Rostrum present, unarmed, about one-third of carapace length; carapace with cervical, post-cervical, branchiocardiac, antennal and gastro-orbital grooves; median dorsal, antennal, branchiostegal, and lateral ridges present; first antennae small, second antennae with large broad scaphocerite; first pereopod large, chelate status unknown; pereopods two through five smaller than first, and two through four subchelate; first pleonic somite short, partially covered by carapace; second pleonic pleura not expanded; apparent pleonic hinges on all pleonic somites; telson broadly subtriangular, unarmed; uropods without diaeresis. This earliest known decapod is a mixture of astacidean and glypheoidean characteristics, and in addition, the antennal scale suggests a 'natantian' affinity. This juxtaposition of characters presents a problem because although most authors consider the dendrobranchiates to be the most primitive decapods, they do not appear in the fossil record until 100 million years after *Palaeopalaemon.* Although we recognize the capricious nature of the fossil record we believe that the available data would indicate that the Dendrobranchiata separated early from the other decapods, a conclusion reached by others. In contrast to most other authors, however, we believe that the origins and relationships of the Caridea and Stenopodidea (and possibly the Procarididea) are to be found among those groups traditionally considered reptants. In this regard our speculations are similar to those of Beurlen & Glaessner (1930), who derive the Caridea from ancestral thalassinoids.

8 ACKNOWLEDGEMENTS

We thank the following individuals for assistance, both allowing us access to specimens and commenting on the manuscript: Drs Raymond B.Manning, Robert H.Gore, Frederick R.Schram, Anthony J.Provenzano, Jr, Daryl L.Felder, Dr Sandra Gilchrist, Ms Elizabeth Woodsmall and Mr Kenneth Womble assisted with the graphics. Specimens were kindly provided by the San Diego Museum of Natural History, San Diego, CA, and Scripps Institution of Oceanography, La Jolla, CA. We also wish to thank Dr Anne Thistle for typing and editing the manuscript.

9 APPENDIX I

Material examined

- Dendrobranchiata
  - Peneidae
    - *Peneus setiferus* (Linnaeus)
  - Solenoceridae
    - *Solenocera vioscari* Burkenroad
  - Sergestidae
    - *Sergestes similis* Hansen
  - Sicyonidae
    - *Sicyona* sp.
- Caridea
  - Palaemonidae
    - *Palaemonetes kadiakensis* Rathbun
    - *Palaemon floridanus* Chace
    - *Macrobrachium acanthurus* (Wiegmann)
    - *Pontonia* sp.
  - Hippolytidae
    - *Thor floridanus* Kingsley
    - *Lysmata wurdemani* (Gibbes)
    - *Hippolyte zostericola* (Smith)
    - *Tozeuma carolinense* Stimpson
    - *Saron marmoratus* (Oliver)
  - Atyidae
    - *Atya innocous* (Herbst)
    - *Aty margaritacea* A.Milne Edwards
    - *Micratya poeyi* (Guerin-Meneville)
    - *Potimirim glabra* (Kingsley)
  - Oplophoridae
    - *Oplophorus* sp.
    - *Acathephyra* sp.
  - Alpheidae

Alpheus lotini Guerin
Crangonidae
Crangon crangon (Linnaeus)
Gnathyphyllidae
Gnathyphyllum sp.
Pasiphaeidae
Leptochela bermudensis Bate
Procaridida
Procarididae
Procaris ascensionis Chace & Manning
P.hawaiana Holthuis
Stenopodidea
Stenopodidae
Stenopus hispidus Oliver
Reptantia
Cambaridae
Cambarus spp.
Upogebiidae
Upogebia pugettensis (Dana)
Axiidae
axiid sp.

10 APPENDIX II

List of abbreviations

ab	branchial axis	m	mandible
cch	cardiac chamber	mp	mandibular palp
cm	convoluted membrane	mpr	molar process
cpv	cardiopyloric value	mo	mesocardiac ossicle
d	denticles	mt	median tooth
e	esophagus	p	pterocardiac ossicle
ep	epistome	pc	pyloric chamber
epi	epipod	pf	pyloric fingerlets
gf	gland filter	po	pyloric ossicle
ip	incisor process	sr	secondary rami
l	lamellae	upg	uropyloric groove
la	labrum	uo	urocardiac ossicle
lb	lateral branch	upo	uropyloric ossicle
lt	lateral teeth	zo	zygocardiac ossicle
lr	lateral ramus		

DISCUSSION

BAUER: You were talking about how some characters in defining carideans, such as the overlap of the second abdominal pleuron of the first and the third, may not be very good. Actually, on the slide you showed of *Glyphocrangon* it looked like the second was overlapping the first. Another point is whether or not there are articulations between the various abdominal segments. For example, in most carideans the hump is caused by the fact there is no articulations between the third and fourth pleura, and that is one of the characters Burkenroad used as a diagnostic feature for the carideans. I have found that in things like *Crangon,* which don't show the caridean hump, they lack that condyle between the third and fourth, whereas the peneids have a condyle between each of the segments. So that might be a better definition for some of these groups since the pleura, because of other selection pressures, are modified.
ABELE: *Glyphocrangon* does have condyles on the exterior surface of the second and third pleura.
BAUER: No, between the third and the fourth.
ABELE: They have them there as well. They are not as well-developed, but they are present there.
BAUER: Oh.

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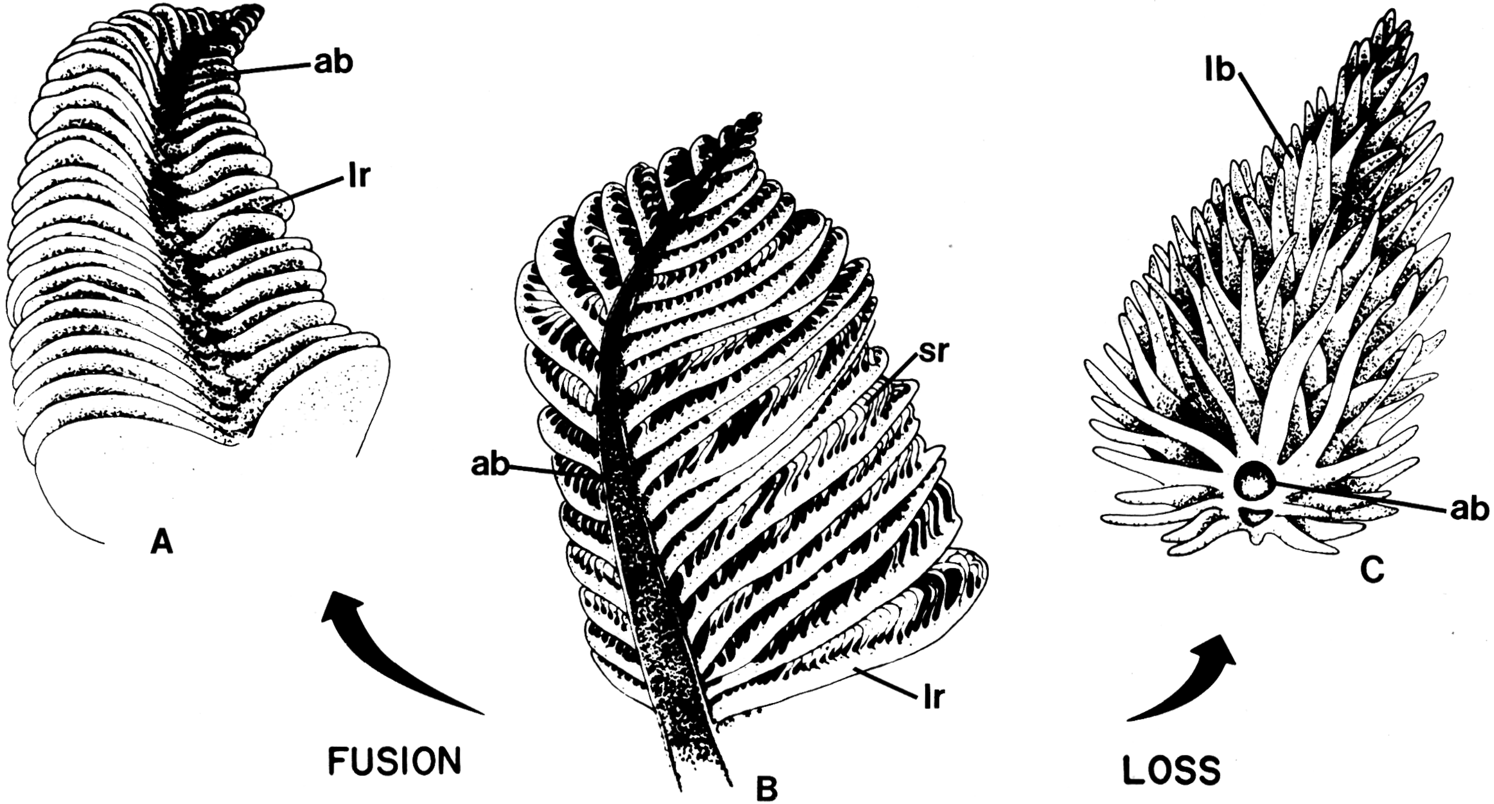


Figure 3. Hypothesis suggested by Boas 1880, and Burkenroad 1981, for the evolution of gill types among the Decapoda. (B) typical dendrobranchiate gill, consisting of lateral branches (1b) extending from the main branchial axis (ab) with a series of subdivided secondary rami (sr) from each lateral branch. Expansion of the lateral branches of the dendrobranchiate type would result in (A) phyllobranchiate gill; whereas loss of the secondary rami (sr) and/or reduction of the lateral branches would give rise to (C) trichobranchiate gill.

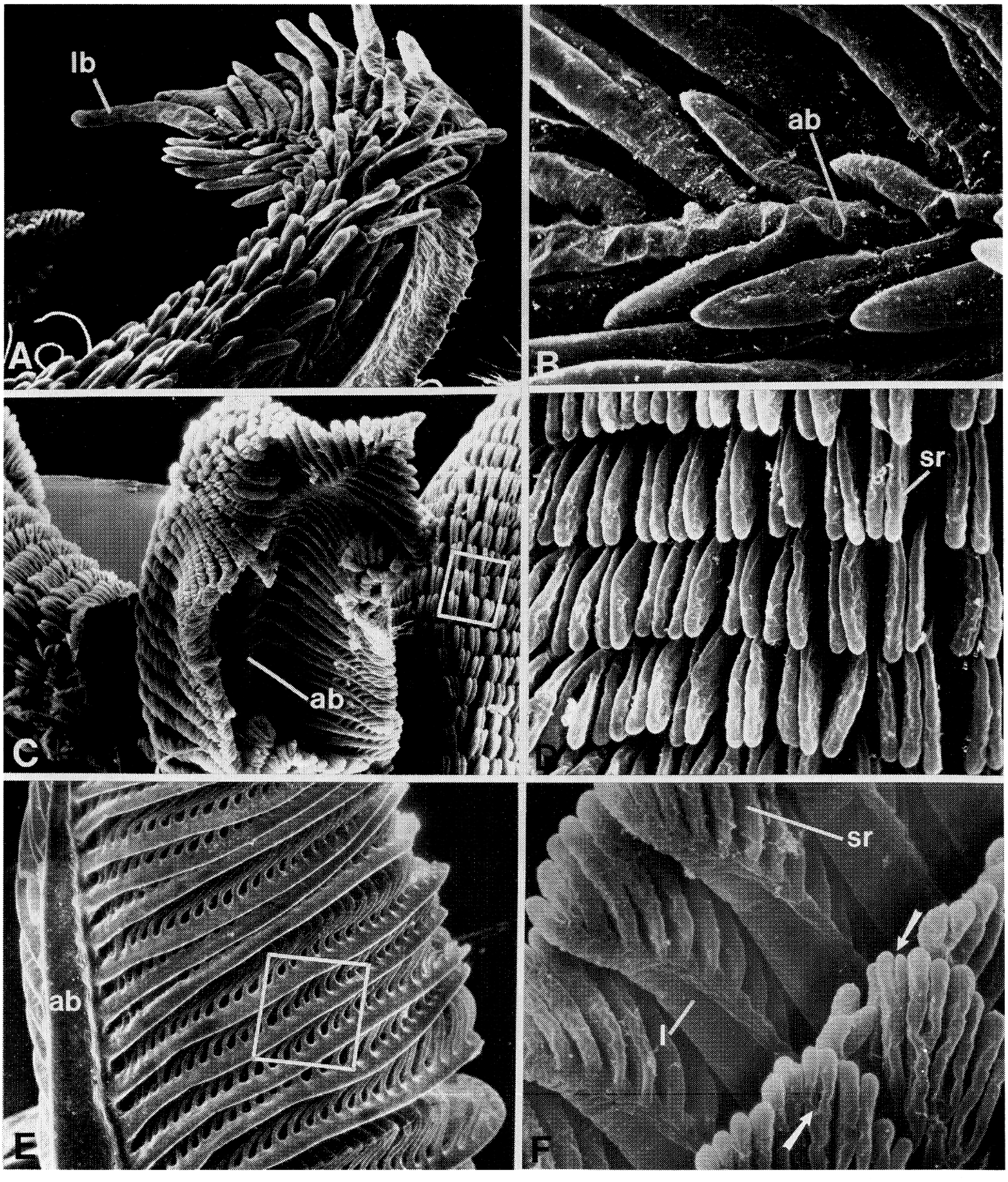


Figure 4. A. Trichobranchiate gill from *Cambarus* sp.; X50. B. Enlargement of trichobranch gill denoting the main branchial axis (ab) with lateral branches (1b) extending from the main gill axis; X100. C. Dendrobranchiate gill from *Peneus setiferus;* note the branchial axis with lateral branches extending from the main branch. The white box indicates the external view of the secondary rami (sr); X50. D. Enlargement of secondary rami (boxed area in C); X200. E. External view of dendrobranchiate gill of *Sergestes similis;* white box indicates branching secondary rami (sr); X60. F. Internal view of *S.similis* gill showing the secondary rami (sr) with white arrows denoting bifurcation of the secondary rami; X200.

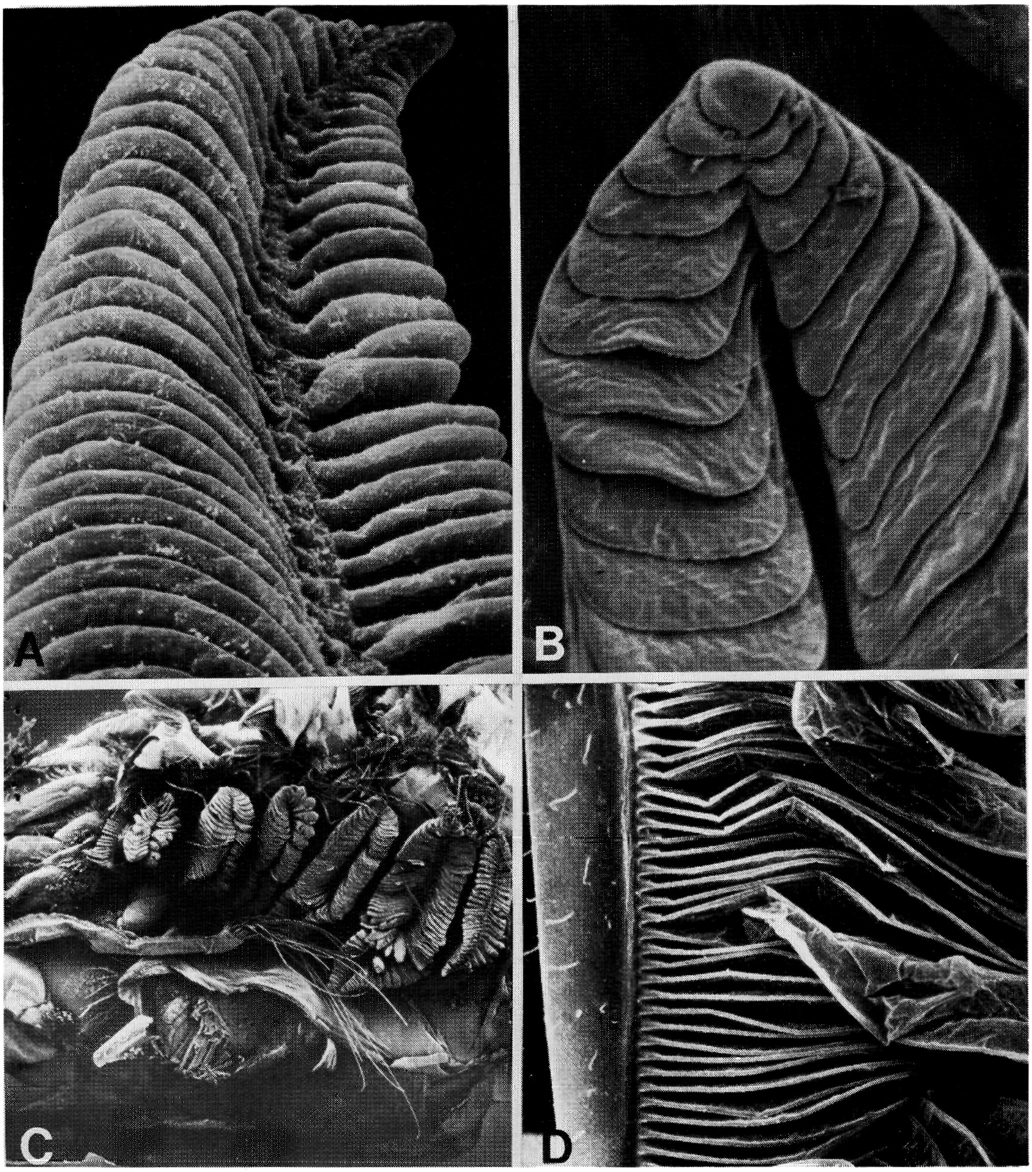
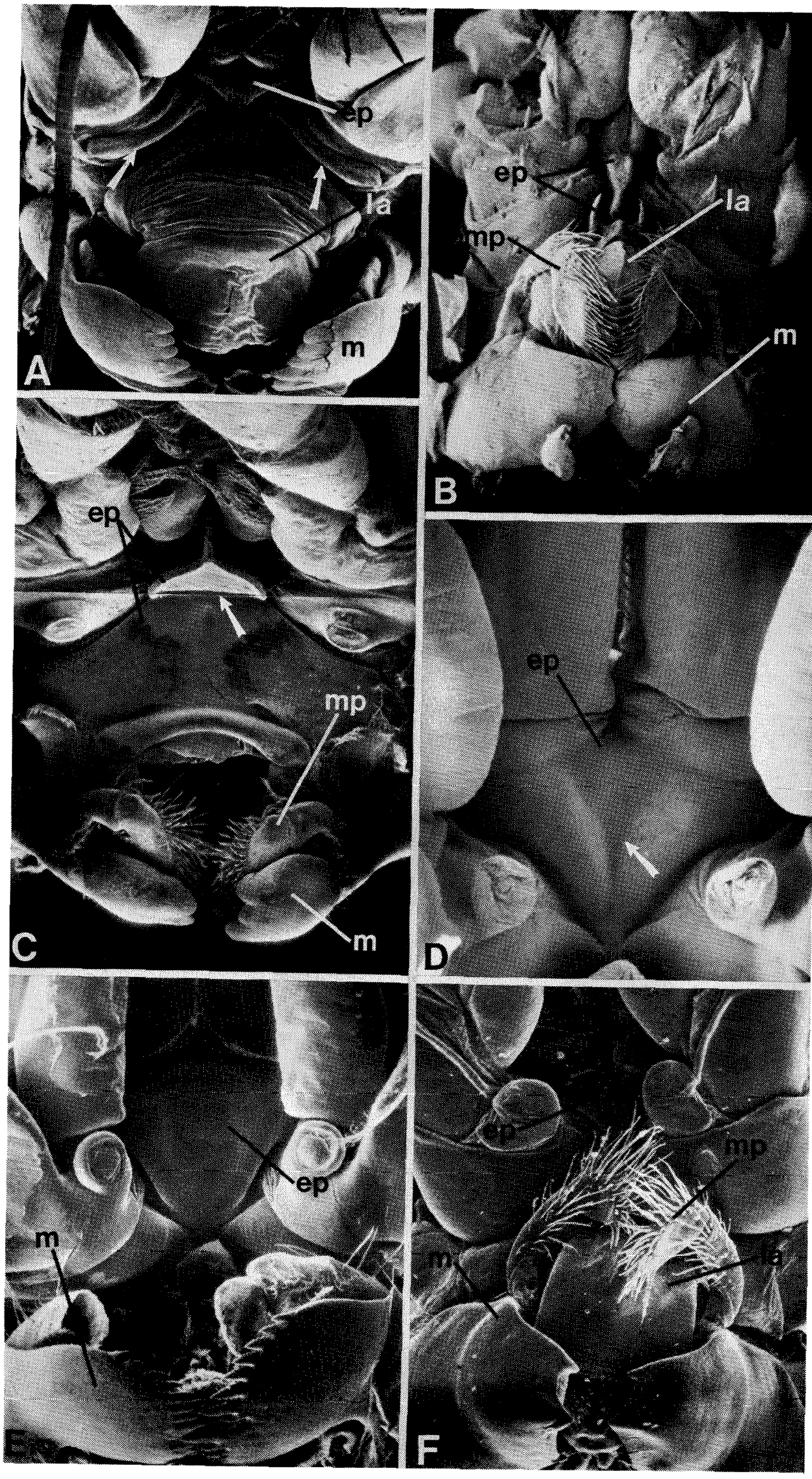


Figure 5. A. Phyllobranchiate gill type from *Palaemonetes kadiakensis;* X60. B. Phyllobranch gill plume of *Atya innocous,* showing thc variation seen within this gill type; X80. C. Lateral view of entire gill region of *A.innocous,* indicating the arrangement of the phyllobranch gills; X20. D. Phyllobranch gill of *Oplophorus* sp.; note the thin, plate-like nature of the lateral rami; X50.



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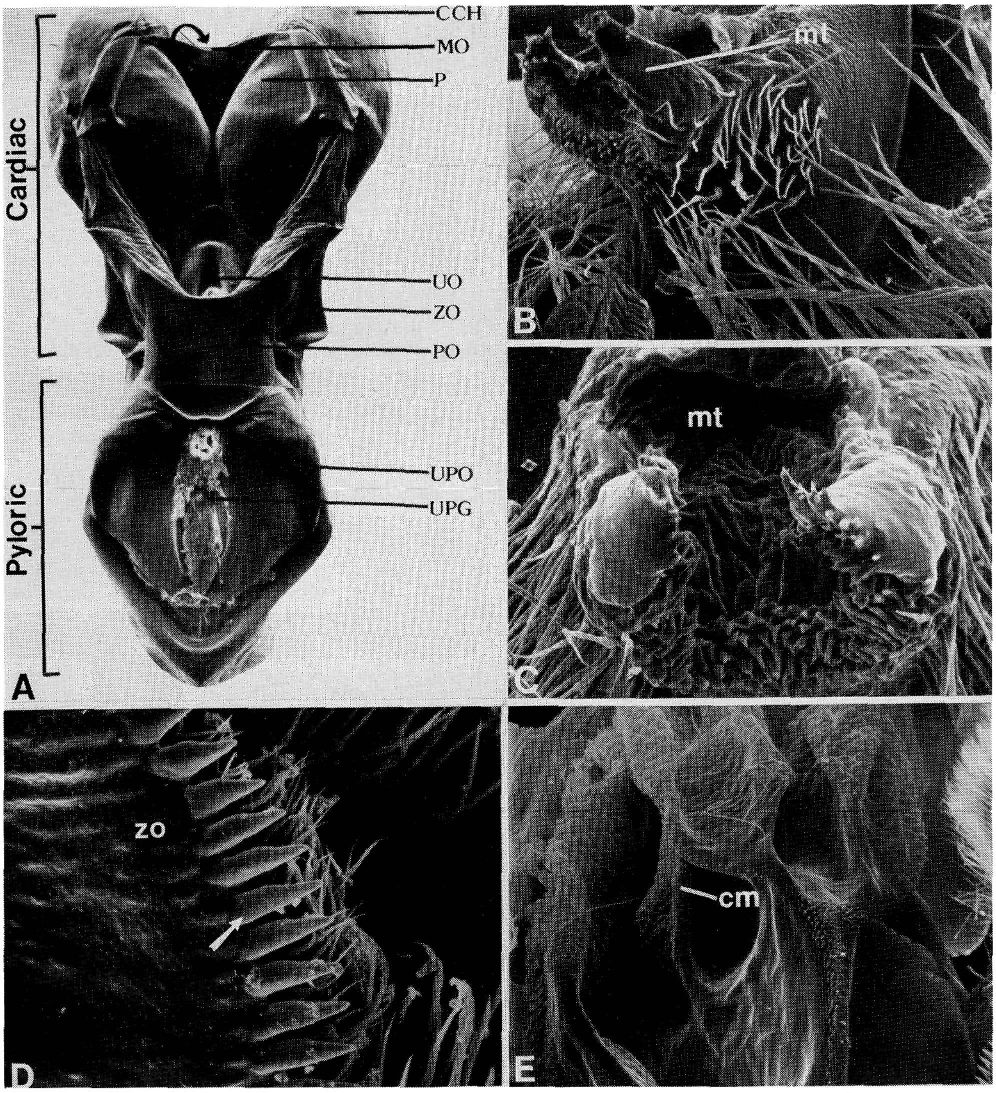

Figure 7. A. Dorsal view of the foregut of *Atya innocous* (membranes and musculature removed); note the distinct cardiac and pyloric regions along with the distinct chitinous regions (ossicles); X100. B. Lateral view of the bifid median tooth of *A.innocous* projecting from roof of cardiac chamber; X250. C. Close-up view of the median tooth of *A.innocous;* note presence of stout denticles on inner portion of tooth; X600. D. Zygocardiac ossicle of *A.innocous,* arrow indicates the lateral teeth; X600. E. Convoluted membrane (cm) of *Potimirim glabra* located within the pyloric chamber; X170.

Figure 6. A. Ventral view of the protocephalon of *Peneus setiferus;* note condition and location of epistome (ep) between the antennae; white arrow indicate epistomal bar; X25. B. Ventral aspect of protocephalon of *Stenopus hispidus;* note distinctive morphology and location of epistome (ep); X30. C. Protocephalon of *Cambarus* sp.; note location and morphology of the epistome; white arrow indicates membranous connection between anterior and posterior portions of rigid epistome; X20. D. Epistome (ep) of *Palaemonetes kadiakensis* in ventral view; white arrow denotes membranous points of articulation; X70. E. Protocephalon of *Oplophorus* sp.; large labrum has been removed to reveal nature of the epistome (ep); X40. F. Ventral aspect of the protocephalon of *Procaris ascensionis;* note condition and location of the epistome (ep); X40.

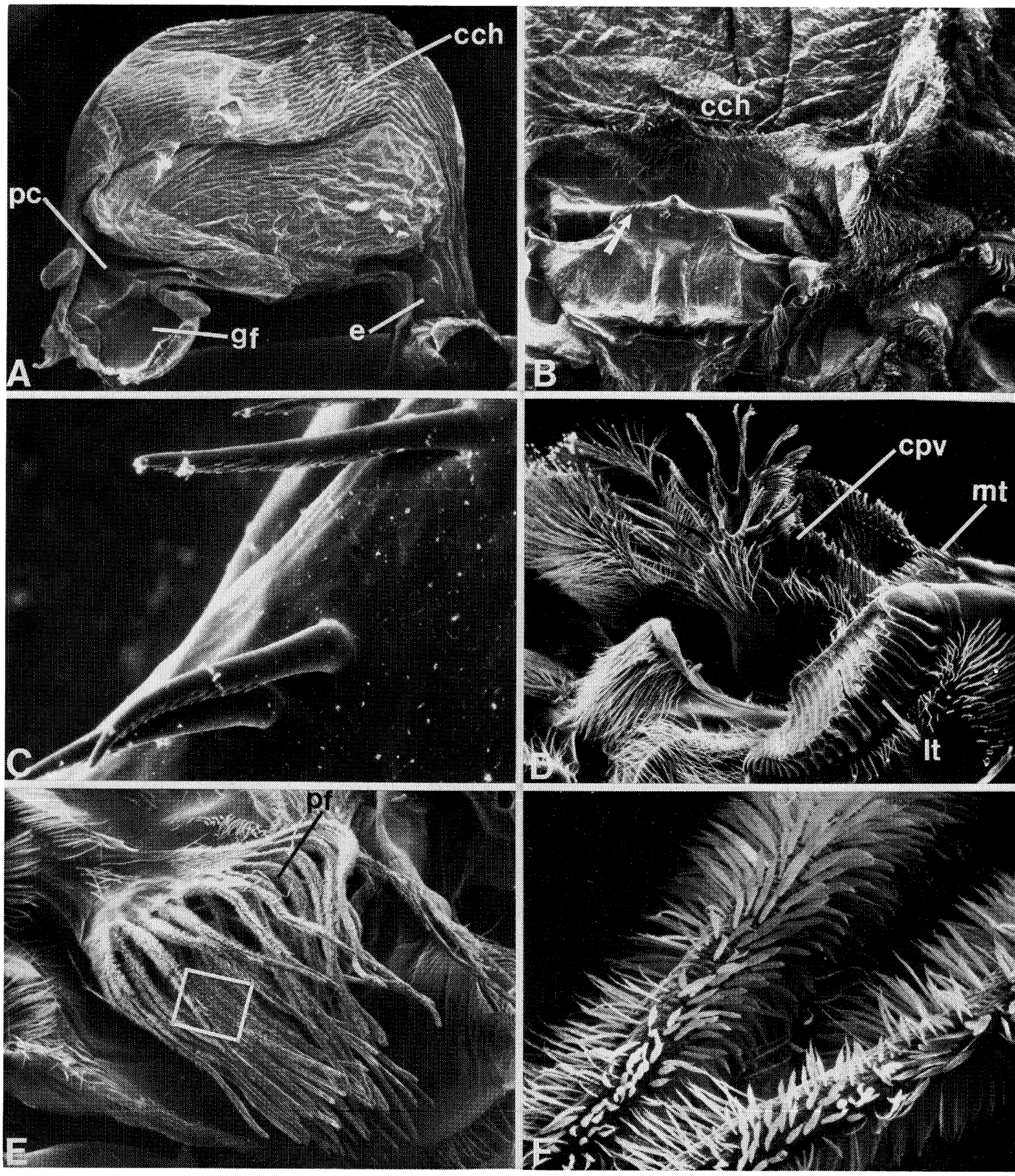

Figure 8. A. Foregut of *Saron marmoratus* (membranes and muscles removed); note lack of chitinized regions (ossicles and reduction of the pyloric chamber (pc); X20. B. Floor of the cardiac chamber (cch) of *Palaemonetes kadiakensis;* note the reduced median tooth (mt) (arrow), and lack of lateral teeth (lt); X1100. D. Lateral view of gastric armature of *Upogebia pugettensis;* note elaborate cardiopyloric valve (cpv); also shown are large lateral teeth (lt) and median tooth (mt) (the median tooth is obscured by the lateral teeth in this micrograph); X25. E. Pyloric fingerlets (pf) within the pyloric chamber of *Upogebia pugettensis;* X25. F. Close-up of pyloric fingerlets; X300.

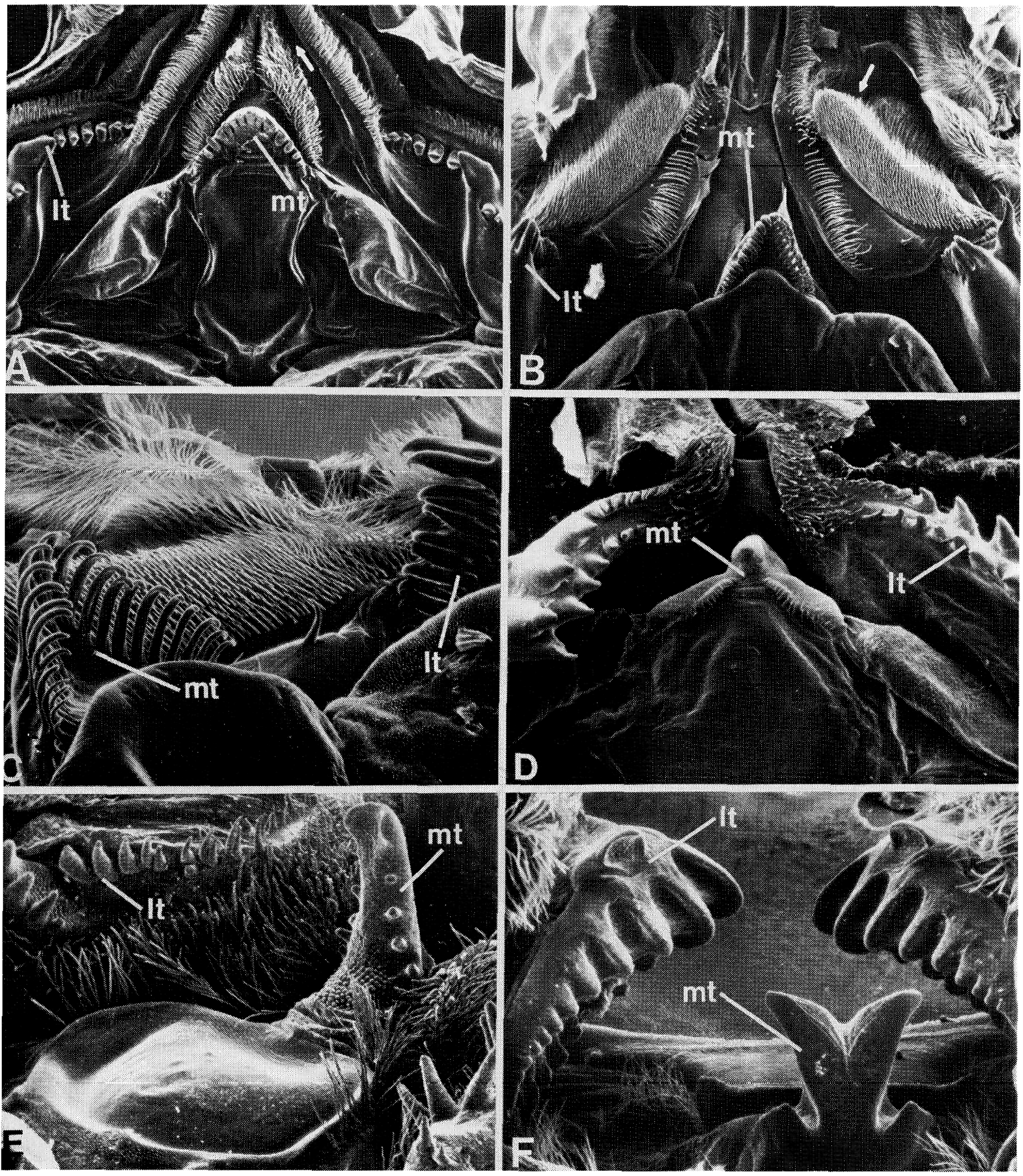

Figure 9. Cardiac chamber of *Peneus setiferus,* showing details of gastric mill; large median tooth is present (mt) flanked by large lateral teeth (lt); note rows of plumose setae anterior to median tooth which direct food to pyloric chamber (arrow); X20. B. Gastric mill of *Solenocera vioscari;* note large median tooth (mt) with robust lateral teeth (lt); dense pads of setae (arrow) direct food to pyloric chamber; X20. C. Lateral view of median tooth of *S. vioscari;* note long teeth borne on median tooth; X80. D. Gastric armature of *Sergestes similis;* note median tooth (mt) and lateral teeth (lt); X40. E. Gastric mill of *Stenopus hispidus,* elongate median tooth present with peg-like spines along its length (mt); lateral teeth also shown (lt); X50. F. Gastric mill of *Cambarus* sp.; note smooth bifid median tooth, massive lateral teeth (lt); X90.