

Arthropoda: Decapoda

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The order Decapoda includes crayfish, lobsters, shrimp, and crabs. It is the largest order in the subphylum Crustacea, encompassing almost one-fourth of the known species of crustaceans. Like all crustaceans, decapods have a chitinous exoskeleton, a segmented body, two pairs of antennae, biramous appendages, and a unique naupliar larval stage. What distinguishes them from other crustaceans is five pairs of jointed thoracic appendages (legs), hence the name Decapoda.

In Pacific Northwest waters, there are approximately 87 species of shrimp-like (so-called "Natantia") decapods, of which the larvae of only 12 have been described (Table 1); most of these are in the genus *Pandalus*. There are approximately 83 non-shrimp-like decapods (the "Reptantia," including the crabs, hermit crabs, thalassinids, and other non-shrimp-like decapods), the larvae of 47 of which have been described (Table 1). Larval descriptions tend to be available for economically important groups, (e.g., the Pandalid shrimp and cancrid crabs) and some ecologically important intertidal groups (e.g., hermit crabs—Paguridae—and Grapsid and Xanthid crabs), but overall we have larval descriptions for only approximately a third of the decapod species.

Within the Decapoda, species display a vast diversity in habitat, feeding, and morphology. Adults can be found in the open ocean, on wave-swept sandy beaches, in the intertidal and subtidal of rocky shores, and in mudflats in estuaries and bays. They are carnivores, herbivores, scavengers, filter feeders, and detritivores. Morphologically they can be cylindrical, dorsoventrally or laterally flattened; they can be as small as half a centimeter, as in the case of commensal crabs, or have a carapace length of 45 cm and chelipeds that span 4 m, as in the case of the Japanese spider crab.

Reproduction and Development

The majority of decapods reproduce by copulating shortly after the female molts. Fertilization of the eggs is external for the majority of decapods but internal for brachyuran crabs. With the exception of the penaeids and sergestids, females attach the eggs to their pleopods, where they are brooded until

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Table 1. Species in the order Decapoda from the Pacific Northwest, with references to larval description

<i>Taxa</i>	<i>References</i>	<i>Reference Contents</i>
Order Decapoda	Gurney 1942 Hart 1971	larval development of decapods larval key to British Columbia decapod families
"Natantia"—Shrimp-like Decapods		
Suborder Dendrobranchiata		
Family Penaeidae		
<i>Bentheogennema borealis</i>		
<i>Bentheogennema burkenroadi</i>		
<i>Gennadas incertus</i>		
<i>Gennadas propinquus</i>		
<i>Gennadas tinayrei</i>		
<i>Hemipenaeus spinidorsalis</i>		
Family Sergestidae		
<i>Eusergestes similis</i>		
<i>Petalidium subspinosum</i>		
<i>Sergia tenuiremis</i>		
Suborder Pleocyemata		
Infraorder Caridea		
	Strathmann 1987	reproduction and development of Caridea
Family Alpheidae		
<i>Betaeus harrimani</i>		
<i>Betaeus setosus</i>		
Family Crangonidae		
<i>Argis alaskensis</i>		
<i>Argis levior</i>		
<i>Crangon alaskensis</i>		
<i>Crangon alba</i>		
	Israel 1936	all larval stages
<i>Crangon franciscorum</i>		
<i>Crangon handi</i>		
<i>Crangon nigricauda</i>		
<i>Crangon stylirostris</i>		
<i>Lissocrangon stylirostris</i>		
<i>Mesocrangon munitella</i>		
<i>Metacrangon acclivis</i>		
<i>Metacrangon munita</i>		
<i>Metacrangon spinosissima</i>		
<i>Metacrangon variabilis</i>		
<i>Neocrangon abyssorum</i>		
<i>Neocrangon communis</i>		
<i>Neocrangon resima</i>		
	Kurata 1964	all larval stages
<i>Paracrangon echinata</i>		
<i>Rhynocrangon alata</i>		
Family Hippolytidae		
	Pike and Williamson 1960	larvae of <i>Spirontocaris</i> and related genera
<i>Eualus avinus</i>		
<i>Eualus barbatus</i>		
<i>Eualus berkeleyorum</i>		
<i>Eualus biunguis</i>		
<i>Eualus fabricii</i>		
<i>Eualus lineatus</i>		
<i>Eualus macrophthalmus</i>		

<i>Taxa</i>	<i>References</i>	<i>Reference Contents</i>
<i>Eualus suckleyi</i>	Haynes 1981b	first two zoeal stages, with illustrations
<i>Heptacarpus brevirostris</i>		
<i>Heptacarpus camtschaticus</i>		
<i>Heptacarpus carinatus</i>		
<i>Heptacarpus decorus</i>		
<i>Heptacarpus flexus</i>		
<i>Heptacarpus herdmani</i>		
<i>Heptacarpus kincaidi</i>		
<i>Heptacarpus littoralis</i>		
<i>Heptacarpus moseri</i>		
<i>Heptacarpus paludicola</i>		
<i>Heptacarpus pictus</i>		
<i>Heptacarpus pugettensis</i>		
<i>Heptacarpus sitchensis</i>		
<i>Heptacarpus stimpsoni</i>		
<i>Heptacarpus taylori</i>		
<i>Heptacarpus tenuissimus</i>		
<i>Hippolyte clarki</i>		
<i>Lebbeus groenlandicus</i>	Haynes 1978a	all larval stages, with illustrations
<i>Lebbeus schrencki</i>		
<i>Lebbeus washingtonianus</i>		
<i>Spirontocaris arcuata</i>		
<i>Spirontocaris holmesi</i>		
<i>Spirontocaris lamellicornis</i>		
<i>Spirontocaris prionota</i>		
<i>Spirontocaris sica</i>		
<i>Spirontocaris spina</i>		
<i>Spirontocaris synderi</i>		
<i>Spirontocaris truncata</i>		
Family Oplophoridae		
<i>Acanthinephyra curtirostris</i>		
<i>Hymenodora acanthitelsonis</i>		
<i>Hymenodora frontalis</i>		
<i>Hymenodora glacialis</i>		
<i>Hymenodora gracilis</i>		
<i>Notostomus japonicus</i>		
<i>Systellaspis braueri</i>		
<i>Systellaspis cristata</i>		
Family Pandalidae		
<i>Pandalopsis ampala</i>		
<i>Pandalopsis dispar</i>	Berkeley 1930	four larval stages, with illustrations
<i>Pandalus eous (borealis)</i>	Berkeley 1930	six larval stages, with illustrations
<i>Pandalus danae</i>	Berkeley 1930	all larval stages, with illustrations
<i>Pandalus gurneyi</i>		
<i>Pandalus jordani</i>	Modin and Cox 1967	eleven larval stages, with illustrations
<i>Pandalus platyceros</i>	Price and Chew 1972	all larval stages, with illustrations
<i>Pandalus stenolepis</i>	Needler 1938	all larval stages, with illustrations
<i>Pandalus tridens</i>	Haynes 1980	six larval stages, with illustrations
Family Pasiphaeidae		
<i>Parapasiphae sulcatifrons</i>		
<i>Pasiphaea pacifica</i>		
<i>Pasiphaea tarda</i>		

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<i>Taxa</i>	<i>References</i>	<i>Reference Contents</i>
"Reptantia"—Crabs, Hermit Crabs, Thalassinids, and Other Non-shrimp-like Decapods		
Suborder Pleocyemata		
Infraorder Thalassinidae		
Family Axiidae		
<i>Axiopsis spinulicauda</i>		
<i>Calastacus stilirostris</i>		
<i>Calocaris investigatoris</i>		
<i>Calocaris quinqueseptatus</i>		
Family Callianassidae		
<i>Neotrypaea (Callianassa) californiensis</i>	McCrow 1972	all zoeal stages, with illustrations
<i>Neotrypaea (Callianassa) gigas</i>		
<i>Callianopsis goniophthalma</i>		
Family Upogebiidae		
<i>Upogebia pugettensis</i>	Hart 1937	all larval stages, with illustrations
Infraorder Anomura		
	Haynes 1984	larval morphology and development in the Anomura
	Lough 1975	key to 5 anomuran families, also keys for zoeae and megalopae for some Oregon species
	MacDonald et al. 1957	larvae of the British species of Diogenes, Pagurus, Anapagurus, and Lithodes
	Strathmann 1987	reproduction and development
Family Diogenidae		
<i>Paguristes turgidus</i>	Hart 1937	all larval stages, with illustrations
<i>Paguristes ulreyi</i>		
Family Galatheididae		
<i>Munida quadrispina</i>	Gore 1979	larval development
<i>Munidopsis quadrata</i>		
Family Hippidae		
<i>Emerita analoga</i>	Johnson and Lewis 1942	all larval stages, with illustrations
Family Lithodidae		
<i>Acantholithodes hispidus</i>		
<i>Cryptolithodes sitchensis</i>		
<i>Cryptolithodes typicus</i>	Hart 1965	all larval stages, with illustrations
<i>Haplogaster grebnitzkii</i>		
<i>Lithodes couesi</i>		
<i>Lopholithodes foraminatus</i>		
<i>Lopholithodes mandtii</i>		
<i>Oedignathus inermis</i>		
<i>Paralomis multispina</i>		
<i>Paralomis verrilli</i>		
<i>Phylloolithodes papillosus</i>		
<i>Rhinolithodes wossnessenskii</i>	Haynes 1984	first two zoeal stages, first zoea illustrated
Family Paguridae		
	Nyblade 1974	larval morphology and development of 18 species, photographs and illustrations of final-stage zoea
<i>Orthopagurus minimus</i>		
<i>Pagurus aleuticus</i>		
<i>Pagurus armatus</i>		

<i>Taxa</i>	<i>References</i>	<i>Reference Contents</i>
<i>Pagurus beringanus</i>	Hart 1937	all larval stages, with illustrations
<i>Pagurus capillatus</i>		
<i>Pagurus caurinus</i>		
<i>Pagurus confragosus</i>		
<i>Pagurus cornutus</i>		
<i>Pagurus dalli</i>		
<i>Pagurus granosimanus</i>		
<i>Pagurus hemphilli</i>		
<i>Pagurus hirsutiusculus</i>	Fitch and Lindgren 1979	all larval stages, with illustrations
<i>Pagurus ochotensis</i>		
<i>Pagurus quaylei</i>		
<i>Pagurus samuelis</i>	MacMillan 1971 Coffin 1960	all larval stages, with illustrations all larval stages, with illustrations
<i>Pagurus setosus</i>		
<i>Pagurus tanneri</i>		
Family Parapaguridae		
<i>Parapagurus pilosimanus</i>		
Family Porcellanidae	Gonor 1970, Gonor and Gonor 1973a	four species' (below) larval stages, with illustrations
<i>Pachycheles pubescens</i>	see above	
<i>Pachycheles rudis</i>	see above	
<i>Petrolisthes cinctipes</i>	see above	
<i>Petrolisthes eriomerus</i>	see above	
Infraorder Brachyura	Lough 1975 Strathmann 1987	key to five families, keys to some Oregon zoeae and megalopae reproduction and development
Family Atelecyclidae		
<i>Telmessus cheiragonus</i>		
Family Calappidae		
<i>Mursia gaudichaudi</i>		
Family Cancridae	Iwata and Konishi 1981 Roesijadi 1976	larval development of eight <i>Cancer</i> species all larval stages, with illustrations
<i>Cancer antennarius</i>		
<i>Cancer branneri</i> (gibbosulus)		
<i>Cancer gracilis</i>	Ally 1975	all larval stages, with illustrations
<i>Cancer jordani</i>		
<i>Cancer magister</i>	Poole 1966	all larval stages, with illustrations
<i>Cancer oregonensis</i>	Lough 1975	all larval stages, with illustrations
<i>Cancer productus</i>	Trask 1970	all larval stages, with illustrations
Family Grapsidae		
<i>Hemigrapsus nudus</i>	Hart 1935	all larval stages, with illustrations
<i>Hemigrapsus oregonensis</i>	Hart 1935	all larval stages, with illustrations
<i>Pachygrapsus crassipes</i>	Schlotterbeck 1976	zoeae, with illustrations
<i>Planes cyaneus</i>		
<i>Planes marinus</i>		
Family Majidae		
<i>Chionoecetes angulatus</i>		
<i>Chionoecetes bairdi</i>	Haynes 1973, 1981a, Jewett and Haight 1977	prezoea, zoea I, II, megalopa, with illustrations
<i>Chorilia longipes</i>		
<i>Mimulus foliatus</i>		
<i>Oregonia bifurca</i>		

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<i>Taxa</i>	<i>References</i>	<i>Reference Contents</i>
<i>Oregonia gracilis</i>	Hart 1960	all larval stages, with illustrations
<i>Pugettia gracilis</i>		
<i>Pugettia producta</i>		
<i>Pugettia richii</i>		
<i>Scyra acutifrons</i>		
Family Pinnotheridae		
<i>Fabia subquadrata</i>	Lough 1975	all larval stages, with illustrations
<i>Pinnixa eburna</i>		
<i>Pinnixa faba</i>		
<i>Pinnixa littoralis</i>		
<i>Pinnixa occidentalis</i>		
<i>Pinnixa schmitti</i>		
<i>Pinnixa tubicola</i>		
<i>Pinnotheres pugettensis</i>		
<i>Pinnotheres taylori</i>	Hart 1935	all larval stages, with illustrations
<i>Scleroplax granulata</i>		
Family Portunidae		
<i>Carcinus maenas</i>	Rice and Ingle 1975	all larval stages, with illustrations
Family Xanthidae		
<i>Lophopanopeus bellus bellus</i>	Hart 1935	all larval stages, with illustrations
<i>Lophopanopeus bellus</i>	Knudsen 1959	all larval stages
<i>diegensis</i>		
<i>Rithropanopeus harrisi</i>	Connolly 1925	all larval stages, with illustrations

hatching. Decapod larvae can undergo two forms of development. In the first, direct development, larval development is completed within the egg; at hatching a first instar juvenile is released. In the second, indirect development, development within the egg is through the embryonic stage; at hatching the larva released must molt through one or more stages before becoming a first instar juvenile. Indirect development is the more common pattern among the decapods. A typical life cycle for a species with indirect development is depicted in Fig. 1. For additional general information on decapods, see Brusca and Brusca (1990) or any invertebrate zoology textbook. For more information on reproduction and development in crustaceans, see Bliss (1982). For more specific information on the reproduction of local decapod families, an excellent starting place is Strathmann (1987).

In penaeids and sergestids the first free-swimming larval stage is the nauplius (Fig. 2A). It is characterized by three pairs of cephalic (head) appendages, with the second and third having longer setae for locomotion. In all other decapod families the naupliar stage is passed while in the egg, and the first free-swimming larval stage is the zoea.

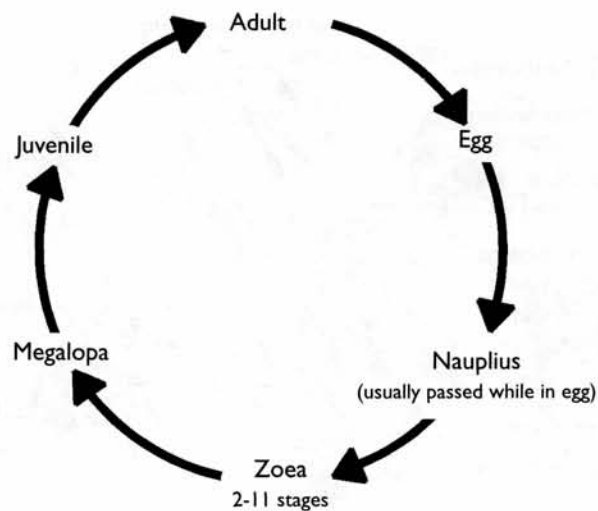


Fig. 1. Generalized decapod life cycle.

Zoae (Fig. 2B, C) are distinguished by a rostral spine and plumose setae on the thoracic appendages, which are used for locomotion. Growth is accomplished by a succession of molts; each intermolt period is called a stage. Each species molts through a set number of stages; however, the number of zoeal stages varies greatly within the Decapoda and is only somewhat consistent at the family level. After spending weeks to months in the plankton as a zoea, the larva molts to the last stage.

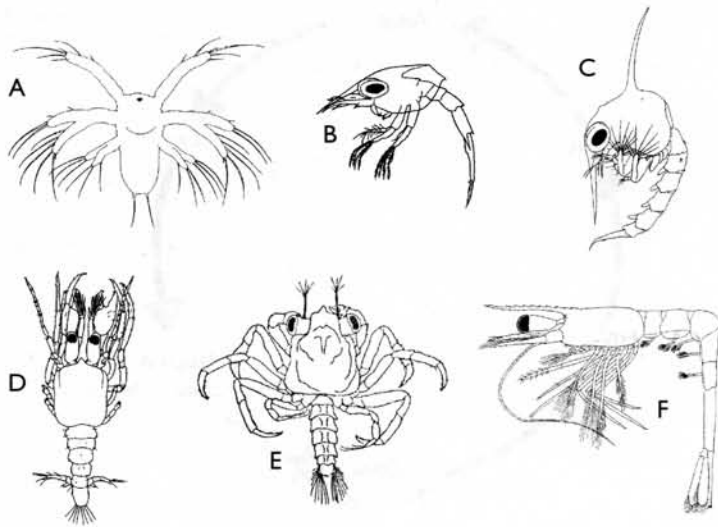
This last stage has several different names including postlarva, decapodid, megalopa, and glaucothoe. Williamson (1957) suggested that megalopa, the last-stage *Brachyura* larva, be applied to all larvae that can locomote by use of pleopods, and this suggestion is adopted here. The megalopa (Fig. 2D-F) resembles the adult form and is the stage during which settlement to the juvenile habitat occurs. It is able to swim using the setose pleopods on its abdomen or walk on the benthos with its thoracic appendages. After settling, the megalopa molts to the first instar juvenile.

Morphology

Although the external morphologies of the various decapod families may look extremely different, they all have the same basic body plan. The body is divided into three main regions: the head or cephalic region, the thorax, and the abdomen (Figs. 3A, 4A, 5A). In decapods, the head and thorax have fused; this is often called the cephalothorax. Each region is further divided into somites, or segments. Each segment has a pair of biramous appendages—appendages that are split in two near the base; the inner branch is the endopod, and the outer branch is the

Fig. 2. Decapod larvae.

(A) Naupliar larva. (B) Anomuran zoea. (C) Brachyuran zoea. (D) Anomuran megalopa. (E) Brachyuran megalopa. (F) Caridean megalopa. Illustration (A from Cook and Murphy, 1971; B, D from Hart, 1937; C from Rice and Ingle, 1975); E adapted from Lough, 1975; F from Berkeley, 1930)



exopod. Some groups have lost the exopod from their pereopods (precursors of the walking legs) (Figs. 3A, 5A).

Covering the cephalothorax dorsally is the carapace (Figs. 3A, 4A, 5A). The anterior-most projection of the carapace is the rostral spine, or rostrum (Figs. 3A, 4A, 5A). Other spines and "teeth" of varying sizes may be present and are typically defined by their location on the carapace.

The head is composed of five indistinguishable fused segments. There are five corresponding pairs of appendages. From anterior to posterior these are the antennules, antennae, mandibles, maxillules, and maxillae (Figs. 3B–E, 4B–E, and 5B–E). In the adult the antennules and antennae become the first and second antennae, and the mandibles, maxillules, and maxillae all become incorporated into mouth parts.

The thorax is composed of eight segments that are dorsally fused. There are eight pairs of corresponding appendages. The first three pairs are maxillipeds (Figs. 3A, F, 4A, F, 5A, F), which become incorporated into or are associated with the mouth in the adult. The last five pairs are pereopods (Figs. 3A, 5A), which become the adult walking legs, some of which may be chelate.

The abdomen is composed of six segments and a telson (Figs. 3A, H, 4A, H, 5A, H), although sometimes the sixth segment remains fused or partially fused to the telson. In late-stage zoea, all or most of the abdominal segments have a pair of pleopods (Figs. 3A, 4A, 5A) that remain or are reduced in the adult. The last abdominal segment may or may not have a pair of uropods (Figs. 3A, 4A) which, when present, form the tail fan in conjunction with the telson.

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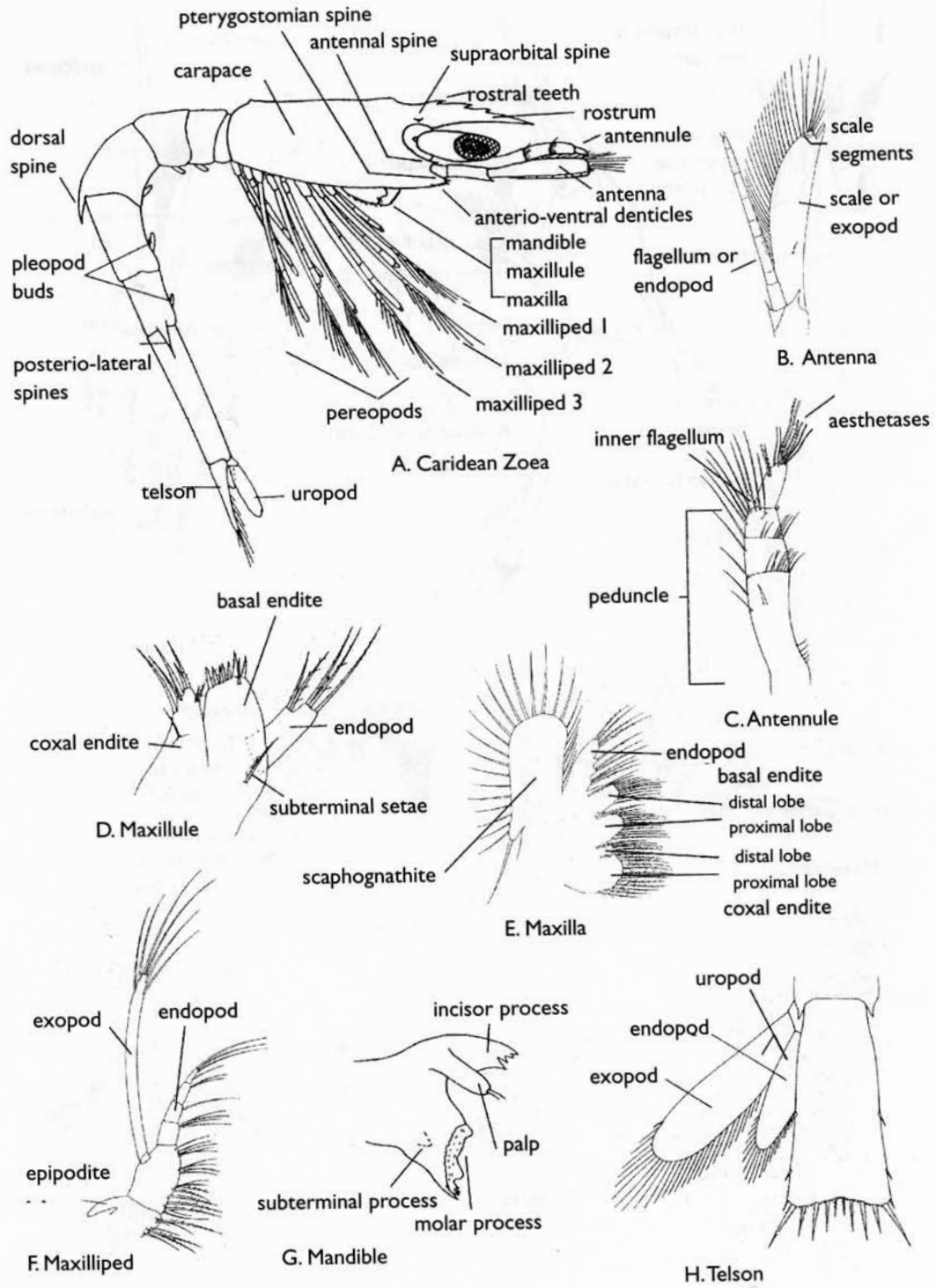


Fig. 3. External morphology and terminology describing caridean zoea.
 (From Haynes, 1985)

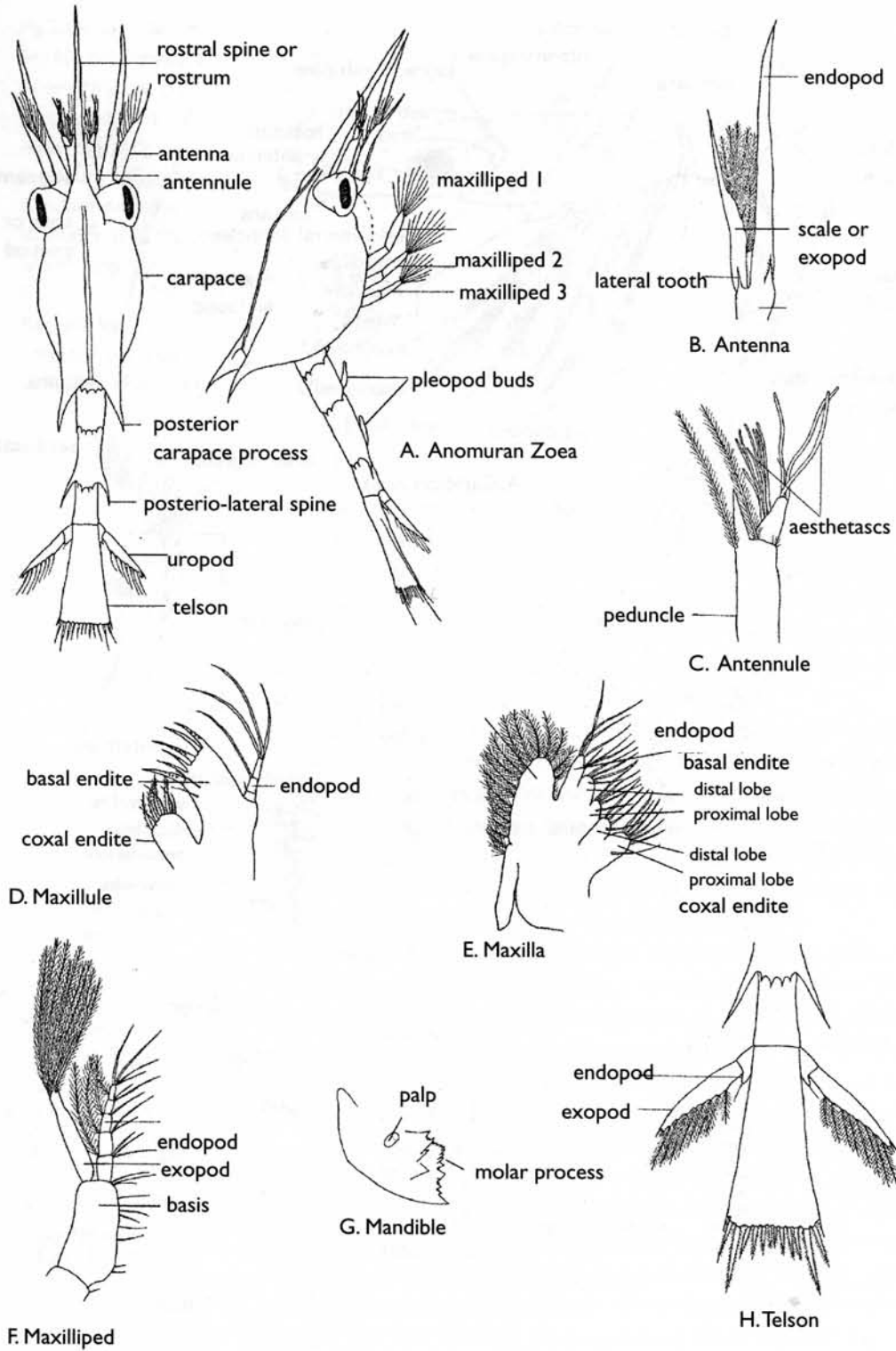


Fig. 4 External morphology and terminology describing anomuran zoea. (From Nyblade, 1974)

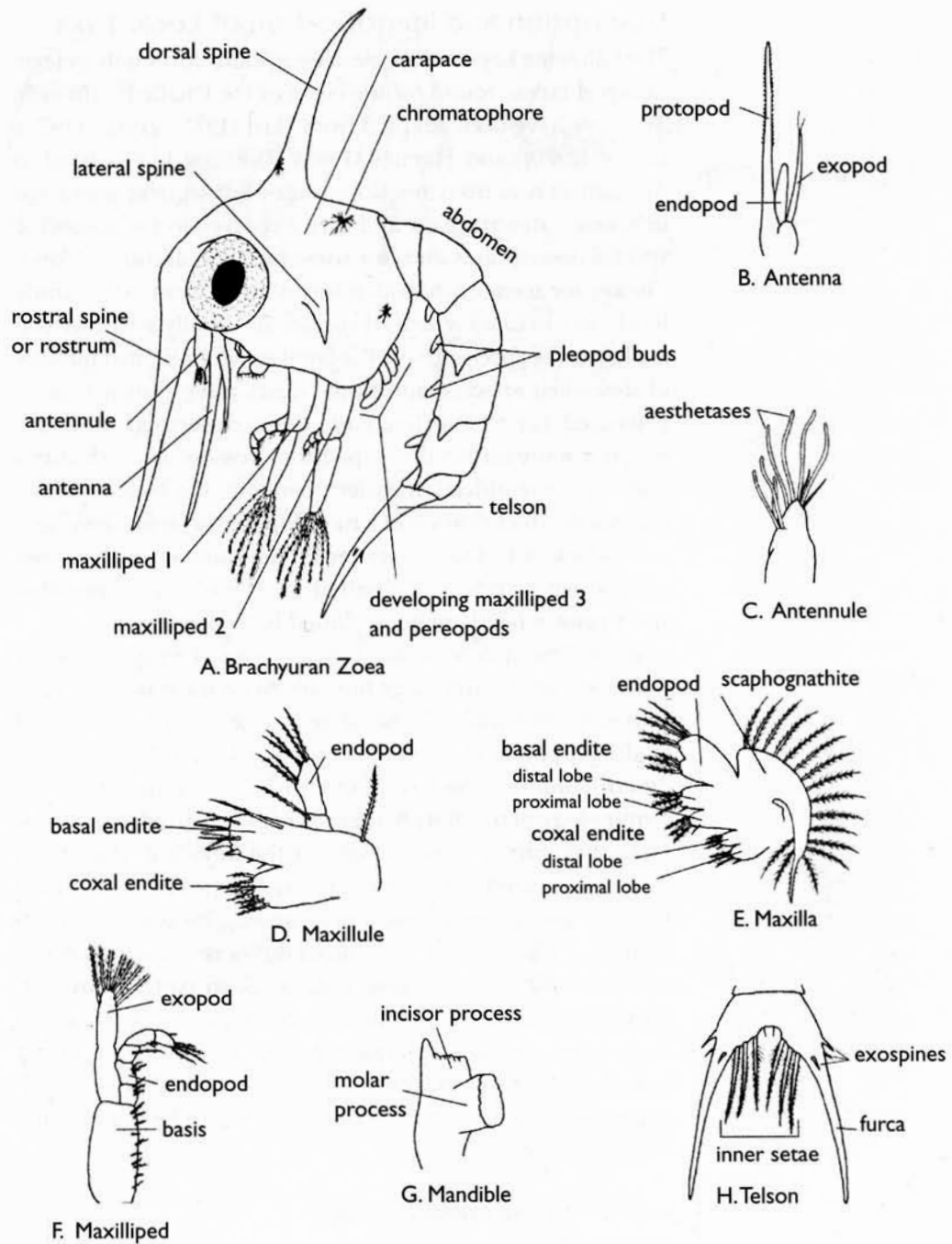


Fig. 5. External morphology and terminology describing brachyuran zoea.
(from Martin, 1984)

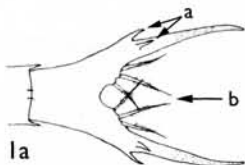
Description and Identification of Local Taxa

The following keys and species descriptions cover only pelagic decapod larvae found off the coast of the Pacific Northwest. The keys have been adapted from Hart (1971), Lough (1975), Gonor (1970), and Haynes (1985). The first key is used to distinguish zoea from megalopa stages. Subsequent keys assist in species identification and direct readers to the following species descriptions and, for some families, additional keys. The key for zoeae enables identification of a larva to the family level; only in cases where all species of a family are described is a key to the species given. For families with a limited number of described species, additional descriptive information is provided for those that have been described. Because megalopae are further developed, they possess unique features that make identification easier; therefore, the megalopa key can enable identification of a megalopa to the genus level and in most cases to the species level. The number of described megalopae is, however, limited, so there is a chance that specimens in hand are not included in the key.

In the descriptions of the known species, if an appendage is described in an early stage but fails to be mentioned in later stages, it has remained unchanged. When possible, the most readily apparent characteristics are used in both the species descriptions and the keys. Refer to Figs. 3, 4, and 5 for the terminology of the morphological characters used in the keys. Note that size approximations in the keys are often from laboratory-reared larvae; larvae that developed in the plankton may have different characteristic sizes. The easiest way to distinguish a species is by chromatophore pattern, since it remains constant regardless of stage. Such patterns are not, however, used in the keys and descriptions, with a few exceptions, because chromatophores are lost in preserved samples. More complete descriptions of all the larval appendages and chromatophore patterns can be found in the original literature.

Key to zoea and megalopa stages

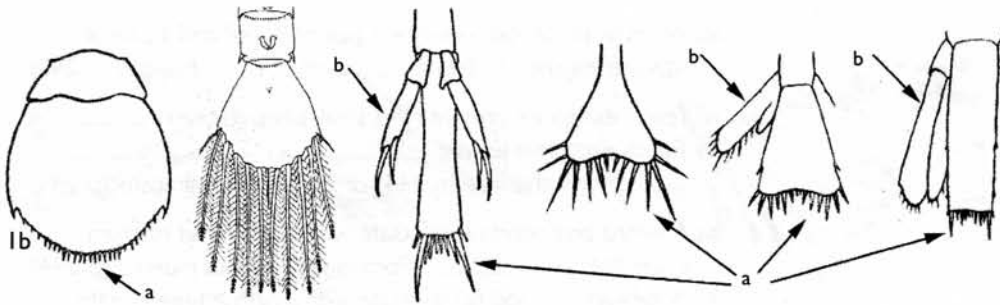
- 1a. Long setae on thoracic appendages; when present, pleopod buds without setae zoea, Key A
 1b. Larval morphology resembles adult form; pleopods with long setae megalopa, Key B



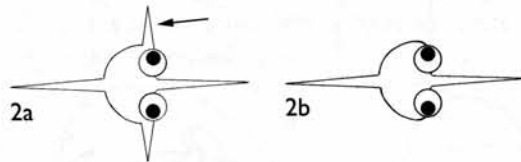
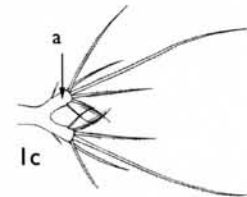
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A. Key to decapod zoeae

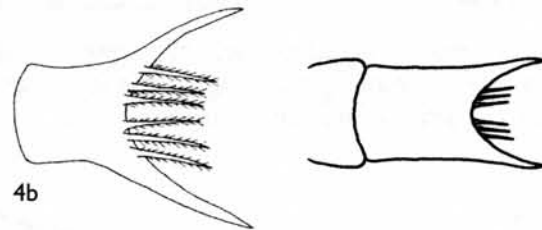
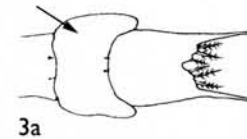
- 1a. Telson forked and may be armed with exospines (a) and inner setae (b); no uropod development in any zoeal stage
 (Brachyura), 2



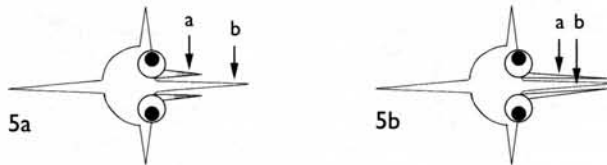
- 1b. Telson broader and flattened, may be armed with spines (a) along posterior margin; uropod (b) development in late-stage larvae (uropods may be rudimentary or absent in early stages and some species) 9
- 1c. Telson composed of 2 cylindrical rami (a) bearing long setae 17
- 2a. Carapace with lateral spines 3
- 2b. Carapace without lateral spines 7



- 3a. Fifth abdominal segment expanded laterally Pinnotheridae (p. 242)
- 3b. Fifth abdominal segment not expanded laterally 4
- 4a. Telson exospines present (1-3 small pairs; arrows) 5
- 4b. Telson exospines absent Grapsidae (p. 236)



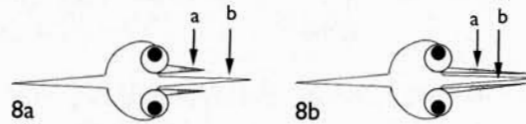
- 5a. Antenna protopod (a) spinulate with length \leq half rostrum length (b) Cancridae (p. 233)
- 5b. Antenna protopod (a) either spinulate or smooth with length \geq three-fourths rostrum length (b) 6



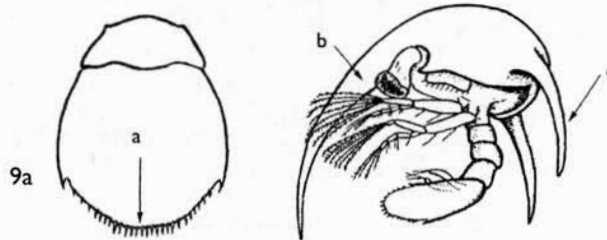
- 6a. Antenna protopod smooth; 1 pair of dorsal exospines on telson (sometimes with 2 very tiny inconspicuous lateral spines in early stages) Xanthidae (p. 246)



- 6b. Antenna protopod spinulate; 1 pair of dorsal and 1 pair of lateral exospines on telson Majidae (p. 240)
- 7a. Telson exospines present (1-3 small pairs; arrows) 8
- 7b. Telson exospines absent Pinnotheridae (p. 244) or Zoea I Pachygrapsus (p. 239)
- 8a. Antenna protopod (a) spinulate with length \leq half rostrum length (b) Portunidae, *Carcinus maenas* (p. 244)
- 8b. Antenna protopod (a) spinulate with length \geq three-fourths rostrum length (b) Majidae (p. 240)

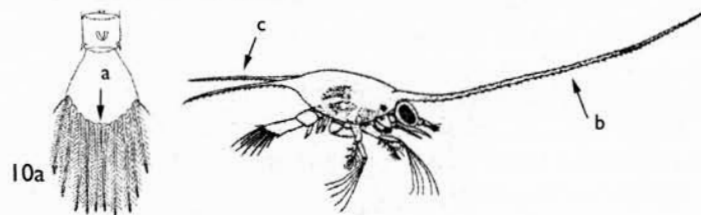


- 9a. Telson posterior margin (a) rounded with numerous minute spines; carapace with long rostrum (b) and pair of posteriolateral spines (c); lateral spines absent in stage I zoeae .. Hippidae, *Emerita analoga* (p. 217)



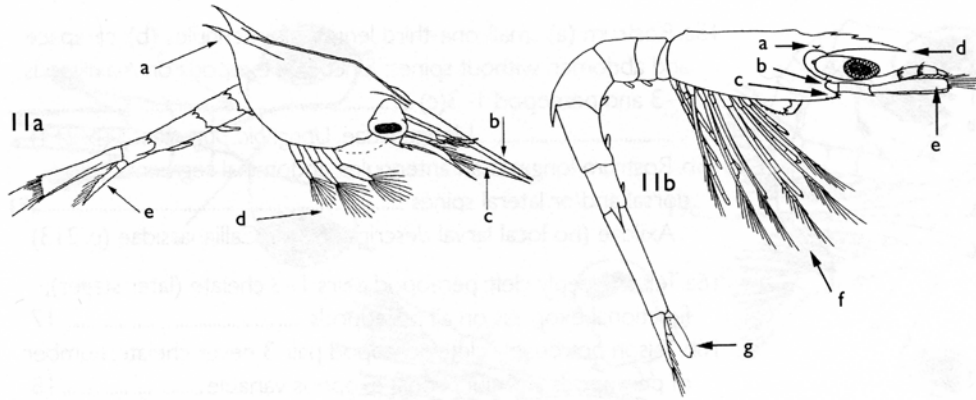
- 9b. Not as above 10

- 10a. Telson posterior margin (a) rounded with numerous long plumose setae; rostrum (b) measuring twice length of carapace; carapace also with pair of posterior spines (c) Porcellanidae (p. 230)

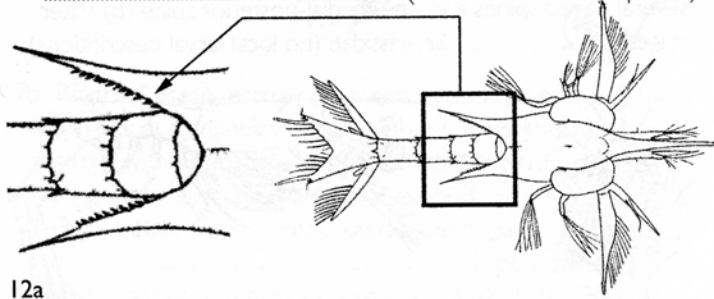


- 10b. Not as above 11

- 11a. Carapace with posterior processes (a); rostrum (b) commonly \geq length of antenna endopod (c); swimming setae on exopods of maxillipeds (d) not on pereopod (early and late stages); exopod of uropod (e) flat and bladelike (later stages) 12
- 11b. Carapace often with orbital (a), antennal (b), and/or pterygostomial spines (c); rostrum (d) rarely longer than antenna (e); swimming setae on exopods of maxillipeds and pereopod (f) (later stages); exopod and endopod of uropod (g) flat and broad (later stages) 14



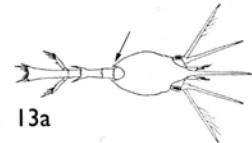
12a. Posterior margin of carapace serrate (arrow; early stages) Galatheidae (no local larval descriptions)



12a

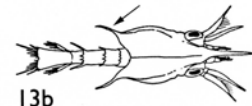
12b. Posterior margin of carapace not serrate 13

13a. Posterior processes of carapace generally close together with parallel edges (arrow); slender appearance Diogenidae (p. 216); Paguridae (p. 221); or Parapaguridae (no local larval descriptions)



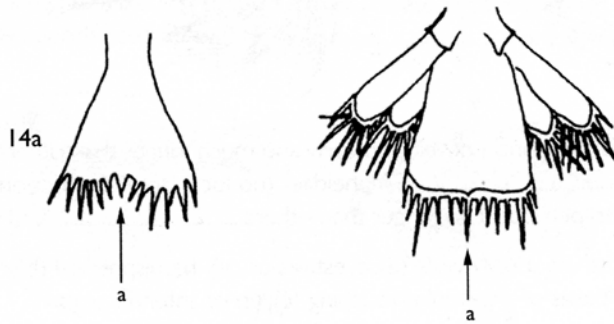
13a

13b. Posterior processes of carapace generally farther apart with sloped diverging edges (arrow); stout appearance Lithodidae (p. 219)



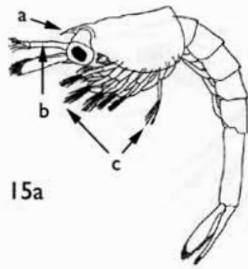
13b

14a. Telson posterior margin with medial tooth (a) (not medial setae) 15



14a

14b. Telson posterior margin without medial tooth 16

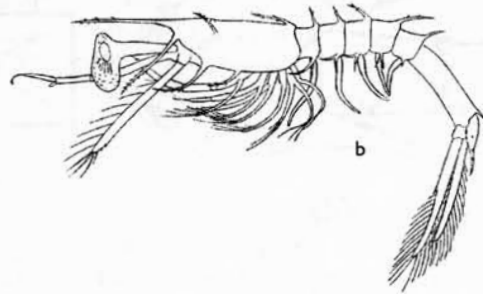


15a

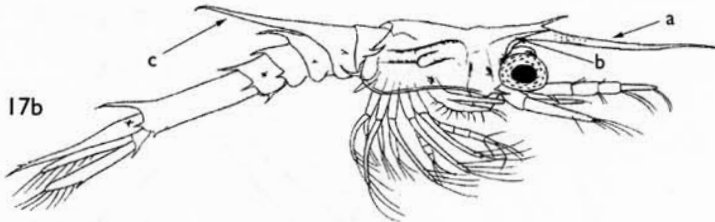
- 15a. Rostrum (a) small, one-third length of antennules (b); carapace and abdomen without spines; functional exopods on maxillipeds 1-3 and pereopod 1-3(c) Upogebiidae, *Upogebia pugettensis* (p. 214)
- 15b. Rostrum longer than antennules; abdominal segments with dorsal and/or lateral spines Axiidae (no local larval descriptions) or Callianassidae (p. 213)
- 16a. Telson deeply cleft; pereopod pairs 1-3 chelate (later stages); functional exopods on all pereopods 17
- 16b. Telson not deeply cleft; pereopod pair 3 never chelate; number of pereopods with functional exopods variable 18
- 17a. Carapace with many spines (a) (early stages); carapace with several paired spines and one medial-posterior spine (b) (later stages) Sergestidae (no local larval descriptions)



17a

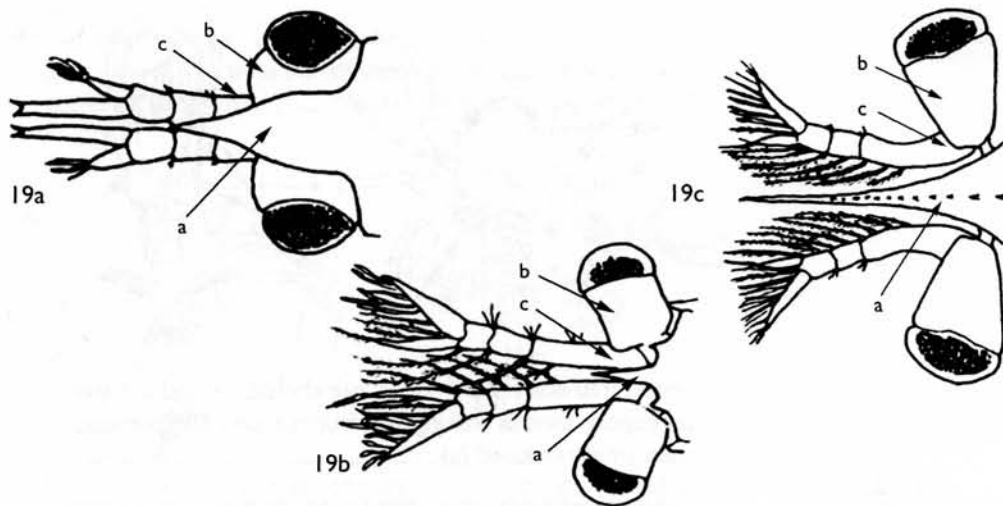


- 17b. Carapace with long rostrum (a) with paired orbital spines (b) at base; abdominal segments with dorsal spines, segment 2 (c) bearing largest spine (later stages) Penaeidae (no local larval descriptions)



17b

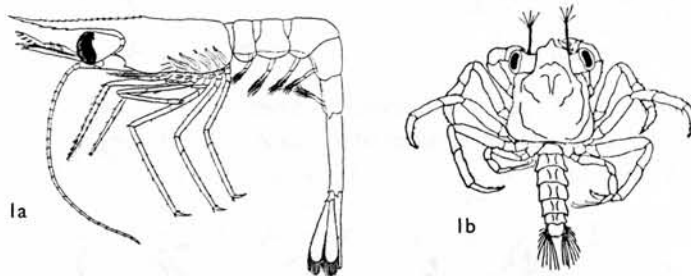
- 18a. Fifth pereopod developed early and much longer than others Alpheidae (no local larval description)
- 18b. Fifth pereopod no longer than others 19
- 19a. Rostrum usually wide (a), eyestalks usually hemispherical (b), and bases of antennules touching (c); tip of antennal scale always unsegmented, inner flagellum of antennule a setose spine or oblong projection, functional exopod usually only on pereopod 1 and never on 3-5, in later stages pereopod 1 subchelate and telson widening posteriorly Crangonidae (no descriptions included)



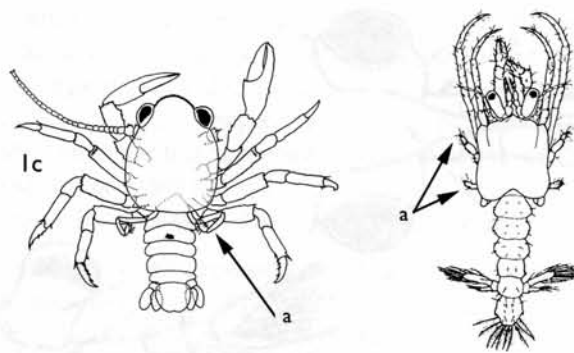
- 19b. Rostrum usually narrow (a), eyestalks usually cylindrical (b), and bases of antennules close together but not touching (c); rostrum without teeth in all stages, basal endite of maxillule lacking subterminal seta, functional exopods on pereopods 1-2, 1-3, or 1-4, abdomen with postero-ateral spines Hippolytidae (p. 202)
- 19c. Rostrum usually slender (a), eyestalks usually taper toward base (b), and bases of antennules relatively far apart (c); rostrum always \geq one-fourth length of carapace (later stages), basal endite of maxillule with subterminal seta, functional exopods on only pereopods 1-2 or 1-3, abdomen lacking posteriolateral spines Pandalidae (p. 203)

B. Key to decapod megalopae

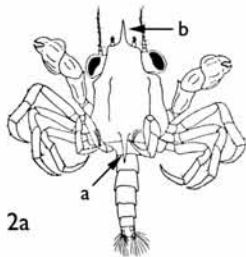
- 1a. Shape shrimp-like; pereopods all long and thin resembling adult form; first and/or second pereopods either chelate or subchelate Caridea (pp. 204-15), or Thalassinidea* 13 (see also pp. 215-34)
- 1b. Shape crab-like; first pereopod pair chelate, second through fifth pereopods used as walking legs Brachyura, 2



* Can be confused with euphausiids and mysids; in euphausiids the last two pereopod pairs are reduced or vestigial, and rarely are any of the pereopods chelate; the majority of mysids have small bubble-like statocysts on the endopods of the uropods.



1c. Shape crab-like; first pereopod pair chelate, second and third pereopods used as walking legs, fourth and/or fifth pereopod pairs greatly reduced (a) Anomura, 13



2a. Carapace with posterior spine (a) and long pointed rostrum (b) Cancridae, 3
 2b. Carapace with more than 1 spine 4
 2c. Carapace without spines; rostrum blunt or flexed downward . 5

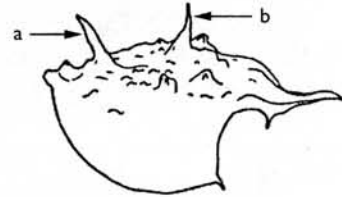
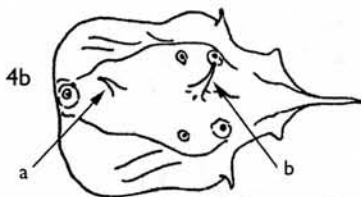
3a. Length of carapace from tip of rostrum to back of carapace, 5.3–6.6 mm; width of carapace across widest point, 3.5–4.6 mm *Cancer magister* (p. 235)

3b. Length of carapace from tip of rostrum to back of carapace, 3.4–3.6 mm; width of carapace across widest point, 2.0–2.1 mm *Cancer oregonensis* (p. 235) or *Cancer productus* (p. 236)

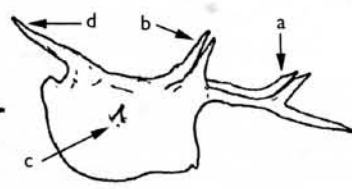
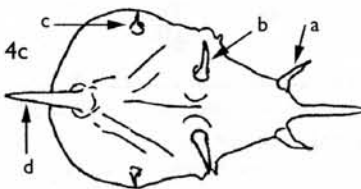
3c. Length of carapace from tip of rostrum to back of carapace, 2.0–3.3 mm; width of carapace across widest point, 1.2–2.4 mm *Cancer antennarius* (p. 234) or *Cancer gracilis* (p. 234)



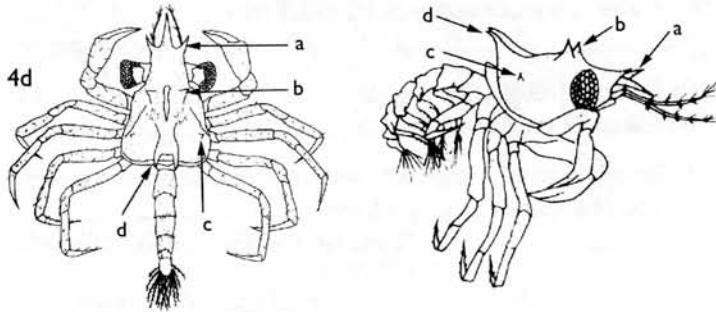
4a. Carapace with elongated posterior spine (a) and 2 anteriolateral spines (b) Pinnotheridae, *Pinnotheres* sp.
 4b. Carapace with 1 posterior spine (a) and 1 mid-dorsal spine (b) Majidae, *Pugettia* sp.



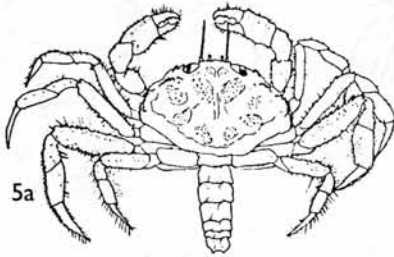
4c. Carapace with pair of anteriolateral spines (a), pair of mid-dorsal spines (b), small pair of lateral spines (c), and elongated posterior spine (d) Majidae, *Oregonia gracilis* (p. 241)



4d. Carapace with pair of anteriolateral spines (a), pair of mid-dorsal spines (b), small pair of lateral spines (c), and set of posterior spines (d)..... Majidae, *Chionoecetes bairdi* (p. 240)

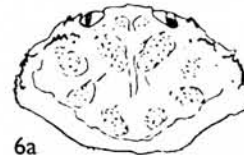


5a. Carapace oval, wider than long, sometimes with lateral teeth and granular texturePinnotheridae, 6

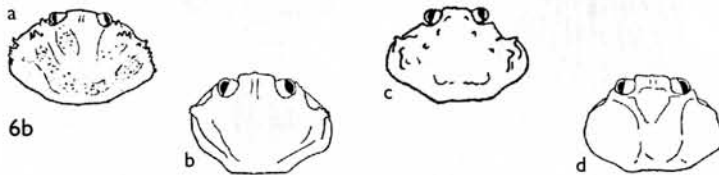


5b. Carapace roughly rectangular or square 7

6a. Largest pinnotherid, carapace ca 2.5 by 3.8 mm Pinnotheridae, *Fabia subquadrata* (p. 242)



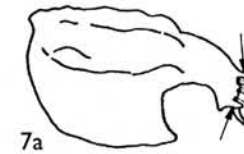
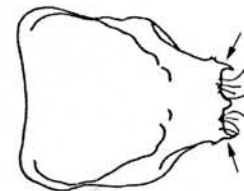
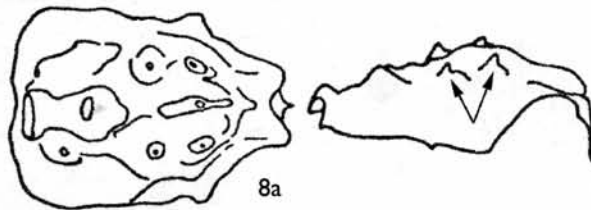
6b. Lateral edges of carapace with or without teeth; carapace surface granular or smooth, ca 1.8 by 2.8 mm (a); 1.4 by 2 mm (b); 1.4 by 2.4 mm (c); 1.5 by 2.4 mm (d); 1.4 by 1.8 mm *Pinnixa* spp.



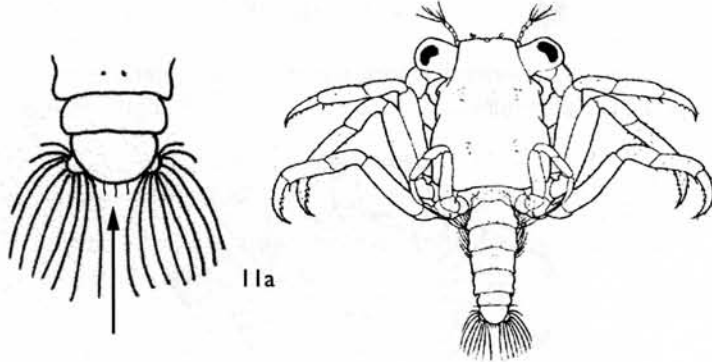
7a. Carapace with small teeth at anterior corners Xanthidae, *Lophopanopeus bellus* (p. 246)

7b. Not as above 8

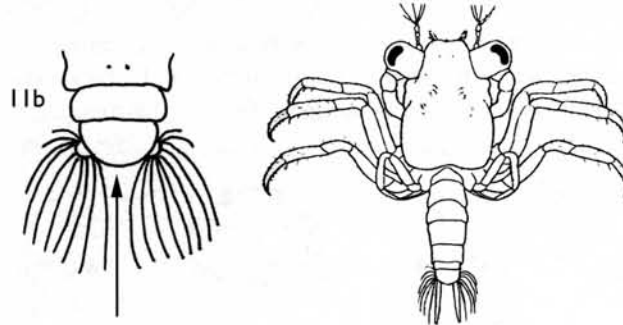
8a. Carapace with prominent cone-like projections 9



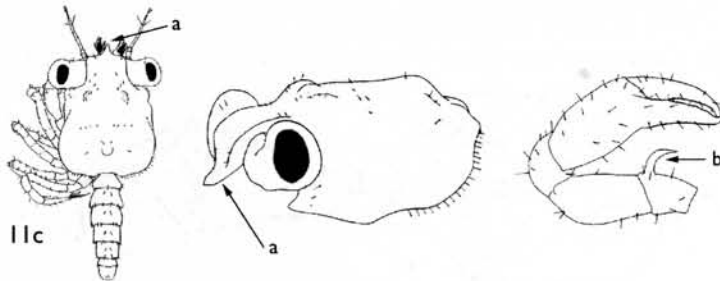
- 8b. Not as above 10
- 9a. Larger species; carapace ca 1.6 by 1.2 mm
 Majidae, *Pugettia productua*
- 9b. Smaller species; carapace ca 1.2 by 0.9 mm
 Majidae, *Pugettia gracilis*
- 10a. Carapace roughly rectangular 11
- 10b. Carapace roughly square 12
- 11a. Telson posterior margin with setae (other than uropod setae;
 arrow); carapace ca 1.8 by 1.5 mm
 Grapsidae, *Hemigrapsus nudus* (p. 238)

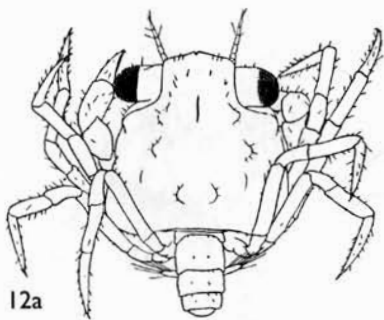


- 11b. Telson posterior margin without setae (arrow); carapace 1.4–
 1.7 by 1.1–1.3 mm
 Grapsidae, *Hemigrapsus oregonensis* (p. 238)

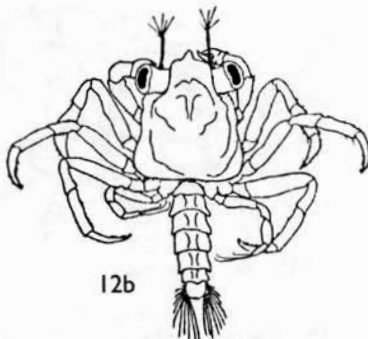


- 11c. Rostrum small and flexed downward (a); cheliped with
 prominent ischiobasal hook (b); carapace 1.3–1.4 by 1.0–1.2
 mm Portunidae, *Carcinus maenas* (p. 244)





12a



12b

12a. Carapace ca 1.1 by 1.0 mm

..... Xanthidae, *Rhithropanopeus harrisi* (p. 247)

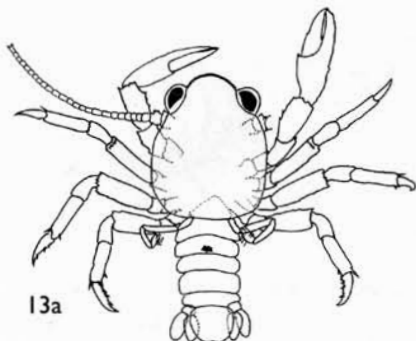
12b. Carapace ca 3.0 by 4.1 mm (average, Coos Bay, Oregon)

..... Grapsidae, *Pachygrapsus crassipes* (p. 239)

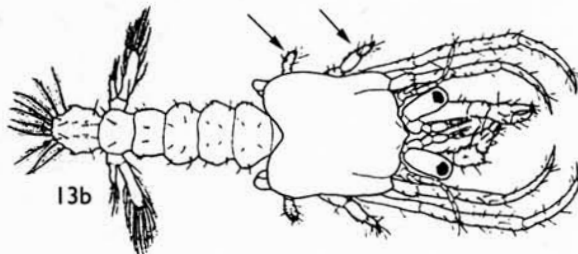
13a. Fifth pereopod pair greatly reduced; carapace rounded;

abdomen wide

Porcellanidae, 14



13a



13b

13b. Fourth and fifth pereopod pairs greatly reduced

..... Diogenidae, Paguridae, or Parapaguridae, 17

14a. Chelipeds long, slender, and dorsoventrally flattened

..... *Petrolisthe*, 15

14b. Chelipeds heavy, broad, and swollen, not dorsoventrally

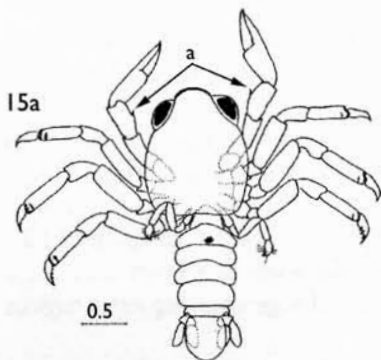
flattened

Pachycheles, 16

15a. Carpus of cheliped with single small spine on inner margin (a);

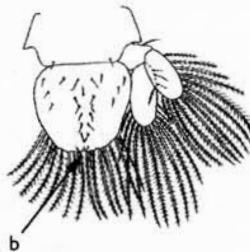
central notch in posterior margin of telson indistinct (b)

..... *Petrolisthes cinctipes* (p. 232)

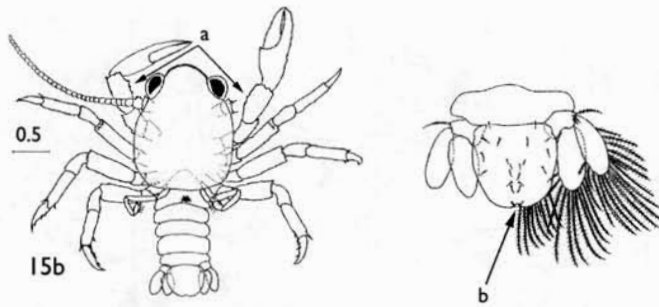


15a

0.5

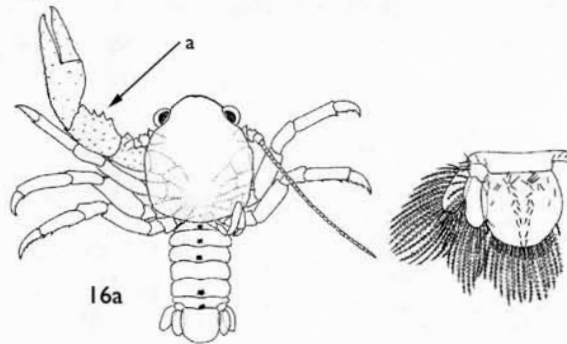


b

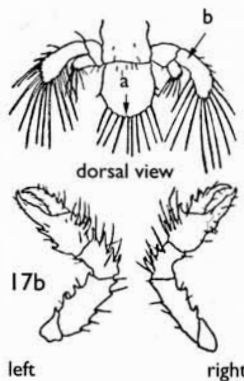
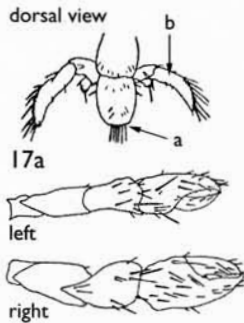


15b. Carpus of cheliped with 2–3 small spines on inner margin (a); central notch in posterior margin of telson distinct (b) *Petrolisthes eriomerus* (p. 232)

16a. Carpus of cheliped with 2–3 prominent spines on inner margin *Pachycheles pubescens* (p. 232)

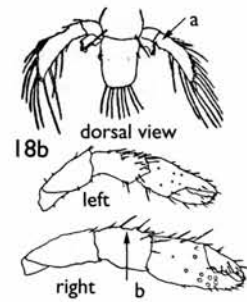
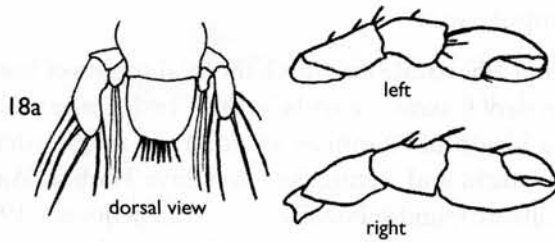


16b. Carpus of cheliped with single prominent spine on inner margin *Pachycheles rudis* (p. 232)

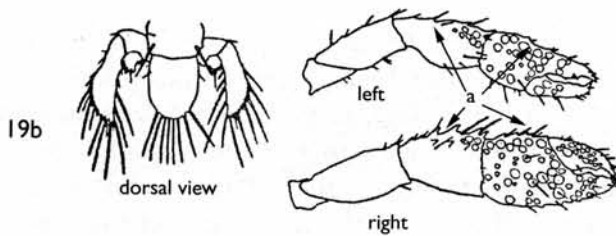
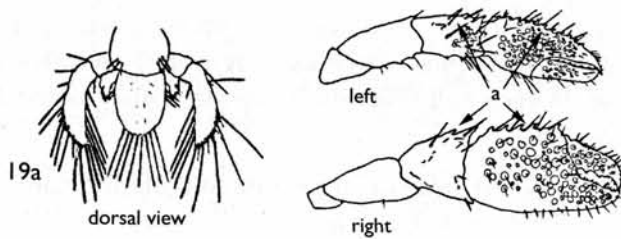


17a. Telson posterior margin (a) with 6 setae; right uropod (b) smaller than left; right cheliped larger than left, chelae smooth, moderately broad, hairy; carapace ca 1.6 mm long, with 1.4 mm wide; total length ca 3.4 mm Paguridae, *Pagurus granosimanus*

17b. Telson posterior margin (a) with 10 setae; right uropod (b) slightly larger than left; chelipeds of equal size, narrow, heavily toothed, hairy; antennal scale scimitar-shaped; carapace ca 1.2 mm long, with 1.0 mm wide; total length ca 3.4 mm Diogenidae, *Paguristes turgidus*



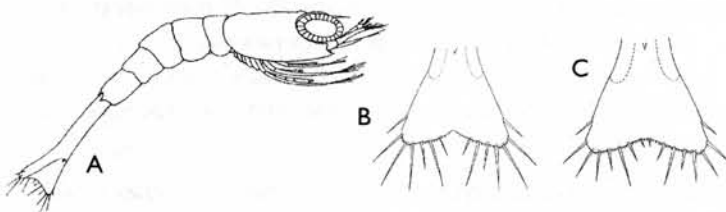
- 17c. Telson posterior margin with 8 setae 18
- 18a. Telson, uropods, and chelipeds comparatively small and reduced; chelae smooth with few hairs and no teeth; carapace ca 1.3 mm long, with 1.0 mm wide; total length ca 2.4 mm
 Paguridae, *Pagurus hirsutiusculus*
- 18b. Uropods stout and unequal in size, with right slightly smaller (a); antennae long reaching beyond chelipeds; chelipeds stout with 4–5 spines on inner margin of right carpus (b)
 Paguridae, *Pagurus ochotensis*
- 18c. Uropods nearly equal in size; chelae broad with rounded tips and serrated margin 19
- 19a. Chela and carpus margins heavily toothed (a); carapace ca 1.84 mm long, with 1.8 mm wide; total length ca 4.4 mm
 Paguridae, *Orthopagurus schmitti*
- 19b. Chela and carpus margins not as heavily toothed as above(a); carapace ca 1.5 mm long, with 1.4 mm wide; total length ca 3.2 mm
 Paguridae, *Pagurus beringanus*



Family Hippolytidae

Eualus suckleyi, **Shortscale Eualid**. Of the local species of *Eualus*, only the larvae of *E. suckleyi* have been described. *Eualus suckleyi* can reach a length of 79 mm as an adult. Its range extends from the Chukchi and Bering Seas to Grays Harbor, Washington. Adults are found subtidally at 11–1,025 m (Jensen, 1995). Haynes collected females carrying eggs from late April to early May. Although Haynes describes only two larval stages, he suggests that they molt through five to nine zoeal stages. Information on the length of the larval period was not found. Sizes below are from laboratory-reared larvae. Larvae described in Haynes (1981b).

Fig. 6. *Eualus suckleyi*.
(From Haynes, 1981b)



Zoea I: Length from tip of rostrum to posterior margin of telson, 3.0–3.5 mm (Fig. 6A). Rostrum thin and without teeth, about half length of antennae. First, second, and third maxilliped pairs with four, five, and five swimming setae on exopods, respectively. Abdomen with five segments and triangular telson. Abdominal segment 5 with pair of posteriolateral spines. Posterior margin of telson with seven setae on each half (Fig. 6B). Uropods visible under thin membrane.

Zoea II: Length from tip of rostrum to posterior margin of telson, 3.5–4.2 mm. Telson now with eight setae on each half (Fig. 6C).

Lebbeus groenlandicus, **Spiny Lebbeid**. Of the species in the genus *Lebbeus* found off the coast of the Pacific Northwest, only the larvae of *L. groenlandicus* have been described. *Lebbeus groenlandicus* grows to a length of 40 mm as an adult. Its range extends from the Bering Sea to the Puget Sound. Adults are found on shell mixed with sand or gravel from the low intertidal to 518 m (Jensen, 1995). They molt through two zoeal stages and one megalopa. Information on the timing and length of larval period was not found. Size approximations below are from larvae reared *in situ* in Kachemak Bay, Alaska. Larvae described in Haynes (1978a).

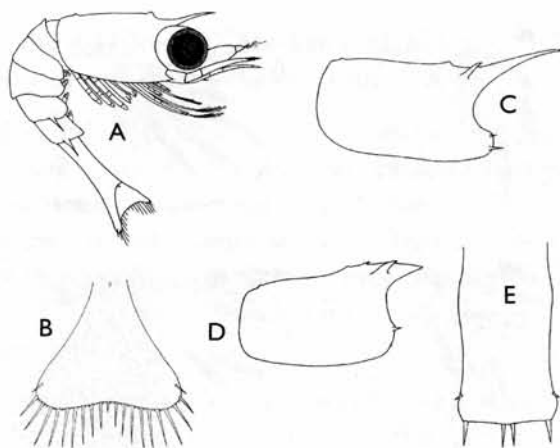


Fig. 7. *Lebbeus groenlandicus*. (From Haynes, 1978a)

Zoea I: Length from tip of rostrum to posterior margin of telson, 6.4–7.4 mm (Fig. 7A). Rostrum thin and pointed, ca half length of antenna. First, second, and third maxilliped pairs with four, five, and five swimming setae on exopods, respectively. Abdomen with five segments and triangular telson. Abdominal segments four and five with posterio-lateral spines. Posterior margin of telson with 19–21 setae (Fig. 7B). Uropods visible under thin membrane. Pleopod buds present on abdominal segments 1–5.

Zoea II: Length from tip of rostrum to posterior margin of telson, 8.1–8.7 mm. Carapace with pair of spines lateral to base of rostrum (Fig. 7C). First, second, and third maxilliped pairs with five, sixteen, and sixteen swimming setae on exopods, respectively. First and second pereopod pairs chelate. Pleopods slightly more developed.

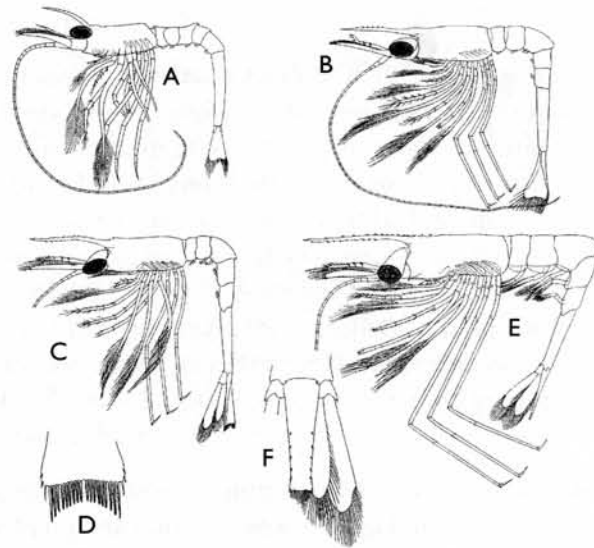
Megalopa: Length from tip of rostrum to posterior margin of telson, 7.4–7.6 mm. Rostrum shorter, with single small medial spine at base (Fig. 7D). Telson rectangular with 1 pair of spines on posteriolateral margin and 2 pairs of spines on posterior margin (Fig. 7E).

Family Pandalidae

Pandalopsis dispar, **Sidestriped Shrimp**. *Pandalopsis dispar* can reach a length of 208 mm as an adult. Its range extends from the Pribilof Islands to Manhattan Beach state park, Oregon. Adults can be found on soft bottoms at 46–649 m (Jensen, 1995). In the descriptions below, stage I zoeae were from laboratory-reared larvae and stages II, III, and V(?) zoeae were collected from plankton samples. Larvae described in Berkeley (1930).

Zoea I: Length from tip of rostrum to posterior margin of telson, 10 mm (Fig. 8A). Rostrum slopes upward and has

Fig. 8. *Pandalopsis dispar*.
(From Berkeley, 1930)



five dorsal teeth and three ventral teeth. Antennal flagellum longer than whole body. Abdomen composed of six unequal segments and triangular telson. Five pairs of pleopod buds present on ventral side of abdomen. Telson posterior margin has twelve pairs of setae. First, second, and third maxilliped pairs with setae. Third, fourth, and fifth pereopod pairs without exopods.

Zoea II: Length from tip of rostrum to posterior margin of telson, 13 mm (Fig. 8B). Rostrum now has six dorsal teeth (as well as three ventral teeth) on anterior half and additional three to four teeth at base. Carapace now has pair of supraorbital spines. All thoracic appendages with swimming setae on exopods, and second pereopod pair endopods chelate.

Zoea III: Length from tip of rostrum to posterior margin of telson, 16 mm (Fig. 8C). Rostrum has eight dorsal teeth between eyes and tip, one tooth near tip, and five to six small ventral teeth (in addition to three or four teeth near base). Pleopods distinctly biramous but lack setae. Uropods free, and telson more rectangular, with eight pairs of setae on posterior margin and two pairs on lateral margins (Fig. 8D).

Zoea V(?): There is at least one zoeal stage between this stage and the third zoea, but there may be more. Length from tip of rostrum to posterior margin of telson, 30 mm (Fig. 8E). Rostrum with total 15 dorsal teeth and 10 ventral teeth. Pleopods with long setae. Telson now narrower at base, with seven pairs of setae on posterior margin and six pairs of lateral spines (Fig. 8F).

Pandalus eous (*borealis*). Alaskan Pink Shrimp.

Larvae described in Berkeley (1930).

Zoea I: Length from tip of rostrum to posterior margin of telson, 5 mm (Fig. 9A, B). Rostrum slender, extending two-thirds way up antennal scale. Abdomen composed of five segments and triangular telson. Telson posterior margin with seven pairs of setae. Three maxilliped pairs have swimming setae on exopods, and pereopods poorly developed.

Zoea II: Length from tip of rostrum to posterior margin of telson, 7 mm (Fig. 9C). Carapace has pair of supraorbital spines. First, second, and third pereopod pairs with swimming setae on exopods. Small pleopod buds present on ventral side of abdomen.

Zoea III: Length from tip of rostrum to posterior margin of telson, 8–9 mm (Fig. 9D). Rostrum has two small teeth at base. Abdomen now composed of six segments and telson. Telson posterior margin now with eight pairs of setae, and uropods free (Fig. 9E).

Zoea IV: Length from tip of rostrum to posterior margin of telson, 9–10 mm (Fig. 9F). Rostrum now with four small teeth near base. Pleopods biramous. Telson rectangular, with five pairs of setae on posterior margin and three pairs of lateral spines (Fig. 9G).

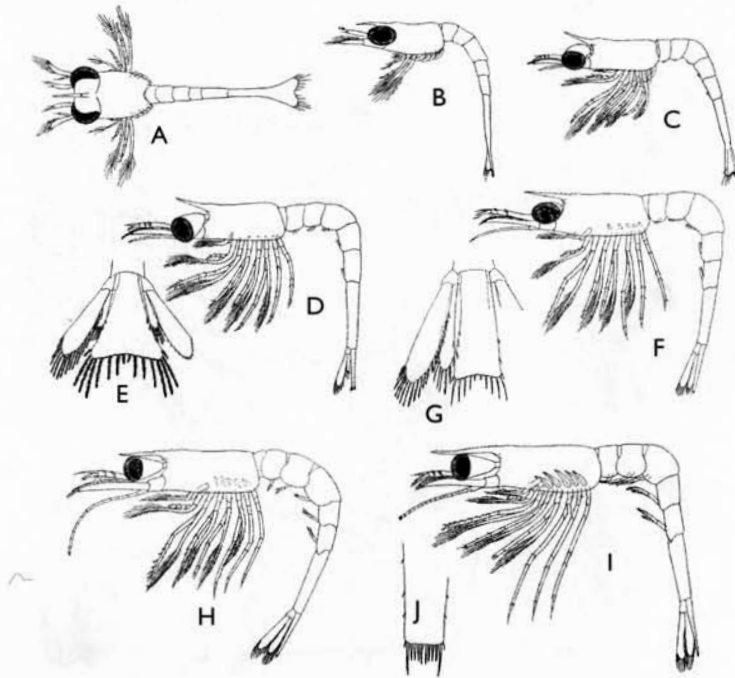


Fig. 9. *Pandalus eous* (*borealis*). (From Berkeley, 1930)

Zoea V: Length from tip of rostrum to posterior margin of telson, 14 mm (Fig. 9H). Rostrum now with 11–12 dorsal teeth. second pereopod pair chelate.

Zoea VI: Rostrum with 14 teeth and one near tip (Fig 9I). Pleopods with setae. Telson (Fig. 9J) now with five pairs of setae on posterior margin and four pairs of lateral spines.

Pandalus danae, **Dock Shrimp**. *Pandalus danae* can reach a length of 140 mm as an adult. Its range extends from the Alaskan Peninsula to Bahía de San Quintín, Baja California. During the day, adults are most commonly found from the intertidal to 185 m on mixed-composition bottoms hidden under algae or in crevices. At night in marinas they come out of hiding and can be found on pilings (Jensen, 1995). Larvae described in Berkeley (1930).

Zoea I: Length from tip of rostrum to posterior margin of telson, 6 mm (Fig. 10A). Rostrum thin and extending two-thirds way up antennal scale. Abdomen composed of six segments and triangular telson. Telson posterior margin with seven pairs of setae (Fig. 10B). First, second, and third maxilliped pairs with swimming setae on exopods.

Zoea II: Length from tip of rostrum to posterior margin of telson, 8 mm (Fig. 10C). Carapace now with pair of supraorbital spines. Telson posterior margin now with eight pairs of setae (Fig. 10D). First and second pereopod pairs with swimming setae on exopods.

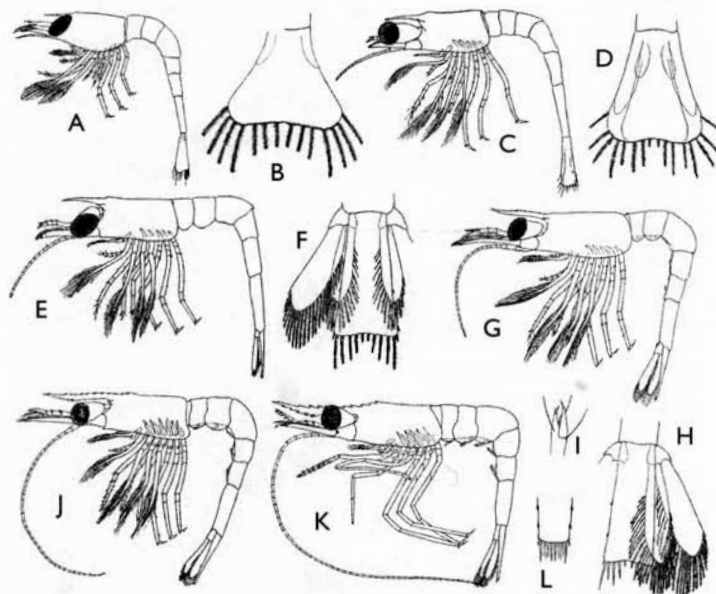


Fig. 10. *Pandalus danae*.
(From Berkeley, 1930)

Zoea III: Length from tip of rostrum to posterior margin of telson, 9 mm (Fig. 10E). Telson rectangular, with five pairs of setae on posterior margin and three pairs of lateral spines (Fig. 10F). Uropods free and setae bare.

Zoea IV: Length from tip of rostrum to posterior margin of telson, 12 mm (Fig. 10G, H). Rostrum has eight to ten dorsal teeth. Second pereopod pair chelate (Fig. 10I). Small pleopod buds present on ventral side of abdomen.

Zoea V: Length from tip of rostrum to posterior margin of telson, 14 mm (Fig. 10J). Rostrum with additional four or five ventral teeth.

Megalopa: Length from tip of rostrum to posterior margin of telson, 17 mm (Fig. 10K). Carapace has lost supraorbital spines. Telson narrows posteriorly (Fig. 10L). Telson posterior margin with spine, three fine hairs, and three pairs of small lateral spines. Pleopods biramous. Maxillipeds and pereopods lack exopods.

Pandalus jordani, **Pacific Ocean Shrimp**. *Pandalus jordan* averages about 100 mm in length but can reach 140 mm. Its range extends from Unalaska, Alaska, to at least as far south as San Diego, California. Adults are found mainly at 45–370 m depth (Morris et al., 1980). Off the coast of Crescent City,

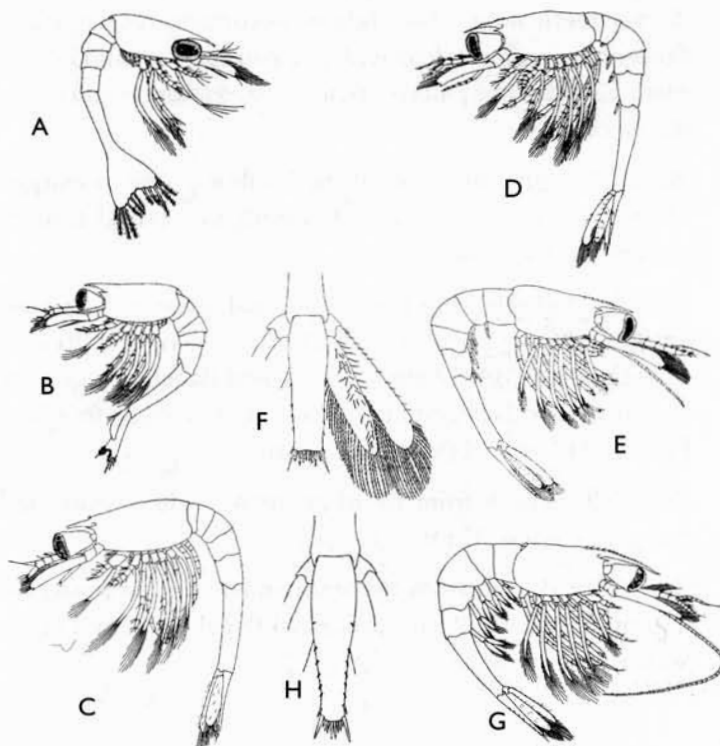


Fig. 11. *Pandalus jordani*.
(From Modin and Cox,
1967)

California, spawning occurs in November and December. Hatching occurs from late February through mid-May. Modin and Cox (1967) report *P. jordani* molting through 11–13 stages in about 80 days. Sizes below are from laboratory-reared larvae. Larvae described in Modin and Cox (1967).

Zoea I: Length from tip of antennal scale to posterior margin of telson, 5 mm (Fig. 11A). Rostrum thin and pointed, ca one-third length of carapace. Abdomen composed of five segments and triangular telson. Posterior margin of telson with seven pairs of setae. First, second, and third maxilliped pairs with swimming setae on exopods. Pereopods poorly developed.

Zoea II: Length from tip of antennal scale to posterior margin of telson, 6.5 mm (Fig. 11B). Carapace with pair of supraorbital spines. First and second pereopod pairs now with swimming setae on exopods. Abdomen now composed of six segments and telson. Posterior margin of telson with additional pair of setae. Uropods free.

Zoea III: Length from tip of antennal scale to posterior margin of telson, 7 mm. Third pereopod pair now with swimming setae on exopods.

Zoea IV: Length from tip of antennal scale to posterior margin of telson, 7.5 mm (Fig. 11C). Rostrum with two small dorsal teeth near base. Telson becoming rectangular. Posterior margin of telson with five pairs of setae and lateral margins with three pairs of spines. Uropods larger and more developed.

Zoea V: Length from tip of antennal scale to posterior margin of telson, 8 mm. Small pleopod buds on ventral side of abdominal segments 2–5.

Zoea VI: Length from tip of antennal scale to posterior margin of telson, 9.5 mm (Fig. 11D). Rostrum now with eight or nine dorsal teeth. Antennal scale and flagellum equal in length. Pleopods beginning to show signs of segmentation. Endopod of second pereopod chelate.

Zoea VII: Length from tip of antennal scale to posterior margin of telson, 11 mm.

Zoea VIII: Length from tip of antennal scale to posterior margin of telson, 12 mm. Antennal flagellum now longer than scale.

Zoea IX: Length from tip of antennal scale to posterior margin of telson, 13 mm (Fig. 11E, F). Endopod of first pereopod now cheliform.

Zoea X: Length from tip of antennal scale to posterior margin of telson, 14.5 mm.

Zoea XI: Length from tip of antennal scale to posterior margin of telson, 17 mm (Fig. G). Pleopods with setae. Telson (Fig. H) narrows posteriorly. Telson with seven pairs of small spines on lateral margin and five pairs of setae on posterior margin.

Pandalus platyceros, **Spot Shrimp**. *Pandalus platyceros* can reach a length of 253 mm as an adult. Its range extends from Unalaska, Alaska, to San Diego, California. Adults can be found from the intertidal zone to 487 m on rocky bottoms and vertical rock faces (Jensen, 1995). Females carrying eggs were collected in Dabob Bay, Washington, in early January. *Pandalus platyceros* molts through four zoeal stages and one megalopa. In the laboratory it took ca 35 days from hatching through the molt to the megalopa. Sizes below from laboratory-reared larvae. Larvae described in Price and Chew (1972).

Zoea I: Length from tip of rostrum to posterior margin of telson, 8.1 mm (Fig. 12A, B). Rostrum thin, extending just beyond tips of antennal scale. Rostrum with 12–13 dorsal

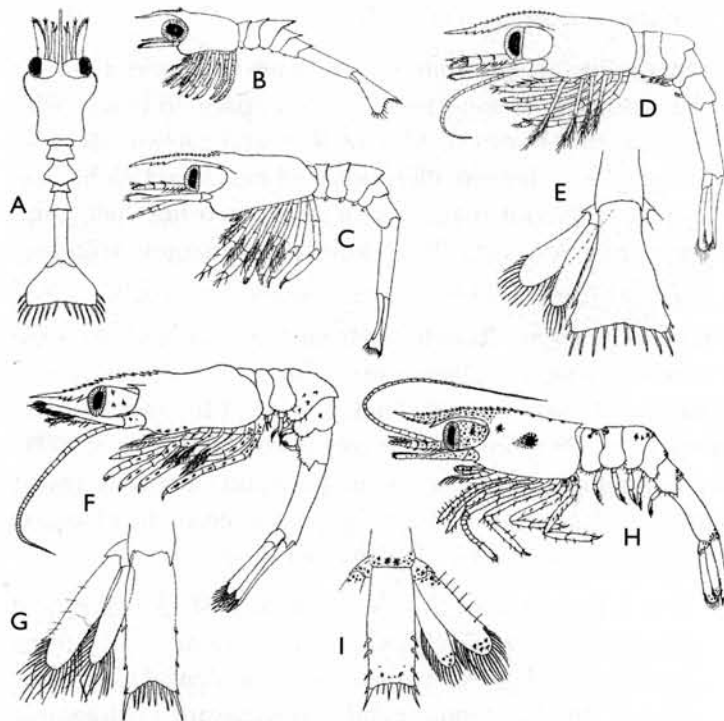


Fig. 12. *Pandalus platyceros*. (From Price and Chew, 1972)

teeth. Along outer edge of carapace, 23–25 fine denticles. Posterior margins of abdominal segments also with fine denticles. Abdomen composed of five segments unequal in size and triangular telson. Posterior margin of telson with eight pairs of setae. First, second, and third maxilliped pairs with swimming setae. Endopod of second pereopod pair chelate. Five pairs of small pleopod buds visible on ventral side of abdomen.

Zoea II: Length from tip of rostrum to posterior margin of telson, 10 mm (Fig. 12C). Denticles on carapace and abdominal segments fewer and finer. Carapace also with pair of antennal spines, pterygostomian spines, and supraorbital spines. Rostrum now with additional three to four ventral teeth. First, second, and third pereopod pairs with swimming setae on exopods. Fourth and fifth pereopod pairs lack exopods. Pleopods beginning to show signs of segmentation.

Zoea III: Length from tip of rostrum to posterior margin of telson, 11 mm (Fig. 12D). Fine denticles now gone from carapace and abdominal segments. Pleopods now biramous. Uropods free (Fig. 12E).

Zoea IV: Length from tip of rostrum to posterior margin of telson, 11.5–12 mm (Fig. 12F). Telson rectangular, with five pairs of setae on posterior margin and three pairs of spines on lateral margins (Fig. 12G).

Megalopa: Length from tip of rostrum to posterior margin of telson, 12–13 mm (Fig. 12H). Carapace no longer with supraorbital spines. Maxillipeds and pereopods now resemble adult form. Pleopods well developed with setae. Telson posterior margin with spine, two fine hairs, and another spine (Fig. 12I). Telson lateral margins with four pairs of small spines.

Pandalus stenolepis, **Rough Patch Shrimp**. *Pandalus stenolepis* can reach a length of 82 mm as an adult. Its range extends from Unalaska, Alaska, to Heceta Bank, Oregon. Adults can be found from 18 to 229 m on mud or cobble bottoms (Jensen, 1995). Descriptions of zoeae I and II are based on laboratory-reared larvae and zoeae III–VII on larvae collected in plankton samples. Larvae described in Needler (1938).

Zoea I: Length from tip of rostrum to posterior margin of telson, 5 mm (Fig 13A, B). Carapace margins and posterior margins of abdominal segments with fine denticles. Rostrum ca same length as carapace and slopes upward. First, second,

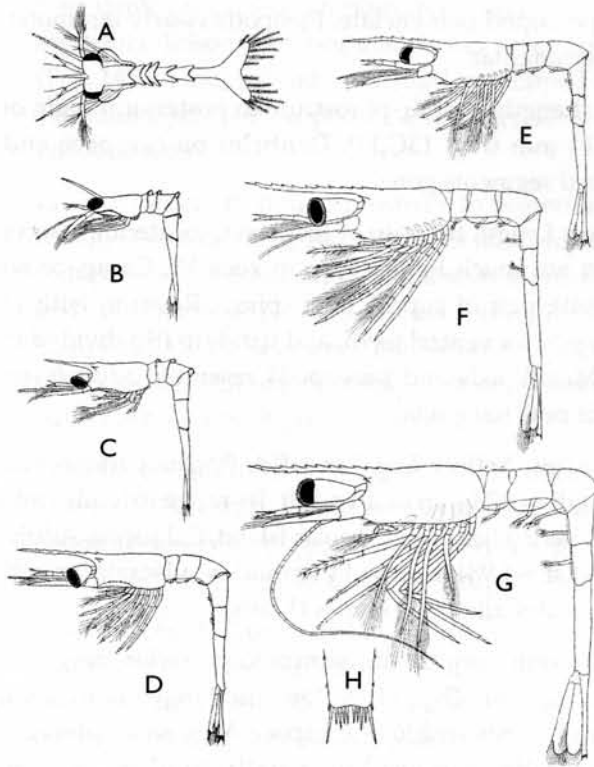


Fig. 13. *Pandalus stenolepis*. (From Needler, 1938)

and third maxilliped pairs with swimming setae on exopods. Pereopods poorly developed. Abdomen composed of five segments and triangular telson. Posterior margin of telson with seven pairs of setae.

Zoea II: Length from tip of rostrum to posterior margin of telson, 6 mm (Fig. 13C). Carapace now with pair of supraorbital spines. Rostrum with four to five dorsal teeth. Telson posterior margin with additional pair of setae.

Zoea III: Length from tip of rostrum to posterior margin of telson, 8 mm (Fig. 13D). Rostrum with eight to nine dorsal teeth and two ventral teeth. First, second, and third pereopod pairs with swimming setae on exopods. Small pleopod buds present on ventral side of abdomen. Uropods free, and telson margin with five posterior pairs of setae and three small pairs of lateral spines.

Zoea IV: Length from tip of rostrum to posterior margin of telson, 9 mm (Fig. 13E). Rostrum with 10–12 dorsal teeth and four ventral teeth. Pleopods beginning to show signs of segmentation.

Zoea V: Length from tip of rostrum to posterior margin of telson, 12 mm (Fig. 13F). Denticles on carapace and abdominal segments reduced considerably. Endopods of

second pereopod pair chelate. Pleopods clearly biramous. Telson rectangular.

Zoea VI: Length from tip of rostrum to posterior margin of telson, 14 mm (Fig. 13G,H). Denticles on carapace and abdominal segments gone.

Megalopa: Length from tip of rostrum to posterior margin of telson not much longer than in zoea VI. Carapace no longer with pair of supraorbital spines. Rostrum with 11 dorsal teeth, six ventral teeth, and trifold tip (tip divided in three). Maxillipeds and pereopods resemble adult form. Pleopods now have setae.

Pandalus tridens, **Yellow Leg Pandalid**. *Pandalus tridens* can reach a length of 123 mm as an adult. Its range extends from the western Bering Sea to San Nicolas Island, California. Adults can be found at 5–1,984 m on rocky or muddy substrate (Jensen, 1995). Larvae described in Haynes (1980).

Zoea I: Length from tip of rostrum to posterior margin of telson, 3.1–3.5 mm (Fig. 14A). Rostrum thin, without teeth, and ca two-thirds length of carapace. Very small pterygostomian spines present but usually hidden by eyes. Abdomen composed of five segments and triangular telson.

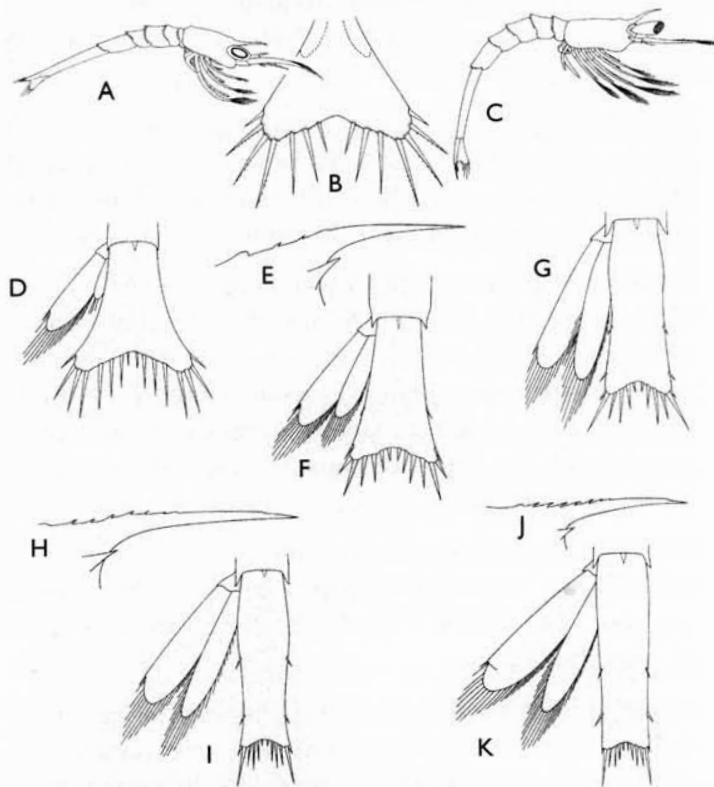


Fig. 14. *Pandalus tridens*.
(From Haynes, 1980)

Fine denticles present on posterior margins of abdominal segments. Telson posterior margin has seven pairs of setae (Fig. 14B). First, second, and third maxilliped pairs with swimming setae on exopods. Pereopods poorly developed and lack setae.

Zoea II: Length from tip of rostrum to posterior margin of telson, 3.9–4.6 mm (Fig. 14C). Rostrum now projects dorsally. Carapace with pair of supraorbital spines, antennal spines, and clearly visible pterygostomial spines. Abdomen now composed of six segments and telson. Telson posterior margin with eight pairs of setae. First and second pereopod pairs have swimming setae on exopods.

Zoea III: Length from tip of rostrum to posterior margin of telson, 5.6–6.3 mm. Denticles along posterior margin of abdominal segments reduced. Third pereopod pair now with swimming setae on exopods. Uropods free (Fig. 14D).

Zoea IV: Length from tip of rostrum to posterior margin of telson, 7.0–8.4 mm. Rostrum projects horizontally and has two teeth near base (Fig. 14E). Pleopods present as small bumps on ventral side of abdominal segments. Telson now with six pairs of setae on posterior margin and two pairs on lateral margins (Fig. 14F).

Zoea V: Pleopod buds longer. Telson narrower with well-developed uropods (Fig. 14G).

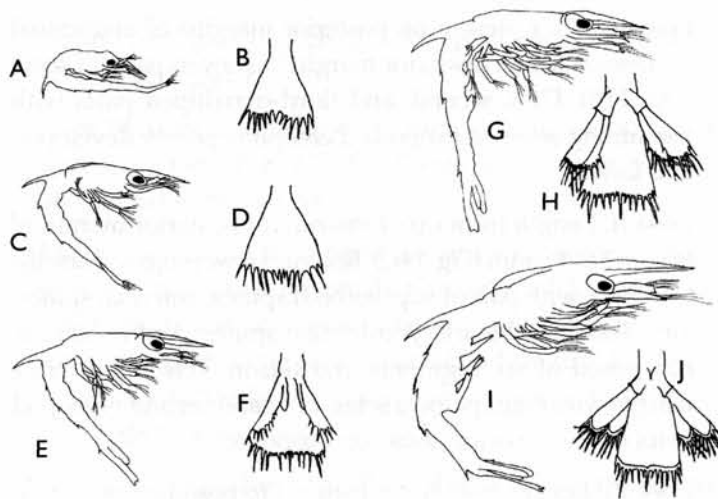
Zoea VI: Length from tip of rostrum to posterior margin of telson, 10.2–11.2 mm. Rostrum with six dorsal teeth and ca one-third length of carapace (Fig. 14H). Second pereopod pair chelate. Pleopods biramous. Telson nearly rectangular (Fig. 14I).

Zoea VII: Length from tip of rostrum to posterior margin of telson, 13.0 mm. Rostrum with seven dorsal teeth and almost half length of carapace (Fig. 14J). Telson lateral margins nearly parallel (Fig. 14K).

Family Callinassidae

Neotrypaea (Callinassa) californiensis, **Bay Ghost Shrimp**. *Neotrypaea californiensis* can reach a length of 120 mm as an adult. Its range extends from Mutiny Bay, Alaska, to Estero Punta Banda, Baja California. Adults can be found burrowing in bays and estuaries in the middle to low intertidal zone in sand and muddy sand, where they build multibranching tunnels (Jensen, 1995). In Yaquina Bay, Oregon, the main breeding season occurs in late spring and early summer.

Fig. 15. *Neotrypaea californiensis*. (From McCrow, 1972)



Neotrypaea californiensis molts through five zoeal stages. The length of the larval period is about six weeks. Sizes below are from larvae taken in plankton samples. Larvae described in McCrow (1972).

Zoea I: Length from tip of rostrum to posterior margin of telson, 2.8–3.6 mm (Fig. 15A). Rostrum long and cylindrical. Prominent spine on dorsal side of second abdominal segment. Telson triangular. Posterior margin of telson has five setae, one small fine hair, and small spine on each half extending from medial tooth outward (Fig. 15B).

Zoea II: Length from tip of rostrum to posterior margin of telson, 3.8–4.4 mm (Fig. 15C). Rostrum now dorsoventrally flattened with serrated margin. Posterior margin of telson with additional pair of spines added on each side of medial tooth (Fig. 15D).

Zoea III: Length from tip of rostrum to posterior margin of telson, 4.7–5.2 mm (Fig. 15E). Telson now with uropods (Fig. 15F).

Zoea IV: Length from tip of rostrum to posterior margin of telson, 5.5–6.3 mm (Fig. 15G,H). Three pairs of pleopod buds on ventral side of abdominal segments 3–5.

Zoea V: Length from tip of rostrum to posterior margin of telson, 6.8–7.5 mm (Fig. #15). Pleopods long and slender. Uropods well developed (Fig. 15J).

Family Upogebiidae

Upogebia pugettensis, **Blue Mud Shrimp**. *Upogebia pugettensis* can reach 150 mm in length as an adult. Its range extends from

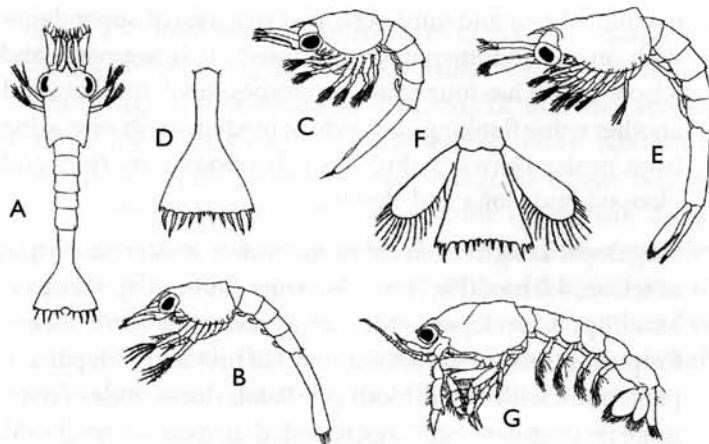


Fig. 16. *Upogebia pugettensis*. (From Hart, 1937)

Valdez Narrows, Alaska, to Morro Bay, California. Adults can be found burrowing in low intertidal mud or muddy sand, where they build Y-shaped burrows (Jensen, 1995). At Friday Harbor, Washington, females carrying eggs were found in December through February and in late spring/early summer. *Upogebia pugettensis* molts through three zoeal stages and one megalopa. Larvae are present in the plankton from February through June, but information on the length of their larval period was not found. Sizes below are from laboratory-reared larvae. Larvae described in Hart (1937).

Zoea I: Length from tip of rostrum to posterior margin of telson, 3.7 mm (Fig. 16A, B). Rostrum small and pointed, ca one-third length of antennules. Four swimming setae on exopods of first and second maxilliped pairs. Abdomen composed of five segments and triangular telson. Posterior margin of telson slightly indented in center. Telson posterior margin with five setae, one small, fine hair, and small spine on each half extending from center outward (Fig. 16A). Four pairs of small buds on ventral side of abdomen eventually develop into pleopods.

Zoea II: Length from tip of rostrum to posterior margin of telson, 4.4 mm (Fig. 16C). Six swimming setae on exopods of first, second, and third maxilliped pairs. First and second pereopod pairs also with six swimming setae on exopods, and third pereopod pair with five swimming setae on exopods. Telson now with additional pair of setae and small median tooth on posterior margin (Fig. 16D). Uropods of telson visible enclosed under membrane. Pleopods buds larger.

Zoea III: Length from tip of rostrum to posterior margin of telson, 5.4 mm (Fig. 16E). Six setae on exopods of first

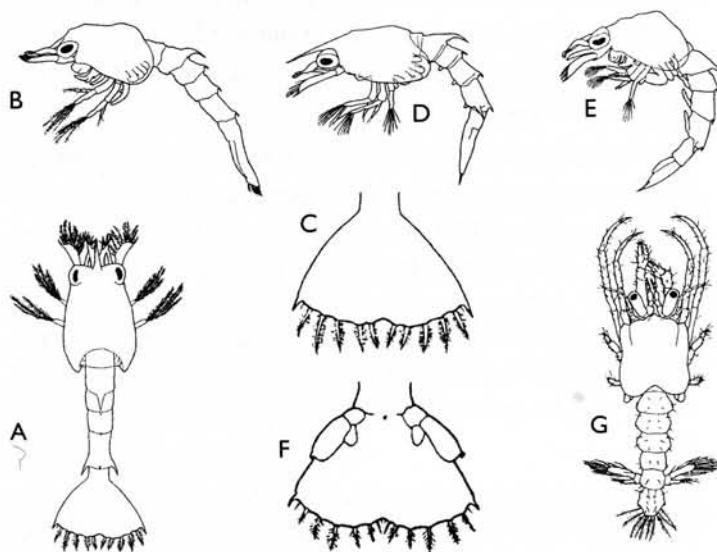
maxilliped pair and third pereopod pair, rest of appendages with seven. Abdomen now composed of six segments and telson. Telson has four setae, two spines, small fine hair, and another spine flanking each side of median tooth extending from center outward (Fig. 16F). Uropods now free, and pleopod buds long and slender.

Megalopa: Length from tip of rostrum to posterior margin of telson, 4.0 mm (Fig. 16G). Rostrum blunt in appearance. Maxillipeds and pereopods now resemble adult forms. Propodus (second-to-last segment) of first and fifth pairs of pereopods with small tooth on distal, dorsal side. Telson more rectangular, with large rounded uropods on each side, with long plumose setae on distal edges. Pleopods, now with long setae, present on abdomen segments 2-5.

Family Diogenidae

Paguristes turgidus, **Hermit Crab**. *Paguristes turgidus* can grow to a carapace length of 32 mm and is usually found occupying shells of *Fusitriton oregonensis*, the Oregon triton. Its range extends from the Chukchi Sea to San Diego, California. Adults are found subtidal on muddy sand at 5-465 m (Jensen, 1995). *Paguristes turgidus* molts through three non-feeding zoeal stages and one megalopa. Females are ovigerous November through September, and hatching occurs August through September. The length of the larval period is reported as being three to four times faster than with pagurid zoeae (Strathmann 1987). Sizes below are from laboratory-reared larvae. Larvae described in Hart (1937).

Fig. 17. *Paguristes turgidus*.
(From Hart, 1937)



Zoea I: Length from tip of rostrum to posterior margin of telson, 4.5 mm (Fig. 17A, B). Rostrum narrow, with length almost equal to antennules. Exopods of first and second maxilliped pairs have four swimming setae. Abdomen composed of five segments and triangular telson. Second abdominal segment with large spine on dorsal, distal margin. Abdominal segments 3–5 with similar smaller spines. Fifth abdominal segment with additional pair of posteriolateral spines. Posterior margin of telson has five setae, one small fine hair, and small spine on each half extending from center outward (Fig. 17C).

Zoea II: Length from tip of rostrum to posterior margin of telson, 4.5 mm (Fig. 17D). Exopods of first and third maxilliped pairs have seven swimming setae, and exopods of second maxilliped pair with eight swimming setae. Abdomen now composed of six segments and telson. Telson has additional pair of medial setae on posterior margin. Uropods visible enclosed under thin membrane on ventral side of telson. Four pairs of small buds on ventral side of abdomen eventually develop into pleopods.

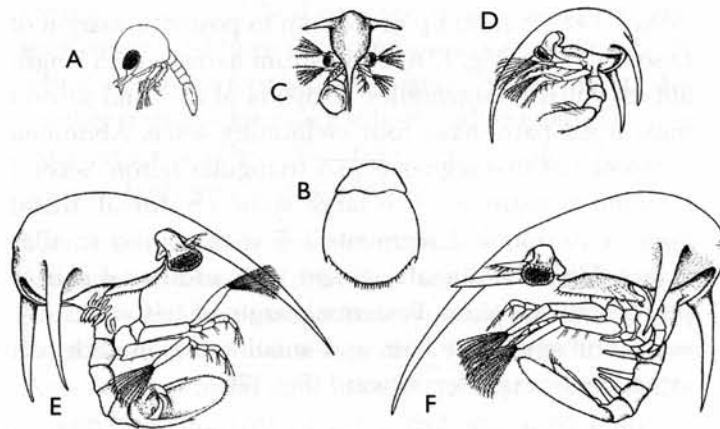
Zoea III: Length from tip of rostrum to posterior margin of telson, 4.4 mm (Fig. 17E). Exopods of first and second maxilliped pairs have eight swimming setae, and third maxilliped pair with seven setae on exopods. Telson with additional pair of medial setae on posterior margin (Fig. 17F). Uropods now free, and pleopod buds long and slender.

Megalopa: Length from tip of rostrum to posterior margin of telson, 3.0 mm (Fig. 17G). Rostrum small, almost blunt. Maxillipeds and pereopods now resemble adult forms. First pair of pereopods chelate and unequal in size. Second and third pereopods long and thin. Fourth and fifth pereopods small and armed with suckorial setae, fifth terminally chelate. Telson hexagonal, bearing two lateral spines and 10 setae on posterior margin. Pleopods with long setae present on abdominal segments 2–5.

Family Hippidae

Emerita analoga, **Pacific Sand Crab**. *Emerita analoga* can reach 40 mm in length. Its range extends from Kodiak, Alaska, to Chile. Adults are found on sandy beaches in the surf zone, moving up and down with the tide (Jensen, 1995). According to MacGinitie (1938), peak mating season is in May and June, which agrees with Johnson and Lewis's (1942) observation that the majority of the larvae are hatched in July and August.

Fig. 18. *Emerita analoga*.
(From Johnson and
Lewis, 1942)



Emerita analoga molts through five zoeal stages and one megalopa. Information on the length of the larval period was not found. Sizes below are from larvae taken in plankton samples. Larval description in Johnson and Lewis (1942).

Zoea I: Carapace ca 0.53 mm wide by 0.70 mm long (Fig. 18A). Rostrum short, stout, and pointed. No lateral spines present. Exopods of first and second maxilliped pairs have four swimming setae. Abdomen composed of four segments. Telson with rounded posterior margin having 26 spines (Fig. 18B); this number remains constant throughout remainder of zoeal stages.

Zoea II: Carapace ca 0.8 mm wide by 1.0 mm long (Fig. 18C). Rostrum longer and thinner. Two posteriolateral spines now present, almost as long as rostrum. First and second maxilliped pairs now have six swimming setae on exopods.

Zoea III: Carapace ca 1.3 mm wide by 1.6 mm long (Fig. 18D). Rostrum and posteriolateral spines longer. First and second maxilliped pairs with eight swimming setae on exopods. Telson now with uropod rudiments on ventral side.

Zoea IV: Carapace ca 2.0 mm wide by 2.4 mm long (Fig. 18E). First and second maxilliped pairs with 16 swimming setae on exopods. Abdomen now composed of five segments. Pereopod buds visible posterior to maxillipeds. Uropods on telson more developed.

Zoea V: Carapace ca 2.6 mm wide by 3.5 mm long (Fig. 18F). Number of swimming setae on exopods of first and second maxilliped pairs still 16. Pereopods longer and more slender with signs of segmentation. Uropods well developed, with endopod three-fourths length of exopod. Pleopod buds on ventral side of abdomen long and slender.

Family Lithodidae

Cryptolithodes typicus, **Butterfly Crab, Turtle Crab**. *Cryptolithodes typicus* can reach a carapace width of 80 mm as an adult. Its range extends from Amchitka Island, Alaska, to Santa Rosa Island, California. Adults are found from the low intertidal to 45 m (Jensen, 1995). *Cryptolithodes typicus* molts through four zoeal stages and one megalopa. The larval period from hatching to (but not including) the first juvenile zoea was 24 days in the laboratory. Sizes below are from laboratory-reared larvae. Larvae described in Hart (1965).

Zoea I: Length from tip of rostrum to posterior margin of telson, 3.0 mm (Fig. 19A, B). Rostrum wide at base, narrowing to point, extending almost to tips of antenna. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and long rectangular telson. Abdominal segments 2-5 with posterio-lateral spines and two small "teeth" on the posterior margin. Telson posterior margin with five setae, one small, fine hair, and another setae on each half extending from center outward (Fig. 19C).

Zoea II: Length from tip of rostrum to posterior margin of telson, 3.25 mm (Fig. 19D,E). First, second, and third maxilliped pairs with eight swimming setae on exopods. Pleopod buds may be present as small bumps.

Zoea III: Length from tip of rostrum to posterior margin of telson, 3.4 mm (Fig. 19F, G). Pleopods present as small buds. Otherwise resembles previous zoeal stages.

Zoea IV: Length from tip of rostrum to posterior margin of telson, 3.6 mm (Fig. 19H, I). Pleopod buds longer and larger. Otherwise resembles previous zoeal stages.

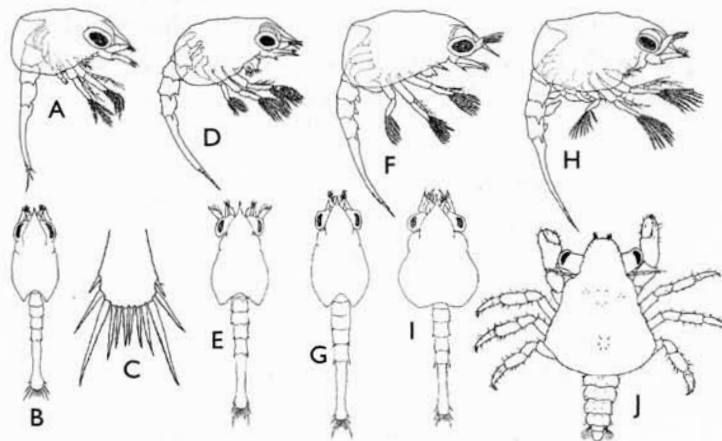


Fig. 19. *Cryptolithodes typicus*. (From Hart, 1965)

Megalopa: Length from tip of rostrum to posterior margin of telson, 2.8 mm (Fig. 19J). Rostrum blunt; carapace triangular. Maxillipeds and pereopods now resemble adult forms. First pereopod pair chelate, with right larger than left. Second, third, and fourth pereopod pairs long and stout. Fifth pereopod pair smaller and hidden under carapace. Posterior margin of telson bare of setae. Uropods and pleopods well developed, with long plumose setae.

Rhinolithodes wossnessenskii, **Rhinoceros Crab**. *Rhinolithodes wossnessenskii* can reach a carapace width of 64 mm as an adult. Its range extends from Kodiak, Alaska, to Crescent City, California. Adults are often found in crevices on rock or gravel bottoms at 6–73 m (Jensen, 1995). Haynes collected females bearing eggs in March near Auke Bay, Alaska. Although he was able to describe only two zoeal stages, it is likely that *R. wossnessenskii* molts through four zoeal stages and one megalopa, as do morphologically similar lithodid species. Sizes below are from laboratory-reared larvae. Larvae described in Haynes (1984).

Zoea I: Size from tip of rostrum to posterior margin of telson, ca 4.45 mm (Fig. 20A, B). Rostrum long and pointed, with length almost equal to antennae. Carapace with spine at mid-dorsal posterior margin and two posteriolateral spines. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and rectangular telson (Fig. 20C). Abdominal segments 2–5 with small teeth on dorsal posterior margin. Abdominal segment 5 with large pair of posteriolateral spines. Telson posterior margin with small spine, five setae, one small fine hair, and small spine on each half, extending from center outward.

Zoea II: Size from tip of rostrum to posterior margin of telson, ca 4.81 mm. First and second maxilliped pairs with seven swimming setae on exopods, and third maxilliped pair with six swimming setae on exopods. Other characteristics nearly identical to zoea I.

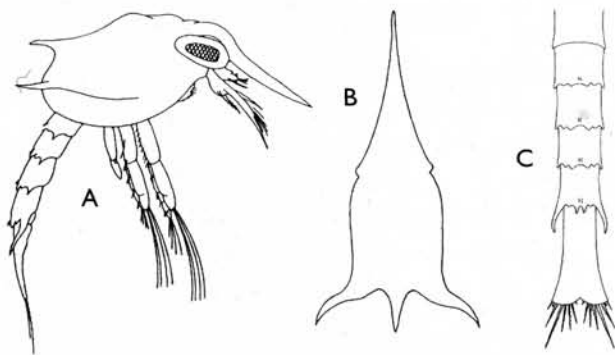


Fig. 20. *Rhinolithodes wossnessenskii*. (From Haynes, 1984)

Family Paguridae

The Paguridae are hermit crabs. Adults can range in size from as small as 6 mm carapace length up to 46 mm carapace length. Most are found intertidally, although some species are found at depths of 600 m or deeper.

Pagurid zoeae are morphologically very similar. The best way to distinguish them is by chromatophore pattern. Chromatophore patterns for several types of pagurid zoea are presented in Fig. 21. Chromatophores are, however, lost during preservation. For those trying to identify preserved pagurids, less extensive keys to four zoeal stages and megalopae based on preserved samples are presented here. There are no additional species descriptions, but the pagurid keys are illustrated by Figs. 22–30.

Key to pagurid zoeal stages (from Lough, 1975)

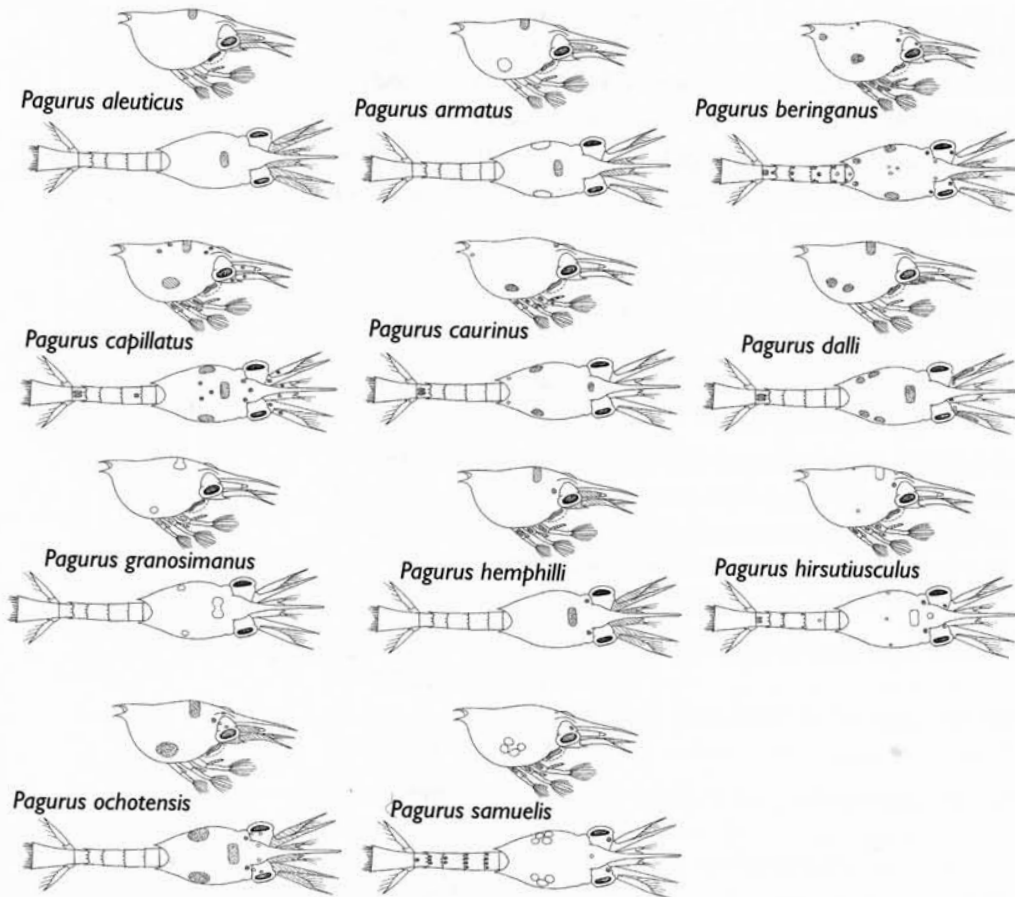
- 1a. Uropods absent; telson and sixth abdominal segment fused ... 2
- 1b. Uropods present; telson and sixth abdominal segment articulated 3
- 2a. Telson spines usually 6 + 6; 4 swimming setae on maxillipeds; eyes fixed Zoea I, Key A
- 2b. Telson spines usually 7 + 7; 4 swimming setae on maxillipeds; eyes movable Zoea II, Key B
- 3a. Pleopods absent, or small buds Zoea III, Key C
- 3b. Pleopods present Zoea IV, Key D

A. Key to pagurid zoeae I

- 1a. Carapace posterior processes short, end in small point or hook 2
- 1b. Carapace posterior processes more elongate, end in distinct point 5
- 2a. Antennal exopodite usually not as broad and shorter than rostrum; telson shape more triangular 3
- 2b. Antennal exopodite markedly broad but more tapered, equal or slightly less in length than rostrum; telson shape more rectangular 4
- 3a. Telson with broad base; total length, 2.68 mm
..... (Fig. 25) *Orthopagurus schmitti*
- 3b. Telson base not as broad; total size, 2.20 mm;
..... (Fig. 26) *Pagurus beringanus*
- 4a. Telson base squarer, with small notch; total size, 2.28 mm
..... (Fig. 22) *Pagurus granosimanus*
- 4b. Telson base with distinct notch separating convex halves; total size, 2.20 mm (Fig. 29) *Pagurus hirsutiusculus*

- 5a. Antennal endopodite with distinct double-pronged spine at apical end; antennal exopodite with distinct short spines; carapace with prominent mid-ridge; total size, 5.36 mm (Fig. 27) *Pagurus tanneri*
- 5b. Antennal endopodite and exopodite not as above 6
- 6a. Telson base narrow with notch separating convex halves; antennal exopodite slender; carapace posterior processes comparatively short; total size, 2.96 mm (Fig. 23) *Pagurus ochotensis*
- 6b. Telson broader at base with distinct notch separating more straight-edged base; antennal exopodite broader; carapace posterior processes more elongate; total size, 3.36 mm (Fig. 24) *Pagurus* sp. C
- 6c. Carapace posterior processes elongate with widely diverging edges, almost lithodid-like appearance; largest pagurid, total size, 6.7 mm (Fig. 28) *Pagurus* sp. I

Fig 21. Chromatophore patterns in pagurid zoea. Hatched circles, red chromatophores; Empty circles, yellow chromatophores; Stippled circles, orange chromatophores; Open hatching, diffuse blue pigment. (From Nyblade, 1974)



B. Key to pagurid zoeae II

- 1a. Antennal exopodite broad, shorter than rostrum 2
 1b. Antennal exopodite tapered, more elongate, length as long as rostrum 3
- 2a. Telson with broad base; total length, 3.64 mm
 (Fig. 25) *Pagurus schmitti*
 2b. Telson base not as broad; total size, 2.64 mm
 (Fig. 26) *Pagurus beringanus*
- 3a. Carapace posterior processes short, end in small point or hook 4
 3b. Carapace posterior processes more elongate, end in distinct point 5
- 4a. Telson base square, no notch, with 6 + 6 spines, fourth spine longest; total size, 2.6 mm (Fig. 22) *Pagurus granosimanus*
 4b. Telson base with notch separating convex halves, usual 7 + 7 spines with fifth spine longest; total size, 2.6 mm
 (Fig. 29) *Pagurus hirsutiusculus*
- 5a. Antennal endopodite with distinct double-pronged spine at apical end; antennal exopodite with distinct short spines; carapace with prominent mid-ridge; total size, 7.2 mm
 (Fig. 28) *Pagurus tanneri*
 5b. Antennal exopodite and endopodite not as above 6
- 6a. Telson base with notch separating convex halves
 (Fig. 23) *Pagurus ochotensis*
 6b. Telson base broader and concave, no notch 7
- 7a. Carapace posterior processes elongate, with widely diverging edges; almost lithodid-like appearance; total size, 7.6 mm
 (Fig. 28) *Pagurus* sp. I
 7b. Carapace posterior processes not as elongate, edges parallel; total size, 4.8 mm (Fig. 24) *Pagurus* sp. C

C. Key to pagurid zoeae III

- 1a. 2 primary setae on uropod inner margin; uropods narrow 2
 1b. 2 primary setae on uropod inner margin; uropod broader 3
- 2a. Telson posterior margin with 5 + 5 spines, fourth spine longest; no additional secondary setae on uropod inner margin; total length, 4.12 mm (Fig. 22) *Pagurus granosimanus*
 2b. Telson posterior margin with usual 7 + 7 spines, fifth spine longest; 1 additional small secondary seta on inner margin of uropods; total size, 3.68 (Fig. 29) *Pagurus hirsutiusculus*
- 3a. Telson posterior margin square; antennal exopodite broad; carapace posterior processes short; stout appearance 4
 3b. Telson posterior margin concave; antennal exopodite elongate; carapace posterior processes elongate; slender appearance 5

Fig 22. *Pagurus granosimanus*. (A, B) Zoea IV, generalized. (C–F) Telson (ventral view), zoea I–IV, respectively. (G–I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 4)

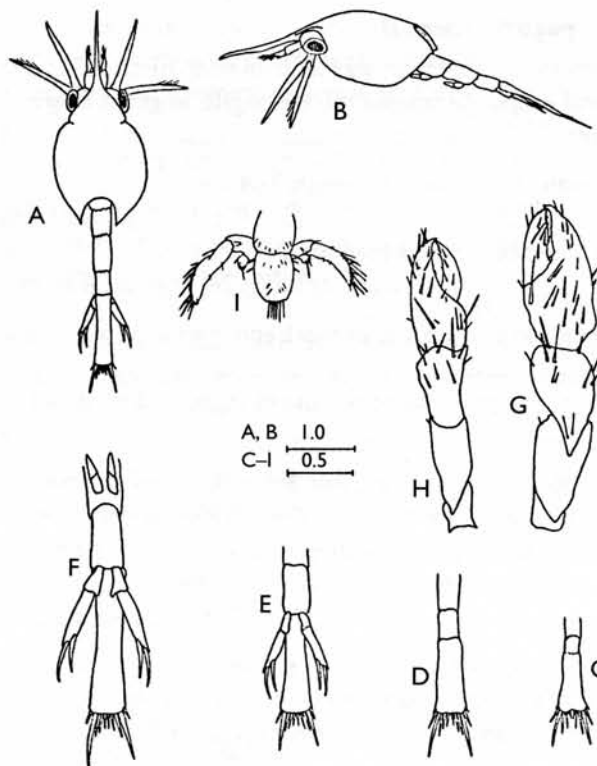
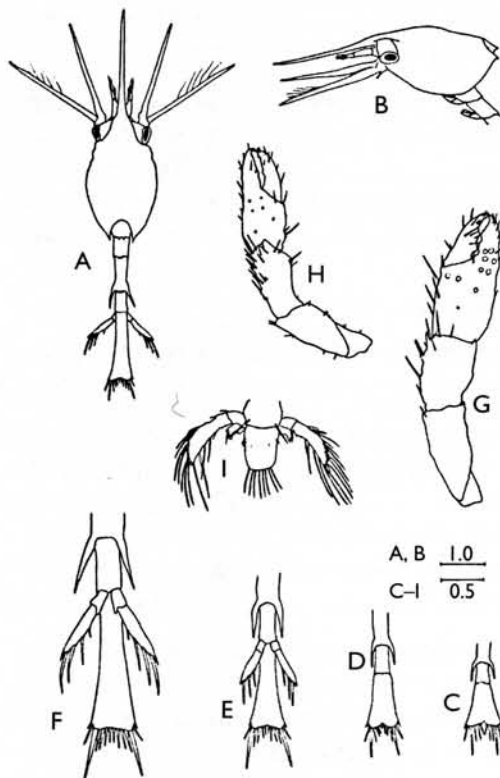


Fig 23. *Pagurus ochotensis*. (A, B) Zoea IV, generalized. (C–F) Telson (ventral view), zoea I–IV, respectively. (G–I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 5)



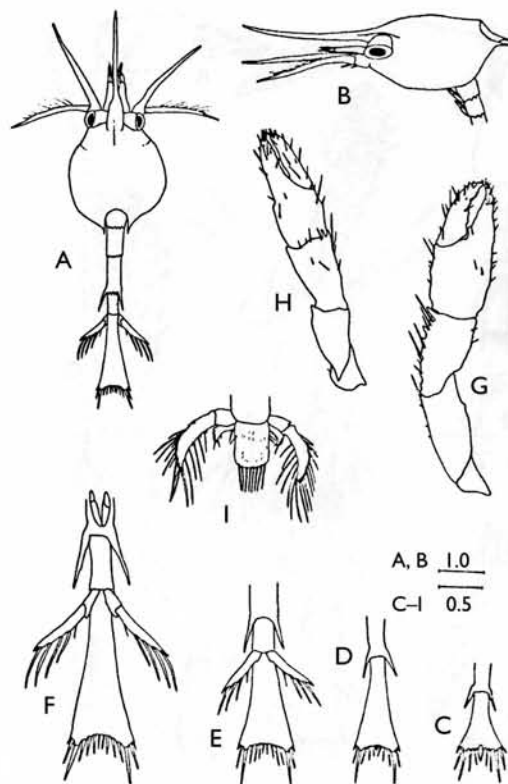


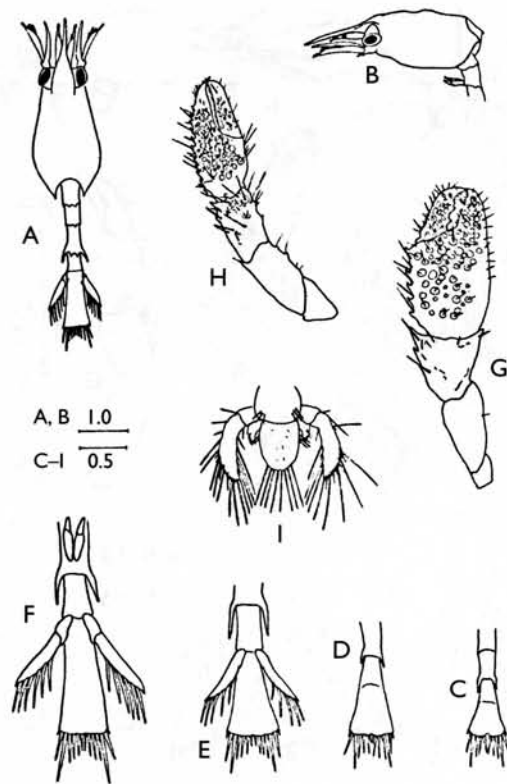
Fig 24. *Pagurus* sp. C. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. (G-I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 6)

- 4a. Uropod inner margin with 5 setae; total size, 5.40 mm
 (Fig. 24) *Orthopagurus schmitti*
- 4b. Uropod inner margin with 3 setae; total size, 3.28 mm
 (Fig. 26) *Pagurus beringanus*
- 5a. Antennal endopodite with distinct double-pronged spine at apical end; antennal exopodite with distinct short spines; uropod inner margin with 5 setae; carapace with prominent mid-ridges; total size, 8.96 mm (Fig. 27) *Pagurus tanneri*
- 5b. Antennal exopodite and endopodite not as above 6
- 6a. Uropod inner margin with 5 long setae; carapace posterior processes elongate, with widely diverging edges; almost lithodid-like in appearance; largest species, total size, 9.60 mm
 (Fig. 28) *Pagurus* sp. I
- 6b. Uropod inner margin with 3 setae; carapace posterior processes comparatively short with small central notch; total size, 5.60 mm (Fig. 23) *Pagurus ochotensis*
- 6c. Uropod inner margin with 4 setae, fourth seta weakly developed; carapace posterior processes intermediate in length; total size, 6.08 mm (Fig. 24) *Pagurus* sp. C

D. Key to pagurid zoeae IV

- 1a. 2 primary setae on uropod inner margin, uropods narrow 2
- 1b. 2 primary setae on uropod inner margin, uropods broader 3

Fig 25. *Orthopagurus schmitti*. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. (G-I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 7)



A, B 1.0
C-I 0.5

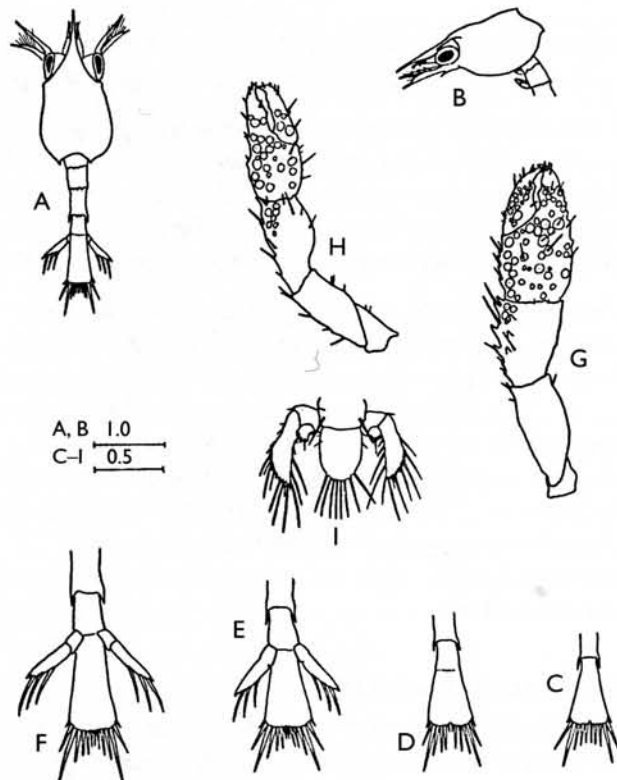


Fig 26. *Pagurus beringanus*. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. (G-I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 8)

A, B 1.0
C-I 0.5

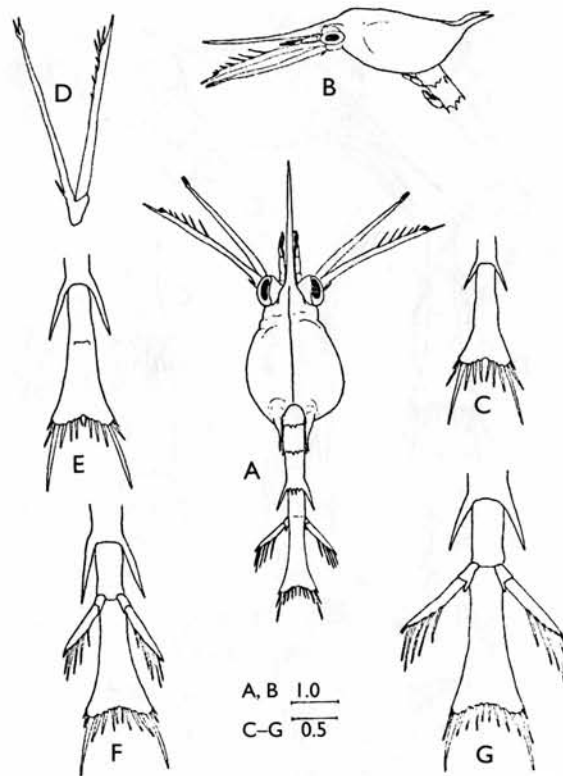


Fig 27. *Pagurus tanneri*. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. (G-I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 9)

- 2a. Telson posterior margin with 5 + 5 spines, fourth spine longest; no additional secondary setae on uropod inner margin; total length, 5.60 mm (Fig. 22) *Pagurus granosimanus*
- 2b. Telson posterior margin with usual 7 + 7 spines, fifth spine longest; 2 small secondary setae on inner margin of uropods; total size, 4.08 mm Fig. 29) *Pagurus hirsutiussculus*
- 3a. Telson posterior margin square; antennal exopodite broad; carapace posterior processes short; stout appearance 4
- 3b. Telson posterior margin concave; antennal exopodite elongate; carapace posterior processes elongate; slender appearance 6
- 4a. Uropod inner margin with 6 setae; total size, 6.80 mm (Fig. 25) *Orthopagurus schmitti*
- 4b. Uropod inner margin with 3 setae; smaller size 5
- 5a. Lateral spines on fifth abdominal segment short; antennae broader; total size, 3.92 (Fig. 26) *Pagurus beringanus*
- 5b. Lateral spines on fifth abdominal segment elongate, extending to sixth segment; antennae more slender; total size, 5.32 mm (Fig. 30) *Pagurus* sp.]
- 6a. Antennal endopodite with distinct double-pronged spine at apical end; antennal exopodite with distinct short spines; uropod inner margin with 5 setae; carapace with prominent mid-ridge; total size, 9.36 mm (Fig. 27) *Pagurus tanneri*
- 6b. Antennal exopodite and endopodite not as above 7

Fig 28. *Pagurus* sp. I. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. Scales in millimeters. (From Lough, 1975, Fig. 10).

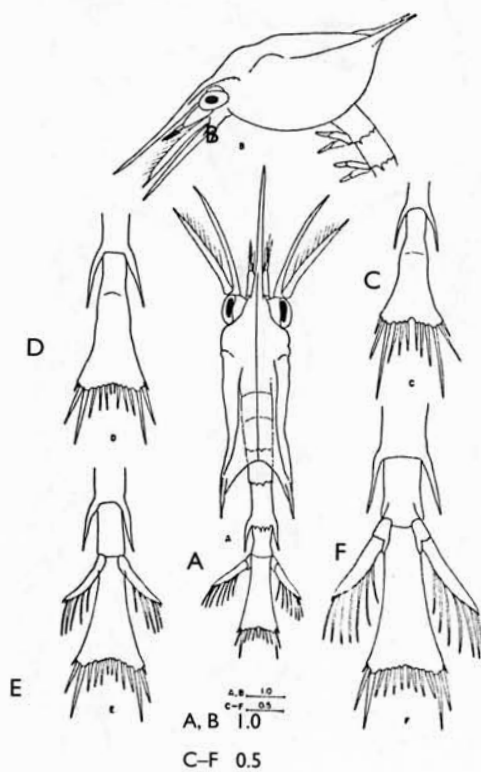
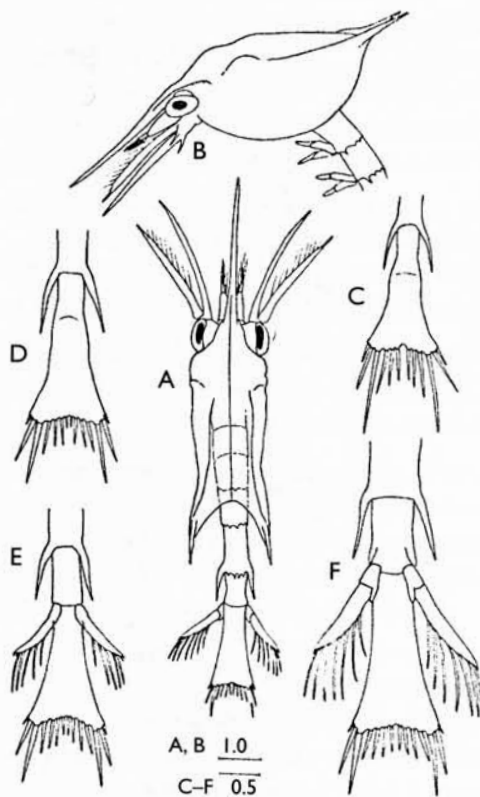


Fig. 29. *Pagurus hirsutiussculus*. (A, B) Zoea IV, generalized. (C-F) Telson (ventral view), zoea I-IV, respectively. (G-I) Right and left cheliped, telson of megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig. 11)



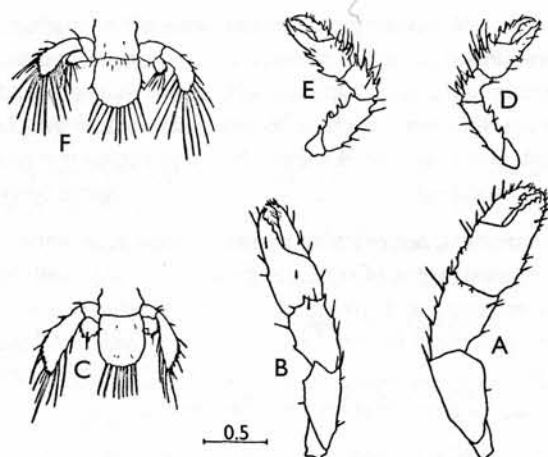


Fig. 30. (A-C) Right and left cheliped, telson of *Pagurus* sp. J. megalopa (dorsal view). (D-F) Right and left cheliped, telson of *Pagurus turgidus* megalopa (dorsal view). Scales in millimeters. (From Lough, 1975, Fig 12)

- 7a. Uropod inner margin with 7 long setae; carapace posterior processes elongate, with widely (Fig. 28) *Pagurus* sp. I
- 7b. Uropod inner margin with 4-5 setae 8
- 8a. Uropod inner margin with 4 setae, fourth seta weakly developed; carapace posterior processes comparatively short with small central notch; total size, 8.88 mm (Fig. 23) *Pagurus ochotensis*
- 8b. Uropod inner margin with 4-5 setae, fifth seta, if present, weakly developed; carapace posterior processes more elongate; telson posterior margin more convex; total size, 8.96 mm (Fig. 24) *Pagurus* sp. C

Key to pagurid megalopae

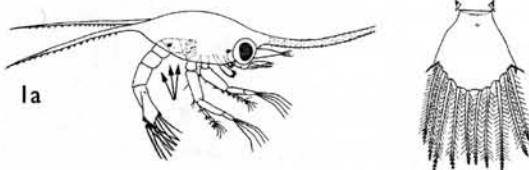
- 1a. Telson posterior margin with 6 setae; right uropod smaller than left; left cheliped smaller than right, chela smooth, moderately broad and hairy; carapace 1.64 mm long by 1.40 mm wide; total length, 3.40 mm (Fig. 22) *Pagurus granosimanus*
- 1b. Telson posterior margin with 10 setae; left uropod slightly smaller than right; both chelipeds ca equal size, narrow, heavily toothed and hairy; antennal scale scimitar-shaped; carapace 1.16 mm long by 1.00 mm wide; total length, 2.36 mm (Fig. 30) *Paguristes turgidus*
- 1c. Telson posterior margin with 8 setae 2
- 2a. Telson and uropods comparatively small and reduced; comparatively small chelipeds with few hairs, no teeth, and smooth surface; carapace 1.32 mm long by 1.00 mm wide; total length, 2.36 mm (Fig. 29) *Pagurus hirsutiusculus*
- 2b. Not as above 3
- 3a. Uropods ca equal in size; telson posterior margin rounded; chela broad with blunt tips, serrated margins 4
- 3b. Uropods unequal, left slightly larger; telson more rectangular; chela long and narrow with pointed tips, margins not serrated 5

- 4a. Carapace, 1.84 mm long by 1.80 mm wide, total length, 4.36 mm; antennal scale with 6 spines; chela and carpus margins heavily toothed (Fig. 25) *Orthopagurus schmitti*
- 4b. Carapace, 1.52 mm long by 1.36 mm wide, total length, 3.12 mm; antennal scale with 4 spines; chela and carpus margins not as heavily toothed (Fig. 26) *Pagurus beringanus*
- 5a. Antennae short, not reaching beyond chelipeds; antennal scale with 7 spines; carpus of right cheliped inner margin with several small teeth and short spines; telson with rounded posterior margin; carapace, 1.60 mm long by 1.20 mm wide; total size, 3.28 mm (Fig. 30) *Pagurus* sp. J
- 5b. Antennae long, reaching beyond chelipeds 6
- 6a. Carapace, 2.40 mm long by 2.28 mm wide, total size, 5.20 mm; telson more rectangular; uropods more elongate with narrower tips; chelipeds longer and narrower; inner margin of right carpus with ca 6 distinct teeth and several long spines; antennal scale with 9 spines (Fig. 24) *Pagurus* sp. C
- 6b. Carapace, 1.88 mm long by 1.64 mm wide, total size, 4.40 mm; telson posterior margin more rounded; uropods stouter; tips broader; chelipeds shorter and stouter; inner margin of right carpus with 4-5 moderate-sized spines; antennal scale with spines (Fig. 23) *Pagurus ochotensis*

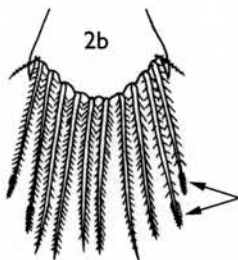
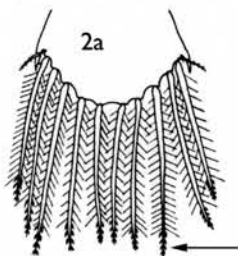
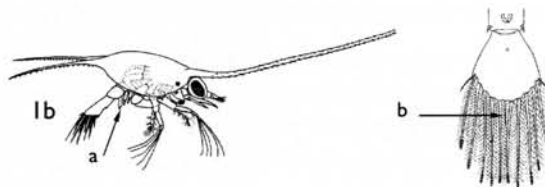
Family Porcellanidae

Key to porcellanid zoeae (illustrations from Gonor, 1970)

- 1a. Zoea without pleopods on abdomen, or just visible beneath cuticle; all setae on telson paired Zoea I, 2

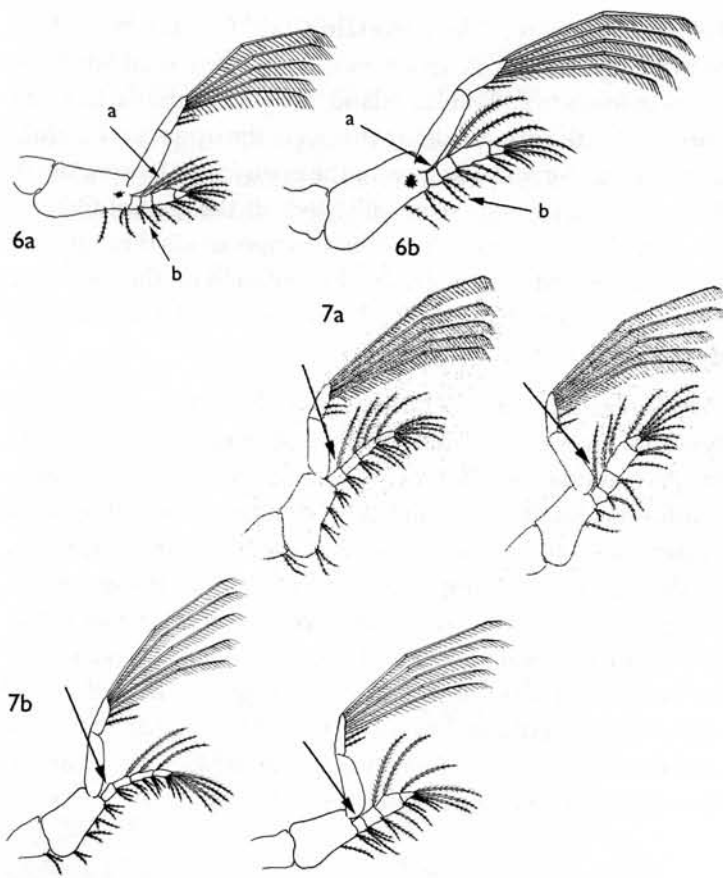
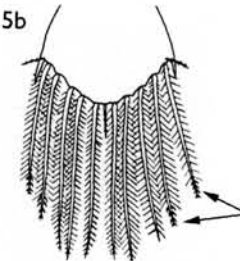
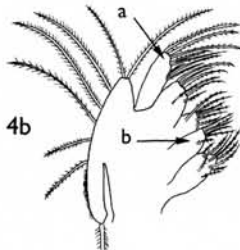
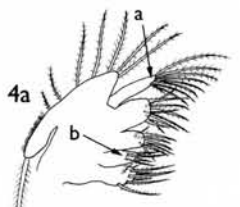
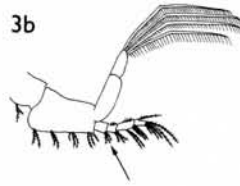
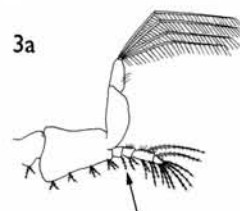


- 1b. Zoea with pleopods (a) on abdomen, 1 unpaired medial seta (b) on telson Zoea II, 5



- 2a. All 5 pairs of major telson setae with terminal brushes of heavy spines *Petrolisthes*, 3
- 2b. Only outer 2 pairs of major telson setae with terminal brushes of heavy spines *Pachychele*, 4

- 3a. 1 distal seta on the inner margin of segment 1 of endopod on maxilliped 1 *Petrolisthes cinctipes*
- 3b. 3 distal setae on the inner margin of segment 1 of endopod on maxilliped 1 *Petrolisthes eriomerus*
- 4a. 9 setae on endopod (a) of maxilla 2; 4 setae on distal lobe of coxal endite (b) of maxilla *Pachycheles rudis*
- 4b. 8 setae on endopod (a) of maxilla 2; 6 setae on distal lobe of coxal endite (b) of maxilla 2 *Pachycheles pubescens*
- 5a. All 5 pairs of major telson setae with terminal brushes of heavy spines *Petrolisthes*, 6
- 5b. Only outer 2 pairs of major telson setae with terminal brushes of heavy spines *Pachycheles*, 7
- 6a. 1 distal seta on outer margin (a), 2 distal setae on inner margin (b) of segment 1 of endopod on maxilliped 2
..... *Petrolisthes cinctipes*
- 6b. No setae on outer margin (a), 2 distal setae on inner margin (b) of segment 1 of endopod on maxilliped 2
..... *Petrolisthes eriomerus*
- 7a. Distal seta present on outer margin of segment 1 of endopod on maxilliped 1 and 2 *Pachycheles pubescens*
- 7b. Not as above *Pachycheles rudis*



Pachycheles pubescens, **Pubescent Porcelain Crab**. *Pachycheles pubescens* typically grows to a carapace width of 22 mm as an adult. Its range extends from the Queen Charlotte Islands to Cabo Thurloe, Baja California. Adults are found from the low intertidal to 55 m under rocks on the open coast or in inshore waters in areas with strong currents (Jensen, 1995). Females bearing eggs were collected off the central Oregon coast in May and June. *Pachycheles pubescens* molts through two zoeal stages and one megalopa. Information on the timing of hatching and length of the larval period were not found. Larvae described in Gonor and Gonor (1973a).

Pachycheles rudis, **Thick-clawed Porcelain Crab**. *Pachycheles rudis* typically grows to a carapace width of 19 mm as an adult. Its range extends from Kodiak, Alaska, to Bahía Magdalena, Baja California. Adults are found from the low intertidal to 29 m under rocks or nestled in holes (Jensen, 1995). Females bearing eggs were collected off the central Oregon coast in May and June. *Pachycheles rudis* molts through two zoeal stages and one megalopa. Information on the timing of hatching and length of the larval period were not found. Larvae described in Gonor and Gonor (1973a).

Petrolisthes cinctipes, **Flat Porcelain Crab**. *Petrolisthes cinctipes* typically grows to a carapace width of 24 mm as an adult. Its range extends from Porcher Island, British Columbia, to Santa Barbara, California. Adults are found in the upper and middle intertidal under rocks on or near the open coast (Jensen, 1995). Females bearing eggs were collected off the central Oregon coast in May and June. *Petrolisthes cinctipes* molts through two zoeal stages and one megalopa. Information on the timing of hatching and length of the larval period were not found. Larvae described in Gonor and Gonor (1973a).

Petrolisthes eriomerus, **Flattop Crab**. *Petrolisthes eriomerus* typically grows to a carapace width of 19 mm as an adult. Its range extends from Chicagof Island, Alaska, to La Jolla, California. Adults are found from the low intertidal to 86 m under rocks on the open coast or in sheltered waters (Jensen, 1995). Females bearing eggs were collected off the central Oregon coast in May and June. *Petrolisthes eriomerus* molts through two zoeal stages and one megalopa. Brood laying occurs February through mid-April, hatching May through mid-August. Second broods are produced mid-May through August, hatching August through early October. Larvae described in Gonor and Gonor (1973a).

Family Cancridae

Zoeae of the genus *Cancer* are morphologically very similar. Below is a general description of the five zoeal stages and megalopa applicable to all local *Cancer* species (Fig. 31). Species details follow.

Zoea I (Fig. 31A): Carapace with thin pointed rostrum ca as long as dorsal spine and pair of smaller lateral spines. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and forked telson (Fig. 31B). Second abdominal segment with small lateral knobs. Each abdominal segment with small posterior lateral extensions that lengthen in successive stages. Each furca of telson with three inner setae and 1–2 exospines.

Zoea II (Fig. 31C): First and second maxilliped pairs with six swimming setae on exopods. Each furca of telson with three or four inner setae.

Zoea III (Fig. 31D): First and second maxilliped pairs with eight swimming setae on exopods. Each furca of the telson now with four or five inner setae.

Zoea IV (Fig. 31E): First and second maxilliped pairs with 10 swimming setae on exopods. Pleopod buds on abdominal segments 2–5 and uropod buds on segment 6. Each furca of telson now with five inner setae (Fig. 31F).

Zoea V (Fig. 31G): First and second maxilliped pairs with 11 and 12 swimming setae on exopods, respectively. Pleopod buds on abdominal segments increased in size.

Megalopa (illustrated in Key B, the megalopa key): Carapace with prominent rostrum and dorsal spine. Maxillipeds and

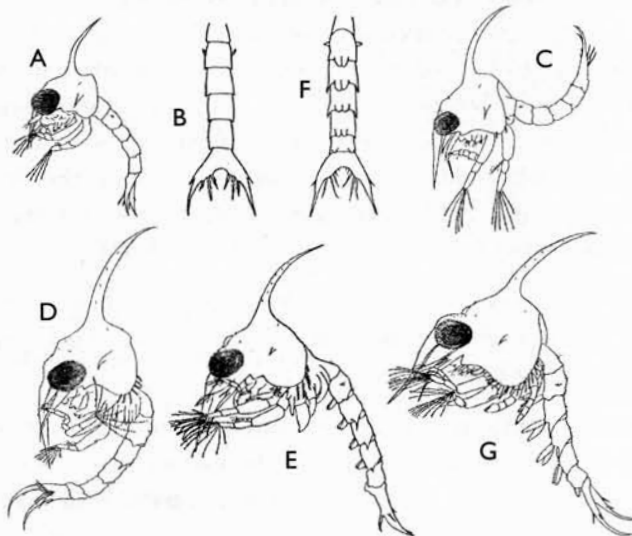


Fig. 31. *Cancer* spp. (From Ally, 1975)

pereopods now resemble adult form. First pereopod pair chelate, pereopod pairs 2–5 walking legs. Three long setae on dactyl (last segment) of fifth pereopod pair.

Cancer antennarius, **Pacific Rock Crab**. *Cancer antennarius* females usually grow to a carapace width of 148 mm; males reach a width of 178 mm. The range extends from Queen Charlotte Sound, British Columbia, to Cabo San Lucas, Mexico. Adults are found in the low intertidal under large rocks and subtidally to 91 m on gravel bottoms and in kelp beds (Jensen, 1995). Females bearing eggs were collected from South Humboldt Bay, California, in April. Information on the timing and length of larval period was not found. Sizes below are from laboratory-reared larvae. Larvae described in Roesijadi (1976).

Zoea I: Length from tip of telson to tip of rostrum, 1.8 mm. Telson with two pairs of lateral exospines.

Zoea II: Length from tip of telson to tip of rostrum, 2.0 mm.

Zoea III: Length from tip of telson to tip of rostrum, 2.3 mm. Each furca of telson now with four inner setae.

Zoea IV: Length from tip of telson to tip of rostrum, 3.1 mm. Each furca of telson now with five inner setae.

Zoea V: Length from tip of telson to tip of rostrum, 4.4 mm.

Megalopa: Carapace 2.3–3.3 mm long, 1.4–2.4 mm wide. Single stout spine on ischiopodite of cheliped. *Cancer antennarius* megalopae similar in appearance to those of *C. gracilis*; former slightly stouter.

Cancer gracilis, **Graceful Crab**. *Cancer gracilis* females typically grow to a carapace width of 87 mm; males reach 115 mm. The range extends from Prince William Sound, Alaska, to Bahía Playa María, Mexico. Adults are found primarily subtidally to 143 m on sand or mud (Jensen, 1995). Females carrying eggs were collected from San Pedro Bay, California, in September. The eggs hatched in late September and reached the first juvenile instar 42–47 days later. Sizes below are from laboratory-reared larvae. Larvae described in Ally (1975).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1.1 mm. Telson with one pair of dorsal exospines and one pair of lateral exospines.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 1.5 mm.

Zoea III: Length from tip of rostrum to tip of dorsal spine, 1.9 mm. Each furca of telson now with four inner setae.

Zoea IV: Length from tip of rostrum to tip of dorsal spine, 2.5 mm. Each furca of telson now with five inner setae.

Zoea V: Length from tip of rostrum to tip of dorsal spine, 3.3 mm.

Megalopa: Carapace 2.3–3.3 mm long, 1.4–2.4 mm wide. *Cancer gracilis* megalopae similar in appearance to those of *C. antennarius*; former with more slender appearance.

Cancer magister, **Dungeness Crab**. *Cancer magister* typically grows to a carapace width of 190–230 mm (rarely 330 mm). Its range extends from the Pribilof Islands to Santa Barbara, California. Adults are most commonly found subtidally on sandy bottoms and in eelgrass beds (Jensen, 1995). Strathmann (1987) reports egg deposition October through December, but mostly November and December, in Washington and Oregon. Hatching occurs January through early March, but mostly January and February, off northern California and Oregon. The larval period is 80–160 days. Sizes below are from laboratory-reared larvae. Larvae described in Poole (1966); lengths for zoea II and zoea IV not provided.

Zoea I: Length from tip of rostrum to tip of telson, 2.5 mm. Telson with one pair of dorsal exospines and one pair of lateral exospines.

Zoea II: Each furca of telson now with four inner setae.

Zoea III: Length from tip of rostrum to tip of telson, 4 mm. Each furca of telson now with five inner setae.

Zoea V: Length from tip of rostrum to tip of telson, 9 mm.

Megalopa: *Cancer magister* is the largest cancrid. Carapace length from tip of rostrum to posterior margin of carapace, 5.3–6.6 mm; width at widest point, 3.5–4.6 mm.

Cancer oregonensis, **Pygmy Rock Crab**. *Cancer oregonensis* typically grows to a carapace width of 53 mm. Its range extends from the Pribilof Islands to Palos Verdes, California. Adults are found in the low intertidal and subtidally to 436 m (Jensen, 1995), often under rocks and in holes, crevices, and kelp holdfasts (Strathmann, 1987). In southern Puget Sound, Washington, ovigerous females are found November through March. Information on the length of the larval period was not found. Sizes below are from larvae taken in plankton samples. Larvae illustrated in Lough (1975).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1.64 mm. Telson with two pairs of lateral exospines.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 2.6 mm.

Zoea III: Length from tip of rostrum to tip of dorsal spine, 3.36 mm. Each furca of telson now with four inner setae.

Zoea IV: Length from tip of rostrum to tip of dorsal spine, 4.48 mm. Each furca of telson now with five inner setae.

Zoea V: Length from tip of rostrum to tip of dorsal spine, 5.28 mm.

Megalopa: Carapace length from tip of rostrum to posterior margin of carapace ca 3.4 mm; width at widest point, ca 2.2 mm. *Cancer oregonensis* is similar in appearance and size to *C. productus*.

Cancer productus, **Red Rock Crab**. *Cancer productus* females grow to a carapace width of 158 mm; males reach 200 mm. The range extends from Kodiak, Alaska, to Isla San Martín, Baja California. Adults are found from the middle intertidal to 79 m, most commonly in protected boulder beaches or gravelly bottoms (Jensen, 1995). Females in the laboratory produced egg masses between December and April. Information on the length of the larval period was not found. Sizes below are from laboratory-reared larvae. Larvae described in Trask (1970).

Zoea I : Length from tip of rostrum to tip of telson, 2.5 mm. Telson with one pair of lateral exospines.

Zoea II : Length from tip of rostrum to tip of telson, 3.0 mm.

Zoea III : Length from tip of rostrum to tip of telson, 3.5 mm. Each furca of telson now with five inner setae.

Zoea IV : Length from tip of rostrum to tip of telson, 4.0 mm.

Zoea V: Length from tip of rostrum to tip of telson, 5.5 mm.

Megalopa: Carapace length from tip of rostrum to posterior margin of carapace, 3.4–3.6 mm; width at widest point, 2.0–2.1 mm. *Cancer productus* is similar in appearance and size to *C. oregonensis*.

Family Grapsidae

Hemigrapsus zoeae are very similar in appearance. General descriptions of the five zoeal stages and the megalopa are given below and followed by species descriptions.

Zoea I: (Fig. 32A) Carapace with rostrum and dorsal spine of ca equal length, and smaller pair of lateral spines. Rostrum ca one-third longer than antennae. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and telson. Second segment with pair of lateral knobs (in *H. nudus*, third segment with pair of smaller lateral knobs). Each furca of telson with three inner setae. No exospines present on telson.

Zoea II (Fig 32B): Rostrum now two-thirds longer than antennae. First and second maxilliped pairs with six swimming setae on exopods. Abdomen now composed of six segments.

Zoea III (Fig. 32C): First and second maxilliped pairs with eight swimming setae on exopods. Each furca of telson now with four inner setae.

Zoea IV (Fig. 32D): First and second maxilliped pairs with 10 swimming setae on exopods. Pleopod buds on abdominal segments 2-5, and uropod buds on segment 6. Each furca of telson now with five inner setae.

Zoea V (Fig. 32E): First and second maxilliped pairs with 12 swimming setae on exopods. Pleopod buds on abdominal segments 2-5 and uropod buds on segment 6 now larger.

Megalopa (illustrated in Key B, the megalopa key): Carapace smooth, with small rostrum bent downward. Maxillipeds and pereopods now resemble adult form. First pereopod pair chelate, pereopod pairs 2-5 walking legs. Three long setae present on dactyl (last segment) of fifth pereopod.

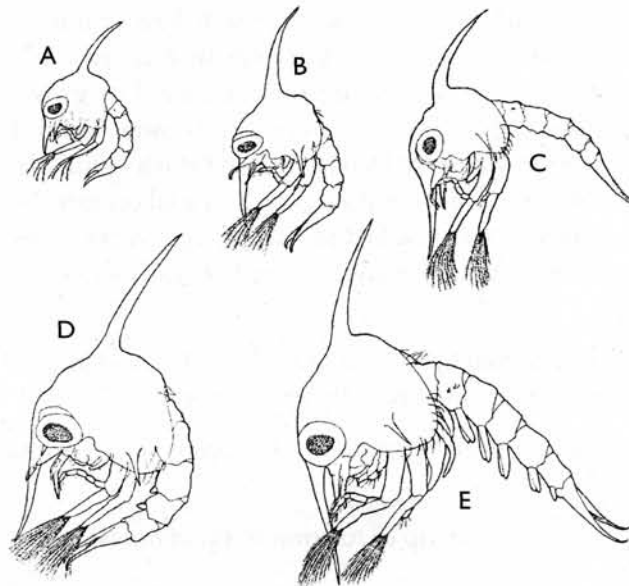


Fig. 32. *Hemigrapsus* spp.
(From Hart, 1935)

Hemigrapsus nudus, **Purple Shore Crab**. *Hemigrapsus nudus* females grow to a carapace width of 34 mm; males typically reach 56 mm. The range extends from Yakobi Island, Alaska, to Bahía de Tortuga, Mexico. Adults are found among rocks in the high and middle intertidal on exposed coasts (Jensen, 1995). Around Departure Bay, British Columbia, females carrying eggs were found by Hart (1935) in April and May. Females in berry have been reported as late as June and July at Friday Harbor, Washington. Information on the length of the larval period was not found. Sizes below are from laboratory-reared larvae. Larvae described in Hart (1935).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1.2 mm. Second segment with pair of lateral knobs, and third segment with pair of smaller lateral knobs.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 1.6 mm.

Zoea III: Length from tip of rostrum to tip of dorsal spine, 2.2 mm.

Zoea IV: Length from tip of rostrum to tip of dorsal spine, 2.8 mm.

Zoea V: Length from tip of rostrum to tip of dorsal spine, 3.5 mm.

Megalopa: Carapace length front to back, 1.8 mm; width at widest point, 1.5 mm. Posterior margin of telson with short setae (other than uropod setae).

Hemigrapsus oregonensis, **Yellow Shore Crab**. *Hemigrapsus oregonensis* can reach a carapace width of 50 mm as an adult. Its range extends from Resurrection Bay, Alaska, to Baja California. Adults are found in mudbank burrows in estuaries and throughout the intertidal among rocks on mud or gravel bottoms (Jensen, 1995). Females carrying eggs were collected near Vancouver in March. At Departure Bay, British Columbia, eggs hatch from mid-May until August. In the laboratory the first instar juvenile was reached in four to five weeks. Sizes below are from laboratory-reared larvae. Larvae described in (Hart 1935).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1.1 mm. Second segment only with pair of lateral knobs.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 1.6 mm.

Zoea III: Length from tip of rostrum to tip of dorsal spine, 2.0 mm.

Zoea IV: Length from tip of rostrum to tip of dorsal spine, 2.5 mm.

Zoea V: Length from tip of rostrum to tip of dorsal spine, 2.5 mm.

Megalopa: Carapace length front to back, 1.7 mm; width at widest point, 1.2 mm. Carapace narrower than in *H. nudus*. Posterior margin of telson without setae (other than uropod setae).

Pachygrapsus crassipes, **Striped or Lined Shore Crab.**

Pachygrapsus crassipes reaches a carapace width of 48 mm as an adult. Its range extends from Ecola State Park, Oregon, to the Gulf of California. Adults are found in the upper and middle intertidal of rocky shores and also in estuaries (Jensen, 1995). Females carrying eggs were collected from Seal Beach, California, from May through November. *Pachygrapsus crassipes* molts through five zoeal stages (there may be a sixth and seventh zoeal stages, Claudio DiBacco pers. comm.) and one megalopa. In the laboratory the larval period from hatching through the fifth zoea was 95 days. Sizes below are from laboratory-reared larvae. Larvae described in Schlotterbeck (1976).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1.0 mm (Fig. 33A). Carapace with rostral and dorsal spines only, small lateral spines not present until zoea II. Rostral spine equal in length to antennae. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of six unequal segments and forked telson (Fig. 33B). Abdominal segments 1–5 with small posterior lateral

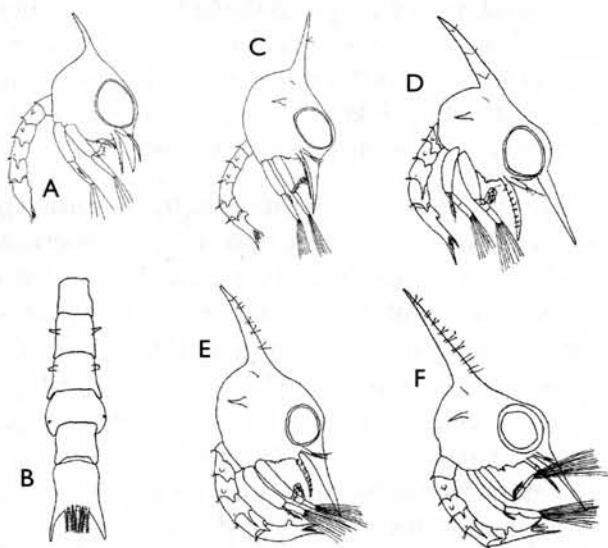


Fig. 33. *Pachygrapsus crassipes*. (From Schlotterbeck, 1976)

extensions which lengthen in successive stages. Second and third abdominal segments with lateral knobs. Each furca of telson has three inner setae. No exospines present on telson, but knob projecting from ventral surface of telson.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 1.2 mm (Fig. 33C). Carapace now with small lateral spines. Antennae now two-thirds length of rostrum. First and second maxilliped pairs with six swimming setae.

Zoea III: Length from tip of rostrum to tip of dorsal spine, 1.5 mm (Fig. 33D). First and second maxilliped pairs with eight swimming setae.

Zoea IV: Length from tip of rostrum to tip of dorsal spine, 1.75 mm (Fig. 33E). First and second maxilliped pairs with 10 swimming setae.

Zoea V: Length from tip of rostrum to tip of dorsal spine, 2.5 mm (Fig. 33F). First and second maxilliped pairs with 12 swimming setae.

Megalopa: Carapace length front to back, 4.1 mm; width at widest point, 3 mm (size from field samples). Second-largest megalopa found off the coast of Oregon.

Family Majidae

Chionoecetes bairdi, **Tanner Crab**. *Chionoecetes bairdi* females typically grow to a carapace width of 81 mm; males can reach 140 mm. The range extends from the Bering Sea to Winchester Bay, Oregon. Adults are found at 6–474 m on sand or mud bottoms (Jensen, 1995). *Chionoecetes bairdi* molts through two zoeal stages and one megalopa. In the Gulf of Alaska, broods are produced April and May and hatch ca 11 months later. The larval period is ca 90 days (Strathmann, 1987). Sizes below are from larvae taken in plankton samples. Larvae described in Haynes (1973, 1981a) and Jewett and Haight (1977).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 4.0–4.5 mm (Fig. 34A). Carapace with relatively short lateral spines. Rostrum long, thin, and spinulate. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and forked telson (Fig. 34B). Abdominal segments 2 and 3 with small lateral spines; abdominal segments 3–5 with long posteriolateral spines. Each furca of telson with three inner setae, lateral exospine, smaller dorsal exospine, and a dorsal exospine located between previous two.

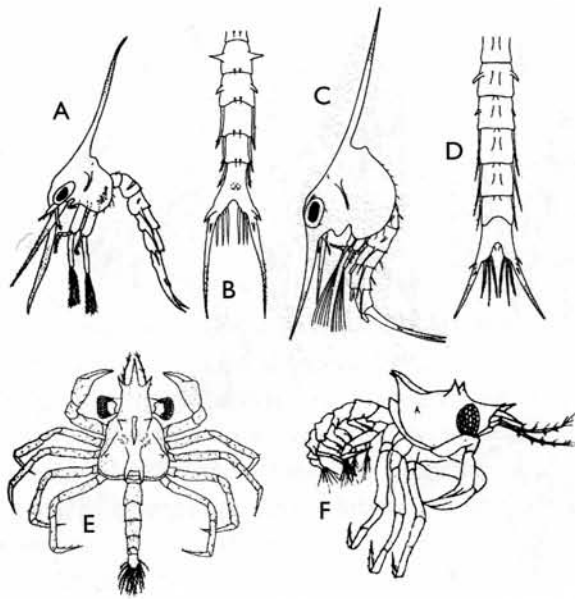


Fig. 34. *Chionoecetes bairdi*. (From Haynes, 1973, 1981a; Jewett and Haight, 1977)

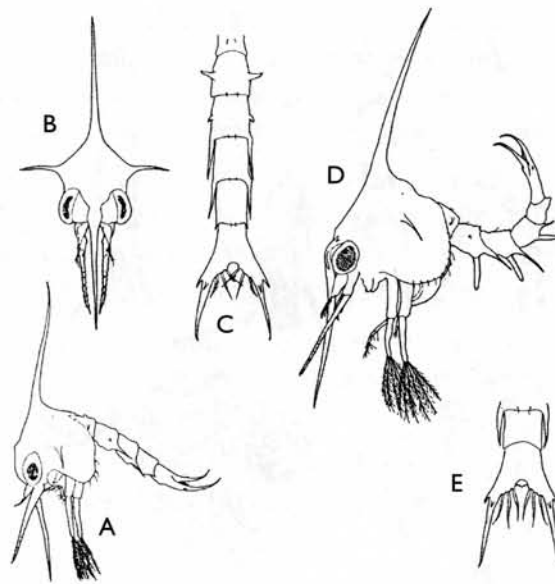
Zoea II: Length from tip of rostrum to tip of dorsal spine, 6.0–6.4 mm (Fig. 34C). First and second maxilliped pairs with six swimming setae on exopods. Abdomen now composed of six segments, and placement of spines on segments unchanged. Spine lengths increased (Fig. 34D). Each half of telson with additional fine seta added medially. Pleopod buds now present on the ventral side of abdominal segments 2–5.

Megalopa: Carapace length 3.1–3.5 mm; width at widest point, 1.8–2.1 mm. Carapace with pair of anteriolateral spines, pair of mid-dorsal spines, small pair of lateral spines, and set of posterior spines (Fig. 34E, F). Maxillipeds and pereopods now resemble adult form. First pereopod pair chelate, pereopod pairs 2–5 walking legs.

Oregonia gracilis, **Graceful Decorator Crab**. *Oregonia gracilis* reaches 39 mm carapace width as an adult. Its range extends from the Bering Sea to Monterey, California. Adults are found from the intertidal to 436 m on bottoms of mixed composition (Jensen, 1995). Hart (1960) collected females bearing eggs from March through September in British Columbia. *Oregonia gracilis* molts through two zoeal stages and one megalopa. In the laboratory, the larval period from hatching to but not including the megalopa was four weeks. Sizes below are from laboratory-reared larvae. Larvae described in Hart (1960).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 3.5 mm (Fig. 35A, B). Carapace with relatively short lateral spines. Rostrum long, thin, and spinulate. First and second

Fig. 35. *Oregonia gracilis*.
(From Hart, 1960)



maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and forked telson (Fig. 35C). Abdominal segments 2 and 3 with small lateral spines, abdominal segments 3 and 4 with long posteriolateral spines, and segment 5 with shorter posteriolateral spines. Each furca of telson with three inner setae, lateral exospine, and smaller dorsal exospine.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 5 mm (Fig. 35D). First and second maxilliped pairs with six swimming setae on exopods. Abdomen now composed of six segments, and placement of spines on segments unchanged. Spines longer than in previous stage. Each half of telson with additional fine setae medially (Fig. 35E). Pleopod buds now present on the ventral side of abdominal segments 2-5.

Megalopa (illustrated in Key B, the megalopa key): Carapace length from tip of rostrum to posterior margin of carapace, 3.3 mm; width at widest point, 1.3 mm. Carapace with pair of anteriolateral spines, pair of mid-dorsal spines, small pair of lateral spines, and elongated posterior spine. Maxillipeds and pereopods now resemble adult form. First pereopod pair chelate, pereopod pairs 2-5 walking legs.

Family Pinnotheridae

Fabia subquadrata, **Mussel Crab**. *Fabia subquadrata* lives commensally within molluscs. Females are typically 22 mm across, males only 7.3 mm. The range extends from Akutan Pass, Alaska, to Ensenada, Baja California. Adults are found

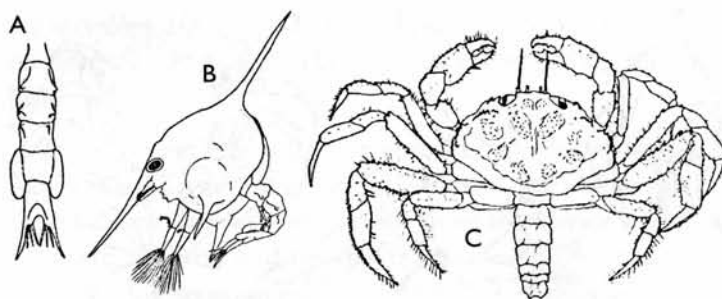


Fig. 36. *Fabia subquadrata*.
(From Lough, 1975)

most commonly in the mussel *Modiolus modiolus* in the intertidal and to 220 m (Jensen, 1995). In Puget Sound, Washington, females carrying eggs were rare in August and increased in numbers to a peak from November to January (Morris et al., 1980). *Fabia subquadrata* molts through five zoeal stages and one megalopa. In the laboratory, the larval period from hatching through the megalopa was 52 days. Sizes below are from laboratory-reared larvae. Larvae described in Lough (1975).

Zoea I: Length between tips of rostrum and dorsal carapace spine, 1.4–1.5 mm. Carapace globular, with pointed rostrum, long dorsal spine, and two posteriolateral spines. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and telson. Fifth abdominal segment laterally expanded (Fig. 36A). Telson forked with three inner setae on each furca.

Zoea II: Length between tips of rostrum and dorsal carapace spine, 2.2–2.4 mm. First and second maxilliped pairs with six swimming setae on exopods. Abdomen now composed of six segments.

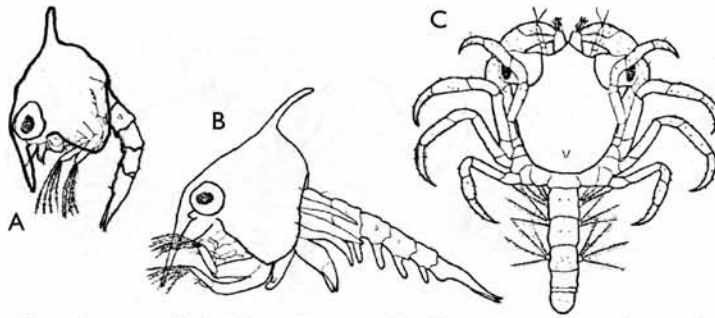
Zoea III: Length between tips of rostrum and dorsal carapace spine, 3.4–3.6 mm. First and second maxilliped pairs with eight swimming setae on exopods.

Zoea IV: Length between tips of rostrum and dorsal carapace spine, 5.2–5.6 mm (Fig. 36B). First and second maxilliped pairs with 9–10 swimming setae on exopods. Small pleopod buds present on abdominal segments 2–5.

Zoea V: Length between tips of rostrum and dorsal carapace spine, 6.6–7.1 mm. First and second maxilliped pairs with 11–12 swimming setae on exopods. Pleopod buds larger.

Megalopa: Carapace oval, wider than long, with "teeth" on lateral edges. Carapace, 2.5 by 3.8 mm (Fig. 36C).

Fig. 37. *Pinnotheres taylori*.
(From Hart, 1935)



Pinnotheres taylori. *Pinnotheres taylori* lives commensally in the tunic of transparent ascidians. Females are typically 7.5 mm across, males only 4.8 mm. The range extends from Quatsino Sound, Vancouver Island, British Columbia, to Puget Sound, Washington. Adults can be found subtidally at 11–64 m (Hart, 1982). A female *P. taylori* bearing eggs was collected from a tunicate in March. Eggs hatched in early May reached the first juvenile instar in four weeks. Sizes below are from laboratory-reared larvae. Larvae described in Hart (1935).

Zoea I: Length from tip of rostrum to tip of dorsal spine, 1 mm (Fig. 37A). Rostrum and dorsal spine thin, relatively short, and blunt at tips. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and telson. Second and third segments with small lateral knobs. Each furca of telson with three inner setae.

Zoea II: Length from tip of rostrum to tip of dorsal spine, 1.3 mm (Fig. 37B). Exopods of first and second maxilliped pairs with six swimming setae. Pleopod buds on abdomen long and thin.

Megalopa (Fig. 37C): Carapace 0.7 mm long, 0.5 mm wide. Rostrum small, almost blunt. Carapace with single small, blunt mid-dorsal, spine.

Family Portunidae

Carcinus maenas, **Shore Crab, Green Crab**. *Carcinus maenas* typically grows to a carapace width of 79 mm. It is native to Europe but has been introduced widely. It was first introduced to the west coast of North America in 1989 in San Francisco Bay and has since been reported as far north as Willapa Bay, Washington. Adults are found in estuaries in intertidal and subtidal waters to 6 m (Jensen, 1995). Females carrying eggs were collected in April and May in Great Britain at Plymouth, Devon, and at Brighton, Sussex, respectively. *Carcinus maenas* molts through four zoeal stages and one megalopa. At 12°C

the larval period was ca 58 days (Williams, 1967). Sizes below are from laboratory-reared larvae. Larvae described in Rice and Ingle (1975).

Zoea I: Length from tip of rostrum to posterior margin of telson, ca 1.4 mm (Fig. 38A). Carapace with large rostral and dorsal spines. Rostral spine more than twice length of antennae. First and second maxilliped pairs with four swimming setae on exopods. Abdomen composed of five segments and forked telson (Fig. 38B). Abdominal segment 2 with dorsolateral spines. Telson posterior margin with three pairs of setae. Each furca of telson with one large dorsal exospine, one small dorsal exospine, and very small thin lateral exospine.

Zoea II: Length from tip of rostrum to posterior margin of telson, 1.6–1.9 mm (Fig. 38C). First and second maxilliped pairs with six swimming setae on exopods. Small dorsal exospines and small lateral exospines now reduced or absent (Fig. 38D).

Zoea III: Length from tip of rostrum to posterior margin of telson, 2.1–2.2 mm (Fig. 38E). First and second maxilliped pairs with eight swimming setae on exopods. Abdomen now composed of six segments. Abdominal segments 2–5 bearing well-developed pleopod buds.

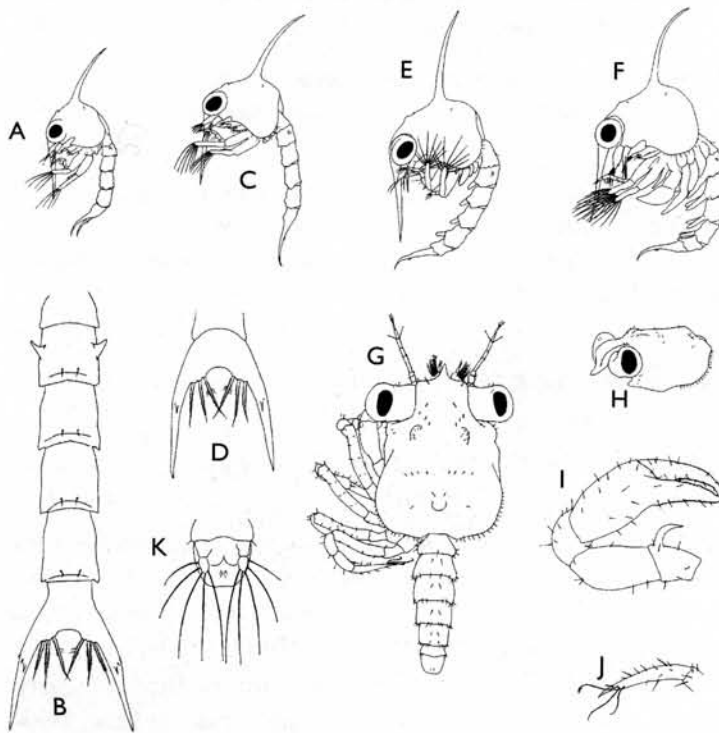


Fig. 38. *Carcinus maenas*.
(From Rice and Ingle,
1975)

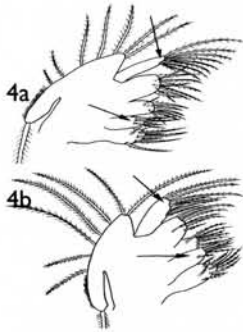
Zoea IV: Length from tip of rostrum to posterior margin of telson, 2.2–2.5 mm (Fig. 38F). First and second maxilliped pairs with 10 swimming setae on exopods. Pleopods now long and slender.

Megalopa: Length from tip of rostrum to posterior margin of carapace, 1.3–1.4 mm (Fig. 38G). Rostrum small and bent slightly downward (Fig. 38H). Maxillipeds and pereopods now resemble adult forms. Chelipeds with prominent ischiobasal hook (Fig. 38I). Dactyl (last segment) of fifth pereopod with three long setae (Fig. 38J). Telson narrows posteriorly and has uropods with setae (Fig. 38K).

Family Xanthidae

Key to xanthid zoeae (drawings from Hart, 1935; Connolly, 1925)

- 1a. Pleopod buds absent from abdomen 2
 1b. Pleopod buds present on abdomen 3
- 2a. First and second maxillipeds with 4 swimming setae on exopods Zoea I, 4
 2b. First and second maxillipeds with 6 and 7 swimming setae on exopods, respectively Zoea II, 4
- 3a. First and second maxillipeds with 8 and 9 swimming setae on exopods, respectively Zoea III, 4
 3b. First and second maxillipeds with 9 and 10–11 swimming setae on exopods, respectively Zoea IV, 4
- 4a. Rostral spines ca same size, dorsal spine may be slightly longer than rostral spines *Lophopanopeus bellus*, 5
 4b. Rostrum longer than dorsal spines *Rhithropanopeus harrisi*
- 5a. In zoeae I and II, 2 tiny, inconspicuous lateral exospines on telson (in addition to one on dorsal exospine) *Lophopanopeus bellus diegensis**
 5b. In all four zoea stages, only 1 dorsal exospine *Lophopanopeus bellus bellus**



*Note that the subspecies of *Lophopanopeus* can be separated only during the first two zoeal stages.

Lophopanopeus bellus bellus, **Black-clawed Crab**. *Lophopanopeus bellus bellus* females typically grow to a carapace width of 24 mm; males can reach 40 mm. The range extends from Resurrection Bay, Alaska, to Point Sur, California. Adults can be found in the low intertidal and subtidal to 80 m under rocks, typically half-buried in sand or gravel (Jensen, 1995). In Puget Sound, females become ovigerous January through early March, and hatching begins in May and peaks in June. Two-

thirds of females produce a second brood that hatches in the fall (Strathmann 1987). Larvae described in Hart (1935) and Knudsen (1959).

Rhithropanopeus harrisi, **Brackish-water Crab**. *Rhithropanopeus harrisi* females typically grow to a carapace width of 11 mm; males can reach 19 mm. Originally an Atlantic species, *R. harrisi* was reported in San Francisco Bay in 1940 and has since spread north to Coos Bay, Oregon. Adults live in the brackish water of estuaries and can tolerate trips into freshwater. They are found under rocks on sand (Jensen, 1995). Larvae described in Connolly (1925).

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Appendix: Sources of illustrations used in keys

decapod zoeal key A illustrations

- 1a. (from Hart, 1971)
- 1b. (adapted from Johnson and Lewis, 1942; Gonor, 1970; Lough, 1975; d Williamson, 1982)
- 1c. (from Gurney, 1942)
- 3a. (from Hart, 1971)
- 4a. (from Hart, 1971)
- 4b. (from Schlotterbeck, 1976)
- 7a. (from Hart, 1971)
- 9a. (from Johnson and Lewis, 1942)
- 10a. (from Gonor, 1970), Gonor and Gonor, 1973b)
- 11a. (from Nyblade, 1974)
- 11b. (adapted from Haynes, 1985)
- 12a. (adapted from Boyd, 1960)
- 13a. (from Lough, 1975)
- 13b. (from Lough, 1975)
- 14a. (from McCrow, 1972)
- 15a. (from Hart, 1937)
- 17a. (from Gurney, 1942)
- 17b. (adapted from Gurney, 1942)
- 19a. (from Hart, 1971)
- 19b. (from Hart, 1971)
- 19c. (from Hart, 1971)

megalopae key B

- 1a. (adapted from Berkeley, 1930)
- 1b. (adapted from Lough, 1975)
- 1c. (from Gonor, 1970; Hart, 1937)
- 2a. (from Lough, 1975)
- 4a. (from Lough, 1975)
- 4b. (from Lough, 1975)
- 4c. (from Lough, 1975)
- 4d. (from Jewett and Haight, 1977)
- 5a. (from Lough, 1975)
- 6a. (adapted from Lough, 1975)
- 6b. (from Lough, 1975)
- 7a. (from Lough, 1975)
- 8a. (from Lough, 1975)
- 11a. Illustrations adapted from Hart, 1935)
- 11b. (adapted from Hart, 1935)
- 11c. (from Rice and Ingle, 1975)
- 12a. (from Connolly, 1925)
- 12b. (adapted from Lough, 1975)
- 13a. (from Gonor, 1970)
- 13b. (from Hart, 1937)
- 15a. (from Gonor, 1970)
- 15b. (from Gonor, 1970)
- 16a. (from Gonor, 1970)
- 16b. (from Gonor, 1970)
- 17a. (from Lough, 1975)
- 17b. (from Lough, 1975)
- 18a. (from Lough, 1975)
- 18b. (from Lough, 1975)
- 19a. (from Lough, 1975)
- 19b. (from Lough, 1975)

xanthidae key

- 4a. (from Hart, 1935)
- 4b. (from Connolly, 1925)