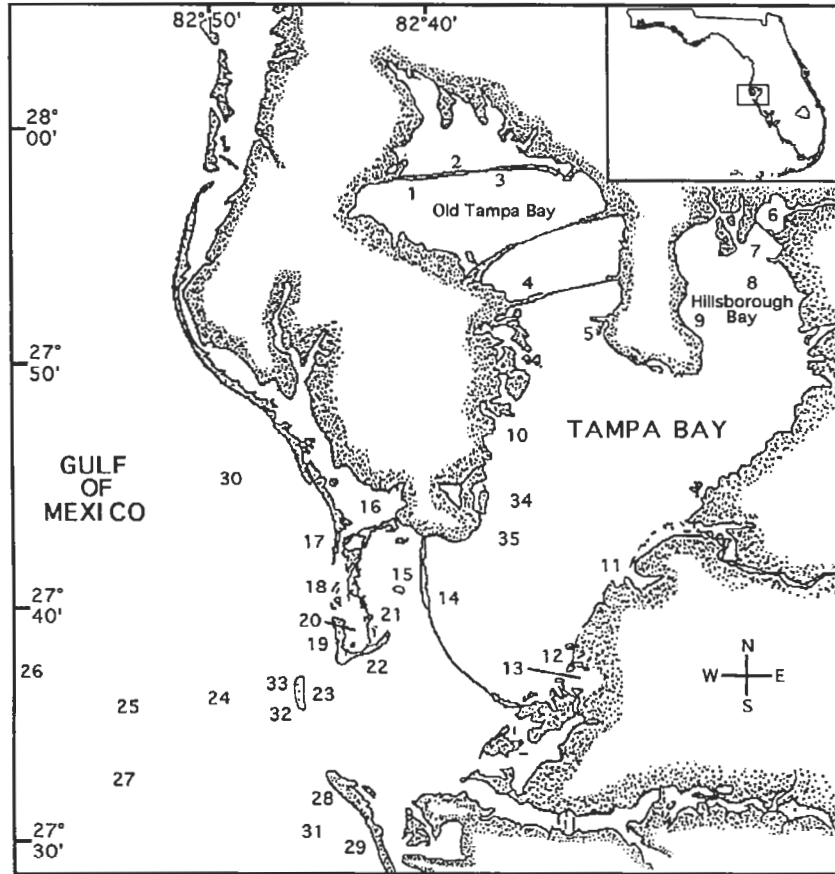


Figure 1. Location of collection sites in the Tampa Bay area.

Key to the Hermit Crabs of the Tampa Bay Area

- | | |
|---|--|
| 1. Third maxillipeds approximated at base (Figure 3a) [Family Diogenidae] 2 | 5. Rostrum broadly rounded or pointed, not extending beyond lateral projections of cephalic shield (Figure 4e) <i>Paguristes hummi</i> |
| Third maxillipeds widely separated at base (Figure 3b) [Family Paguridae] 8 | Rostrum slender and clearly extending beyond level of lateral projections (Figures 4f, g, h) 6 |
| 2. No paired appendages present on first 2 abdominal segments of either sex; dactyl of fourth pereopod subterminal (Figure 3e) 3 | 6. Ocular acicles ending in more than one terminal spine (Figure 4f) <i>Paguristes</i> sp. |
| Paired appendages present on first 2 abdominal segments of male (Figure 3c), and first only of female (Figure 3d); dactyl of fourth pereopod terminal (Figure 3f) 5 | Ocular acicles ending in simple spine (Figures 4g, h) 7 |
| 3. Chelipeds dissimilar and unequal, right slightly larger than left, right with calcareous tip (Figure 4a) <i>Petrochirus diogenes</i> | 7. Anterior and lateral margins of cephalic shield meeting at broadly obtuse angle (Figure 4g) <i>Paguristes puncticeps</i> |
| Chelipeds similar and subequal, both with corneous tips (Figures 4b, c) 4 | Anterior and lateral margins of cephalic shield meeting at near right angle (Figure 4h) <i>Paguristes sericeus</i> |
| 4. Finger tips spooned (Figure 4b); antennal flagellum long and not setose <i>Clibanarius vittatus</i> | 8. Ocular acicles ending in more than one spine or with submarginal spines (Figure 4i) <i>Pagurus carolinensis</i> |
| Finger tips acuminate (Figure 4c); antennal flagellum short and very setose (Figure 4d) <i>Isocheles wurdemanni</i> | Ocular acicles ending in a single terminal spine or with subterminal spine (Figure 4j) 9 |

9. Antennal flagellum with paired setae, 3-8 articles in length, at least every second article proximally, decreasing in length distally (Figure 4k)
 *Pagurus gymnodactylus*
 Antennal flagellum with setae 1 article in length or less (Figure 4l), or irregularly short and long setae over entire length 10
10. One or both chelipeds broad, right chela dorsoventrally flattened (Figures 4m, n) 11
 Both chelipeds narrow, right chela not dorsoventrally flattened (Figures 4o, p, q) 12
11. Dactyl of right cheliped with sharply produced angle on outer margin; lacking depression on dorsal surface of propodus of either cheliped (Figure 4m)
 *Pagurus pollicaris*
 Dactyl of right cheliped without sharply produced angle on outer margin; with depression on dorsal surface of propodus of both chelipeds (Figure 4n)
 *Pagurus impressus*
12. Dactyls of 2nd and 3rd pereopods each without row of corneous spines on ventral margin (Figure 4r); eyestalks short, length approximately 3 times the width
 *Pagurus longicarpus*
 Dactyls of 2nd and 3rd pereopods armed with row of strong corneous spines on ventral margin (Figure 4s); eyestalks long, length at least 4 times the width
 13
13. Left chela with longitudinal ridge on dorsal surface of propodus, unarmed or with weak spines or tubercles (Figure 4p) *Pagurus simpsoni*
 Left chela without ridge on dorsal surface of propodus, midline armed with a single or double row of strong spines (Figure 4q) *Pagurus maclaughlinae*

SYSTEMATIC ACCOUNT

Family Diogenidae Ortmann, 1892

Clibanarius vittatus (Bosc, 1802)

Pagurus vittatus.—Bosc 1802:78, Plate 12, Figure 1.

Clibanarius vittatus.—Stimpson 1862:83.—Hay and Shore 1918:410, Plate 30, Figure 9.—Provenzano 1959:371, Figure 5D.—Holthuis 1959:141, Figures 26, 27.—Williams 1965:120, Figure 97.—Forest and de Saint Laurent 1967:104.—Coelho and Ramos 1972:170.—Felder 1973:32, Plate 3, Figure 20.—Williams 1984:194, Figure 135.—Abele and Kim 1986:29, 339d,e.

Material. Station 14: 3 Aug 1993(1).— Station 20:25 June 1993 (1).—Station 23:May 1973 (2).

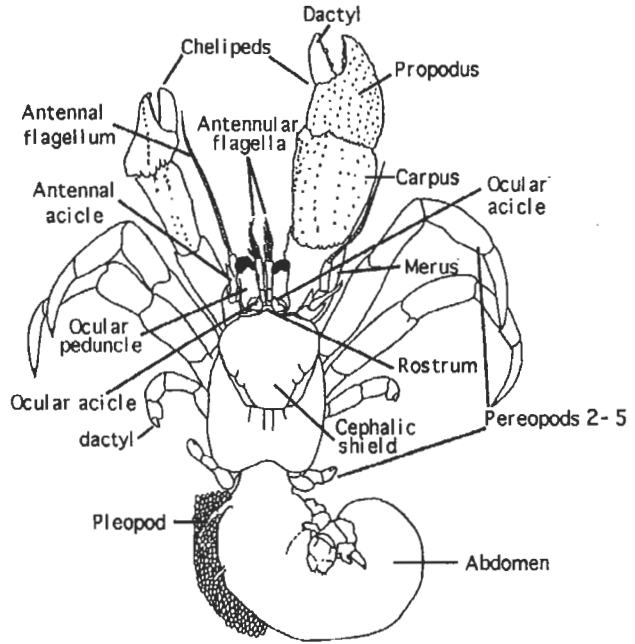


Figure 2. Schematic drawing of a hermit crab in dorsal view (after McLaughlin 1980)

Known range. Potomac River, Gunston, Virginia, to Florianopolis, Santa Catarina, Brazil (Forest and de Saint Laurent 1967).

Remarks. Only 4 specimens of *C. vittatus* were collected at the mouth of Tampa Bay in seagrass, sand/mud and rock jetty habitats. This species is commonly found in shallow subtidal and intertidal zones of harbor beaches, mud flats (Pearse et al. 1942), rock jetties, bay shores (Whitten et al. 1950), salt marshes near the ocean (Heard 1982), and seagrass-sand/mud areas (Lowery and Nelson 1988). Although *C. vittatus* is euryhaline (10-35‰) (Heard 1982), it is more commonly found at higher salinities, which may be necessary for egg development (Lowery and Nelson 1988). Although higher salinity habitats were sampled at different seasons in the present study, few animals were found. Thus, it appears that *C. vittatus* is uncommon in the Tampa Bay area.

Ovigerous females of *C. vittatus* were reported from North Carolina in June (Kircher 1967), South Carolina in July and August (Lang and Young 1977), east coast of Florida from April-September (Lowery and Nelson 1988), southern Florida in October (Provenzano 1959), northwestern Florida in June (Cooley 1978) and Texas from May-August (Fotheringham 1975). No ovigerous females were collected during this study.

Coloration. Light longitudinal stripes on the second and third pereopods. See Provenzano (1959) for additional detail.

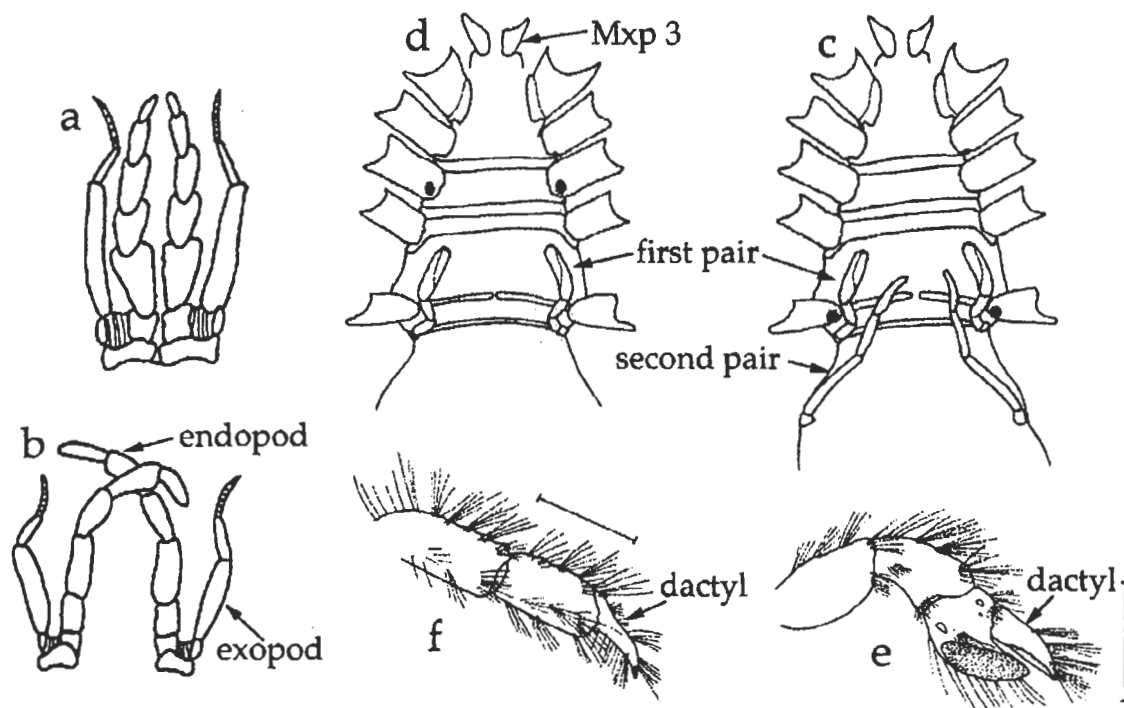


Figure 3. a) Third maxillipeds of Diogenidae, b) third maxillipeds of Paguridae (a and b redrawn from Provenzano 1961), c) *Paguristes*, ventral surface of male, gonopores on coxa of fifth pereopods, d) *Paguristes*, ventral surface of female, Mxp 3 = coxa of third maxilliped, gonopores on coxa of third pereopod, e) *Clibanarius vittatus*, distal end of fourth pereopod, dactyl subterminal (scale = 2.5 mm), f) *Paguristes sericeus*, distal end of fourth pereopod, dactyl terminal (scale = 2.5 mm).

Isocheles wurdemanni Stimpson, 1862

Isocheles wurdemanni—Stimpson 1862:85.—Provenzano 1959:375, Figure 7.—Felder, 1973:32, Plate 3, Figure 21.—Abele and Kim 1986:29, 353d.

Material. Station 28: 1 June 1991 (3).

Known range. Texas, Louisiana, west coast of Florida and Venezuela (Provenzano 1959).

Remarks. Whereas this species was only collected in shallow offshore waters along the high energy beaches of Anna Maria Island, it is probably found in similar habitats along the entire west coast of Florida. This is consistent with observations made by Caine (1978) who studied activities of *I. wurdemanni* along the Gulf of Mexico beaches of St. George Island, Florida. In his study, the majority of specimens were collected within 3 m of the splash zone or on the beach side of sand bars, 20-50 m offshore. Peak abundances were reported in the fall and spring with densities reaching 286 m⁻² along the offshore sand bars.

Ovigerous females of *I. wurdemanni* were reported from St. George Island, Florida, in the months of May, June, September, October and November (Caine 1978). No ovigerous females were collected in the present study.

Coloration. Body color white, see Stimpson (1859), Wass (1955), and Provenzano (1959) for additional detail.

Petrochirus diogenes (Linnaeus, 1758)

Cancer diogenes—Linnaeus 1758:631.

Cancer bahamensis—Herbst 1796:30.

Petrochirus granulatus—Stimpson 1859:234.

Petrochirus bahamensis—Benedict 1901:140.—Hay and Shore 1918:410, Plate 30, Figure 6.—Schmitt 1935:206, Figure 66.—Provenzano 1959:378, Figure 8.—Provenzano 1961:153.

Petrochirus diogenes—Holthuis 1959:151.—Williams 1965:122, Figure 98.—Provenzano 1968:147, Figures. 1-12.—Felder 1973:30, Plate 3, Figure 14.—Williams 1984:198, Figure 138.—Abele and Kim 1986:31, 353e,f.

Material. Station 10: 28 May 1966* (1).—Station 14: 23 Jan. 1993 (1).—Station 23: 9 Feb. 1965* (1).—Station 26: 8 May 1983 (3), 24 Oct. 1992 (1).—Station 27: May 1978 (1), 30 Aug. 1980 (1).—Station 30: 2 Oct. 1993 (1).

Known range. Off Cape Lookout, North Carolina, through Gulf of Mexico and West Indies south to off Ilha de São Sebastiao, Brazil, 23°42.5' S, 45°14.5' W (Forest and de Saint Laurent, 1967).

Remarks. *Petrochirus diogenes* is rare in shallow waters of the Tampa Bay area. Most specimens were collected on sand near hard substrates at the mouth of Tampa Bay or in offshore waters. This species has been reported on mud, mud/shell and sand bottoms in

HERMIT CRABS OF TAMPA BAY, FLORIDA

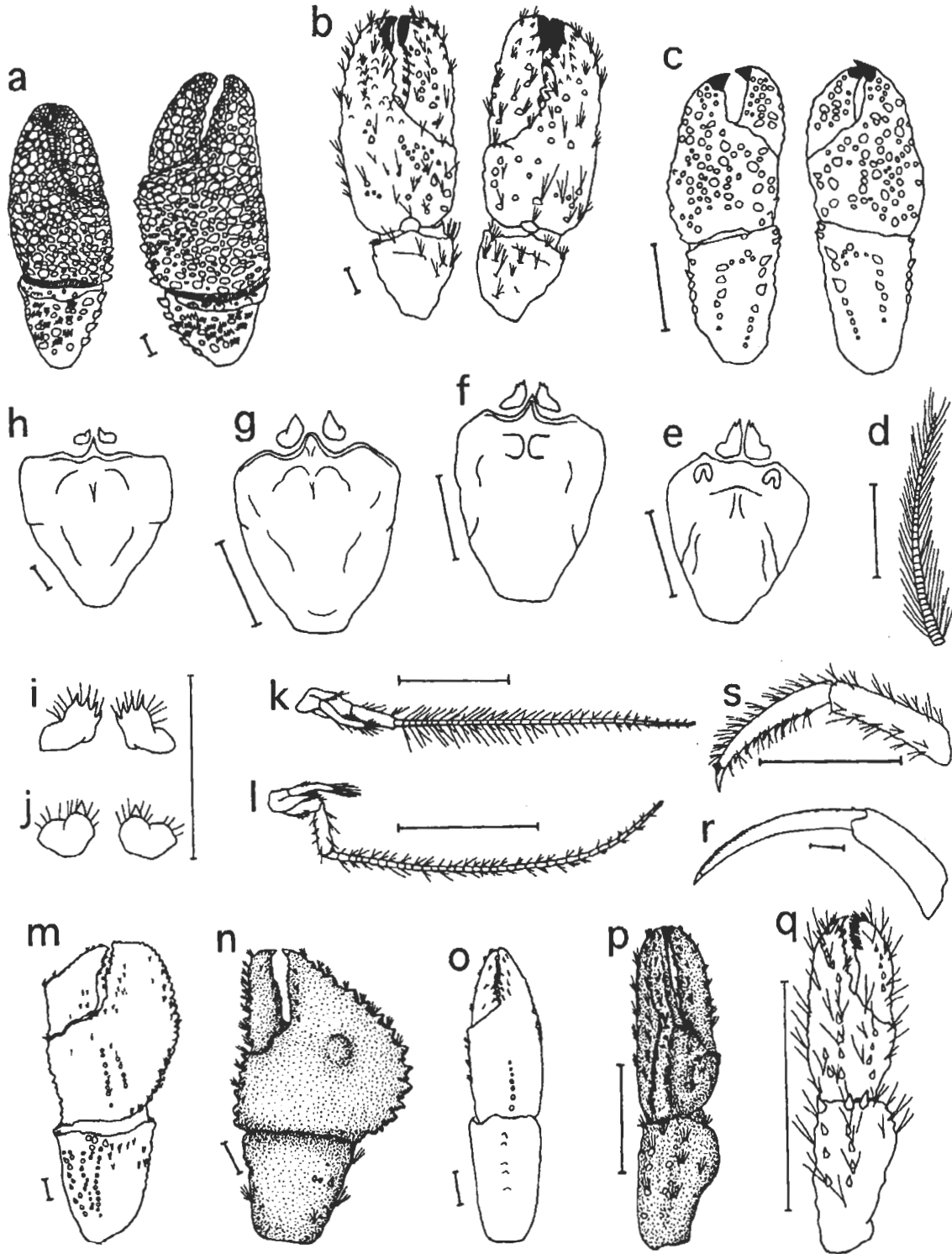


Figure 4. Hermit crabs of the Tampa Bay area. a) Chelipeds of *Petrochirus diogenes*, b) chelipeds of *Clibanarius vittatus*, c) chelipeds of *Isocheles wurdemanni*, d) antennal flagellum of *Isocheles wurdemanni*, e) cephalic shield and ocular acicles of *Paguristes hummi*, f) cephalic shield and ocular acicles of *Paguristes* sp., g) cephalic shield and ocular acicles of *Paguristes puncticeps*, h) cephalic shield and ocular acicles of *Paguristes sericeus*, i) ocular acicles of *Pagurus carolinensis*, j) ocular acicles of *Pagurus maclaughlinae*, k) antennal peduncle of *Pagurus gymnodactylus*, l) antennal peduncle of *Pagurus maclaughlinae*, m) right cheliped of *Pagurus pollicaris*, n) right cheliped of *Pagurus impressus*, o) right cheliped of *Pagurus longicarpus*, p) left cheliped of *Pagurus stimpsoni*, q) left cheliped of *Pagurus maclaughlinae*, r) dactyl and propodus of second pereopod of *Pagurus longicarpus*, s) dactyl and propodus of second pereopod of *Pagurus maclaughlinae*. Scales equal 2 mm for k and l and 1 mm for all other illustrations.

continental shelf waters on the Tortugas shrimping grounds (Provenzano 1959), off Mississippi (Franks et al. 1972), on brown shrimp grounds in the western Gulf of Mexico (Hildebrand 1954), and has been found as deep as 128 m (Wenner and Read 1982). It may be fairly common in deeper continental shelf waters off Tampa Bay.

Ovigerous females were reported in June from Texas, in August from west Florida (Provenzano 1968), and in March from the Virgin Islands (Provenzano 1961). No ovigerous females were found during this study.

Coloration. Body color generally reddish with color fading at joints. Antennal flagellum with red and white bands; cornea blue and black. See Provenzano (1959) for additional detail.

Paguristes hummi Wass, 1955

Paguristes hummi—Wass 1955:148, Figures 1-4.—Provenzano 1959:381, Figure 9.—Felder 1973:31, Plate 3, Figure 16.—Williams 1984:200, Figure 139.—Abele and Kim 1986:30, 343a.—Campos and Sánchez 1995:576, Figure 7.

Material. Station 13: 26 Sept. 1992 (1).—Station 14: 13 June 1993 (1).—Station 16: 12 Oct. 1983 (1).—Station 18: 2 Oct. 1993 (3).—Station 24: 3 Jan. 1966* (1).—Station 25: 31 May 1966* (1).—Station 27: 1 Sept. 1991 (1).—Station 28: 1 June 1991 (4), 1 Oct. 1991 (1).—Station 30: 2 Oct. 1993 (1), 29 April 1994 (4).—Station 31: 26 July 1995 (4,1o).

Known range. Newport River, North Carolina, to Sapelo Island, Georgia; Marco Island, southwestern Florida, to off Isles Dernieres, Louisiana (Williams 1984); Caribbean coast of Colombia (Campos and Sánchez 1995).

Remarks. *Paguristes hummi* was found both offshore and in lower Tampa Bay, usually associated with hard substrates. Wass (1955) reported *P. hummi* inhabiting a variety of gastropod shells in the intertidal zone only on the south side of Mullet Key at the mouth of Tampa Bay where it was abundant at times. This species was found in shelly areas of Beaufort, North Carolina, but was more abundant offshore on rocky outcrops (Kellogg 1971). In the Alligator Harbor-Dog Island area of northwest Florida, *P. hummi* has been found to inhabit sponges (Wass 1955, Wells 1969, Sandford 1995), which have been identified as the hermit crab sponge *Spongosorites suberitoides* (Sandford and Kelley-Borges 1997). All specimens collected in the present study were found in gastropod shells.

Ovigerous females of *P. hummi* were reported from northwestern Florida in January and July (Cooley 1978), and from southwestern Florida in February (Provenzano 1959), October, and November (Rouse 1970). The only ovigerous female collected in this study was taken in July.

Coloration. Body color generally white. Striking blue color mark, ringed by black and yellow, present on the

inner surface of the merus of both chelipeds. See Wass (1955) and Provenzano (1959) for additional detail.

Paguristes puncticeps Benedict, 1901

Paguristes puncticeps—Benedict 1901:144, Plate 4, Figure 4, Plate 5, Figure 2.—Provenzano 1959:384, Figure 10a.—Abele and Kim 1986:30, 347e.—Campos and Sánchez 1995:572, Figure 2.

Material. Station 25: 31 Dec. 1966* (1).—Station 26: 8 May 1983 (1), 4 Oct. 1992 (1), 19 April 1997 (1, 1o).—Station 27: 1 May 1978 (1), Oct. 1981 (1), 1 Sept. 1991 (2).—Station 30: 2 Oct. 1993 (4).

Known range. Northwestern Florida; south Florida to Jamaica, probably throughout the West Indies (Provenzano 1959); Caribbean coast of Columbia (Campos and Sánchez 1995); off Tampa Bay, Florida (present study).

Remarks. This report of *P. puncticeps* is the first from a locality that occurs between northwestern Florida and Miami and is indicative of a probable continuous distribution of the species along the west coast of Florida and throughout the Caribbean Sea. This species was only found offshore of Tampa Bay in association with hard substrates in depths of 10-15 m. *Paguristes puncticeps* has been collected as deep as 19 m from the Tortugas shrimp grounds (Provenzano 1959). One ovigerous female was collected in April during the present study, and one was reported from Cuba in January (Provenzano 1959).

Paguristes sericeus and *P. puncticeps* are morphologically similar species and were collected together in continental shelf waters off Tampa Bay. Some confusion exists in the literature concerning the length of the antennal peduncles in relation to the antennal acicles for these 2 species. All illustrations except Figures 93a and 142a of Williams (1965, 1984), respectively, show the relationship of these characters to be similar in both species: the antennal peduncle is slightly longer than the antennal acicle (Milne Edwards and Bouvier 1893, Benedict 1901, Provenzano 1959). The relationship of these characters is not mentioned in descriptions of either species (Milne Edwards 1880, Milne Edwards and Bouvier 1893, Benedict 1901, Provenzano 1959), with the exception of Williams (1965, 1984) who states correctly, "Antennal peduncles slightly exceeding acicles." However, an error exists in Figure 93a (Williams 1965, reproduced as Figure 142a in Williams 1984). In these figures the antennal peduncle of *P. sericeus* is shown to be considerably shorter than the antennal acicle. Abele and Kim (1986) used this inaccurate illustration along with a probable misinterpretation of the word "acicle" in the passage above as a basis for separating *P. sericeus* and *P.*

puncticeps. They appear to have interpreted Williams' use of "acicle" to mean ocular acicle, whereas he was instead referring to the antennal acicle in that section. Using this interpretation and Williams' illustration, *P. puncticeps* appears to have a much longer antennal peduncle in relation to the ocular acicle than does *P. sericeus*. However, since the relationships among the lengths of the antennal peduncle, antennal acicle and ocular acicle are similar for both species, these characters cannot be used to distinguish them.

As indicated in couplet 7 of the key and Figures 4g,h of the present study, the shape of the antero-lateral margins of the cephalic shield appears to be the most reliable character which separates *P. sericeus* from *P. puncticeps*. Provenzano (1959) discussed the contrast between the sloping angles of the shield in *P. puncticeps*, and the near right angles found in *P. sericeus* (= *P. rectifrons* sensu Provenzano). The presence of white spots on the ocular peduncles of fresh *P. puncticeps* is also mentioned by Provenzano as a differentiating characteristic. However, this color pattern is not always present in live material and should be used with caution.

Coloration. Body color red with white spots. At times, juveniles bright red and adults rust red. Ocular peduncles reddish orange, usually with white spots; cornea bright blue. Antennular and antennal flagella reddish. Proximal and distal ends of each segment lighter in color than middle on all walking legs; setae fringing dorsal and ventral areas occasionally green from accumulation of algae. See Provenzano (1959) for additional coloration notes.

Paguristes sericeus Milne Edwards, 1880

Paguristes sericeus—Milne Edwards 1880:44.—Milne Edwards and Bouvier 1893:46, Plate 3, Figures 14-22.—Provenzano 1961:155.—Williams 1965:117, Figure 93.—Provenzano and Rice 1966: 54, Figures 1-10.—Felder 1973:32, Plate 3, Figure 19.—Pequegnat and Ray 1974:242, Figure 44.—Williams 1984:203, Figure 142.—Abele and Kim 1986:30, 347c,d.

Paguristes tenuirostris—Benedict 1901:143, Plate 4, Figure 1.

Paguristes rectifrons—Benedict 1901:145, Plate 4, Figure 7.

Material. Station 26: 8 May 1983 (3), 30 Apr. 1995 (2).—Station 27: 1 Sept. 1991 (1).

Known range. Off Cape Lookout, North Carolina; West Flower Garden Bank, northwest Gulf of Mexico to the Virgin Islands (Williams 1984).

Remarks. This species was collected only offshore of Tampa Bay on sand near limestone outcroppings at a depth of 15 m. *Paguristes sericeus* has been found on sand and coral rubble (Provenzano 1961) at depths of 9 to 145 m (Williams 1984).

Ovigerous females were reported from off St. Petersburg Beach, Florida, in July (Provenzano 1959), on the Dry Tortugas shrimping grounds in March and May (Provenzano 1959, Rice and Provenzano 1965), and in the Virgin Islands in March and April (Provenzano 1961). No ovigerous females were collected during the present study.

For taxonomic considerations see remarks under *P. puncticeps*.

Coloration. Similar to *P. puncticeps*, except overall color generally more orange-red, and eyestalks without white spotting. See Provenzano (1959, 1961), Provenzano and Rice (1966), and Williams (1984) for additional coloration notes.

Paguristes sp.

Material. Station 13: 2 Mar. 1991 (1), 26 Sept. 1992 (6).—Station 14: Apr. 1979 (1), 18 June 1992 (1, 3o), 3 Aug. 1993 (1).—Station 26: 24 Oct. 1992 (3), 19 Apr. 1997 (1).—Station 27: 1 Sept. 1991 (7).—Station 29: 12 Oct. 1991 (2).—Station 30: 2 Oct. 1993 (3).—Station 31: 26 July 1995 (3, 1o).—Station 33: 29 Sept. 1996 (3, 1o).

Remarks. These specimens appear to be of an undescribed species most similar to *Paguristes tortugae* Schmitt, 1933. The most obvious differences occur in the color patterns. *Paguristes tortugae* has reddish-purple, transverse bands on the pereopods whereas our specimens are unbanded with a brownish-green body color (see coloration section). Future work with these species should yield additional characters for their distinction.

Paguristes sp. is relatively common in lower Tampa Bay, especially near Bishop Harbor (station 13) where it was often found in large groups on or near basket sponges. It was rarely taken offshore, but was found near hard substrates in all collections. Ovigerous females were found in the summer and fall.

Coloration. Cephalic shield green or brownish-green with yellowish-orange and white spots; posterior part of thorax pinkish with irregular red spots and occasionally blue patches laterally; area postero-medial to cephalic shield yellowish-orange with green and white patches; posterior border of carapace red. Proximal one-fourth of ocular peduncles brown or greenish-brown, distal part white, circumscribed with one proximal orangish-yellow and one distal dark brown band; cornea black. Proximal

half of ocular acicles brown, distal half white. Antennular peduncles marked with 3 brown or brownish-green and white bands; flagella brown. Antennal peduncles brown with white spines, distal segments circumscribed with 2 brown and 2 white bands; flagella colorless, every other article white distally, middle part of each article solid brown or with brown streaks laterally. Third maxillipeds with brown and white bands. Chelipeds with dactyls and fixed fingers yellowish, proximal part of propodi and remaining segments greenish-brown; proximal one-half of dactyls and three-fourths of propodi with reddish, white-tipped tubercles or spines; spines on dorsomesial margins of propodi and carpus reddish proximally, followed by yellow rings and brown tips; merus with yellowish reticulations and white dots mesially and laterally, and reddish-orange patches along dorsal margin. Pereopods generally greenish-brown with white or bluish-white spots and reticulations; dactyls with brown spines, other articles with reddish, white-tipped spines; carpi with dorsal one-half reddish proximally. Abdomen yellowish with red patches and white spots; transverse blue streaks laterally.

Family Paguridae Latreille, 1803

***Pagurus carolinensis* McLaughlin, 1975**

Pagurus near *bonairensis*—Pearse and Williams 1951:143.

Pagurus brevidactylus—Provenzano 1959:413, Figure 20.—Williams 1965:132, Figure 107.

Pagurus carolinensis—McLaughlin 1975:365, Figures 4-6.—Lemaitre et al. 1982:677.—Williams 1984:212, Figure 150.—Abele and Kim 1986:33, 375f,g.

Material. Station 26: 24 Oct. 1992 (1), 4 Mar. 1997 (1).—Station 27: Oct. 1991 (1).—Station 30: 2 Oct. 1993 (3).—31: 26 July 1995 (2).

Known range. Off Newport River (Kellogg 1971) and Cape Lookout, North Carolina, to southeastern Florida (Williams 1984); off Tampa Bay, Florida (present study).

Remarks. This is the first record of *P. carolinensis* in the Gulf of Mexico. Only 6 specimens were collected offshore in association with hard substrates at depths of 5-15 m. This species has been reported to prefer hard bottom in areas of good water circulation (Provenzano 1959) at depths of 2 to 53 m (Lemaitre et al. 1982).

Ovigerous females were reported in June, July, and August from North Carolina, November, July-October in Georgia and March-August in Florida (Williams 1984). No ovigerous females were collected in the present study.

Pagurus carolinensis, reported from the Gulf of Mexico for the first time in the present study, is morphologically very similar to *P. brevidactylus*. Although

this latter species was not found in the Tampa Bay area, it occurs in northwest Florida. Future studies may document an overlap in the ranges of these 2 species in the Gulf of Mexico similar to their overlap in southeast Florida (Lemaitre et al. 1982). The spination of the left chelae may be used to separate these 2 species. *Pagurus brevidactylus* (Stimpson, 1859) has a longitudinal row of strong or moderately strong spines near the dorsolateral margin of the propodus, while *P. carolinensis* may have small or no spines in this area. In addition, *P. brevidactylus* has shorter setae on the articles of the antennal flagella and longer, more slender ocular peduncles than *P. carolinensis*. Coloration may be used to separate live specimens of these species. *Pagurus brevidactylus* has dark green to brownish black continuous stripes on the pereopods, and striped chelipeds. *Pagurus carolinensis* has rust red to maroon stripes on the pereopods that do not extend to the distal and proximal margins of each segment, and the chelipeds are not striped (Lemaitre et al. 1982).

Coloration. See remarks above. Additional coloration notes are found in Provenzano [1959 (= *P. brevidactylus*)].

***Pagurus gymnodactylus* Lemaitre, 1982**

Pagurus annulipes—Felder 1973:26, Plate 3, Figure 4 [not *P. annulipes* (Stimpson)].—Williams 1974: 41.

Pagurus gymnodactylus—Lemaitre 1982:657, Figures 1, 2, 4c, d, 5a, b.—Lemaitre et al. 1982: 687.—Abele and Kim 1986: 33, 377h, i, j.

Material. Station 14: 3 Aug. 1993 (4).—Station 18: 2 Oct. 1993 (8, 1o).—Station 32: 26 July 1995 (1).

Known range. Gulf of Mexico from Mexico to west coast of Florida (Lemaitre et al. 1982).

Remarks. *Pagurus gymnodactylus* was collected on sand and hard substrates in shallow subtidal depths at the mouth of Tampa Bay. This species has been found from the subtidal zone to 19 m (Lemaitre et al. 1982).

No information is available on the reproduction of this species. However, in the present study, one ovigerous female was found in October.

Coloration. While some specimens appeared to be almost completely white, those with color displayed the following characteristics: carapace mottled yellow-brown, occasionally with green and red splotches, red flecks laterally. Abdomen transparent blue. Ocular acicles, eyestalks, and antennular flagella transparent with red and white flecks; eyestalks sometimes with central, horizontal, blue-green band. Antennal flagella transparent, marked with white every 2-5 articles; peduncle transparent with red and white flecks. First and second maxillipeds

mottled red and white at bases. Third maxillipeds with blue to red transverse bands. Merus, carpus and propodus of right cheliped mottled brown, distal part of propodus and dactyl white. Dactyls, propodi, carpi, and meri of second and third pereopods with mottled brown transverse bands.

***Pagurus impressus* (Benedict, 1892)**

Eupagurus impressus—Benedict 1892:5.

Pagurus impressus—Provenzano 1959:399, Figure 15.—Williams 1965:129, Figure 104.—Felder 1973:27, Plate 3, Figure 9.—Williams 1984:215, Figure 153.—Abele and Kim 1986:33, 377a,b,c.

Material. Station 13: 26 Sept 1992 (4).—Station 14: Apr. 1982 (3), May 1983 (1), 23 Jan. 1993 (25+), 3 Aug. 1993 (25+), 11 Sept. 1993 (2).—Station 15: May 1983 (2).—Station 16: 12 Oct. 1983 (1).—Station 19: 19 Feb. 1982 (2), 25 June 1993 (1).—Station 28: 1 Oct. 1990 (2).—Station 29: 12 Oct. 1991 (25+).—Station 30: 2 Oct. 1993 (6), 29 April 1994 (2).—Station 31: 26 July 1995 (9).

Known range. North Carolina to Cape Canaveral, Florida; Florida Bay north to Pensacola, Florida; Port Aransas, Texas (Williams 1984); Padre Island, Texas (Felder 1973).

Remarks. This species is very common at the mouth of Tampa Bay and in shallow offshore waters. It was often found in congregations on sand near hard substrates. *Pagurus impressus* has been reported to inhabit areas of sand, seagrass beds or pilings, and has been found in hermit crab sponges (Wass 1955, Wells 1969, Sandford 1995). In the Dog Island area, *P. impressus* has been shown to move into the intertidal zone close to the shoreline in January, with many individuals inhabiting the hermit crab sponge *S. suberitoides* (Sandford and Kelley-Borges 1997).

Ovigerous females were collected from the Carolinas and Georgia in January and February, and in Florida in February and April (Williams 1984). In the present study, ovigerous females were collected in January only.

Coloration. Eyestalks dark brown with white specks on dorsal surface, red at base, and longitudinal blue stripe on ventral surface. Cornea black with translucent yellow covering. Antennal and antennular flagella yellow, sometimes red at base. Cephalic shield mottled yellow and brown. Thorax generally reddish-brown with white spots; laterally, darker red with white spots. Third maxillipeds brown with white spots, white at joints. First and second maxillipeds reddish with white spots. Propodi and dactyls of chelipeds almost solid brownish-orange to rust-red on dorsal surface, sometimes with small white spots, ventral surface darker brown with white spots; carpi and meri mottled dark brown with white transverse bands. Dactyls of second and third pereopods mottled brownish orange,

with thin longitudinal stripe on lateral and mesial faces; propodi, carpus and meri mottled brown, with white transverse bands near joints. Joint between carpus and merus of all walking legs reddish in color. See Provenzano (1959) for additional coloration notes.

***Pagurus longicarpus* Say, 1817**

Pagurus longicarpus—Say 1817:163.—Hay and Shore 1918:411.—Provenzano 1959:394, Figure 13.—Williams 1965:125, Figure 101.—Felder 1973:27, Plate 3, Figure 7.—Williams 1984:216, Figure 154.—Abele and Kim 1986:33, 381c,d,e.

Material. Station 1: May 1986 (18), 5 Feb. 1991 (24), 13 Jan., 1992 (2), 23 June 1992 (10), 1 Sept. 1992 (12), 21 Jan. 1993 (5), 29 Nov. 1993 (6).—Station 2: 5 May 1977 (7).—Station 3: 1 Feb. 1992 (4), 5 May 1992 (5), 18 June 1992 (10), 19 Sept. 1992 (6), 13 Jan. 1993, 11 May 1993 (6, 10).—Station 4: 11 Nov. 1991 (2), 4 Jan. 1993 (4).—Station 5: 26 Sept. 1976 (1), 28 Sept. 1976 (2), Sept. 1991 (3), 16 Jan. 1993 (3), 11 May 1993 (9).—Station 6: 8 June 1978 (12).—Station 9: 18 Sept. 1992 (2), 6 Jan. 1993 (1), May 1993 (3).—Station 12: 7 May 1983 (1).—Station 14: Oct. 1979 (6), 3 Aug. 1993 (6), 11 Sept. 1993 (4).—Station 17: 31 Dec. 1964* (1).—Station 18: 11 Dec. 1965* (8).—Station 19: 2 Nov. 1991 (7).—Station 20: 8 Jan. 1965* (4).—Station 21: 9 Feb. 1965* (1).—Station 22: 25 June 1993.

Known range. Minas Basin and Chignecto Bay, Nova Scotia (Bousfield and Liem 1960) to Hutchinson Island, Florida (Camp et al. 1977); southwestern Florida to the coast of Texas (Whitten et al. 1950, Provenzano 1959, Rouse 1970).

Remarks. *Pagurus longicarpus* is commonly found on sand, sand/mud, grass, and hard substrate habitats throughout the intertidal and shallow subtidal waters of the entire Tampa Bay area. This species has been reported from harbor beaches and channels on a variety of substrates (Williams 1984), from the intertidal to 200 m (Wenner and Boesch 1979). Its ubiquity in bays and estuaries prevents its use in distinguishing shallow water habitats (Allee 1923).

Ovigerous females of *P. longicarpus* were collected from April-September in Massachusetts (Carlson and Ebersole 1995), February-September in North Carolina, March-July in Georgia (Williams 1984), September-April in Florida (Wass 1955, Dragovich and Kelley 1964, Lyons et al. 1971), and winter in Texas (Fotheringham 1975). In the present study, ovigerous females were collected in May.

Coloration. Abdomen and thorax brown, sometimes with white spots on cephalic shield. Ocular acicles white, eyestalks white with brown near black corneas. Antennular

peduncles brown and white; flagella white. Antennal peduncles and acicles brown; flagella brown with white article every 2-4 articles. Maxillipeds brown proximally. Right cheliped white or off-white, with 3 longitudinal brown, rust or yellowish-brown stripes; stripes joined at merus, then separated distally on mesial, dorsal, and lateral margins. Second and third pereopods with longitudinal stripe on lateral and mesial faces. See Provenzano (1959) for additional coloration notes.

***Pagurus maclaughlinae* García-Gómez, 1982**

?*Eupagurus annulipes*—Ives 1891:193. [not *E. annulipes* Stimpson].

Pagurus annulipes—Schmitt 1935:205 (in part).—Provenzano 1959:407, Figure 18 [not *P. annulipes* (Stimpson)].—Williams 1965:130 (in part), Figure 105.—Forest and de Saint Laurent 1967:127 (in part).

Pagurus bonairensis—Felder 1973:26 (in part), Plate 3, Figure 5. [not *P. bonairensis* Schmitt].

Pagurus maclaughlinae—García-Gómez 1982:647, Figures 1, 2.—Lemaitre et al. 1982:691.—Abele and Kim 1986:33, 377d,e,f.

Material. Station 1: 13 Jan. 1992 (1), 21 Jan. 1993 (25+).—Station 3: 28 Jan. 1992 (25+o), 1 Feb. 1992 (1), 28 Feb. 1992 (25+), 5 May 1992 (25+), 18 June 1992 (1), 13 Jan. 1993 (25+), 11 May 1993 (25+).—Station 5: 18 Sept. 1992 (25+), 16 Jan. 1993 (25+o), 11 May 1993 (25+).—Station 9: 6 Jan. 1993 (3).—Station 11: 2 Oct. 1992 (25+o), 16 Jan. 1993 (25+o), 12 May 1993 (25+o), 17 July 1993 (25+o).—Station 13: 26 Sept. 1992 (5).—Station 14: 23 Jan. 1993 (25+), 3 Aug. 1993 (25+o), 11 Sept. 1993 (25+).—Station 15: 1 June 1991 (5).—Station 20: 25 June 1993 (15).—Station 28: 1 June 1991 (3).—Station 34: 15 Apr. 1995 (4, 1o).—Station 35: 28 Apr. 1996 (3, 1o).

Known range. Wassaw Sound, Georgia, to Puerto Rico; northern Gulf of Mexico to Florida Keys (García-Gómez 1982, Lemaitre et al. 1982)

Remarks. *Pagurus maclaughlinae* is one of the most common species found in the shallow subtidal waters of Tampa Bay. Although this species is typically found in seagrass beds, specimens have also been collected on hard substrates and high energy beaches. At Station 14, individuals were found clinging to the gorgonian *Leptogorgia virgulata*. *Pagurus maclaughlinae* has been reported at depths of 1-5 m (Lemaitre et al. 1982).

Ovigerous females were collected each month of the year in Indian River Lagoon, on the Atlantic Coast of Florida, with peaks (> 50%) occurring in August-October and February-June (Tunberg et al. 1994). In Tampa Bay, *P. maclaughlinae* appears to reproduce throughout the

year since ovigerous females were found during each season.

Coloration. Antennal flagellum with blue and white transverse bands. Pereopods with brown and white transverse bands. Chelipeds light brown with white tubercles, distal ends of dactyl and fixed finger white. See García-Gómez (1982) for additional detail.

***Pagurus pollicaris* Say, 1817**

Pagurus pollicaris—Say 1817:162.—Hay and Shore 1918:411, Plate 30, Figure 1.—Provenzano 1959:401, Figure 16.—Williams 1965:128, Figure 103.—Felder 1973:27, Plate 3, Figure 8.—Williams 1984:220, Figure 157.—Abele and Kim 1986:33, 375h,i.

Material. Station 1: 13 Jan. 1992 (1), 1 Sept. 1992 (2).—Station 3: 11 May 1993 (1).—Station 4: 3 July 1992 (3), 4 Jan. 1993 (4).—Station 5: 26 Sept. 1976 (1), 28 Sept. 1976 (1), Sept. 1991 (1), 11 May 1993 (1).—Station 7: 10 Dec. 1982 (1).—Station 8: 4 Jan. 1974 (1).—Station 9: 18 Sept. 1992 (3), 6 Jan. 1993 (1), 11 May 1993 (2).—Station 12: 7 May 1983 (1).—Station 13: 7 May 1983 (1), Apr. 1991 (1), 26 Sept. 1992 (2).—Station 14: 14 Apr. 1970 (1), April 1979 (4), Oct. 1979 (1), 3 Aug. 1993 (3), 11 Sept. 1993 (3).—Station 15: Apr. 1979 (3).—Station 19: 1 Feb. 1992 (3).—Station 30: Oct. 1993 (2).—Station 33: 29 Sept. 1996 (1).—Station 34: 15 Apr. 1995 (2).—Station 35: 28 Apr. 1996 (2).

Known range. Grand Manan, New Brunswick, to northeastern Florida; Key West, Florida, to Texas (Provenzano 1959, Williams 1984).

Remarks. *Pagurus pollicaris* was collected throughout Tampa Bay, was usually found alone on sand in the shallow subtidal zone, and was occasionally near hard substrates. This species is known to inhabit shallow estuaries, deep harbor channels, and littoral waters (Williams 1984), although it has been collected to a depth of 112 m (Wenner and Boesch 1979).

Ovigerous females were collected from early spring to June in Massachusetts (Nyblade 1970, Carlon and Ebersole 1995), January and February in North Carolina, and in the winter in Texas (Fotheringham 1975). Ovigerous females were taken from northwestern Florida in February (Cooley 1978), near Crystal River in December (Lyons et al. 1971), in Tampa Bay in November and December (Dragovich and Kelley 1964), and in southwestern Florida in March (Provenzano 1959). No ovigerous females were collected during this study.

Coloration. Eystalks white with dark brown surrounding cornea on dorsal part, light yellow near cornea; cornea light blue-grey with black ring. Antennular peduncles tan to green; flagella mostly drab green with

red and white bands. Antennal peduncles with thin, reddish, longitudinal stripe; flagella with 2-4 tan or green articles to every white article. Right chela white to light brown from merus to area of propodus at insertion of dactyl; dark brown L-shaped patch beginning at proximal end of propodus and ending at insertion of dactyl; adjacent mesial margins of dactyl and propodus darker brown. Left chela with similar coloring, L-shaped patch less defined. Second and third pereopods light brown, darker on dorsal and lateral surfaces. See Provenzano (1959) for additional coloration notes.

***Pagurus stimpsoni* (Milne Edwards and Bouvier, 1893)**

Eupagurus stimpsoni—Milne Edwards and Bouvier 1893:144, Plate 10, Figures 13-18.—Alcock 1905:182.

Pagurus annulipes—Schmitt 1935:206 (in part). [not *P. annulipes* (Stimpson)].

Pagurus bonairensis—Schmitt 1936:376.—Felder 1973:26 (in part), [not Plate 3, Figure 5].

Pagurus hendersoni—Wass 1963:144, Figure 5.

Pagurus stimpsoni—Lemaitre et al. 1982:687, Figure 2.

Material. Station 14: 18 June 1992 (2o), 23 Jan. 1993 (1).—Station 18: 2 Oct. 1993 (3).—Station 30: 2 Oct. 1993 (1).—Station 32: 28 Oct. 1996 (1o).—Station 33: 29 Sept. 1996 (1o).

Known range. North Carolina to Florida; Gulf of Mexico; Caribbean coast of South America (Lemaitre et al. 1982).

Remarks. Only 9 specimens of *P. stimpsoni* were collected at the mouth of Tampa Bay or in offshore waters. Specimens were found on hard substrates with *P. maclaughlinae* at Station 14, and *P. carolinensis* at Station 30. This species may have an unusually wide depth range. While most reports are from the shallow subtidal to depths of 30 m (Lemaitre et al. 1982), Wass (1963) reported it in the Straits of Florida at depths of 228 m and 347-512 m.

Ovigerous females of *P. stimpsoni* were collected during the present study in June, September and October. Wass (1963) reported a gravid female from the Straits of Florida in August.

Coloration. Antennal flagellum with brown and white transverse bands. Pereopods with white and brown transverse bands. Chelipeds mottled brown and white; distal ends of dactyl and fixed finger white.

DISCUSSION

Distribution within the Tampa Bay Area

Pagurus maclaughlinae, *P. longicarpus* and *P. pollicaris* were distributed throughout the shallow waters of Tampa Bay and were often collected together. They were the only species taken in the upper part of the bay, including Old Tampa Bay and Hillsborough Bay (for subdivisions of Tampa Bay see Lewis and Whitman, Jr. 1985); however, no subtidal hard substrates were examined in these areas. Savercool and Lewis (1994) documented several hard-bottom communities in Old Tampa Bay and collections on these limestone outcroppings and oyster reefs may reveal additional hermit crab species. *Pagurus maclaughlinae* was found in a variety of subtidal habitats, but was the dominant species collected in seagrass beds. *Pagurus longicarpus* and *P. pollicaris* were most commonly taken in intertidal or shallow, subtidal waters on sand and sand/mud substrates. Because no seasonal quantitative sampling was conducted in subtidal areas, it was impossible to determine whether these 2 species underwent seasonal migrations. Along the Texas coast, both species are subtidal, but migrate to the upper subtidal zone briefly during the winter, presumably to breed (Fotheringham 1975).

Clibanarius vittatus, *Pagurus gymnodactylus* and *P. stimpsoni* inhabited shallow waters of the bay entrance near hard substrates, sand and seagrass beds. Four species, *Paguristes hummi*, *Paguristes* sp., *Petrochirus diogenes* and *Pagurus impressus* were collected from lower bay waters to offshore of Tampa Bay, mainly on hard substrate and sand habitats. *Paguristes puncticeps*, *P. sericeus* and *Pagurus carolinensis* were taken only offshore on hard substrates in depths of 5-15 m. Although several species were collected occasionally on high energy beaches, *Isocheles wurdemanni* appears to be the only species restricted to this habitat.

Hermit crab species richness was greatest on the hard substrate habitats of the bay entrance and shallow offshore waters where 12 of the 14 species found in the study were taken. The number of species decreased to only 3 in the lower salinity waters of upper Tampa Bay and less drastically in the deeper offshore waters.

Zoogeography

Of the 15 species of hermit crabs reported previously from the shallow waters of the west coast of Florida (Table 1), 13 were found in the Tampa Bay area during this study. Only *Iridopagurus caribbensis* (Milne Edwards and Bouvier, 1893), *Paguristes tortugae* and *Pagurus brevidactylus* were not represented in the survey.

Iridopagurus caribbensis appears to be a rare species ranging from off South Carolina to the Caribbean Sea in depths of 10 to 180 m (Williams 1984). There is only one report of this species from the west coast of Florida (Table 1). *Paguristes tortugae* has been found from the Carolinas through the Caribbean to northern Brazil (Williams 1984). In the Gulf of Mexico, this species has been documented only along the coast of southwest Florida (Table 1). *Pagurus brevidactylus* ranges from Bermuda and northeast Florida through the Caribbean to northern South America (Lemaitre et al. 1982). Its only documented occurrence in the Gulf of Mexico is from northwest Florida, but the distribution of this species may extend to the Texas coast (McLaughlin 1975). It is highly probable that the species diversity of the hermit crab fauna of the Tampa Bay area is greater than the 14 species reported in this study. Only additional sampling, especially on the continental shelf, will help to determine the extent of the faunal richness of this area.

Tampa Bay is considered by some authors (Hedgpeth 1953, Rehder 1954, Earle 1969, Humm 1969) to be the boundary between the warm-temperate Carolinian province and the tropical Antillean province for marine organisms along the Gulf coast of Florida. The hermit crab fauna of the Tampa Bay area reflects the transition between these 2 provinces. Thirty-nine per cent of the species have widespread distributions including the U.S. east coast, Gulf of Mexico and Caribbean Sea (*Clibanarius vittatus*, *Petrochirus diogenes*, *Paguristes sericeus*, *Pagurus maclaughlinae*, *P. stimpsoni*). Five (39%) species have a temperate distribution and have been found along the U.S. east coast and the Gulf of Mexico (*Paguristes hummi*, *Pagurus carolinensis*, *P. impressus*, *P. longicarpus*, *P. pollicaris*). A lesser tropical influence is indicated by the presence of only 2 species (15%), *Isocheles wurdemanni* and *Paguristes puncticeps*, with distributions in the Caribbean and Gulf of Mexico only. One species, *Pagurus gymnodactylus*, appears to be endemic to the Gulf of Mexico. Although the Tampa Bay fauna contains elements from both provinces, as expected, there is no evidence to support the assertion that this area serves as a biotic boundary for shallow-water hermit crabs. McCoy and Bell (1985) came to the same conclusion about Tampa Bay.

Symbionts

The porcellanid crab *Porcellana sayana* (Leach 1820) was associated with 4 hermit crab species collected in the Tampa Bay area. This species was found in shells with *Petrochirus diogenes* (Station 30), *Pagurus impressus* (Stations 30, 31), *Paguristes puncticeps* (Stations 26, 27) and *P. sericeus* (Stations 26, 27). While only one or 2 crabs

were typically found per hermit crab, 3 specimens of *Porcellana sayana* were collected with *Petrochirus diogenes*. *Porcellana sayana* appears to show little host specificity and has been reported with *Petrochirus diogenes* (Telford and Daxboek 1978, Williams 1984), *Pagurus pollicaris* (Williams 1984), *Paguristes grayi*, *Dardanus venosus*, the queen conch *Strombus gigas* (Telford and Daxboek 1978), and the decorator crab *Stenocionops furcata* (Hildebrand 1954). The large reported depth range of *Porcellana sayana*, shallow to 92 m (Gore 1974) and 713 m? (Schmitt 1935), has led to speculation that more than one species may be represented in these reports (personal communication D. L. Felder).

A male-female pair of bopyrid isopods tentatively identified as *Parathelges* sp. (personal communication R.W. Heard, Gulf Coast Research Laboratory, Ocean Springs, MS 39564) was found attached to the abdomen of a specimen of *Paguristes* sp. (Station 26).

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Appendix 1. Station data and occurrence of species.

1. Southwest side of Courtney Campbell Causeway; sand/mud; 18.5-26‰ salinity; <1.5 m; triangular dredge. Species present: *Pagurus longicarpus*, *P. maclaughlinae*, *P. pollicaris*.
2. Northwest side of Courtney Campbell Causeway; sand/mud, *Spartina* marsh; <1.5 m; dip net. Species present: *Pagurus longicarpus*.
3. Southeast side of Courtney Campbell Causeway; sand/seagrass beds; <1.5 m; dip net; Species present: *Pagurus longicarpus*, *P. maclaughlinae*, *P. pollicaris*.
4. Northwest side of Gandy Bridge; sand/mud, seagrass beds; 22‰ salinity; <1.5 m; dip net; Species present: *Pagurus longicarpus*, *P. pollicaris*.
5. Picnic Island; sand/seagrass beds; 22-32 °C; 22-27‰ salinity; <1.5 m; dip net; Species present: *Pagurus longicarpus*, *P. maclaughlinae*, *P. pollicaris*.
6. McKay Bay; mud/sand; dip net. Species present: *Pagurus longicarpus*.
7. Hooker Point; dip net. Species present: *Pagurus pollicaris*.
8. Spoil Island, Hillsborough Bay; dip net. Species present: *Pagurus pollicaris*.
9. Ballast Point, sand/seagrass bed; 21-33.5 °C; 20-26‰ salinity; <1 m; dip net, hand collection. Species present: *Pagurus longicarpus*, *P. maclaughlinae*, *P. pollicaris*.
10. Coffeepot Bayou; 1.5 m; hook and line. Species present: *Petrochirus diogenes*.
11. Cockroach Bay; mud, oyster reefs, seagrass beds; 20-29 °C; 18-30‰ salinity; <1.5 m; dip net. Species present: *Pagurus maclaughlinae*.
12. Piney Point; sand; <1.5 m. Species present: *Pagurus longicarpus*, *P. pollicaris*.
13. Bishop Harbor, limestone outcroppings, sponges, sand; 27-32‰ salinity; 3.5 m; hand collection, SCUBA. Species present: *Paguristes hummi*, *Paguristes* sp., *Pagurus impressus*, *P. maclaughlinae*, *P. pollicaris*.
14. Northeast Skyway Bridge jetty; sand, concrete blocks; 28-32‰ salinity; <3.5 m; hand collection, SCUBA. Species present: *Clibanarius vittatus*, *Petrochirus diogenes*, *Paguristes hummi*, *Paguristes* sp., *Pagurus gymnodactylus*, *P. impressus*, *P. longicarpus*, *P. maclaughlinae*, *P. pollicaris*, *P. stimpsoni*.
15. Blackthorn Memorial Park; seagrass beds; 32‰ salinity; <1.5 m; dip net. Species present: *Pagurus impressus*, *P. maclaughlinae*, *P. pollicaris*.

16. Boca Ciega Bay. Species present: *Paguristes hummi*, *Pagurus impressus*.
17. Near Shell Key off Pass-a-Grille Beach. Species present: *Pagurus longicarpus*.
18. West Tierra Verde south of Pass-a-Grille Channel; sand, seagrass beds; 0.6 m; hand and tater rake/scooper/dipnet. Species present: *Paguristes hummi*, *Pagurus gymnodactylus*, *P. longicarpus*, *P. stimpsoni*.
19. Fort Desoto Beach; sand; <3 m; hand collection, snorkeling. Species present: *Pagurus impressus*, *P. longicarpus*, *P. pollicaris*.
20. Mullet Key Bayou; mud, seagrass beds; <1.5 m; dip net. Species present: *Clibanarius vittatus*, *Pagurus longicarpus*, *P. maclaughlinae*.
21. Mullet Key bayside. Species present: *Pagurus longicarpus*.
22. Fort Desoto Pier; sand, algal mats; <0.5 m; hand collection. Species present: *Pagurus longicarpus*.
23. Egmont Key, bayside; seagrass beds; 1.2 m; frame trawl with rollers. Species present: *Clibanarius vittatus*, *Petrochirus diogenes*.
24. 4 miles west of Egmont Key; sand, crushed shell; 6 m; dredge. Species present: *Paguristes hummi*.
25. 8 miles west of Egmont Key; sponge, coral, shell; 13.5-15 m; trawl. Species present: *Paguristes hummi*, *P. puncticeps*.
26. Larry's Ledge; sand, limestone outcroppings, corals, sponges; 32‰ salinity; 15 m; hand collection, SCUBA. Species present: *Petrochirus diogenes*, *Paguristes puncticeps*, *P. sericeus*, *Paguristes* sp., *Pagurus carolinensis*.
27. Jack's Hole; sand, limestone outcroppings, corals, sponges; 15 m; hand collection, SCUBA. Species present: *Petrochirus diogenes*, *Paguristes hummi*, *P. puncticeps*, *P. sericeus*, *Paguristes* sp., *Pagurus carolinensis*.
28. North Anna Maria Island front beach; sand; 3-4 m. Species present: *Isocheles wurdemanni*, *Paguristes hummi*, *Pagurus impressus*, *P. maclaughlinae*.
29. Molasses Barge off Anna Maria Island; sand, barge remains; 7 m; hand collection, SCUBA. Species present: *Paguristes* sp., *Pagurus impressus*.
30. St. Petersburg Artificial Reef; concrete, boat remains, sand; 10 m; hand collection, SCUBA. Species present: *Petrochirus diogenes*, *Paguristes hummi*, *P. puncticeps*, *Paguristes* sp., *Pagurus carolinensis*, *P. impressus*, *P. pollicaris*, *P. stimpsoni*.
31. 1 Mile Artificial Reef off Anna Maria Island; sand, 35‰ salinity; concrete pilings; 5-9 m; hand collection, SCUBA. Species present: *Paguristes hummi*, *Paguristes* sp., *Pagurus carolinensis*, *P. impressus*.
32. Egmont Key, front beach; sand; 35‰ salinity; 1.5 m; hand collection. Species present: *Pagurus gymnodactylus*, *P. stimpsoni*.
33. Egmont Key, front beach; concrete, fort remains; 24°C; 34‰ salinity; 3 m; hand collection, SCUBA. Species present: *Pagurus pollicaris*.
34. Lower Tampa Bay, off Lewis Island; shell; 3-4 m; otter trawl. Species present: *Pagurus maclaughlinae*, *P. pollicaris*.
35. Lower Tampa Bay, off Point Pinellas, seagrass beds; 2 m; otter trawl. Species present: *Pagurus maclaughlinae*, *P. pollicaris*.