KEYS TO THE LARVAE OF COMMON DECAPOD CRUSTACEANS (Lobsters, Crabs and Shrimp) IN LONG ISLAND SOUND

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Dedication

This book is dedicated to Dr. Ralph J. Yulo, esteemed colleague and friend, who has provided wise advice, encouragement, and invaluable support throughout my career.

Acknowledgments

Many thanks to the following individuals who made important contributions to this book:

Project Oceanology staff and volunteers who helped collect the larvae photographed in this book: Danielle Banko, Chris Dodge, James Downs, Dale Kline, Ian Morrison, Abby O'brien, Lauren Rader, Brae Rafferty, Callie Scheetz , and Kirsten Tomlinson,.

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The many authors and publishers of scientific journal articles who granted permission to use their line drawings (see list of figure credits on page 42-43).

The basic structure and diagnostic characteristics used in this key are adapted from Sandifer (1972), Roff et al. (1985), and Bullard (2003). These sources were, in turn, influenced by earlier and pioneering work on the identification of decapod crustacean larvae, such as Lebour (1928), Aikawa (1929, 1937), Gurney (1942), and Bourdillon-Casanova (1960).

Introduction

Decapod crustacean larvae are a common constituent of Long Island Sound (LIS) zooplankton. This identification guide bridges the gaps between two other currently existing manuals for the identification of these larvae in the northeast region: Sandifer (1972) for Chesapeake Bay and Rolf et al. (1985) for the Canadian Atlantic. This book includes LIS species at the northern end of their range not found in Canada, LIS species at the southern end of their range not found in Chesapeake Bay, as well as recently introduced species. Illustrations, descriptions and keys to the identification of the adults of these species can be found in Weiss (1995).

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Getting Started Key

#1. Carapace* is deeper than wide and is much deeper than abdomen (Fig. A); carapace, in side view, is somewhat round, oval or helmet-shaped; with dorsal spine at middle of carapace on all but one species; slender abdomen curves or hangs loosely below carapace; no chelate (pincer-like) claws on any legs; telson usually forked .... **crab zoeae,** page 7

#1. Carapace* is crablike, wider than deep, and is much wider than abdomen (Fig. C); abdomen may be folded under carapace or may extend behind carapace; with chelate (pincer-like) claws on front legs; no dorsal spine at middle of carapace .... **crab megalopae,** page 16

#1. Carapace* and abdomen are about the same width and depth (Figs. B & D-F); carapace somewhat cylindrical; no dorsal spine at middle of carapace; telson a triangular plate (early stages) or with uropods forming a tail fan (later stages); chelate (pincer-like) claws may or may not be present on some legs; abdomen may extend straight behind carapace or may be curved beneath carapace .... #2

#2. Looks like a miniature adult lobster; with large chelate claws on front legs; long whip-like antennae are longer than carapace length; the largest decapod crustacean larva in Long Island Sound with a total length often over 12 mm .... stage 4 larva (postlarva or megalopa) of ***Homarus americanus*, American lobster** (Fig. F)

#2. Does not look like an adult lobster (Figs. B, D, E); chelate claws, if present, are slender; antennae are shorter than carapace; total length under 12 mm .... #3

#3. With prominent dorsal spines on all abdominal segments; large larva, total length greater than 7.5 mm; abdomen not as deep as carapace and often curves beneath carapace ....stages 1-3 larvae (zoeae) of ***Homarus americanus*, American lobster** (Figs. D-E)

#3. No prominent dorsal spines on abdominal segments; shrimp-like body form (Fig. B), abdomen about the same depth and width as carapace and extends straight behind carapace or sometimes with angular bend; total length less than 7.0 mm... ....**shrimp and hermit crab zoeae**, page 14

*Size abbreviations: CW=carapace width, CL=carapace length, TL=total length.

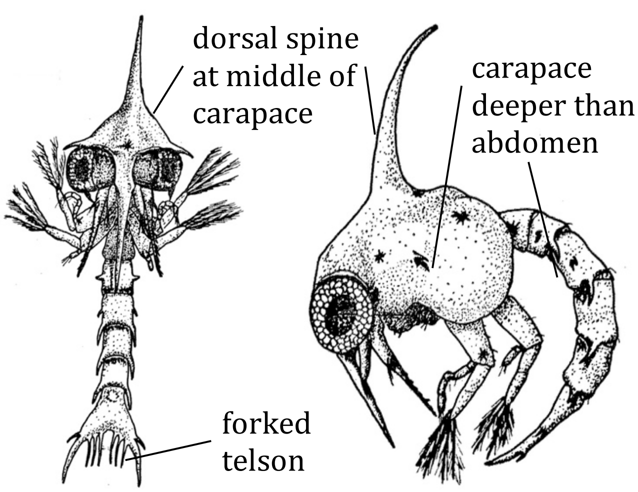


Fig. A. Typical zoeae of brachyuran crabs

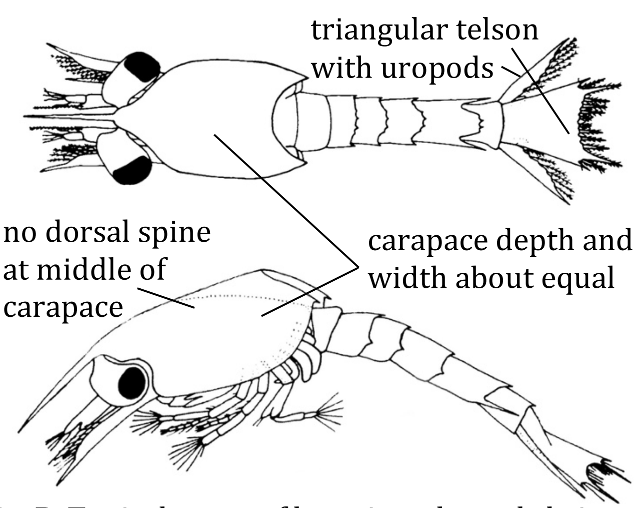


Fig. B. Typical zoeae of hermit crabs and shrimp

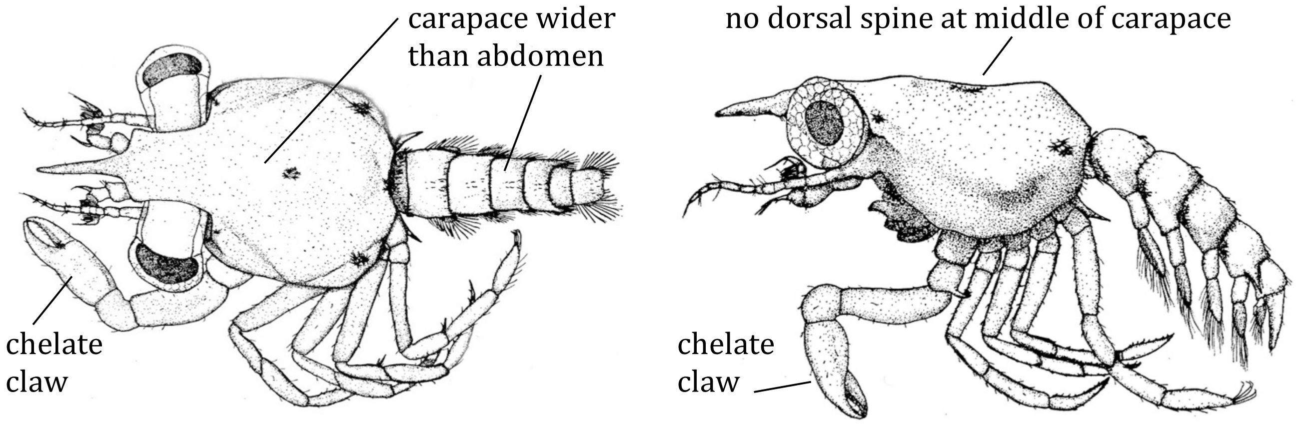


Fig. C. Typical megalopae of brachyuran crabs

Larvae of *Homarus americanus,* American lobster

Lobsters have 3 strictly planktonic larval stages before settling to the bottom during stage 4. Stage 1 (Fig. D) has a triangular telson with no uropods and does not have pleopods (swimmerets). Stage 2 has pleopods but no uropods. Stage 3 (Fig. E) has uropods and pleopods. The legs of stage 4 (Fig. F) lack the feather-like branches (exopodites) found on stages 1 -3.

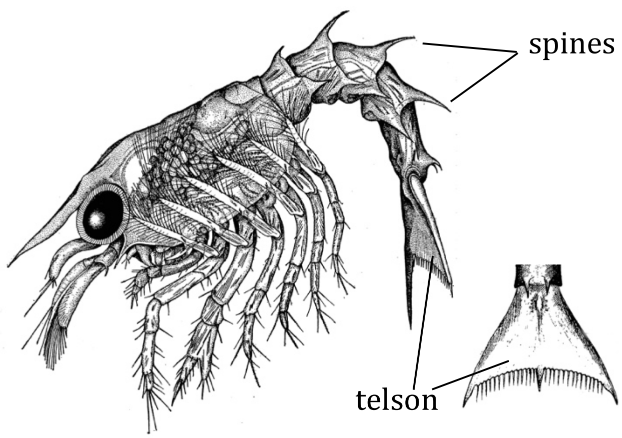


Fig. D. Stage 1: CL=1.7 mm, TL= 7.8 mm.
(see photo, page 26)

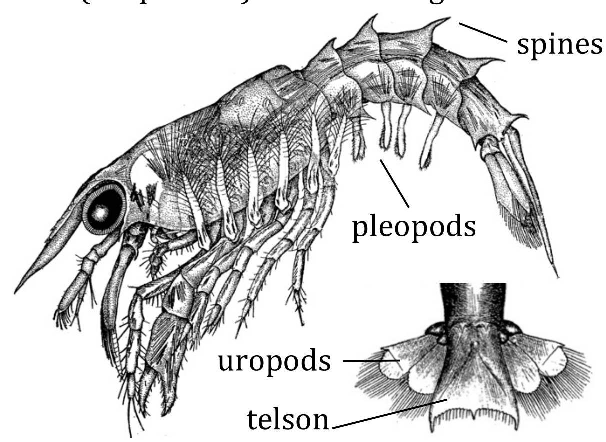


Fig. E. Stage 3: CL=3.2 mm, TL= 11.1 mm.
(see photo, page 26)

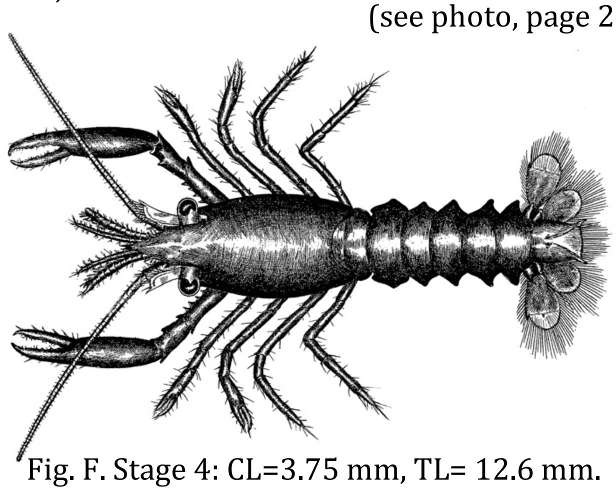


Fig. F. Stage 4: CL=3.75 mm, TL= 12.6 mm.
(see photo, page 26)

Larvae Of Brachyuran ("True") Crabs

After hatching from their eggs, crabs usually go through several zoeal larval stages before metamorphosing into a megalopa larva (Fig. B). The number of zoeal stages varies, depending on the species of crab, and the stages can often be distinguished based on changing anatomical features. For example, the blue crab, *Callinectes sapidus*, goes through 7-8 zoeal stages that can be distinguished by the number of setae (bristles) on their maxillipeds and other changes shown in Fig. A. The early zoeal stages of most crab species do not have pleopods on their abdomen or an antennal endopodite. The final zoeal stage often has well formed pleopods and an antennal endopodite (see Fig. A). The identifying characteristics used in the keys in this manual apply to all of the zoeal stages for each species of crab. Refer to the references at the end of this manual to distinguish the zoeal stages for specific crab species.

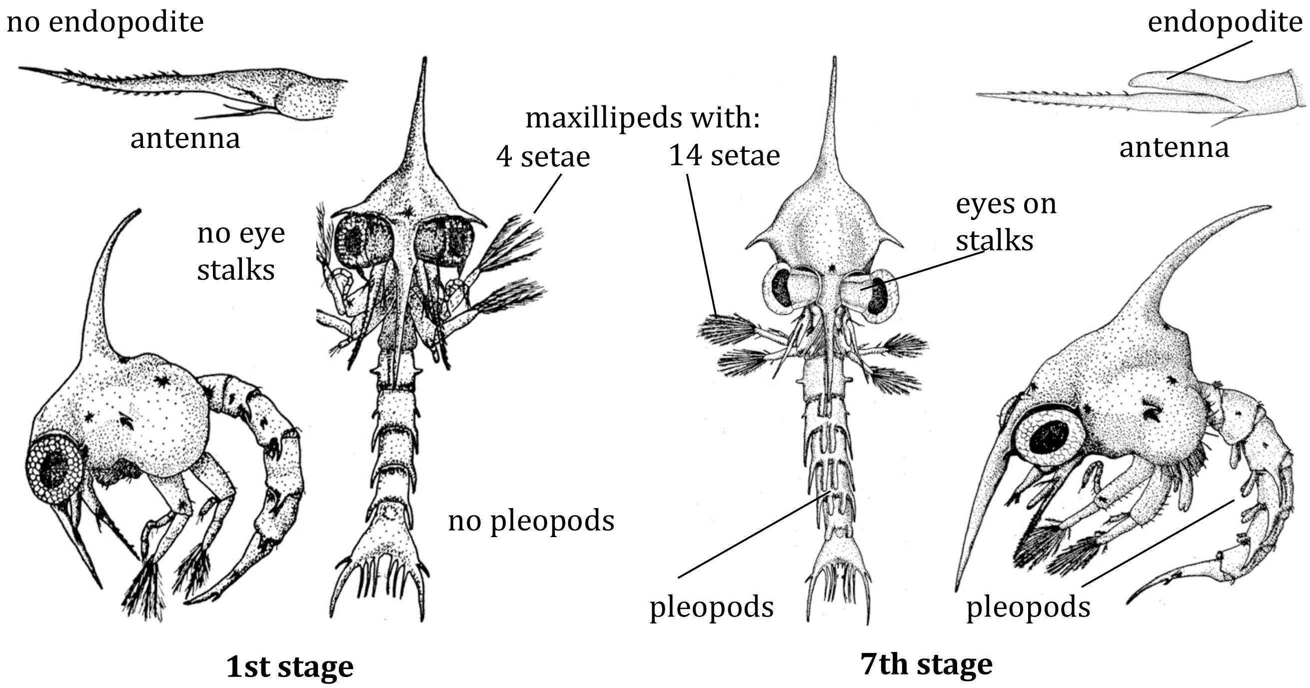


Fig. A. Zoeal stages 1 and 7 of the blue crab, *Callinectes sapidus*.

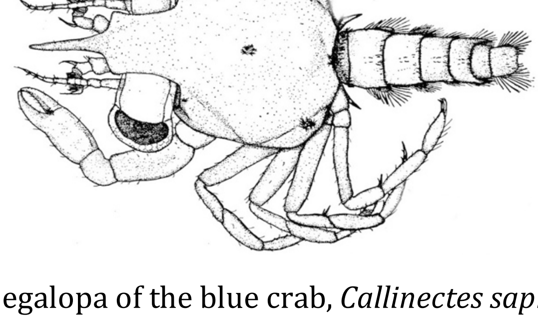


Fig. B. Megalopa of the blue crab, *Callinectes sapidus*

Zoeae Of Brachyuran ("True") Crabs

#1. With lateral spines (Figs. A-C) .... #2
#1. No lateral spines .... page 12

#2. Lateral spines arise ventrally, below middle of carapace sides (Fig. A) .... page 9
#2. Lateral spines arise dorsally, at or above middle of carapace sides (Figs. B-C) .... #3

#3. Dorsal, rostral and antennal spines are longer than carapace (Fig. C) .... page 8
#3. Dorsal, rostral and antennal spines are same length or shorter than carapace (Fig.B).page 10

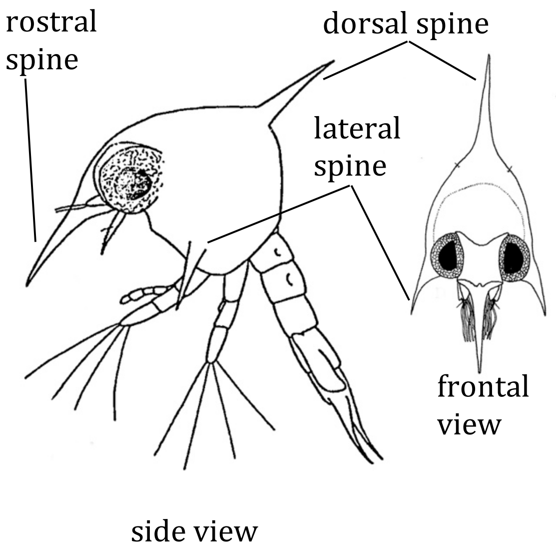


Fig. A. Zoeae with lateral spines arising ventrally, below mid-sides of carapace.

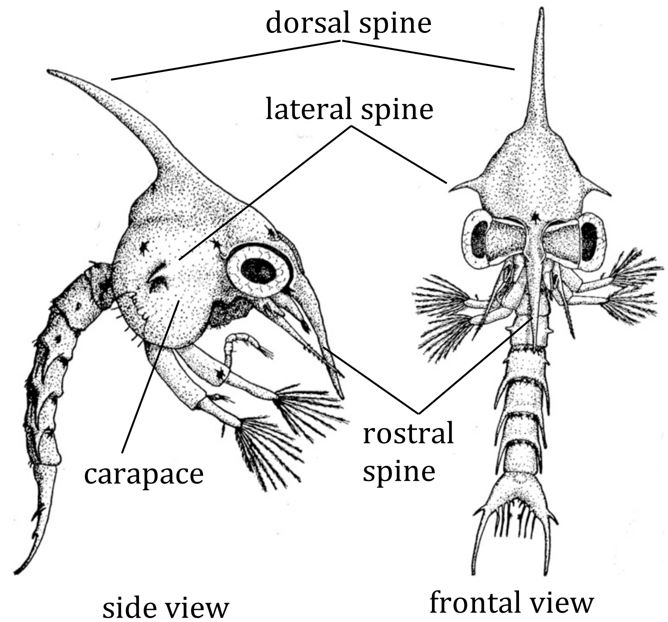


Fig. B. Zoeae with lateral spines arising dorsally, at or above mid-sides of carapace. No spines longer than carapace.

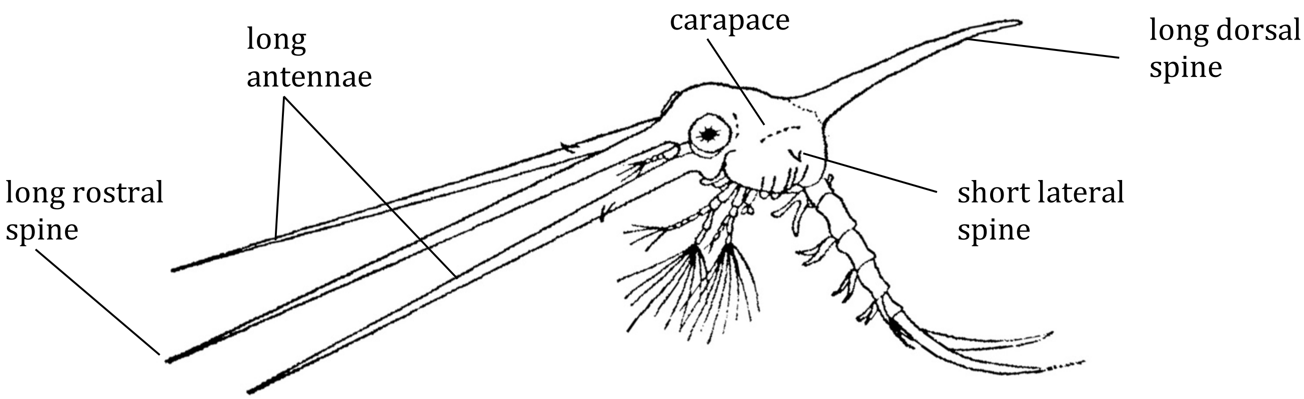


Fig. C. Zoeae with rostral, dorsal and antennal spines longer than carapace.

Zoeae With Long Dorsal, Rostral And Antennal Spines

Dorsal, rostral and antennal spines are longer than carapace length
Base of lateral spines are at or above middle of carapace sides

#1. Rostral spine with numerous spinules .... ***Hyas* spp.** (Fig. A)
#1. Rostral spine is smooth, without spinules (Fig. B) .... #2

#2. Rostral and antennal spines longer than abdomen; with elongate lateral spines on fourth abdominal segment .... ***Rithropanopeus harrisii*** (Fig. B)
#2. Rostral and antennal spines about same length as abdomen; spines on fourth abdominal segment same length as on other segments .... **family Xanthidae, mud crabs,** in part (see photos, page 29)

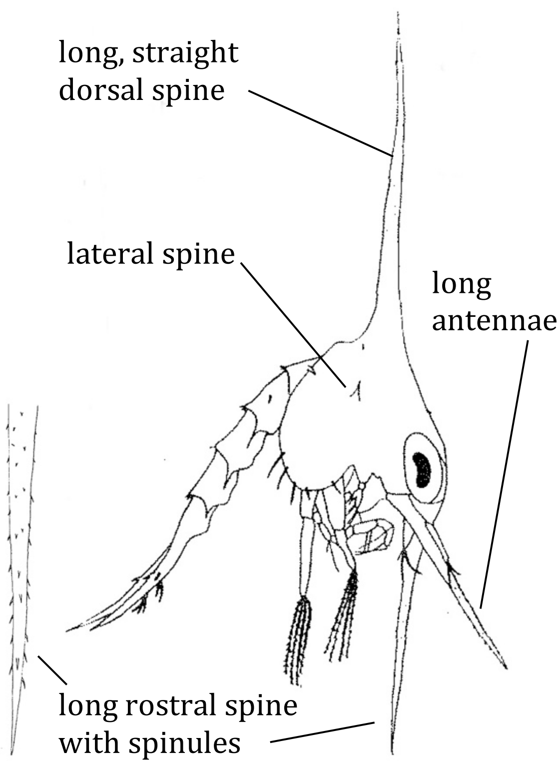


Fig. A. ***Hyas* spp., lyre or toad crabs**

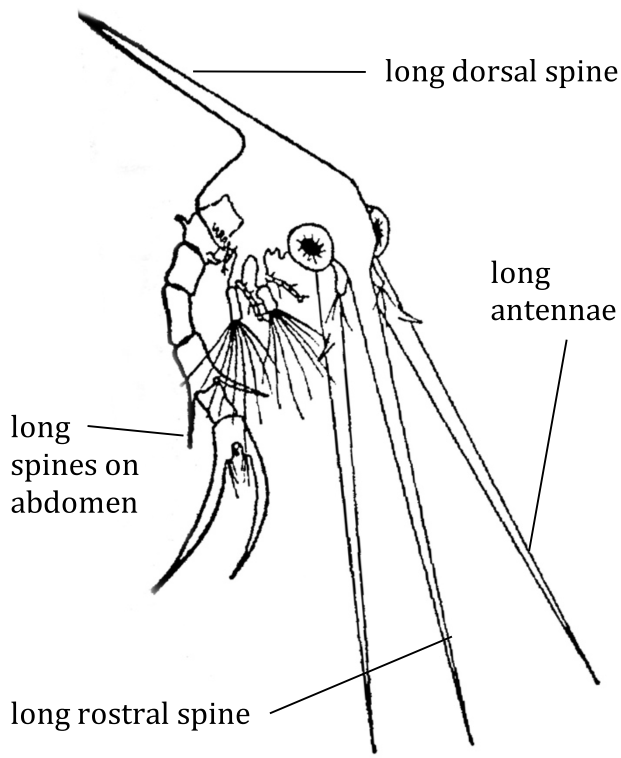


Fig. B. ***Rithropanopeus harrisii,* Harris mud crab**

Zoeae With Lateral Spines Arising Ventrally

Base of lateral spine is below middle of carapace sides

#1. Abdomen with wing-like projections on segment next to telson ....***Pinnixa* spp.** (Fig. A)
#1. No wing-like projections on abdomen.. (Figs. B-C)

#2. Lateral spines are long and curved, extending ventrally far below carapace.................................
....***Pinnotheres maculatus*** (Fig. B)
#2. Lateral spines are short, do not extend below carapace.....***Hemigrapsus sanguineus*** (Fig. C)

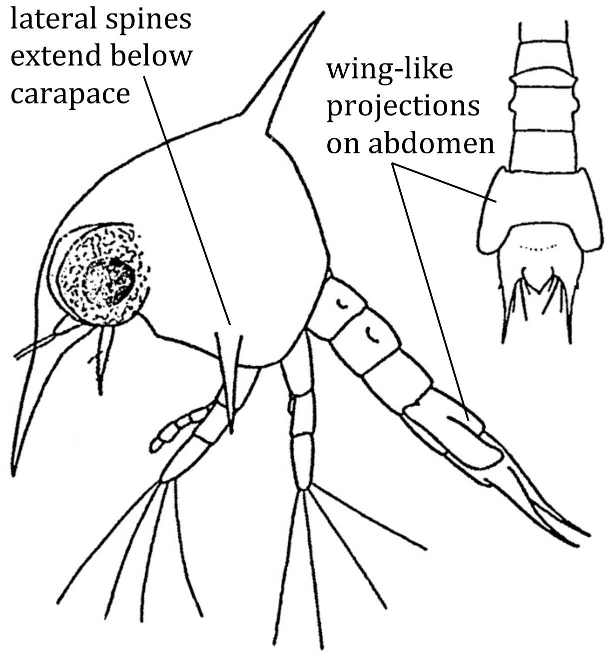


Fig. A. ***Pinnixa* spp., pea crabs:** See Bullard, 2003, to identify species. (See photos, p.32)

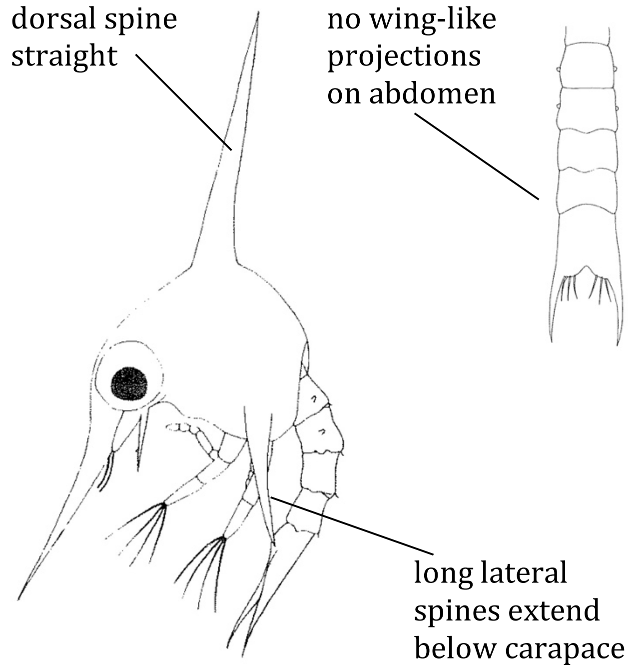


Fig. B. ***Pinnotheres maculatus*, squatter pea crab**

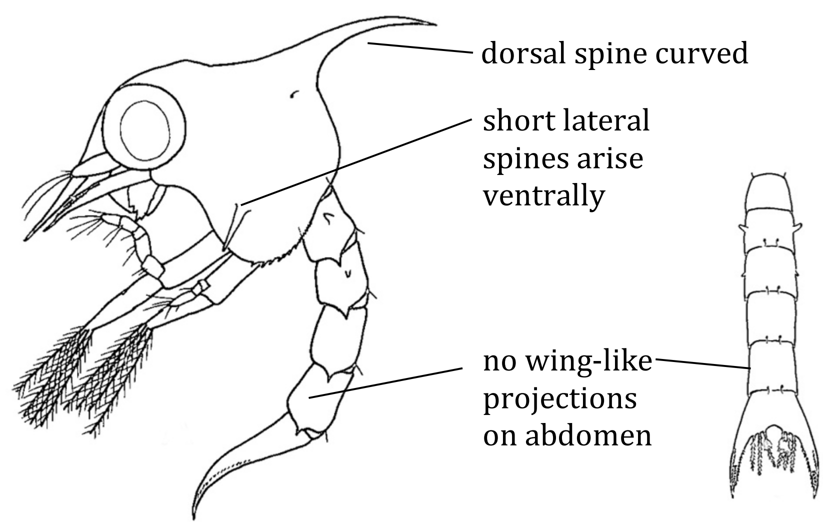


Fig. C. ***Hemigrapsus sanguineus*, Asian shore crab:** (See photos, page 32)

Zoeae With Lateral Spines Arising At Or Above Middle Of Carapace Sides

#1. Antennal exopodite 1/3 to ½ length of protopodite (Figs. A-B) .... #2
#1. Antennal exopodite much shorter than 1/3 length of protopodite (Figs. C-D) .... #3

#2. No dorsolateral spines on abdominal segment 5 (last segment before telson); no lateral knobs or hooks at the center of abdominal segments; posterior margin of all abdominal segments end as posterolateral spines overlapping the next segment..... ***Cancer*** **spp.** (Fig.A)
#2. With prominent hook-shaped dorsolateral spines on abdominal segment 5 and sometimes segment 4; center of abdominal segments 3-5 with lateral knobs or dorsolateral hooks AND with posterolateral spines at the posterior margins........ ***Ovalipes ocellatus*** (Fig. B)

#3. Antennae (Fig. D) are much longer than twice the length of the antennules; antennae are all or mostly smooth, with spinules, if present, only near the tip........ #4
#3. Antennae are about half the length of the antennules; distal (outer) half of antennae with 2 rows of spinules........ ***Callinectes sapidus*** (Fig. C)

#4. With lateral spines on telson .... ***Panopeus herbstii*** (Fig. D)
#4. No lateral spines on telson .... **family Xanthidae, mud crabs,** in part (see photos, page 29)

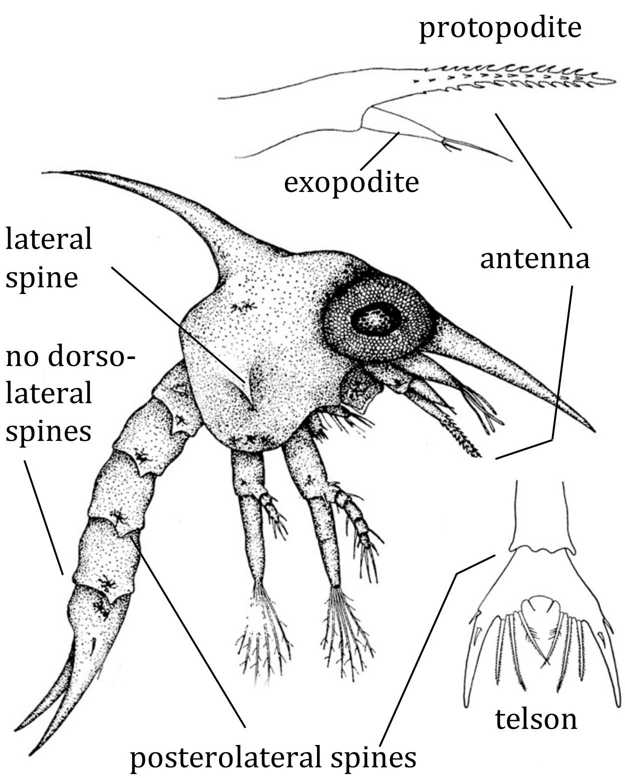


Fig. A. ***Cancer*** **spp., rock and Jonah crabs:** (see photos, pages 30-31)

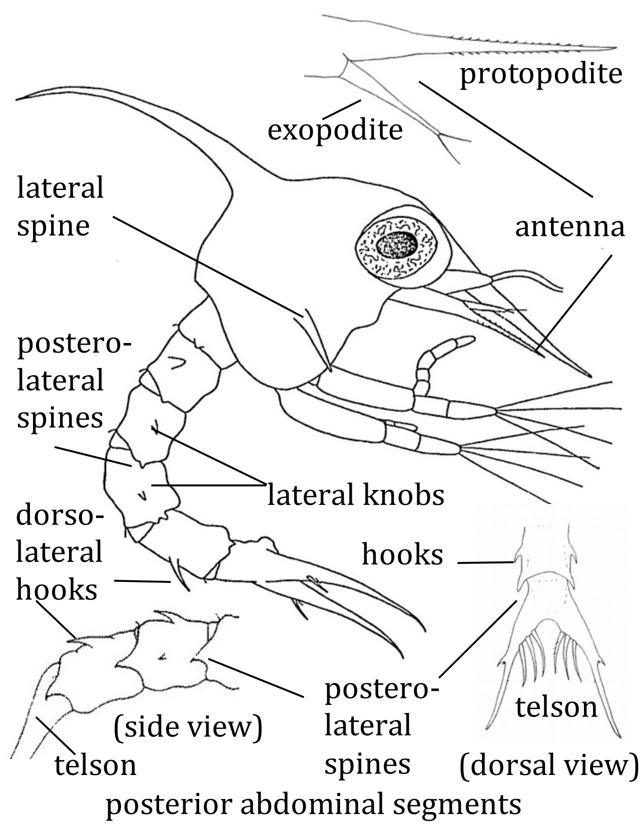


Fig. B. ***Ovalipes ocellatus*, calico or lady crab**

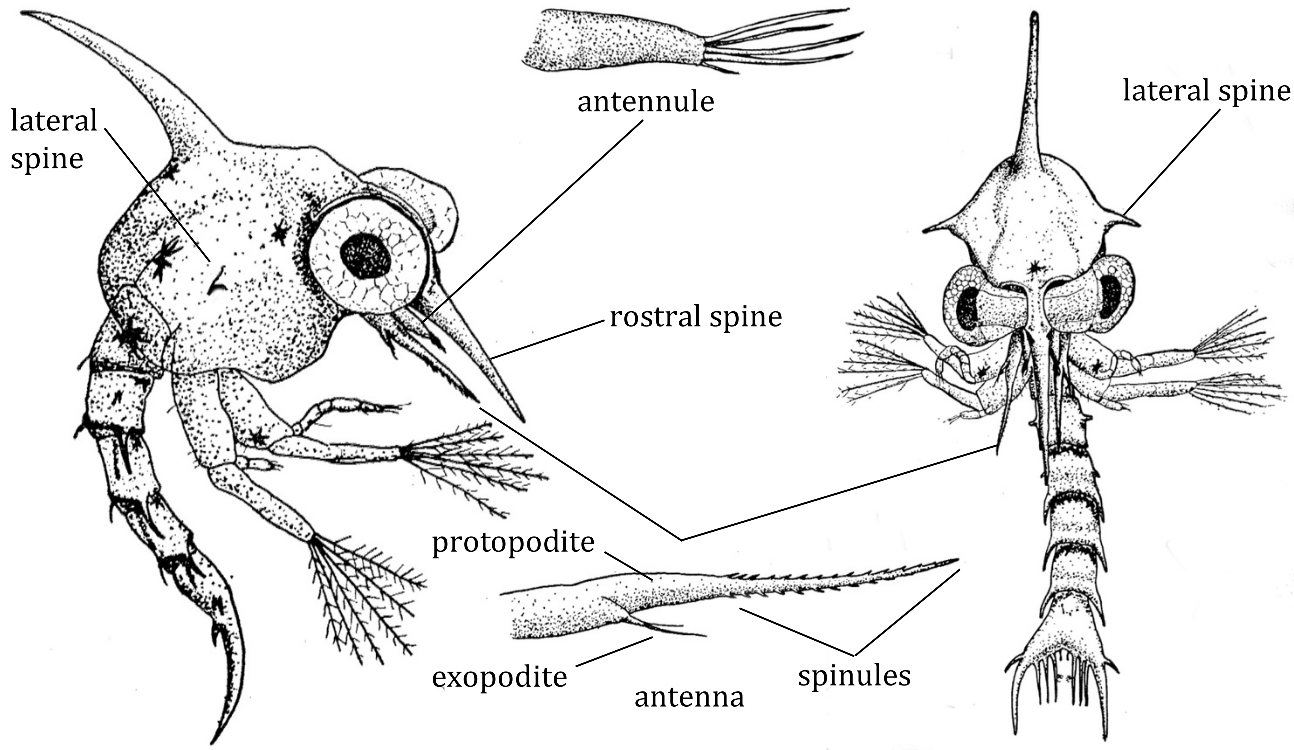


Fig. C. ***Callinectes sapidus*, blue crab**

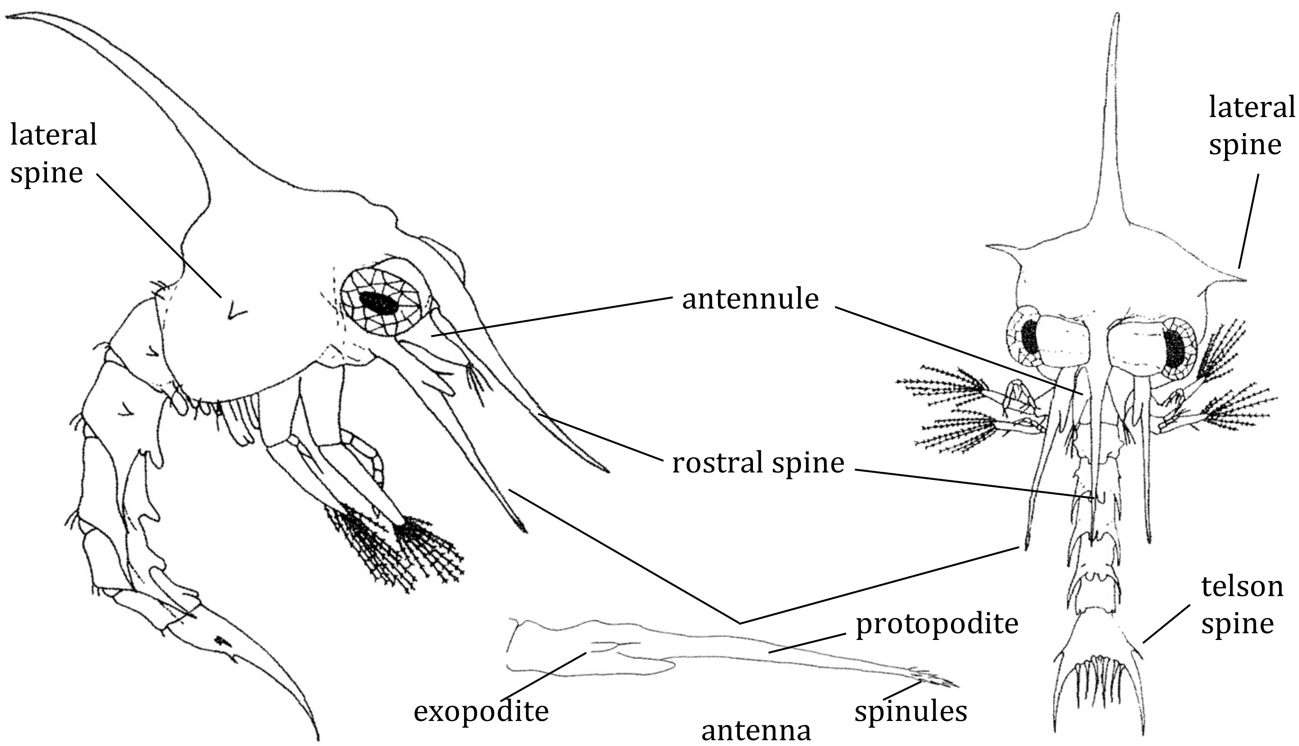


Fig. D. ***Panopeus herbstii*, Atlantic mud crab**: (see photos, page 29)

Zoeae With No Lateral Spines

#1. No dorsal spine .... ***Pinnotheres ostreum*** (Fig. A)
#1. With dorsal spine (Figs. B-E) .... #2

#2. Rostral spine is very short, shorter than antennae .... ***Libinia* spp.** (Fig. B)
#2. Rostral spine is long, about same length or longer than antennae (Figs. C-E) .... #3

#3. Rostral spine is much longer than antennae (Figs. D-E) .... #4
#3. Rostral spine about same length as antennae .... ***Sesarma reticulatum*** (Fig. C)

#4 Dorsal spine as long or longer than carapace .... ***Carcinus maenas*** (Fig. D)
#4 Dorsal spine short, about half as long as carapace .... ***Uca* spp.** (Fig. E)

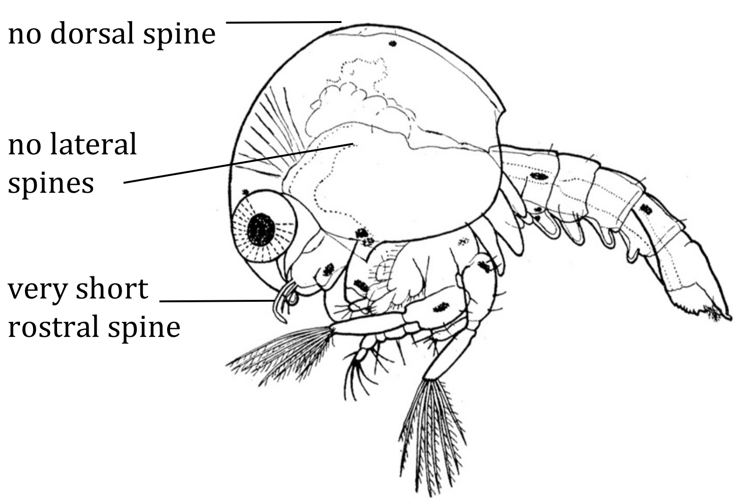


Fig. A. ***Pinnotheres ostreum*, oyster pea crab**

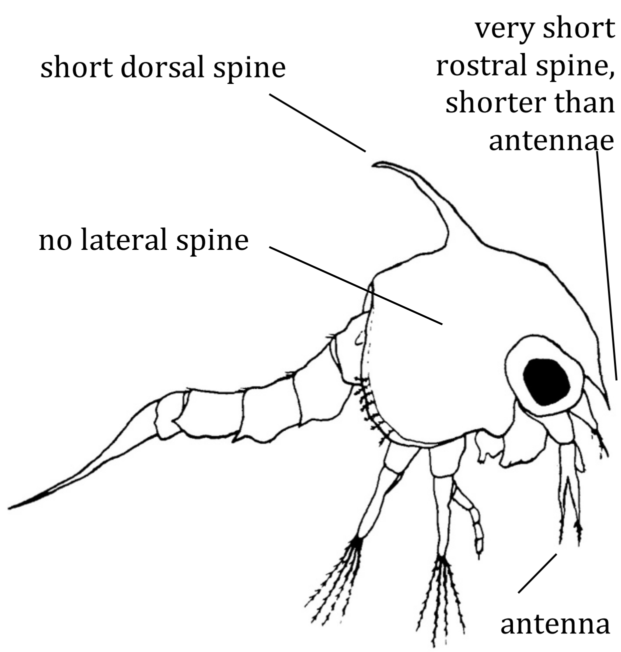


Fig. B. ***Libinia* spp., spider crabs:**
(see photo, page 34)

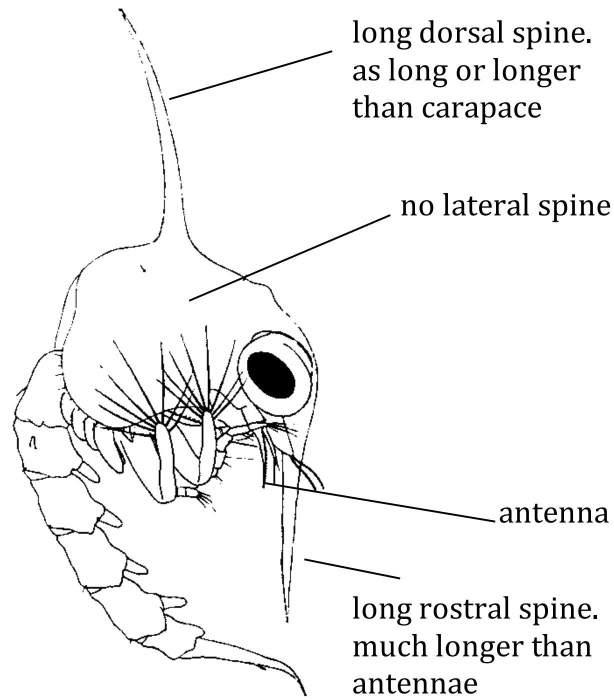


Fig. D. ***Carcinus maenas*, green crab:**
(see photos, page 33)

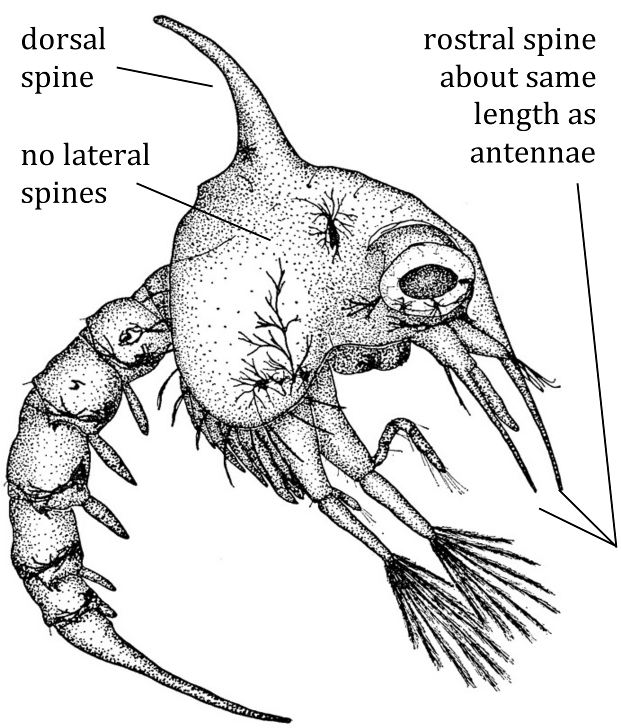


Fig. C. ***Sesarma reticulatum*, marsh crab**

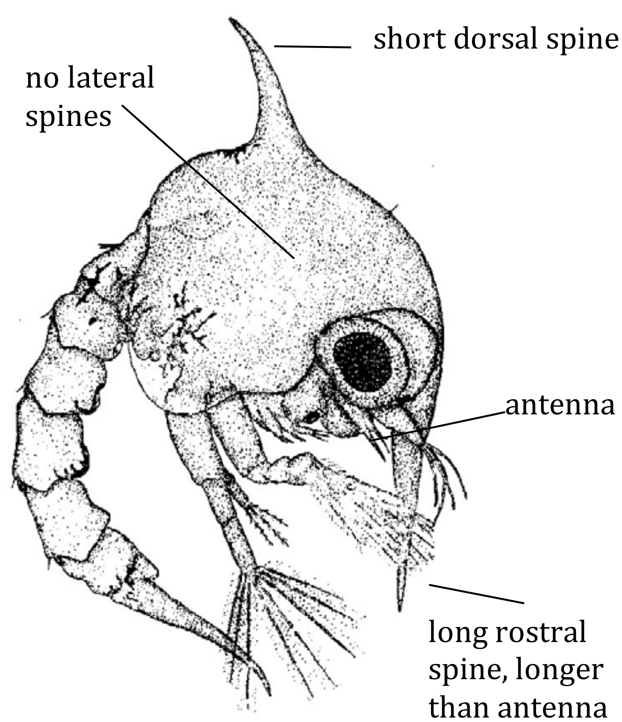


Fig. E**. *Uca* spp., fiddler crabs**

Shrimplike Zoeae With No Lateral Or Dorsal Spines
(hermit crabs, porcellanid crabs and shrimp)

#1. Rostral spine much longer than carapace; with 2 long posterior spines extending beyond abdomen .... **porcellanid crabs** (Fig. A)
#1. Rostral spine is shorter than carapace; without long posterior spines .... #2

#2. Dorsal posterior corners of carapace are pointed; posterior abdominal segment is about same length as other abdominal segments (Figs. B-C)........................ **hermit crabs**, #3
#2. Dorsal posterior corners of carapace are rounded; posterior abdominal segment is much longer than other abdominal segments (Figs. D-F) .... **shrimp**, #4

#3. Ventrolateral spines on abdominal segment #5 long, almost reaching telson; carapace and abdomen (when alive) with few chromatophores (color cells), most are red .... ***Pagurus longicarpus*** (Fig. B)
#3. Ventrolateral spines on abdominal segment #5 not much longer than the spines on other segments; carapace and abdomen (when alive) with numerous chromatophores, most are yellow, some are red........................ ***Pagurus pollicaris*** (Fig. C)

#4. Anterior ventrolateral edge of carapace with 1 or no teeth; base of rostrum with dorsal teeth (except on stage 1); total length usually over 3.5 mm........................ ***Palaemonetes* spp.** (Fig. D)
#4. Anterior ventrolateral edge of carapace with 2 or more teeth; no dorsal teeth at base of rostrum (Figs. D-E); total length usually less than 3.5 mm .... #5

#5. Abdominal segment #3 with dorsal spine (can be difficult to see if spine is lying flat on dorsal surface of abdomen)........................ ***Crangon septemspinosus***, (Fig. E)
#5. Abdominal segment #3 without spine........................ ***Hippolyte* spp.** (Fig. F)

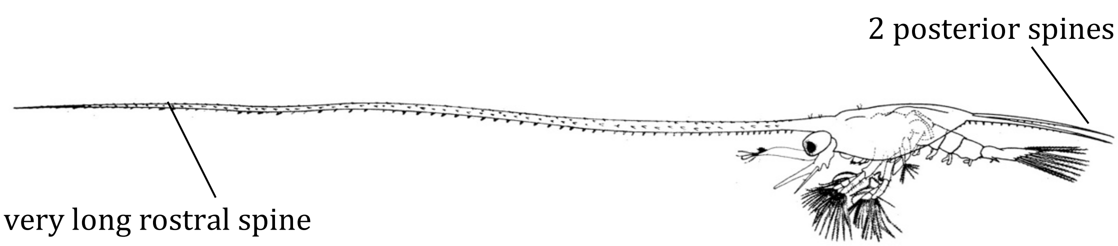


Fig. A. **Infraorder Anomura, family Porcellanidae,** such as ***Polyonyx gibbesi*, eastern tube crab** shown here: CL = 1.2-1.7 mm. (see photo, page 28)

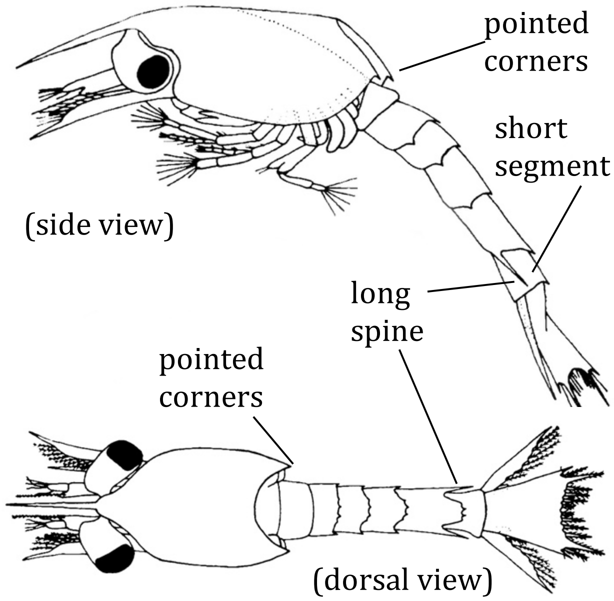


Fig. B**. *Pagurus longicarpus*, longwrist hermit crab:** TL=2.0-3.5 mm. (see photos, page 26)

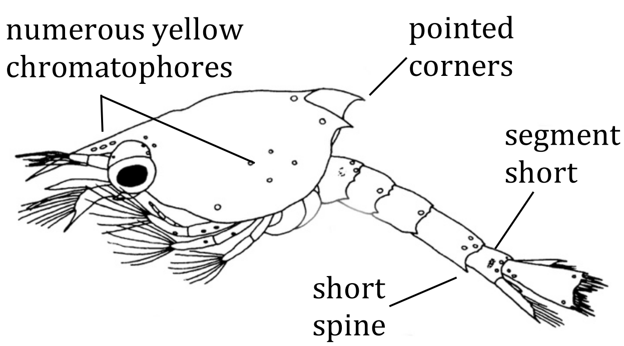


Fig. C. ***Pagurus pollicaris*, flatclaw hermit crab:** TL=2.8-3.8 mm.

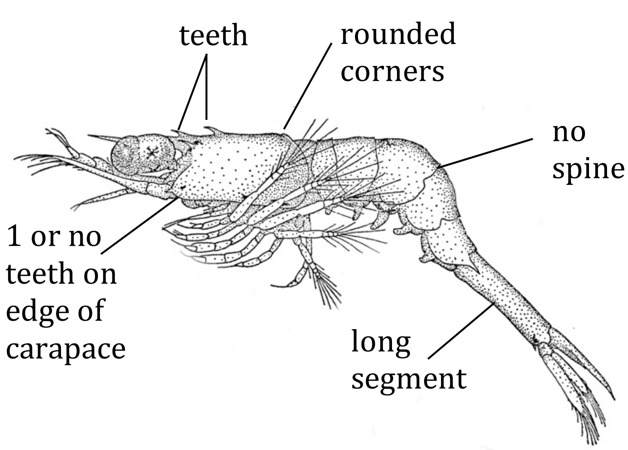


Fig. D. ***Palaemonetes* spp., grass shrimp:** TL=3.5-7.0 mm.

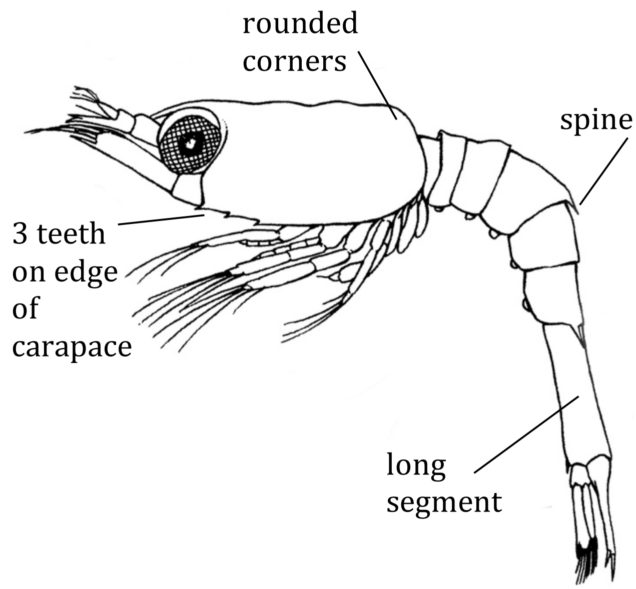


Fig. E. ***Crangon septemspinosa*, sevenspine bay shrimp = sand shrimp:** TL=1.9-3.3 mm.

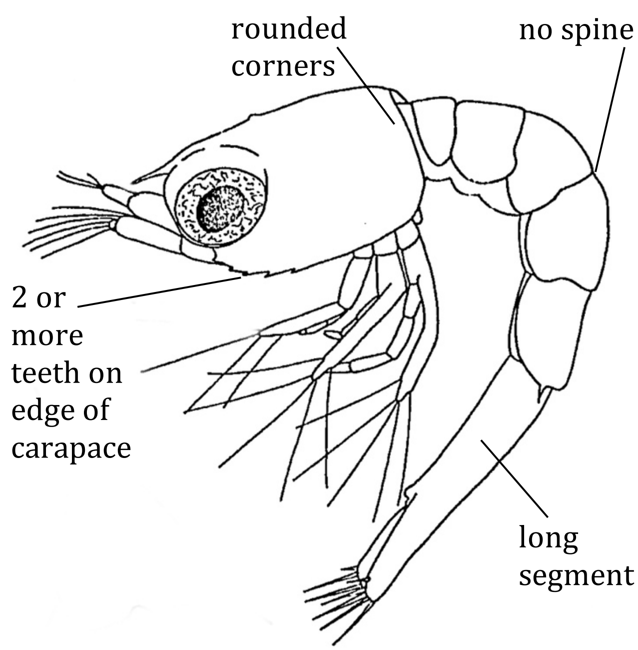


Fig. F. ***Hippolyte* spp., zostera shrimp**: TL=1.3-2.9 mm.

Crab Megalopae

#1. Telson with well developed uropods, forming fan-like tail; antennae are as long or longer than carapace .... Anomura: hermit and porcellanid crabs, this page
#1. Telson without uropods; antennae much shorter than carapace ... brachyuran crabs, page 17

Anomuran crabs: hermit and porcellanid crabs

#1. First legs (with claws) very long, longer than walking legs .... ***Polyonyx gibbesi*** (Fig. A)
#1. First legs (with claws) shorter than walking legs (Fig. B) .... hermit crabs, #2

#2. Numerous chromatophores (color cells), mostly yellow; telson with 2-3 small but distinct spines at lateral posterior corners .... ***Pagurus pollicaris*** (Fig. B)
#2. Few chromatophores, mostly red; telson with no distinct spines at lateral posterior corners .... ***Pagurus longicarpus*** (Fig. B)

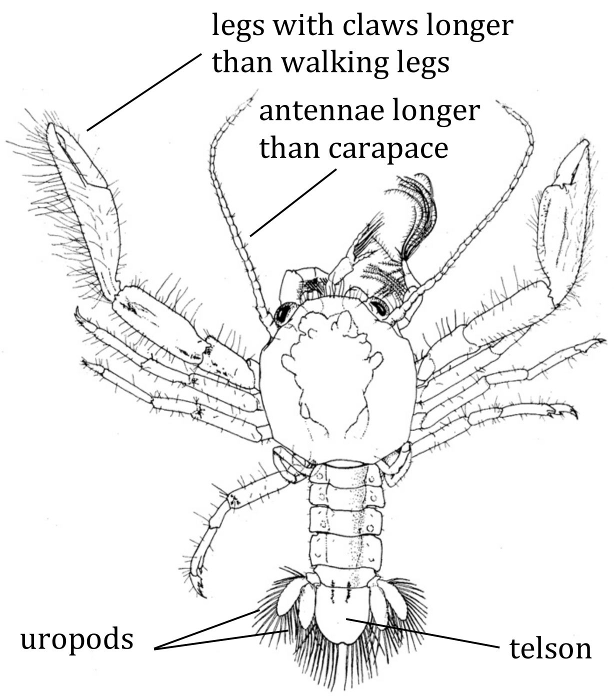


Fig. A: ***Polyonyx gibbesi*, eastern tube crab (porcellanid crab):** CW=CL= 1.2-1.4 mm. (see photo, page 28)

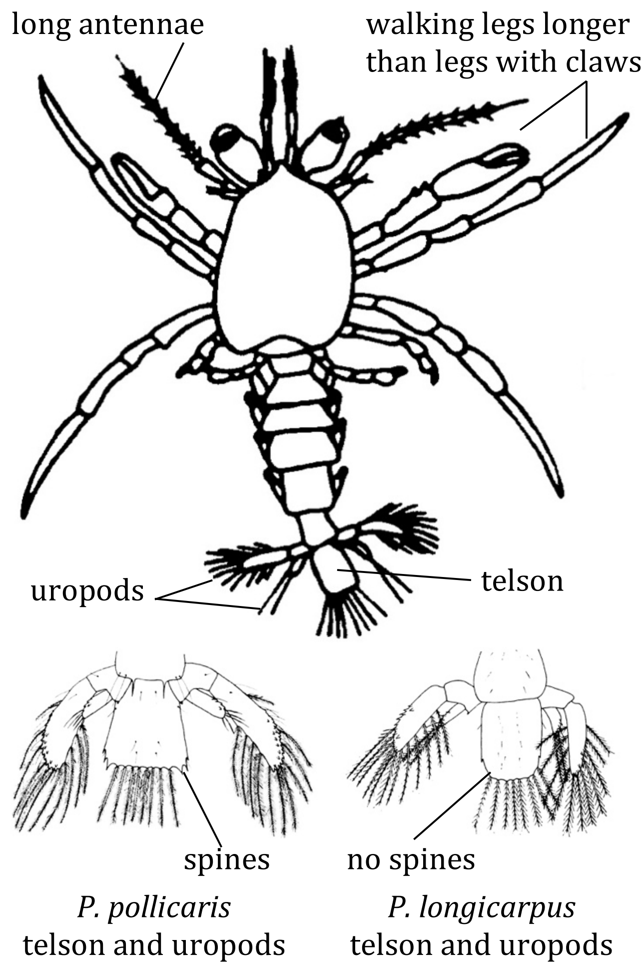


Fig. B: ***Pagurus* spp., hermit crabs:** CW=CL= 1.2-1.4 mm. (see photos, page 27)

Megalopae Of Brachyuran ("True") Crabs

#1. Carapace with one or two posterior spines pointing toward rear (Figs. A-B); spines may be on dorsal or ventral surface of carapace..page 18
#1. Carapace with no posterior spines (Fig. C)..#2

#2. Rostral spine is present and visible in dorsal view (viewed from above) (Figs. A-B)............#3
#2. Rostral spine is absent or not visible when viewed from above* (Fig. C)..........................page 22

#3. Rostral spine is long, at least half the length of the antennae (Fig. A)................................page 24
#3. Rostral spine is short, less than half the length of the antennae* (Fig. B)..........................page 20

*When megalopae are observed in dorsal view, some rostral spines are barely visible and easily overlooked, especially if the spine points downward (see Fig. D). If in doubt, try keys on both pages 20 and 22.

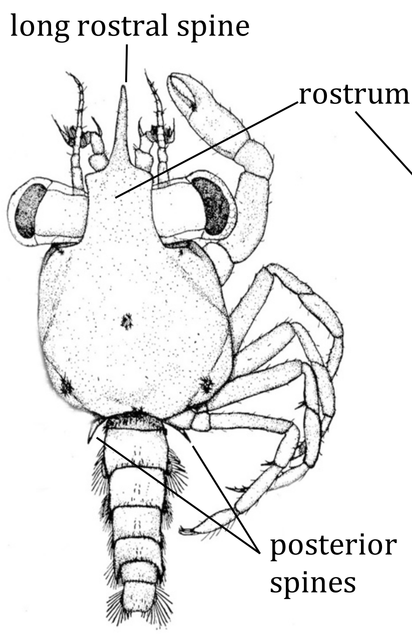


Fig. A. Megalopa with two ventral posterior spines and long rostral spine

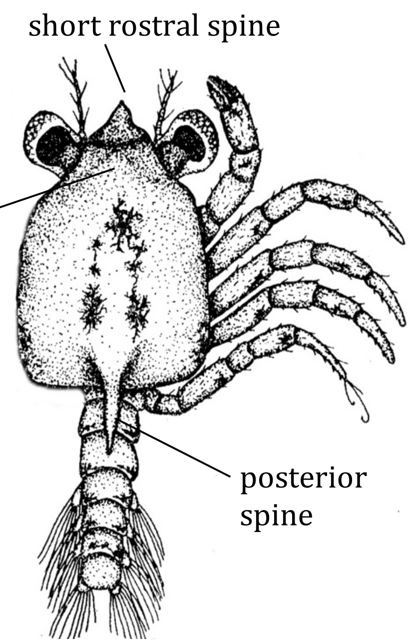


Fig. B. Megalopa with one dorsal posterior spine and short rostral spine

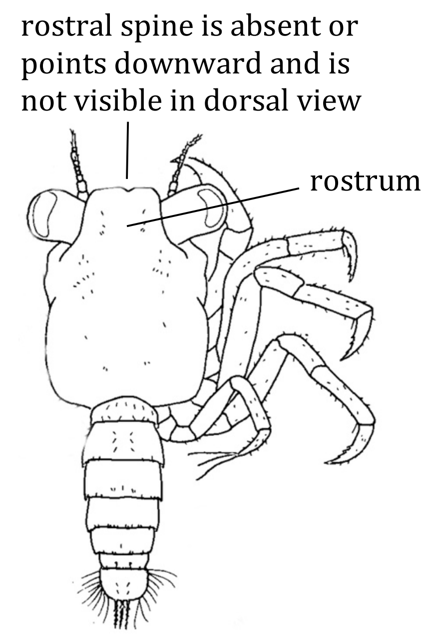


Fig. C. Megalopa with no posterior spine and no rostral spine visible in dorsal view

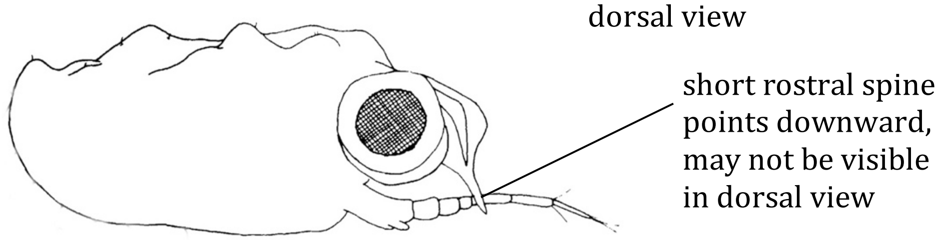


Fig. D. Megalopa (side view) with short rostral spine pointing ventrally (downward)

Megalopae With Posterior Spines On Carapace

#1. Carapace with two small ventral posterior spines pointing toward rear..***Callinectes sapidus*** (Fig. A)
#1. Carapace with one large dorsal posterior spine pointing toward rear (Figs. B-F) .... #2

#2. Carapace with a pair of dorsal anterior spines pointing forward, horn-like, over eyes ....***Pinnotheres maculatus*** (Fig. B)
#2. Carapace without horn-like dorsal anterior spines pointing forward (Figs. C-F).................... #3

#3. Rostrum with lateral spines and central spine ....***Hyas*** spp. (Fig. C)
#3. Rostrum with single central spine, no lateral rostral spines (Figs. D-F) .... #4

#4. Carapace with small lateral projections near rear; carapace is somewhat triangular in dorsal view..***Parthenope serrrata*** (Fig. D)
#4. Carapace without lateral spines near rear; carapace is somewhat square in dorsal view (Figs. E-F)... ***Cancer*** spp., #5

#5. Rostrum ends in sharp point; setae of fourth antennal segment (counting from distal end) do not reach end of antenna; no setae on third antennal segment....***Cancer borealis*** (Fig. E)
#5. Rostrum ends in rounded point; no setae on fourth antennal segment; setae of third antennal segment reach beyond end of antenna...***Cancer irroratus*** (Fig. F)

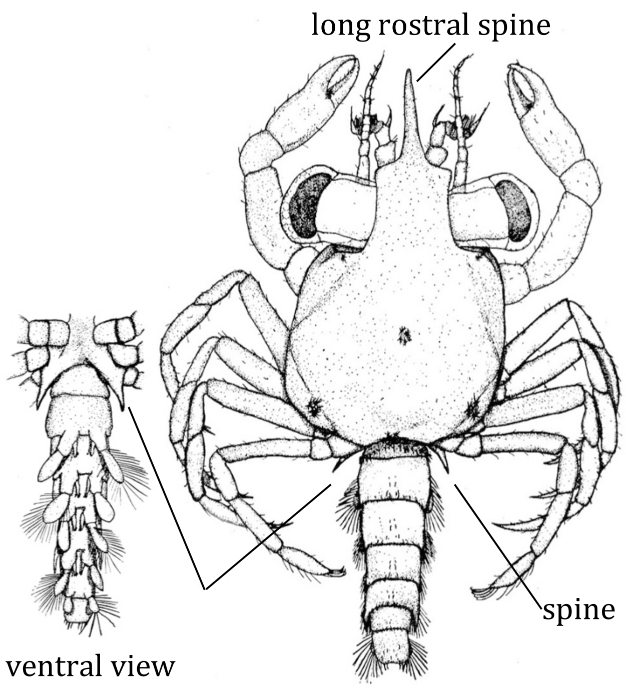


Fig. A. ***Callinectes sapidus,* blue crab:**
CW= 0.85 mm, CL= 1.4 mm.
(see photos, page 35)

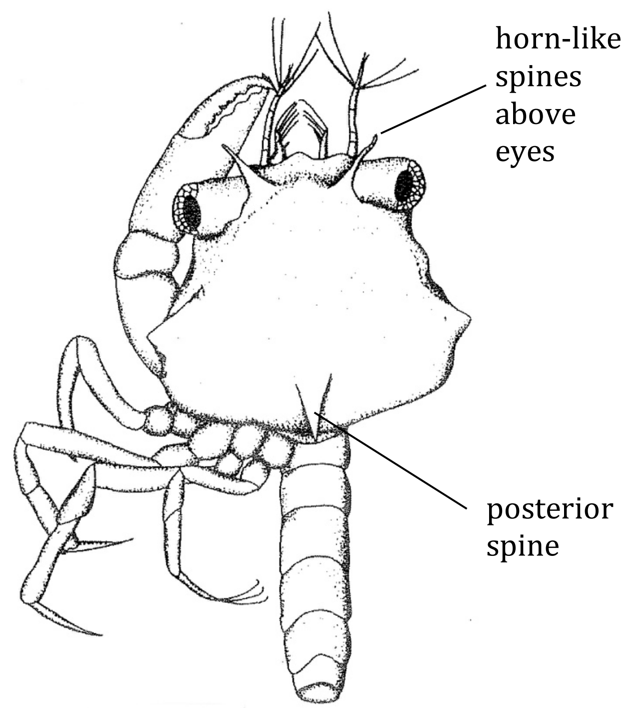


Fig. B: ***Pinnotheres maculatus*, squatter pea crab**: CW= 1.1 mm, CL= 0.9 mm.

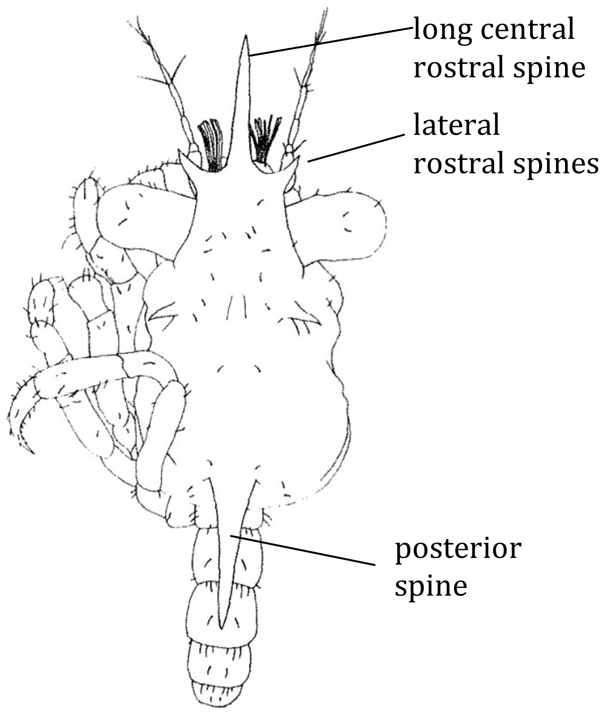


Fig. C. ***Hyas* spp., lyre or toad crabs:** CW= 1.2-1.5 mm, CL= 2.3-2.6 mm.

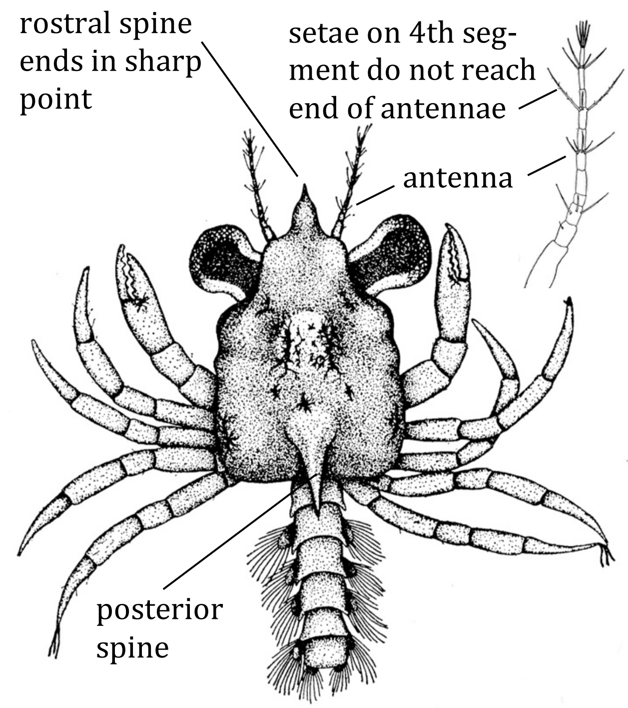


Fig. E. ***Cancer borealis,* Jonah crab:** CW=1.2 mm CL=1.9 mm. (see photos, page 39)

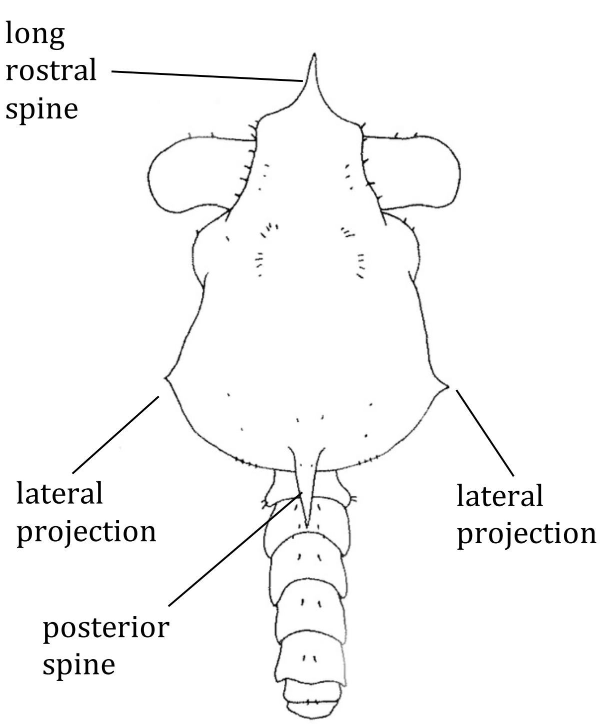


Fig. D. ***Parthenope serrata:*** CW=1.0 mm CL= 1.5 mm. (see photos, page 40)

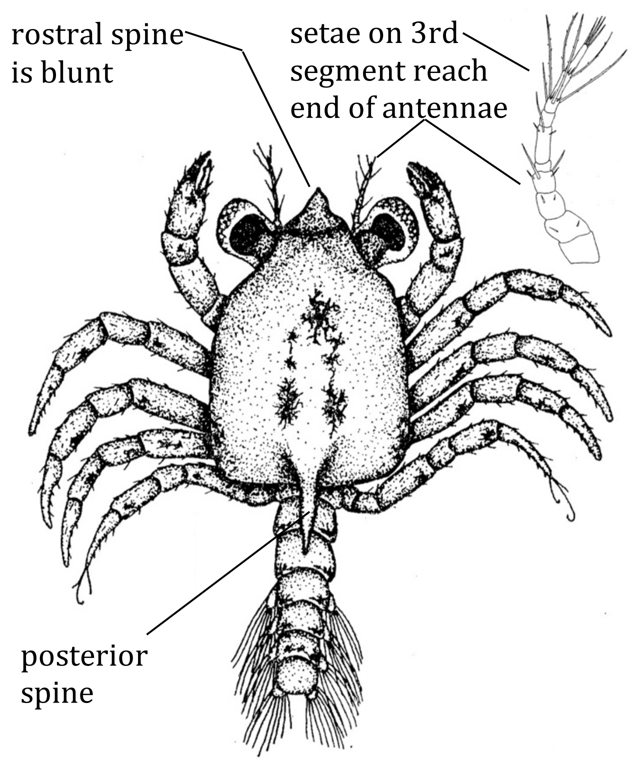


Fig. F. ***Cancer irroratus,* Atlantic rock crab:** CW=1.4 mm CL= 1.5 mm.

Megalopae With Short Rostral Spine

Rostral spine less than half as long as antenna

#1. Rostrum with lateral spines and central spine .... ***Panopeus herbstii*** (Fig. A)
#1. Rostrum without lateral spines (Figs. B-F)... #2

#2. Tip of rostral spine is notched; with tiny horn-like projections at anterior corners of rostrum .... ***Dyspanopeus*** (=***Neopanope***) spp. (Fig. B)
#2. Tip of rostral spine is pointed, not notched; corners of rostrum are rounded or bluntly pointed (Figs. C-F) .... #3

#3. Dorsal surface of carapace with distinct tubercles (knobs or protuberances) (Fig. D); rostral spine points sharply downward (Fig. D), may appear as a tiny point in dorsal view (Figs E-F); median line between eyes deeply concave; antennae with setae (bristles) on distal (outer) end of next to last segment.. ***Libinia*** spp., #4
#3. Dorsal surface of carapace without distinct tubercles, sides of carapace may have rounded lumps or bumps; tip of rostrum points forward or slightly downward; rostrum between eyes with shallow depression; antennae with no setae on distal end of next to last segment, with setae on distal end of 2nd from last segment .... ***Carcinus maenas*** (Fig. C)

#4. With 2 median cardiac tubercles; anterior corners of rostrum are rounded............................ .... ***Libinia emarginata*** (Fig. E)
#4. With one median cardiac tubercle; corners of rostrum are pointed ....***Libinia dubia*** (Fig. F)

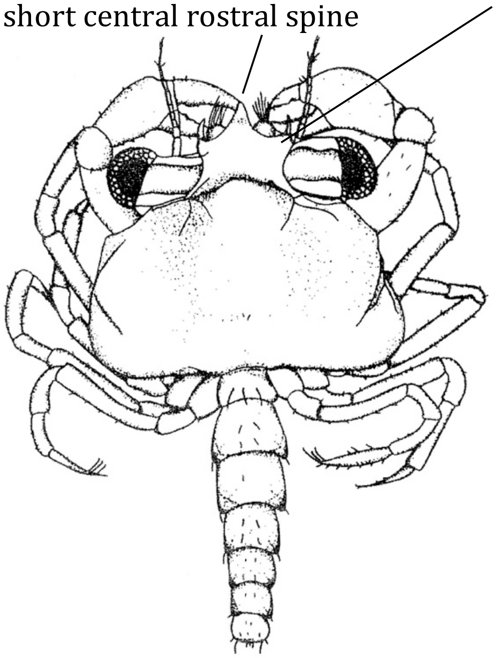


Fig. A. ***Panopeus herbstii*, Atlantic mud crab**: CW= 1.0 mm, CL= 0.8 mm**.**

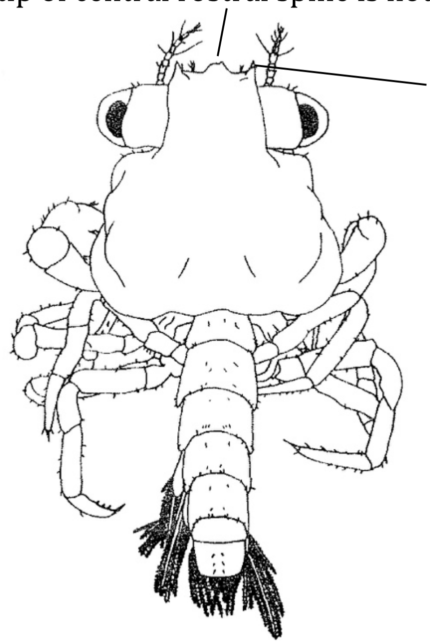


Fig. B. ***Dyspanopeus (=Neopanope)* spp. mud crabs**: CW= 1.5 mm, CL= 1.4 mm.
(see photos, page 35)

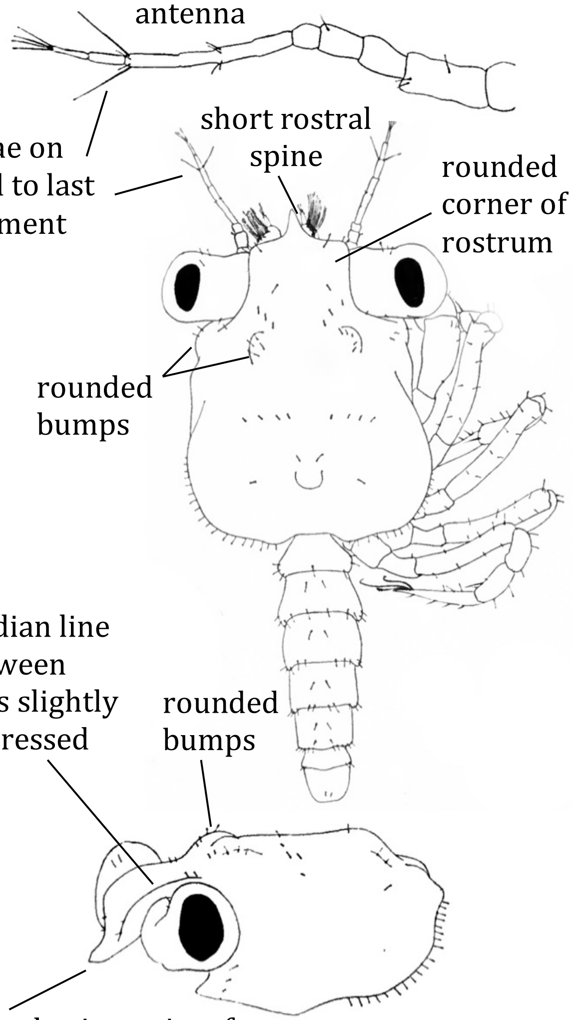


Fig. C. ***Carcinus maenas,* green crab:** (see photos page 37) CW=1.1 mm CL= 1.3 mm.

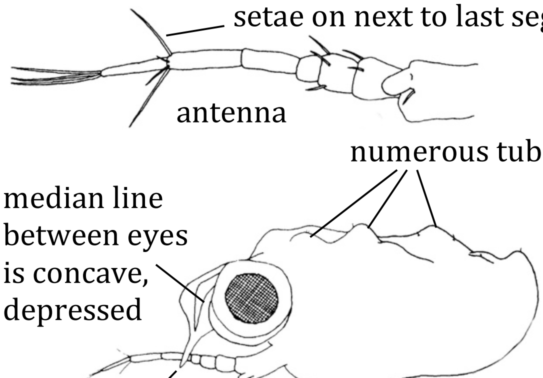


Fig. D. ***Libinia* spp., spider crabs,** antenna and carapace side view. (see photos, p. 38)

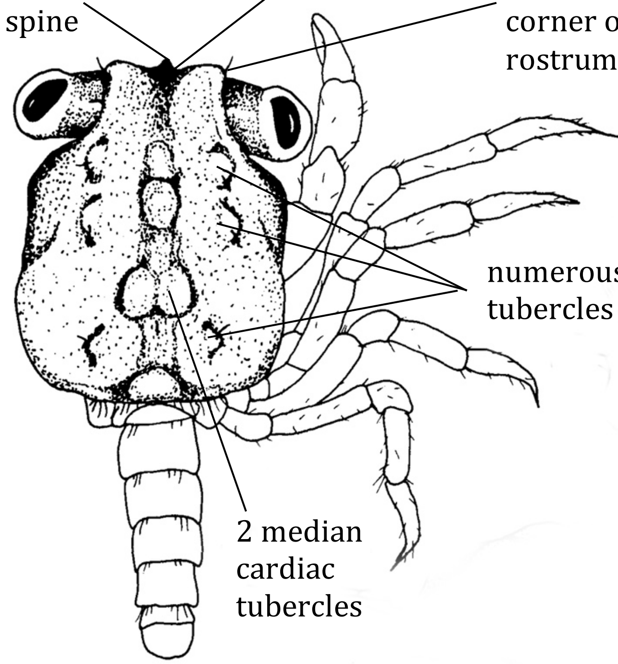


Fig. E. ***Libinia emarginata,* portly spider crab:** CW=0.9 mm CL= 1.2 mm.
(see photos, page 38)

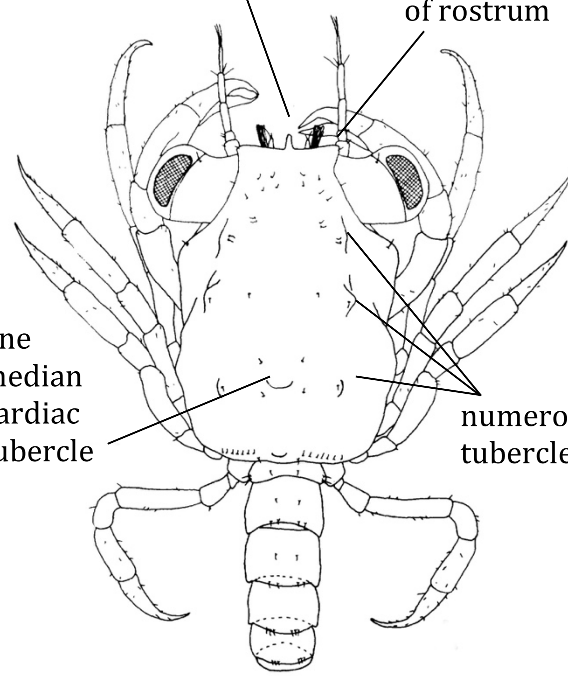


Fig. F. ***Libinia dubia*, longnose spider crab:** CW=0.7 mm CL= 1.1 mm.

Megalopae With No Rostral Spine Or With Short Rostral Spine Pointing Downward And Not Visible In Dorsal View

#1. Dorsal surface of carapace with tubercles (page 21, Figs. D-F). Also see color photos, page 38) .... ***Libinia* spp.**, page 20
#1. Dorsal surface of carapace without tubercles .... #2

#2. Front of edge of rostrum is straight, not notched in center .... ***Pinnixia* spp.** (Fig. A)
#2. Front edge of rostrum notched in center, with blunt knobs on either side (Figs. B-D); rear legs carried on top of carapace .... #3

#3. Antennae with 5 segments.......... ***Pinnotheres ostreum*** (Fig. B)
#3. Antennae with more than 5 segments (see Fig. F); carapace and abdomen with spidery, dark brown and red chromatophores .... #4

#4. With 3 plumose (feather-like) setae* attached to the end of telson; no spines on sides of abdomen .... ***Hemigrapsus sanguineus*** (Fig. C)
#4. No plumose setae* at end of telson; with spines on sides of abdomen.......... ***Uca* spp.** (Fig. E)

*The pleopods (appendages under the abdomen) of both *Hemigrapsus* and *Uca* have long and plumose (featherlike) setae (see photo on page 36). These setae extend to the sides and beyond the end of the telson. They can obscure or be confused with the plumose setae that are attached to the telson of *Hemigrapsus*. Examine the rear edge of the telson carefully.

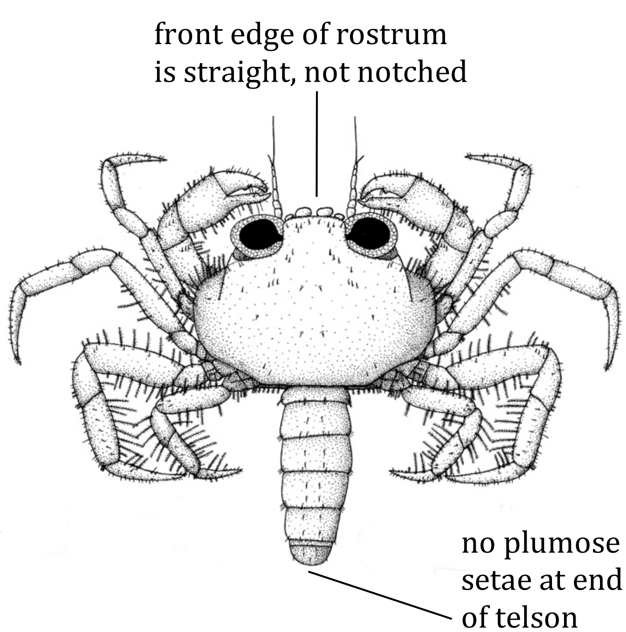


Fig. A, ***Pinnixia* spp., pea crabs:** CW=1.0 mm CL= 0.7 mm

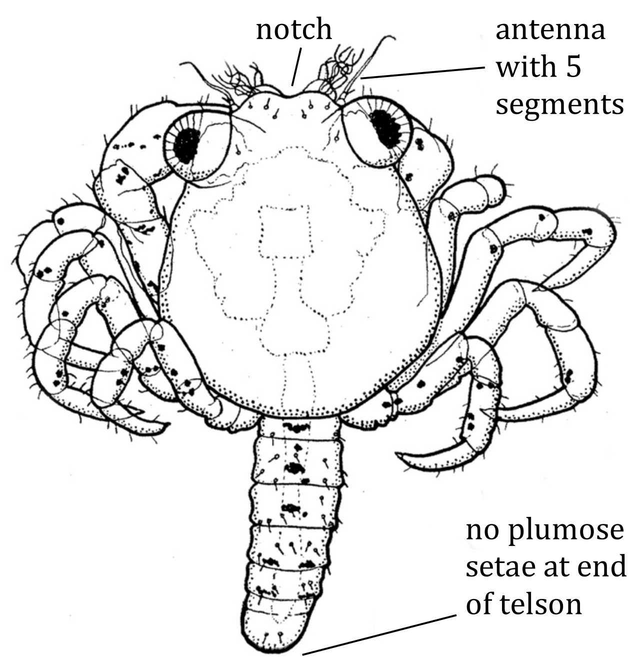


Fig. B. ***Pinnotheres ostreum*, oyster pea crab**: CW=0.6 mm CL= 0.6 mm.

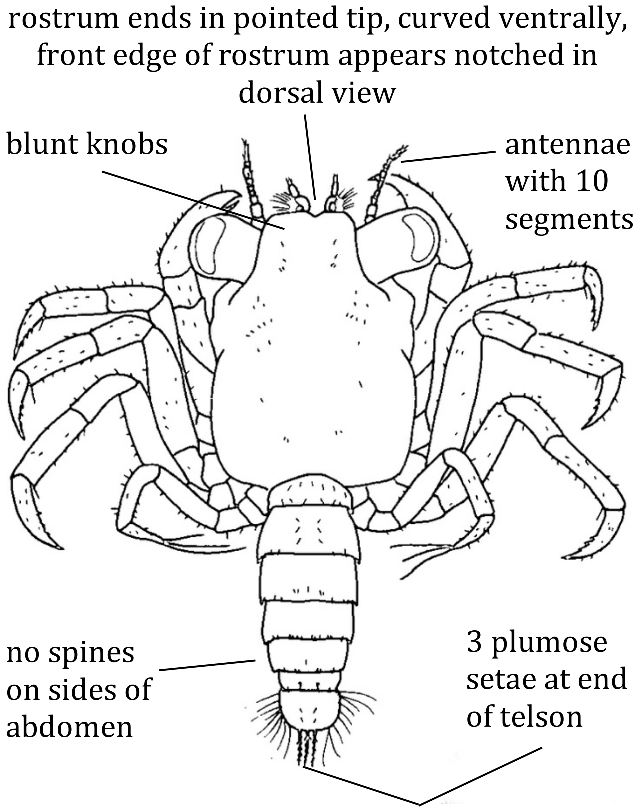


Fig. C. ***Hemigrapsus sanguineus*, Asian shore crab:** CW=1.5 mm CL= 1.7 mm.

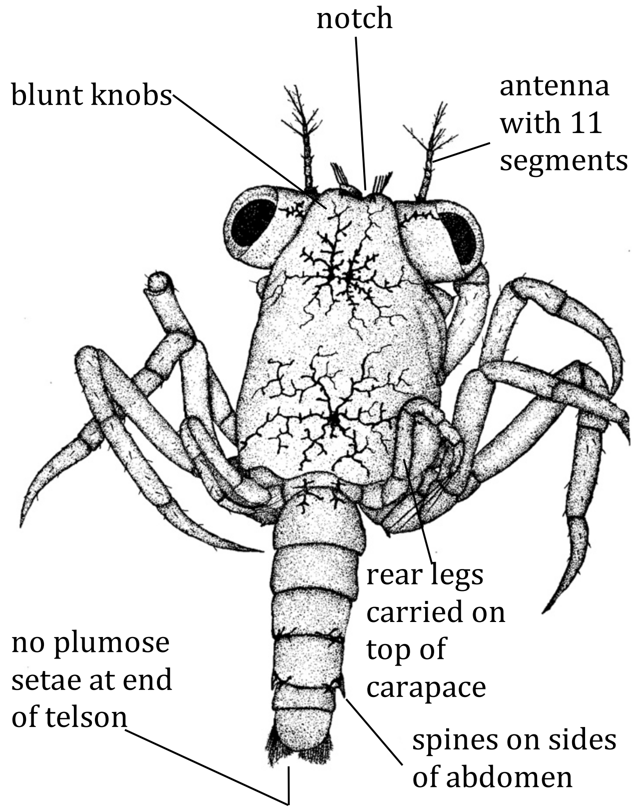


Fig. E. ***Uca* spp., fiddler crabs:** (see photos, page 36)

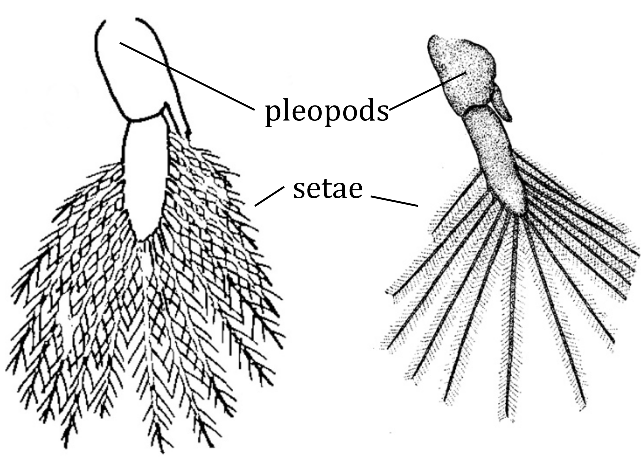


Fig. D. Pleopods of *Hemigrapsus* (left) and *Uca* (right) with long plumose (featherlike) setae

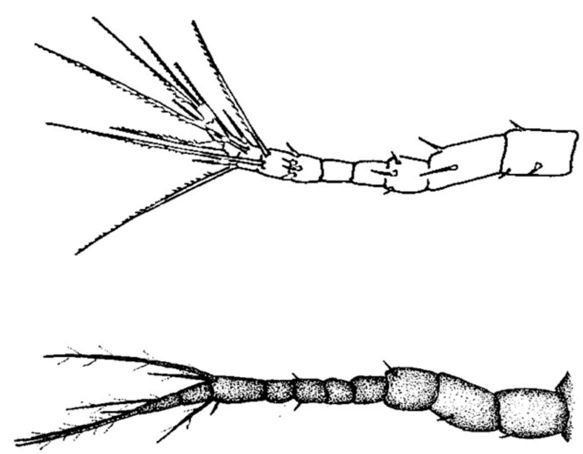


Fig. F. Antennae of *Hemigrapsus* (top) and *Uca* (bottom) with 10-11 segments

Megalopae With Long Rostral Spine

Rostral spine more than half as long as antenna;
no posterior spines on carapace

#1. Sides of carapace with pointed lateral projections; rostrum broadens between eyes .... ***Ovalipes ocellatus*** (Fig. A)

#1. Sides of carapace rounded, without lateral projections; rostrum narrows between eyes .... ***Sesarma reticulatum*** (Fig. B)

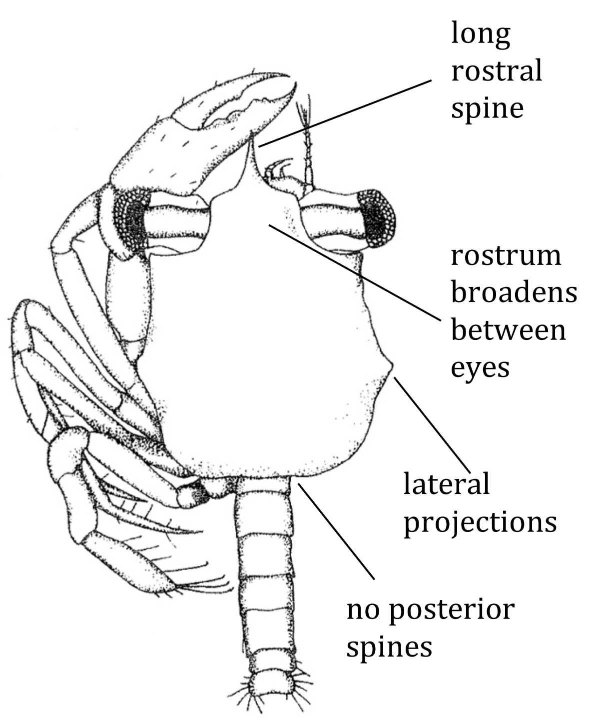


Fig A. ***Ovalipes ocellatus*****, lady or calico crab:**
CW= 1.1 mm, CL= 1.4 mm

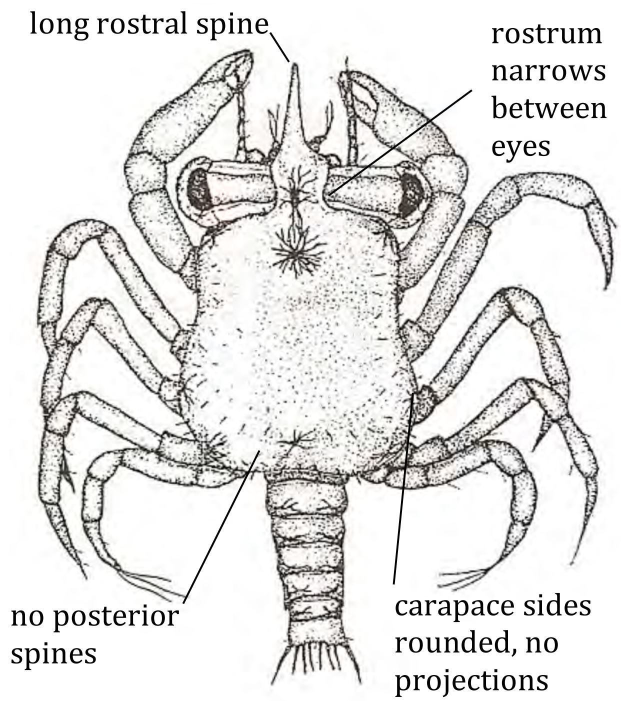


Fig. B. ***Sesarma reticulatum,*** **marsh crab:**
CW=0.6 mm CL= 1.0 mm.
(see photos, page 40)

Color Photos

Homarus americanus, American lobster

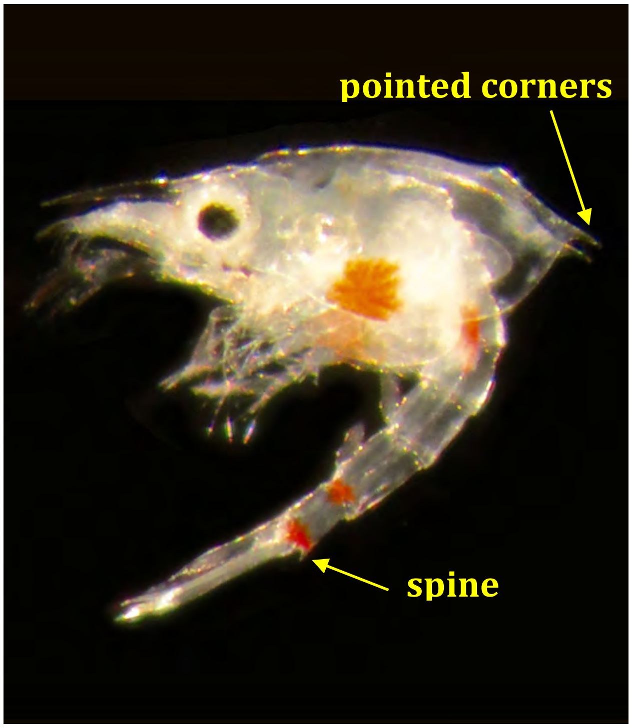
Stage II photo provided by Huntsman Marine Science Centre (hunstmanmarine.ca).
Stage IV photo provided by Lobster Institute. (lobsterinstitute.org)

stage II larva

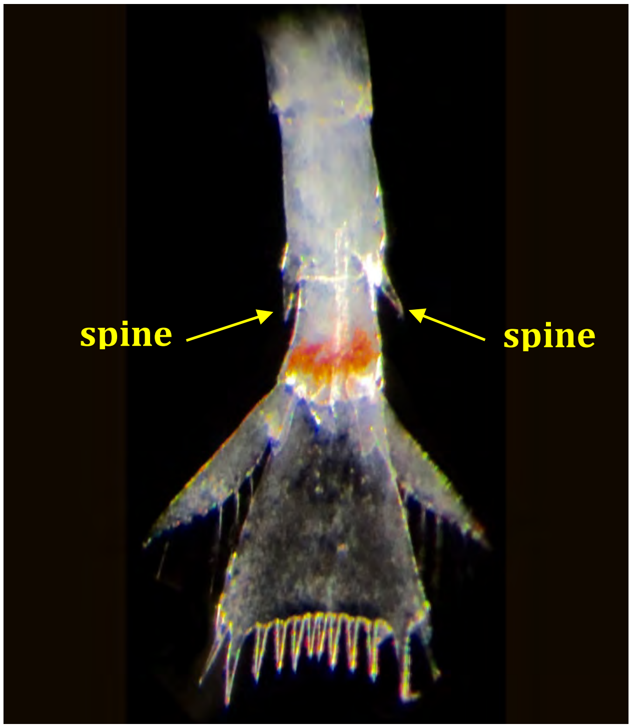
stage IV larva

Pagurus longicarpus, longwrist hermit crab: zoea

Note: Red chromatophores not always present.



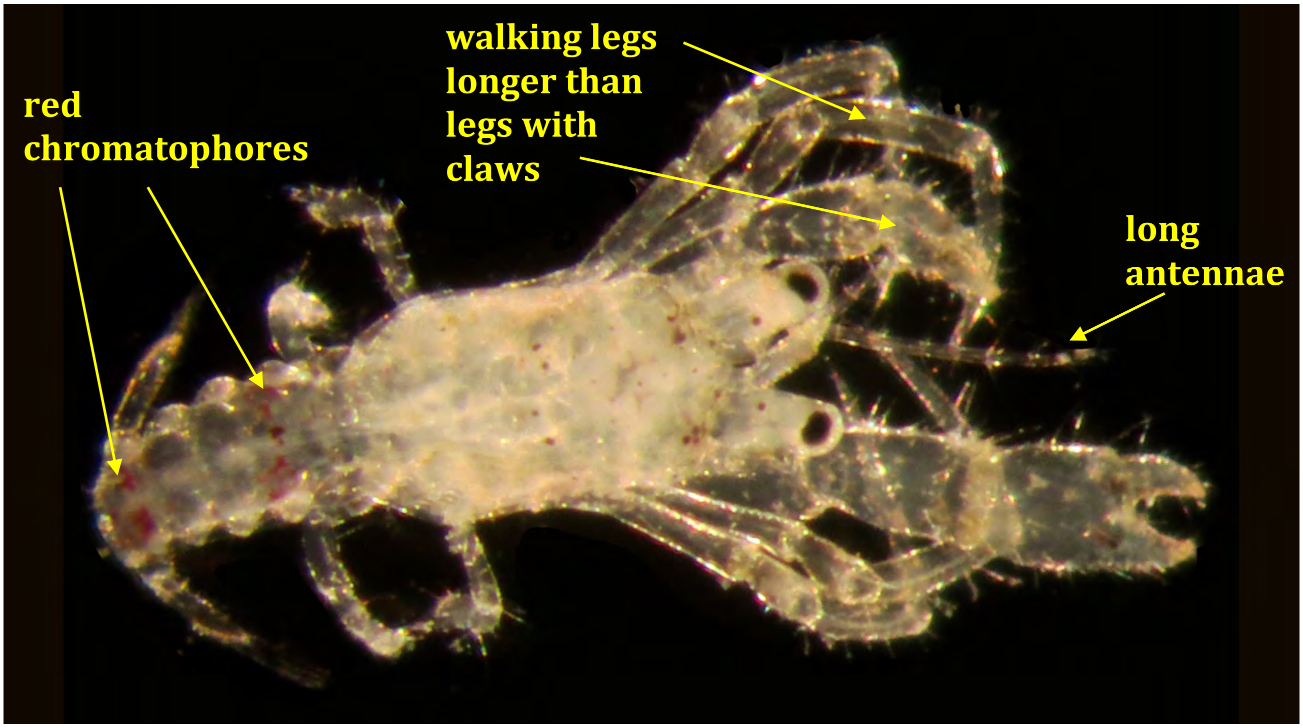
side view



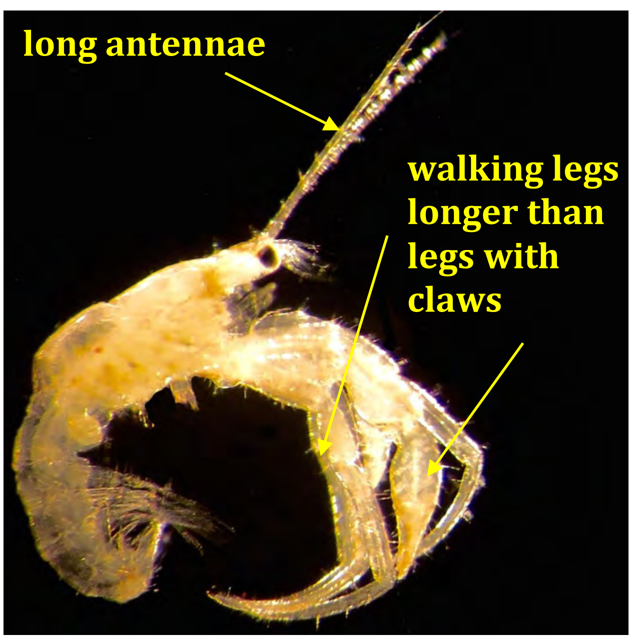
abdomen, dorsal view

Pagurus longicarpus, longwrist hermit crab: megalopae

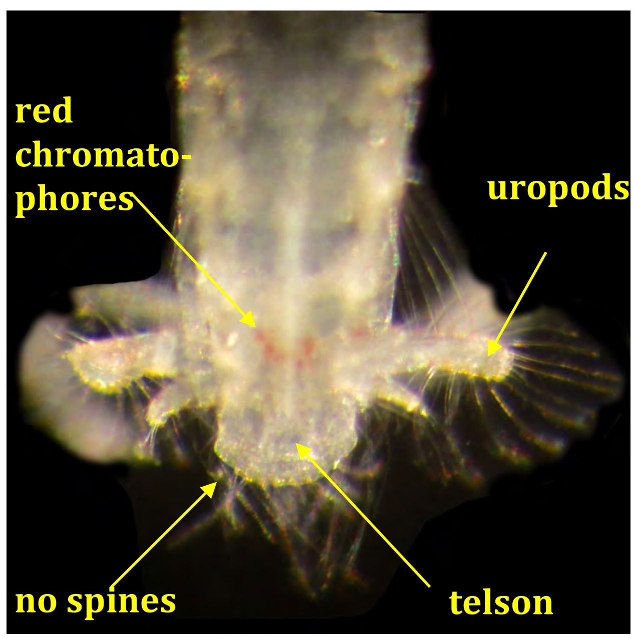
Note: Red chromatophores not always present.



dorsal view



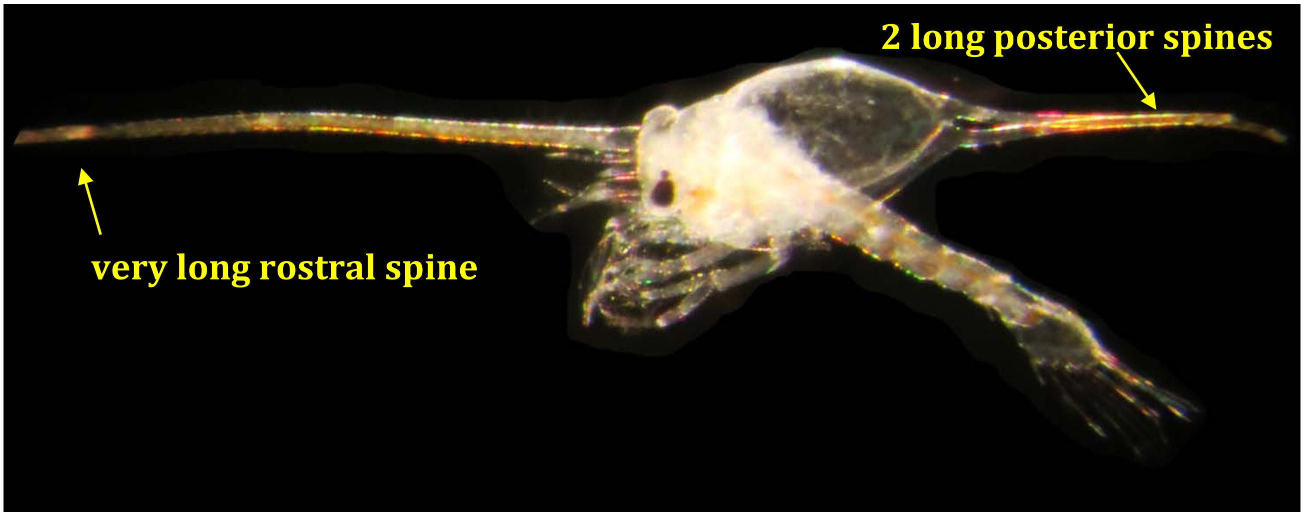
side view



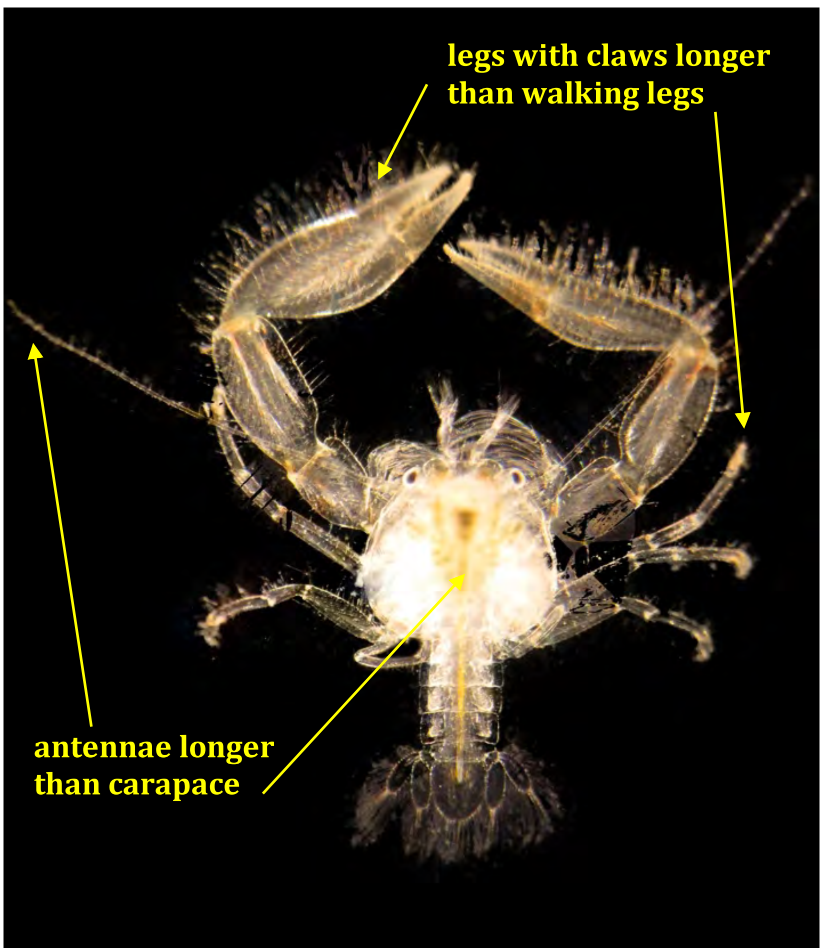
abdomen, dorsal view

Infraorder Anomura, family Porcellanidae: zoea

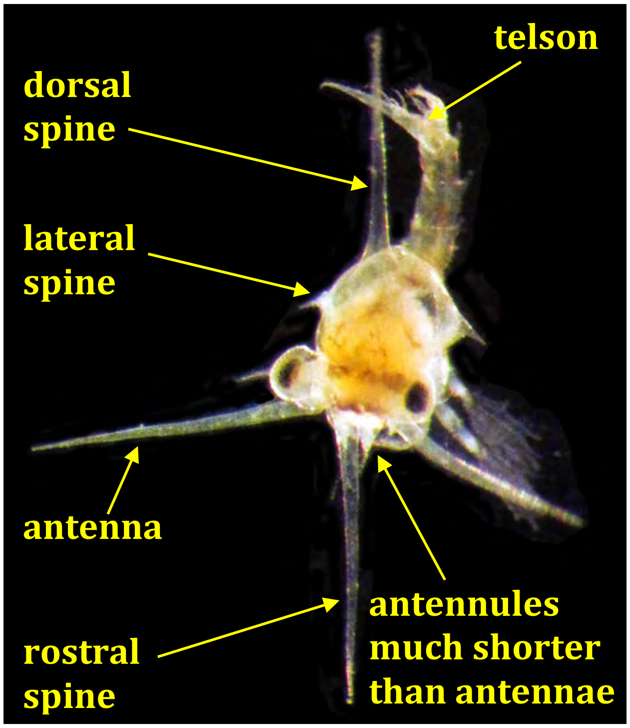
such as ***Polyonyx gibbesi*, eastern tube crab**



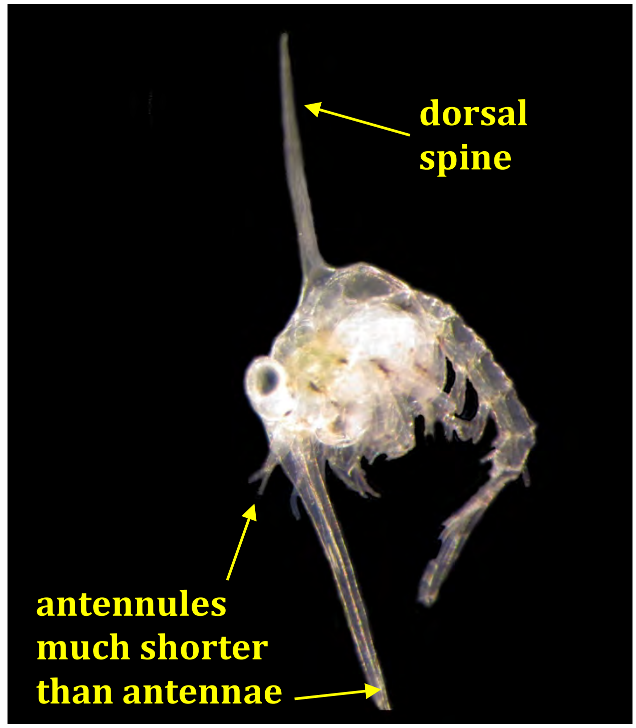
Polyonyx gibbesi, eastern tube crab: megalopa



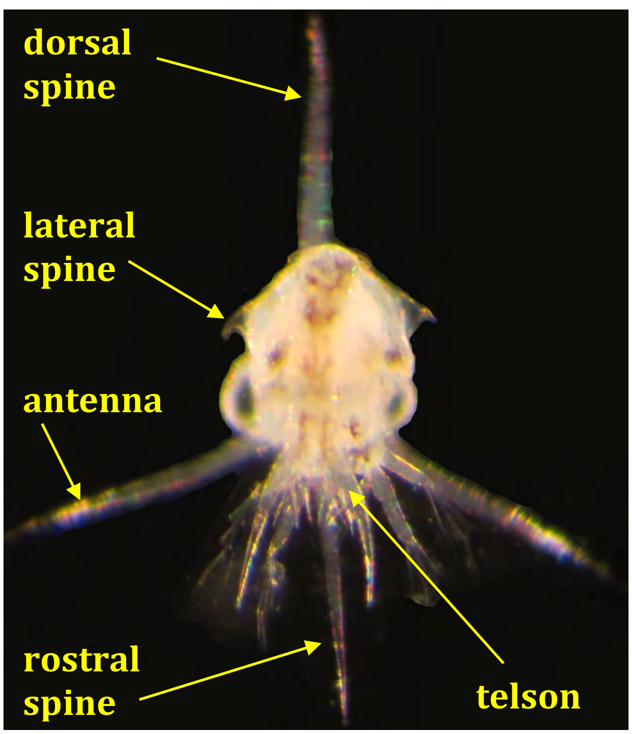
Family Xanthidae, mud crabs: zoeae



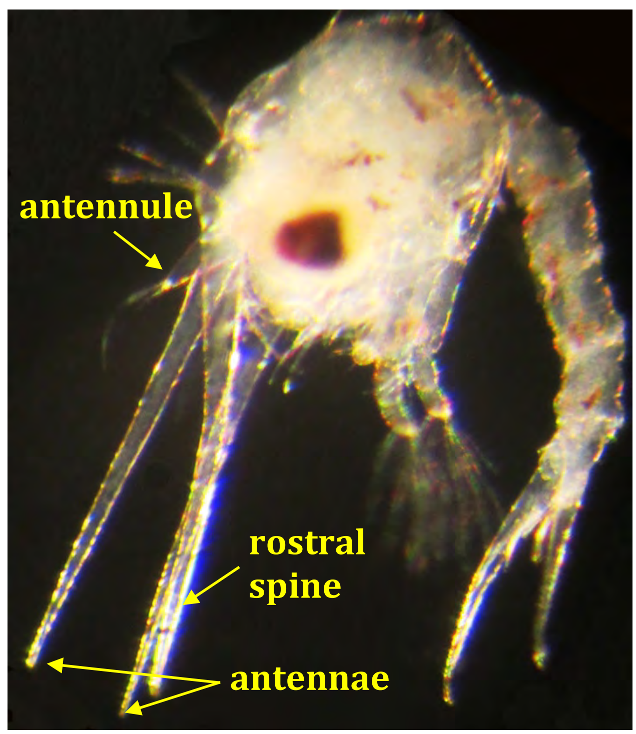
frontal view



side view

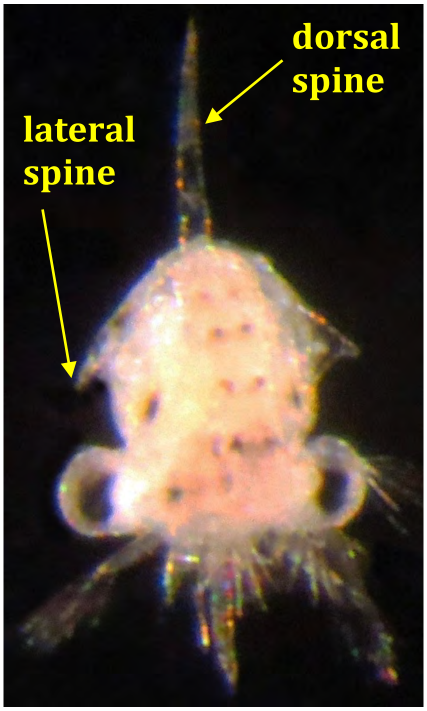


posterior view

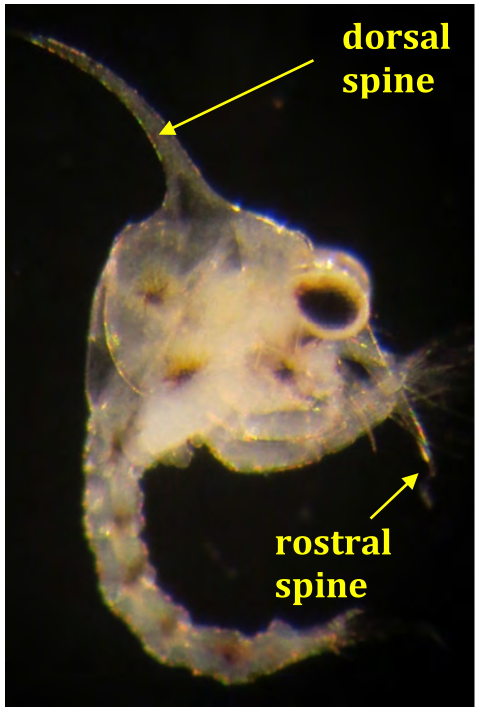


side view

Cancer spp., rock and Jonah crabs: zoea

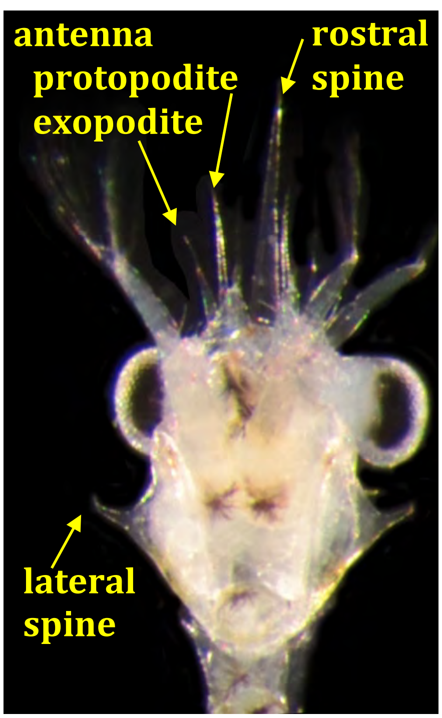


anterior view

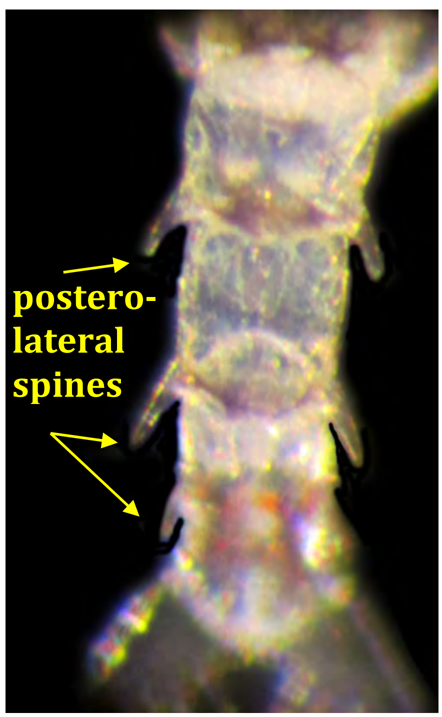


side view

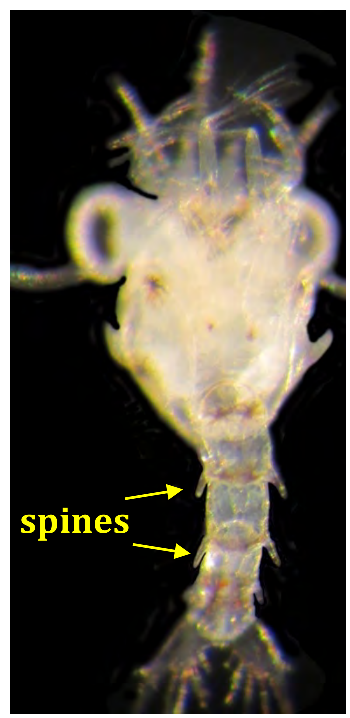
posterior view



ventral view

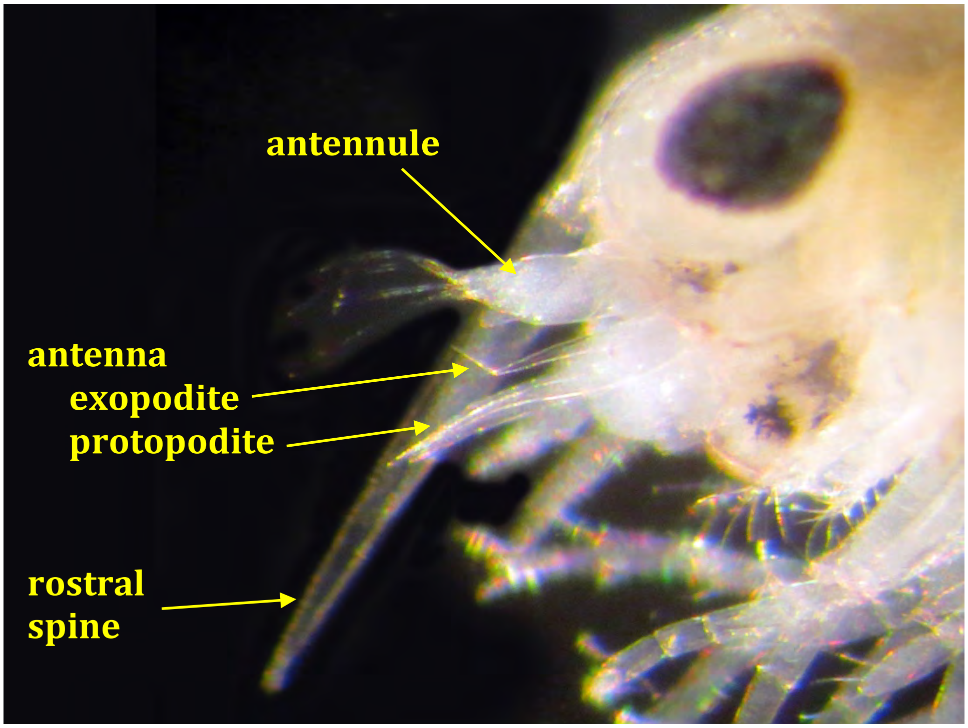


abdomen, ventral view

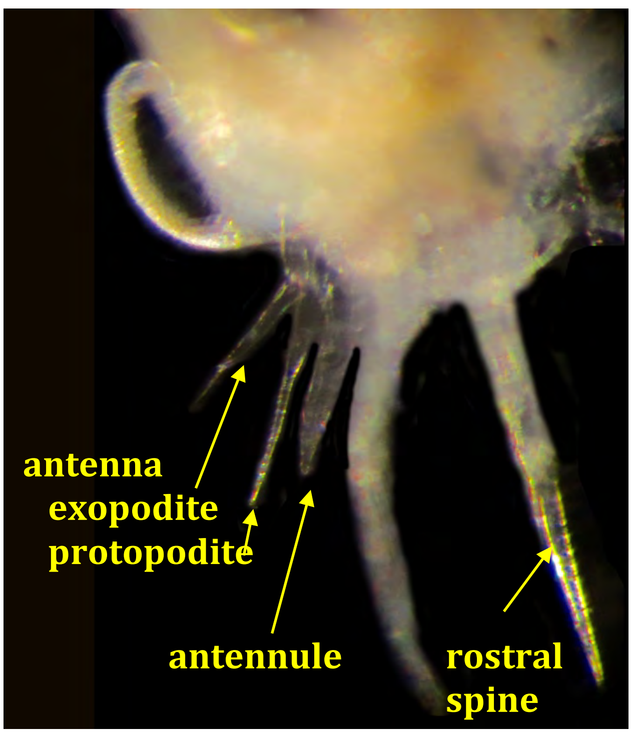


ventral view

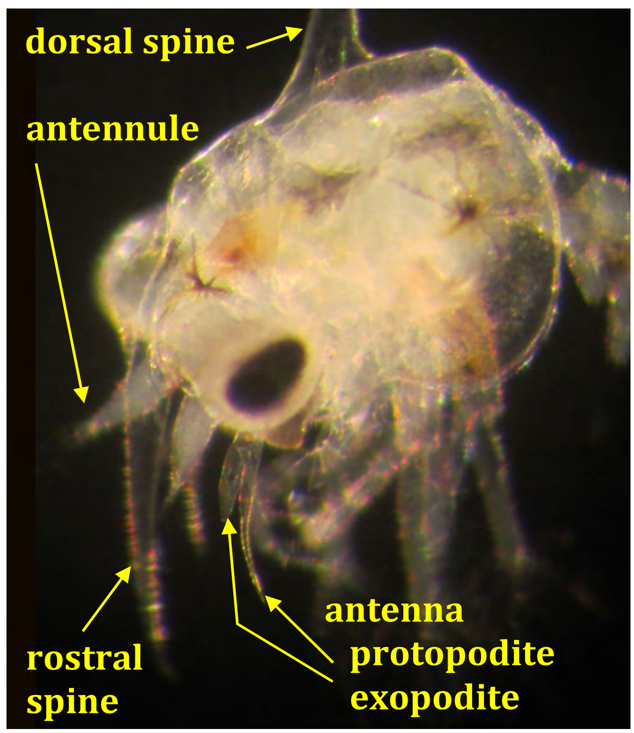
Cancer spp., rock and Jonah crabs: zoea



head, side view

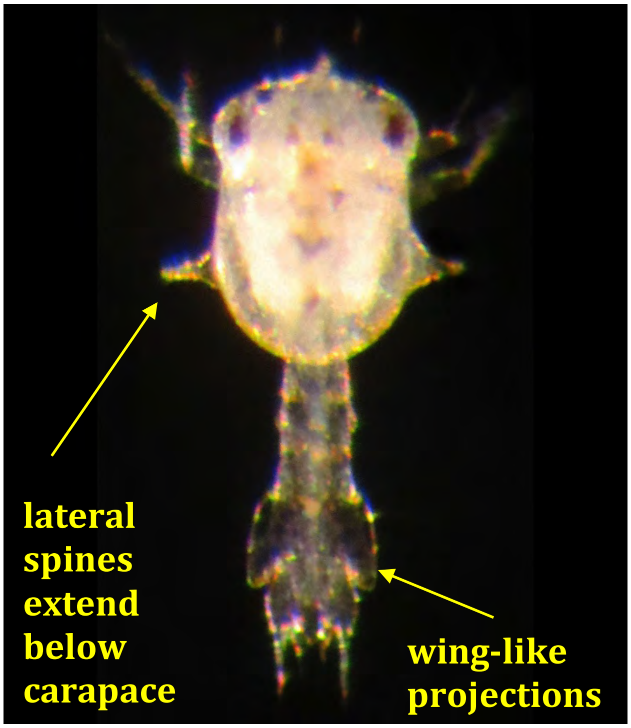


head, ventral view

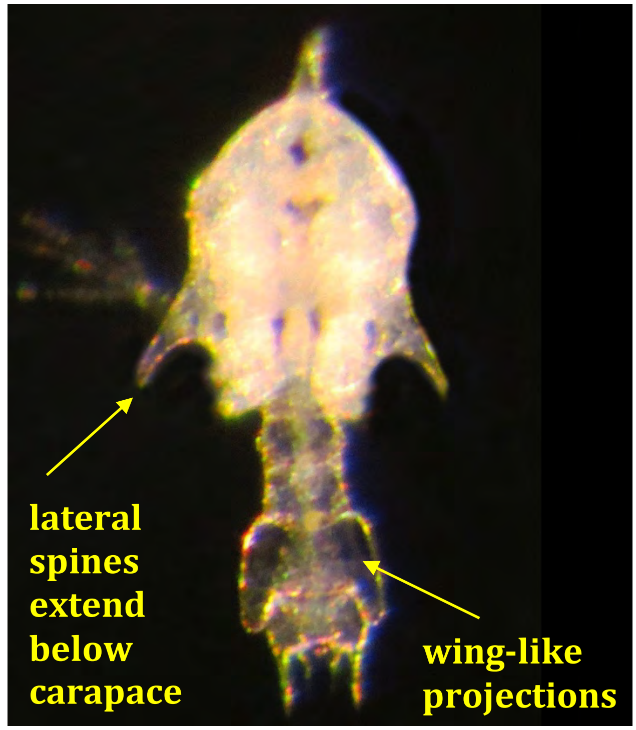


cephalothorax, side view

Pinnixia sp., pea crab: zoeae

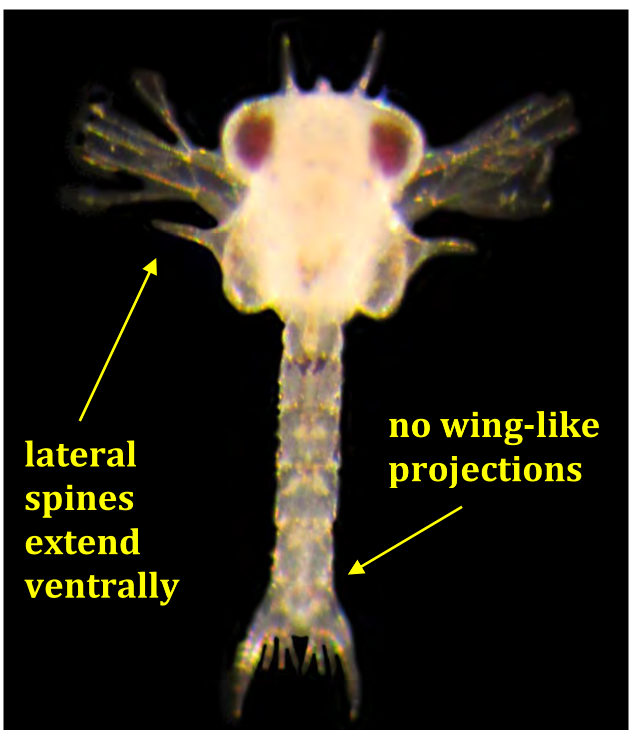


dorsal view

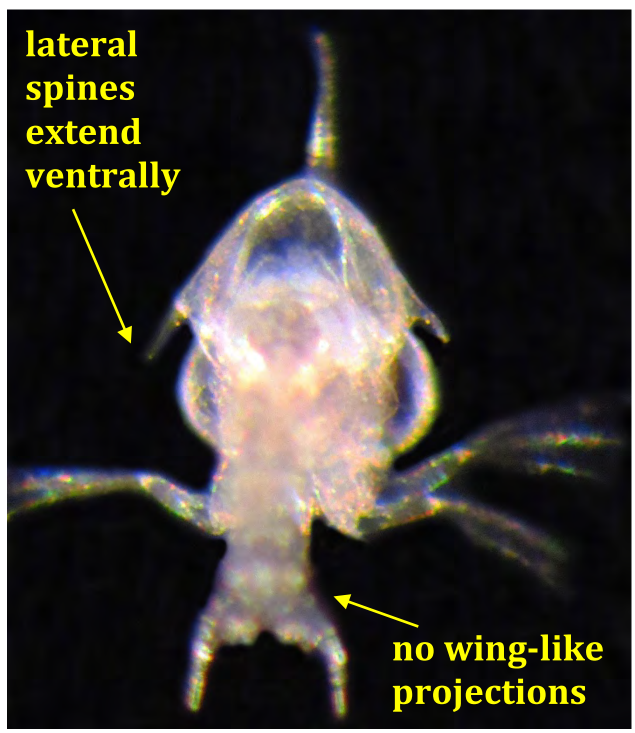


posterior view

Hemigrapsus sanguineus, Asian shore crab: zoeae

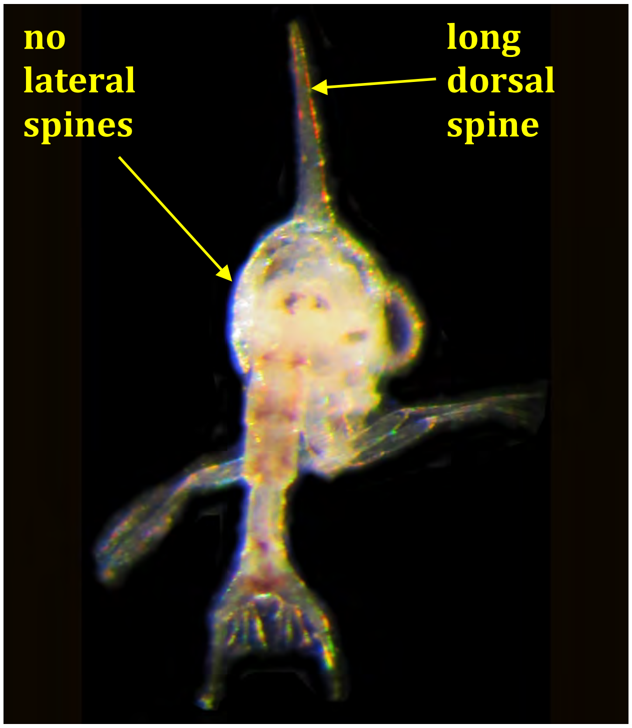


dorsal view

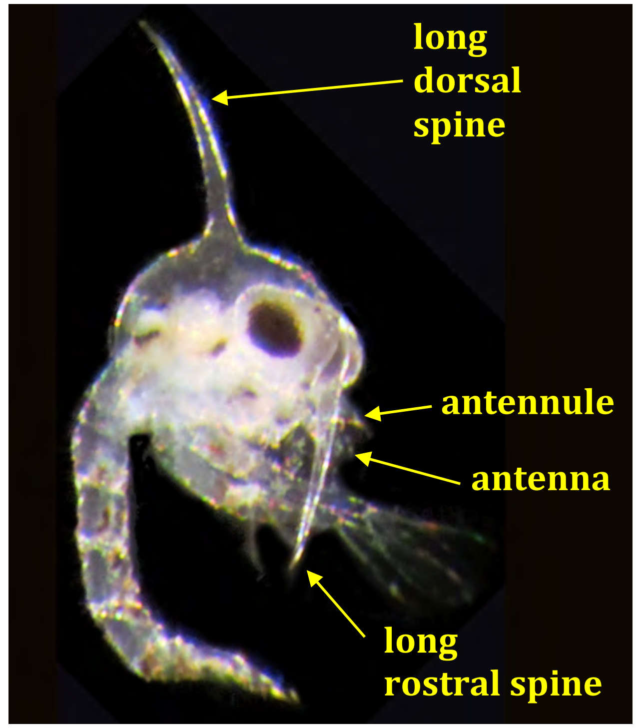


posterior view

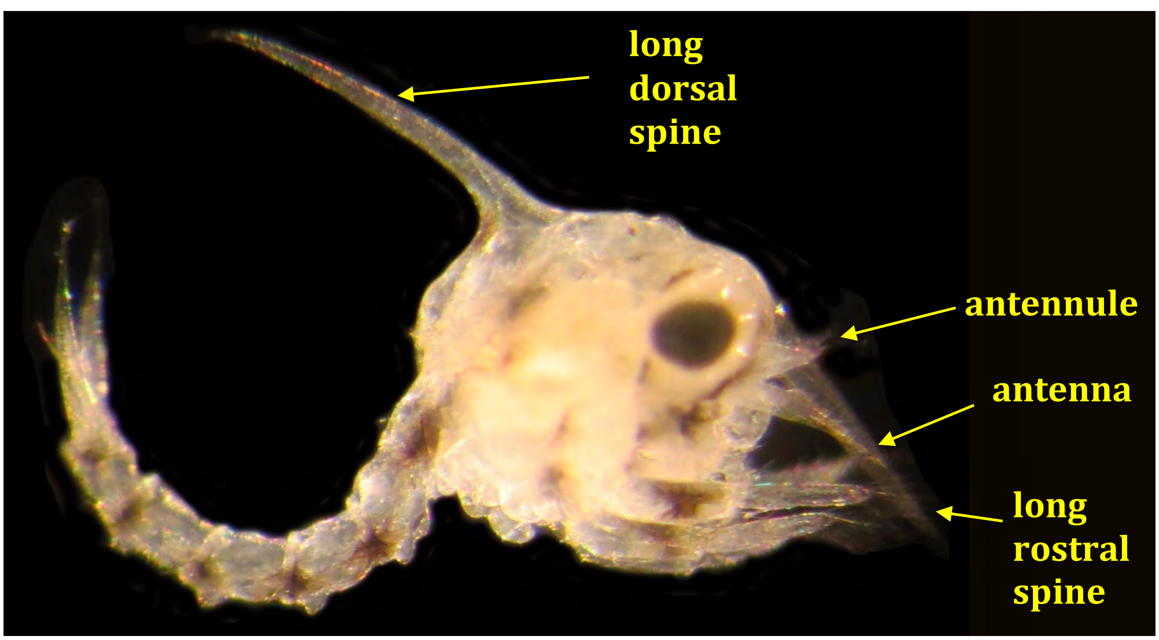
Carcinus maenas, green crab: zoeae



posterior view

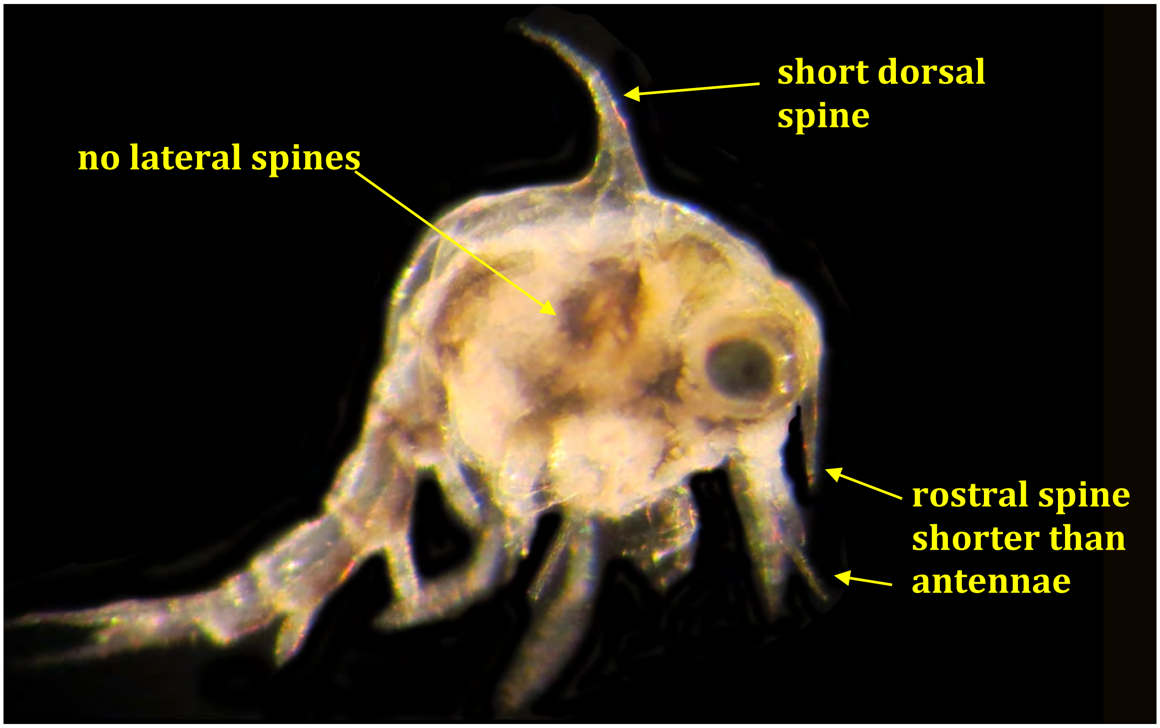


side view



side view

Libinia spp. spider crabs: zoea



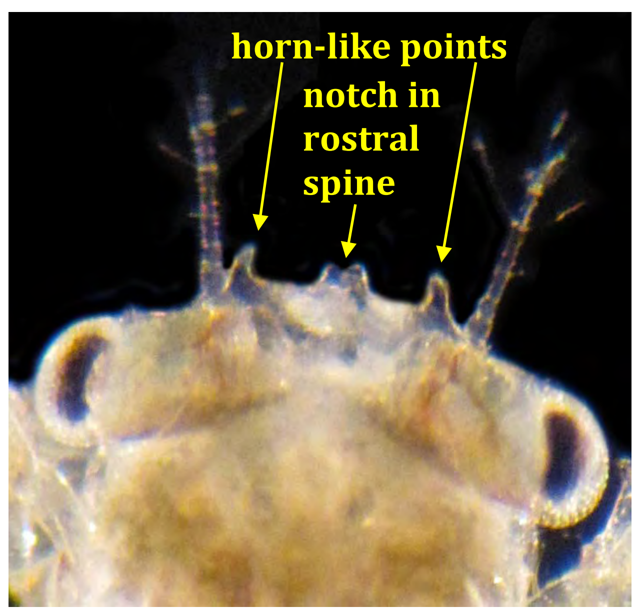
Callinectes sapidus, blue crab: megalopae

dorsal view

ventral view

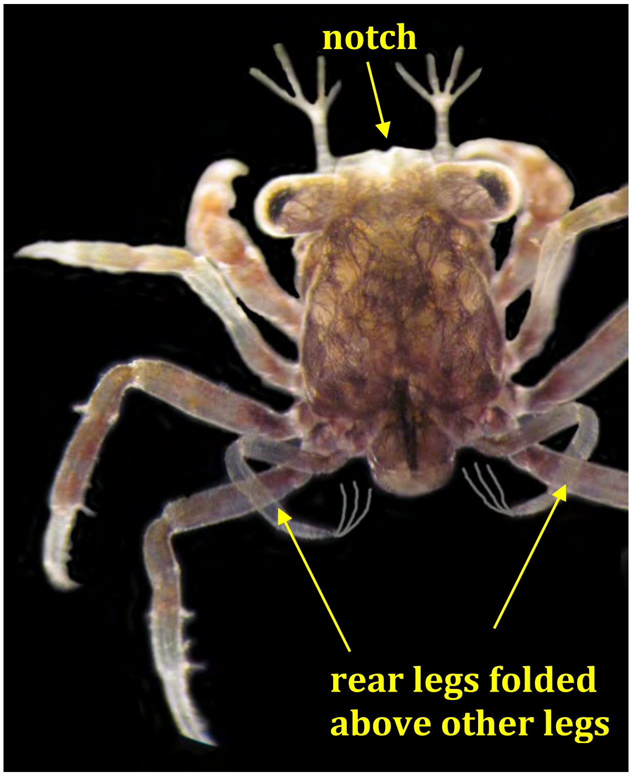
Dyspanopeus (=Neopanope) spp. mud crab: megalopae

dorsal view

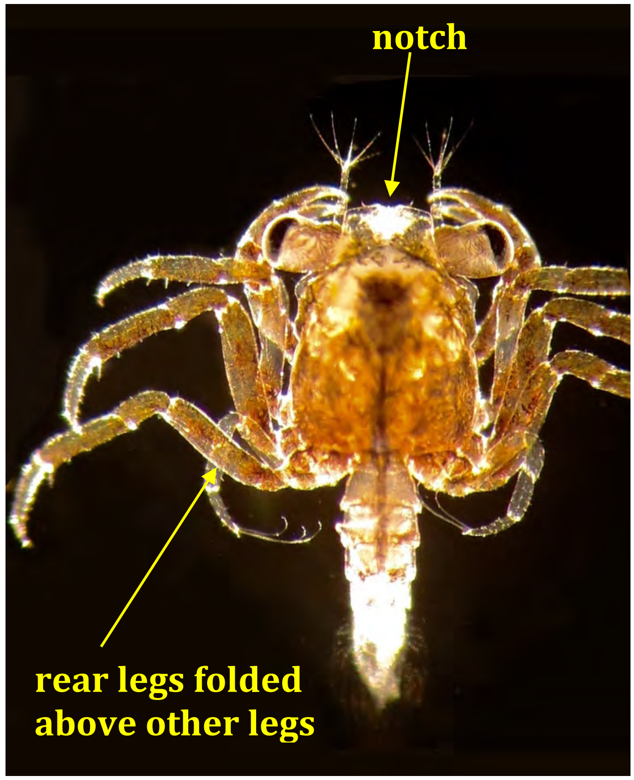


head region, dorsal view

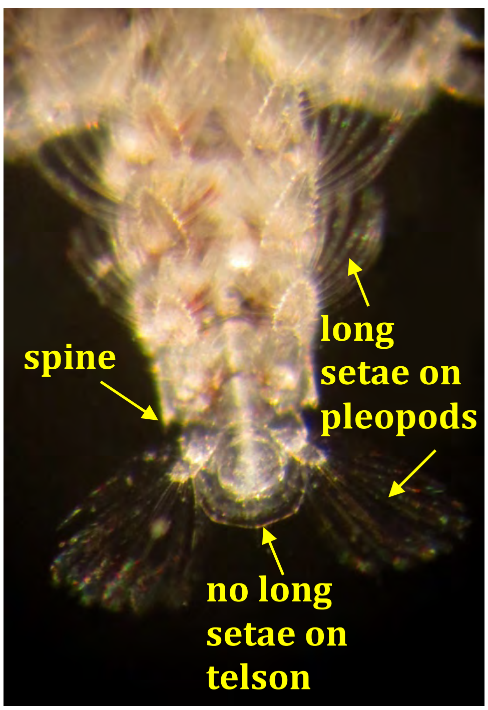
Uca spp., fiddler crabs: megalopae



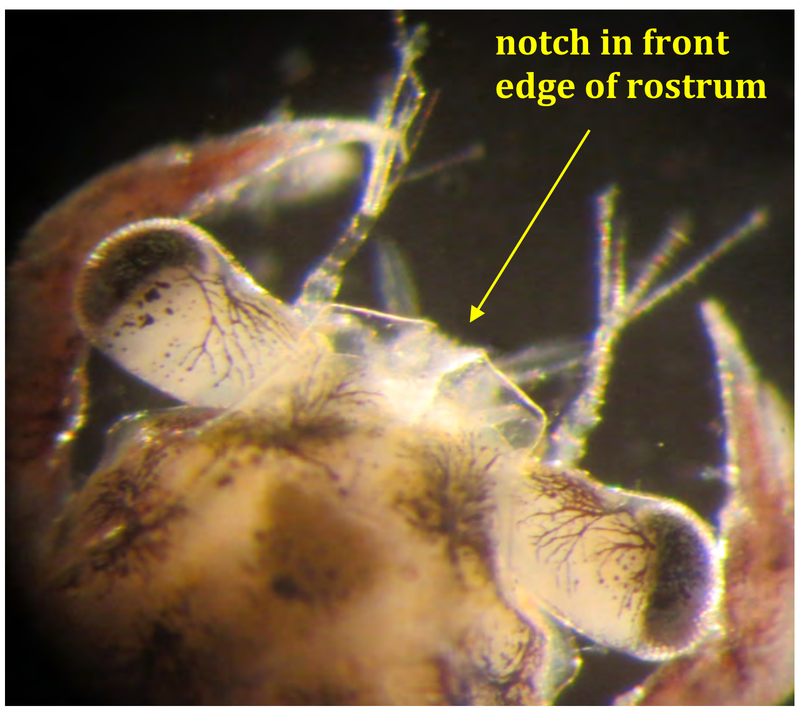
with abdomen folded under carapace



with abdomen extended behind carapace



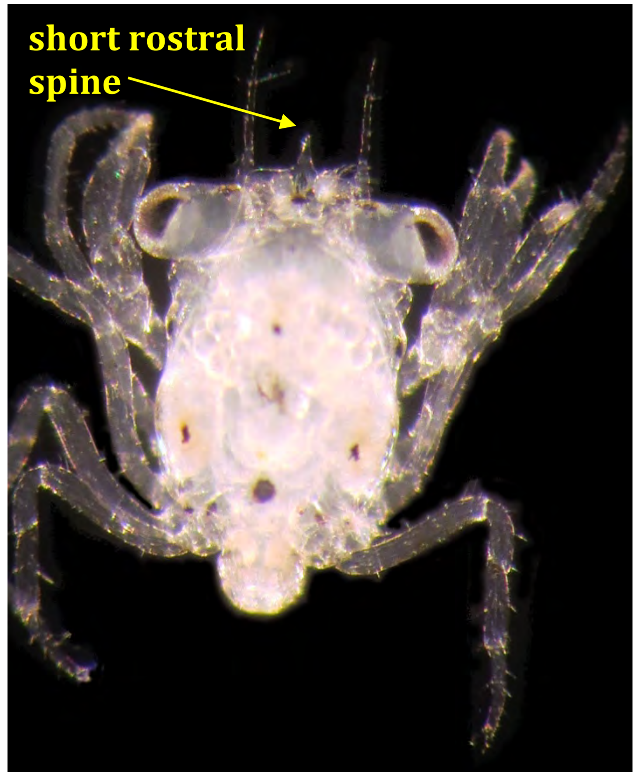
abdomen, ventral view



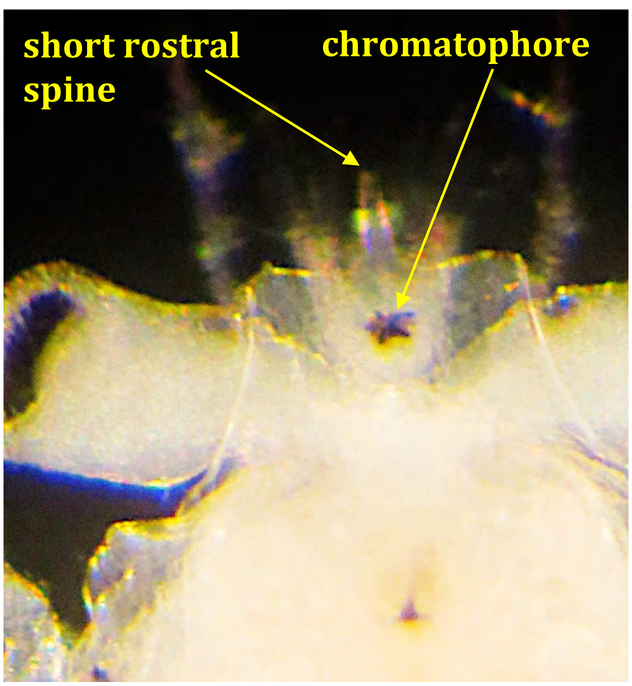
rostrum

Carcinus maenas, green crab: megalopae

dorsal view showing typical anchor-shaped dark pigment pattern on carapace and spidery chromatophores between eyes



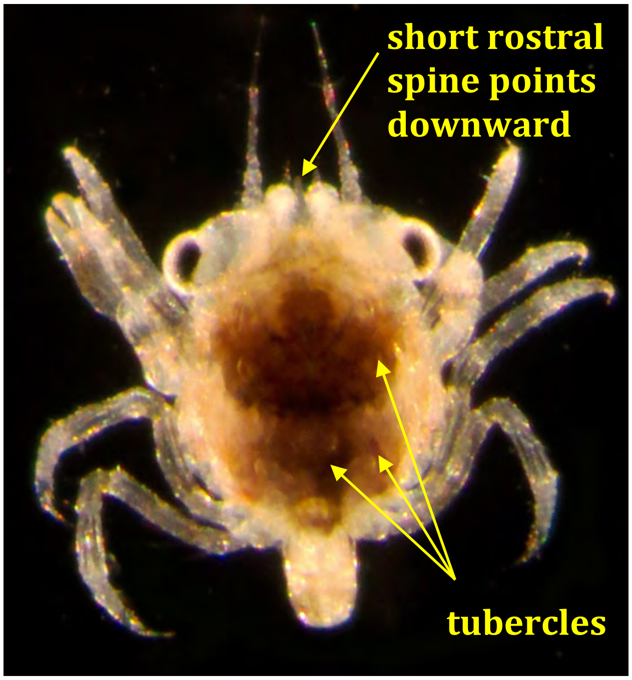
dorsal view showing a typical light color pattern with only a few scattered round chromatophores on carapace



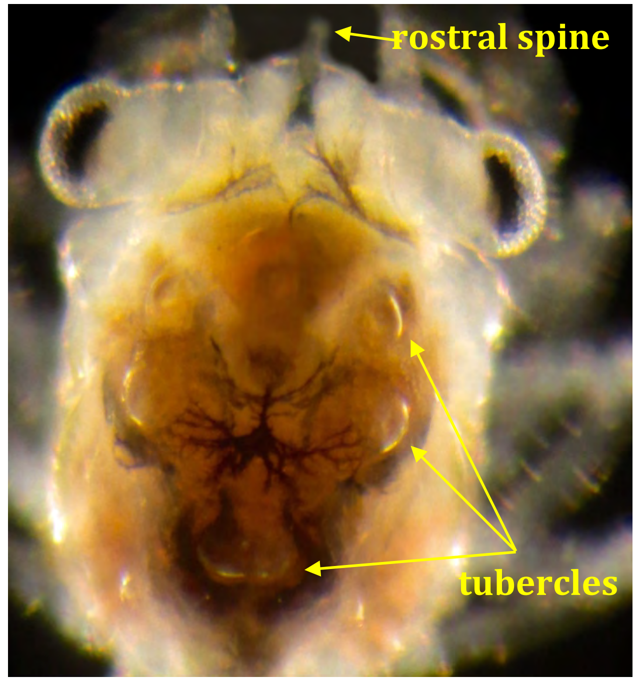
rostrum

ventral view, with abdomen extended behind carapace

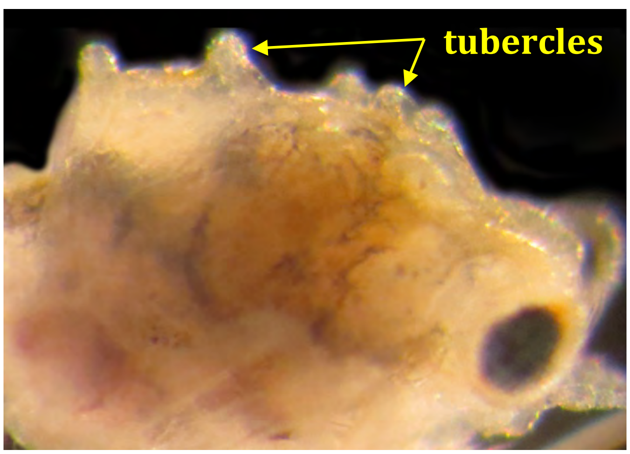
Libinia emarginata, portly spider crab: megalopae



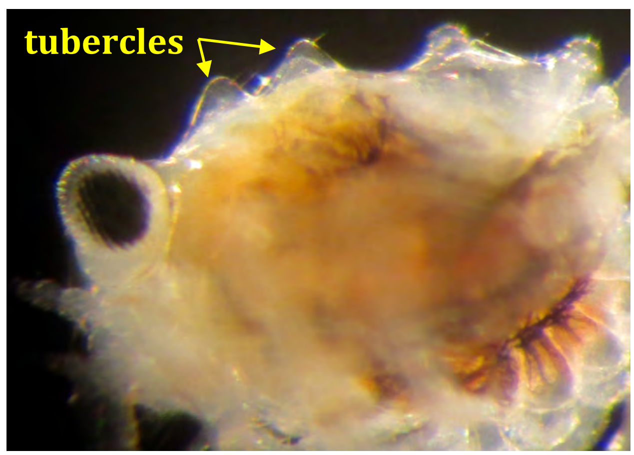
dorsal view



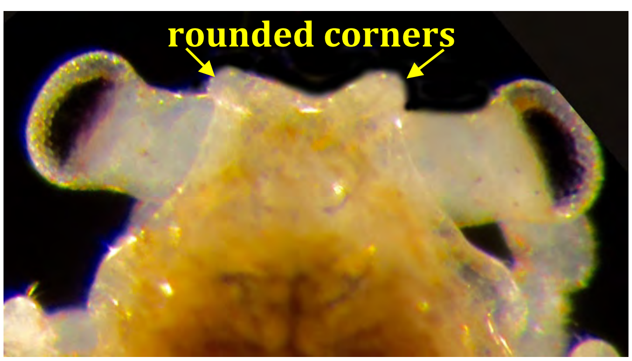
tubercles on carapace, dorsal view



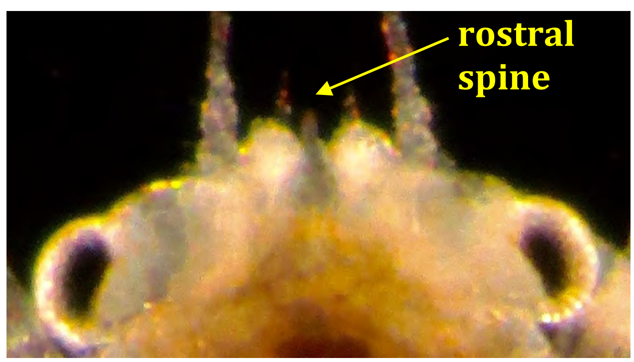
tubercles on carapace, side view



tubercles on carapace, side view

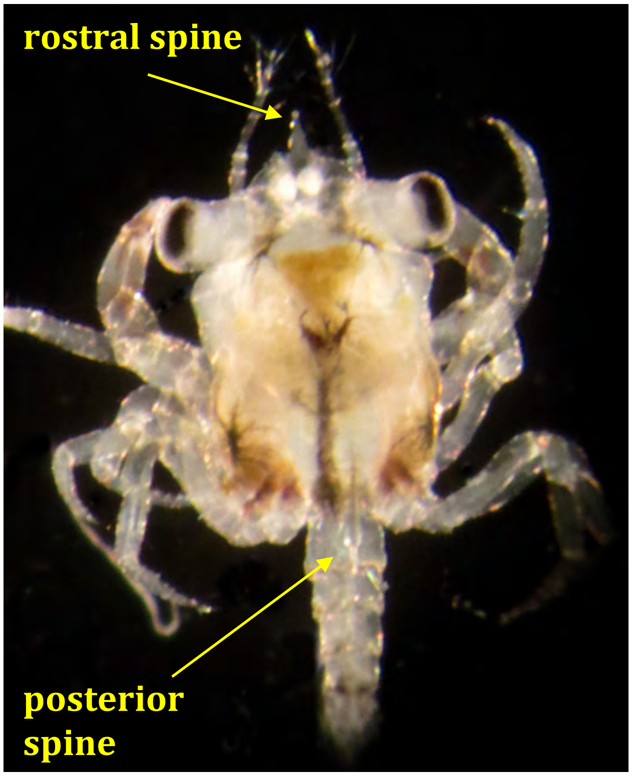


rostrum (rostral spine often not visible)

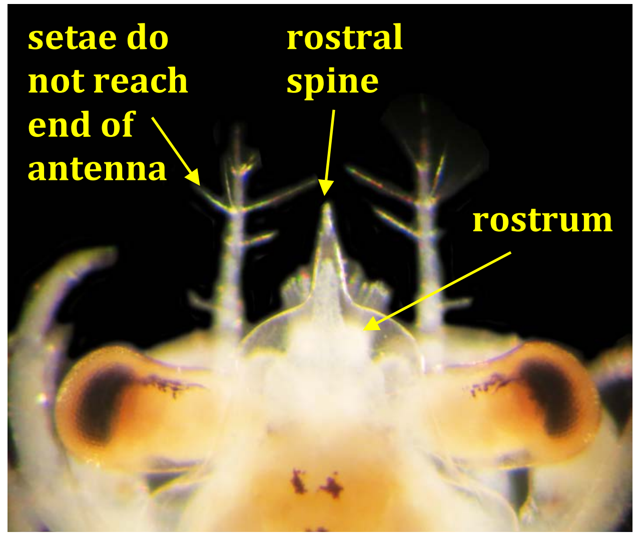


short rostral spine points downward

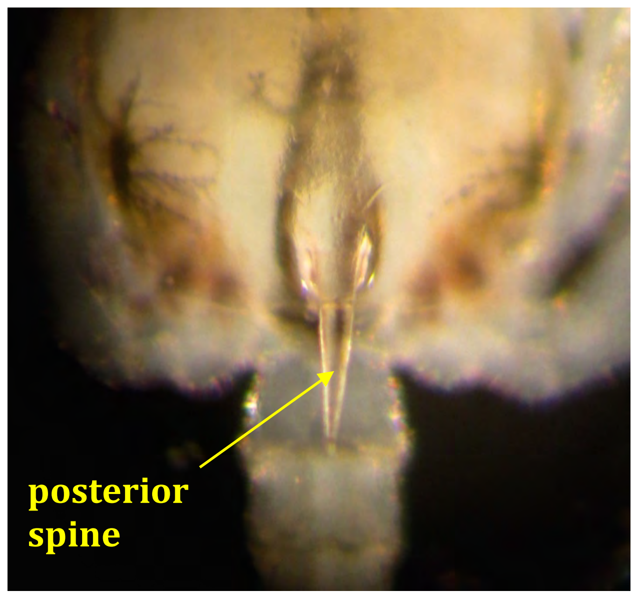
Cancer borealis, Jonah crab: megalopae



dorsal view



anterior of carapace

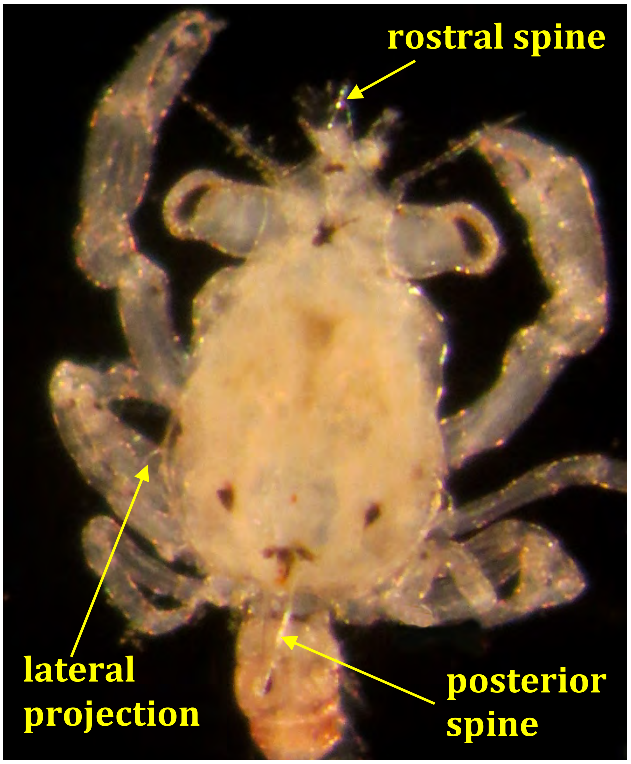


posterior of carapace

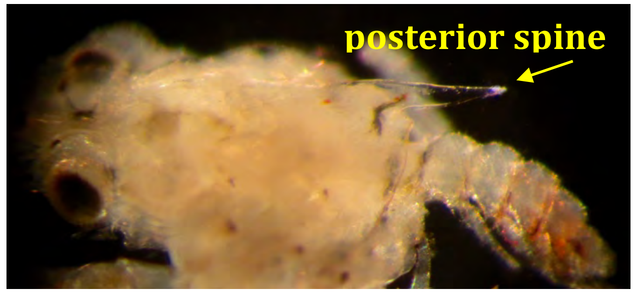
dorsal view

side view

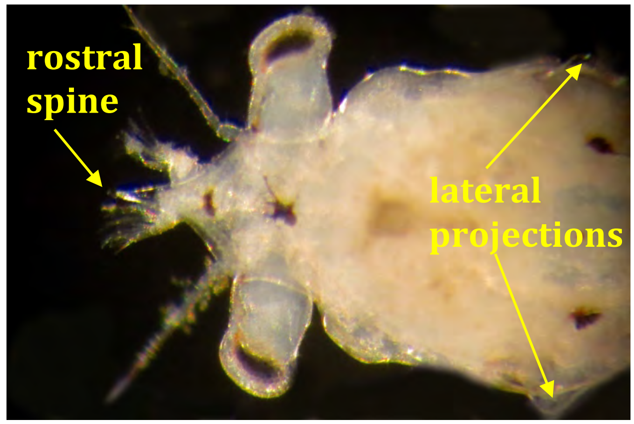
Parthenope serrata: megalopae



dorsal view



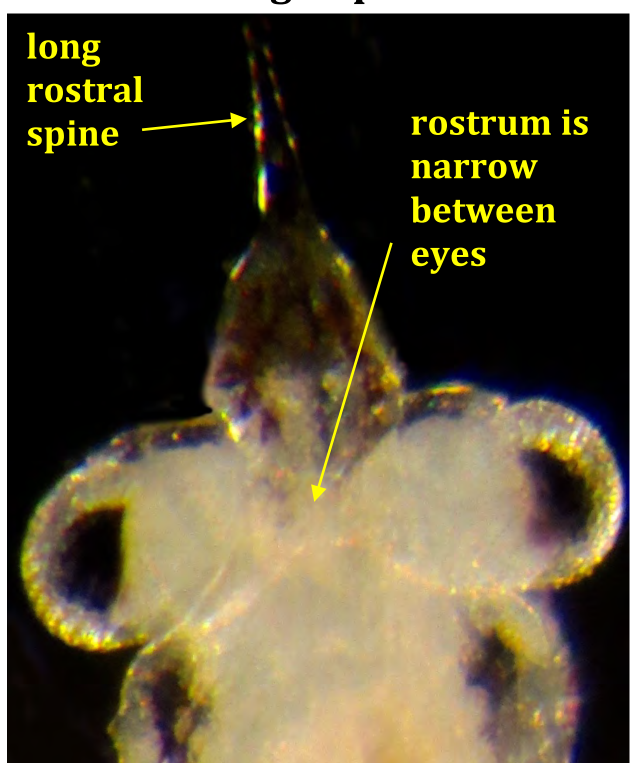
side view



dorsal view, carapace and rostrum

Sesarma reticulatum, marsh crab: megalopae

dorsal view



rostrum

Fig. A. Collecting crab larvae near surface with a neuston sampler (rectangular plankton net).

Fig. B. Megalops collector float using an air conditioning filter pad as an artificial settling substrate.

Figure credits

The line drawings shown in this book were reproduced from the sources listed below. We are grateful to the authors and publishers who granted their permission to use these drawings.

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Fig. A. *Callinectes sapidus*: from Millikin and Williams, 1984 after Costlow and Bookhout, 1959.
Fig. B. *Pagurus longicarpus*: from Roberts, 1970.

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Fig. A. *Pinnixa* spp.: from Bousquette, 1980. *P. longipes*, shown here, occurs on the west coast of the US. No drawings were found of the megalopa of east coast *Pinnixa* species
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All color photographs, unless noted otherwise, by Howard Weiss.

Appendix

Sampling Decapod Crustacean Larvae

The most common methods of sampling decapod crustacean larvae utilize plankton nets or passive collectors.

Plankton nets for collecting these larvae typically have a mesh size of about 250 μm and are fitted to a circular (e.g. 0.5 m diameter) or rectangular (e.g. 1.5 m x 0.5 m neuston sampler) frame. A flow meter (e.g. General Oceanics digital mechanical flowmeter) can be installed in the mouth of the net for quantitative sampling. Most larval studies use nets towed near the surface by a boat (see Fig. A on page 41). However, in some studies the nets are towed at other depths or are attached to a fixed object (e.g. dock piling or bridge railing) where the passing current flows through the net.

Passive larvae collectors are also used to sample megalopae or postlarvae of decapod crustaceans which settle on an artificial substrate. Blue crab and other species have been sampled at many locations along the US east and Gulf coasts utilizing settling substrates (see Fig. B on page 41) constructed from 2 cm thick "Hog's Hair" air-conditioner filter material pads (37.5 cm X 67.1cm = 0.25 m^2 surface area) wrapped around a cylinder of PVC pipe (16.3 cm diameter X 37.5 cm length) and held in place with rubber straps. Each cylinder contains internal flotation and is weighted at the bottom, so that it floats at the water surface with a vertical orientation in the current. Substrates can be deployed from a pier or attached to a line anchored to the bottom. After being immersed for a standard time period (e.g. 24-hrs) the entire substrate is placed in a bucket. The pads of filter material are then removed and replaced with rinsed, sun-dried filter pads before redeployment of the substrates. Larvae which have settled on the filter material are washed off by rinsing the filter pads in freshwater and sieving the rinse water. See van Montfrans et al. 1995, for a complete description of this collector and a typical study using this sampling method.

The concentrations of crustacean larvae can vary considerably, depending on the species, larval stage, time of year, location (e.g. nearshore or offshore), depth, salinity, temperature, stage of tidal cycle, lunar phase, and other factors. The distribution of decapod crustacean larvae in the water is often very patchy. Therefore, the sampling method, frequency and program must be carefully designed to take this variability into consideration.

Preserving, splitting and concentrating larvae

Crustacean larvae samples can be initially preserved in 4-5 % formaldehyde (approx. 10:1 dilution of formalin). After a minimum of 1 week in formaldehyde, samples should be transferred to 70 % ethanol for longer storage, identification and counting. Chromatophores (color cells) degrade quickly when crustacean larvae are preserved. Examine live or recently preserved specimens when comparing the color of the larvae to the descriptions or color photos in this manual.

Samples with high densities can be subdivided with a Folsom plankton splitter. Low concentration samples can be concentrated using a 250 μm mesh sieve.

Microscopic Examination, Identification and Photography

Dissecting style stereoscopic microscopes with variable magnifications up to 40X (e.g. 10X ocular lens and up to 4X objective lens) are sufficient to identify most of the larvae using the keys in this book. The microscope should be equipped with light sources and a base allowing the larvae to be viewed with incident and/or transmitted illumination. Many of the diagnostic characteristics of the larvae can be best seen using a microscope stand capable of darkfield illumination such as the Wild Heerbrugg bright/darkfield transmitted-light stand sold by Leica Microscopes.

Compound microscopes with magnifications of up to 400X are necessary to determine the different stages of the zoeal stages of the brachyuran crabs and to distinguish between the larvae of some very similar species, such as the zoea of *Cancer borealis* and *Cancer irroratus*. For example, it is often necessary to count the number of antennal segments or the number setae (bristles) on their maxillipeds (see Fig. A, p. 7). Individual appendages sometimes must be dissected from the body to help identification. Mount appendages under a cover slip in a water miscible medium containing acid fuchsin which rapidly stains the appendages and makes detailed examination of setation easier.

The identifying characteristics used in the keys in this manual apply to all of the zoeal stages for each species of crab. Refer to the references at the end of this manual to determine the zoeal stages for specific crab species and to distinguish between the larvae of very similar species. Illustrations, descriptions and keys to the identification of the adults of these species can be found in Weiss (1995).

The color micro-photographs in this book were taken with a Canon PowerShot Elph 330HS camera using a Wild Heerbrugg M-3 trinocular stereo microscope with a bright/darkfield transmitted-light stand set for darkfield illumination. The Photoshop computer application was used to remove spots of backscattered light, particulate material and extraneous objects from the black background surrounding the larvae in the photos. All photos are of unpreserved larvae photographed within 48 hours of sampling to show their natural color.

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