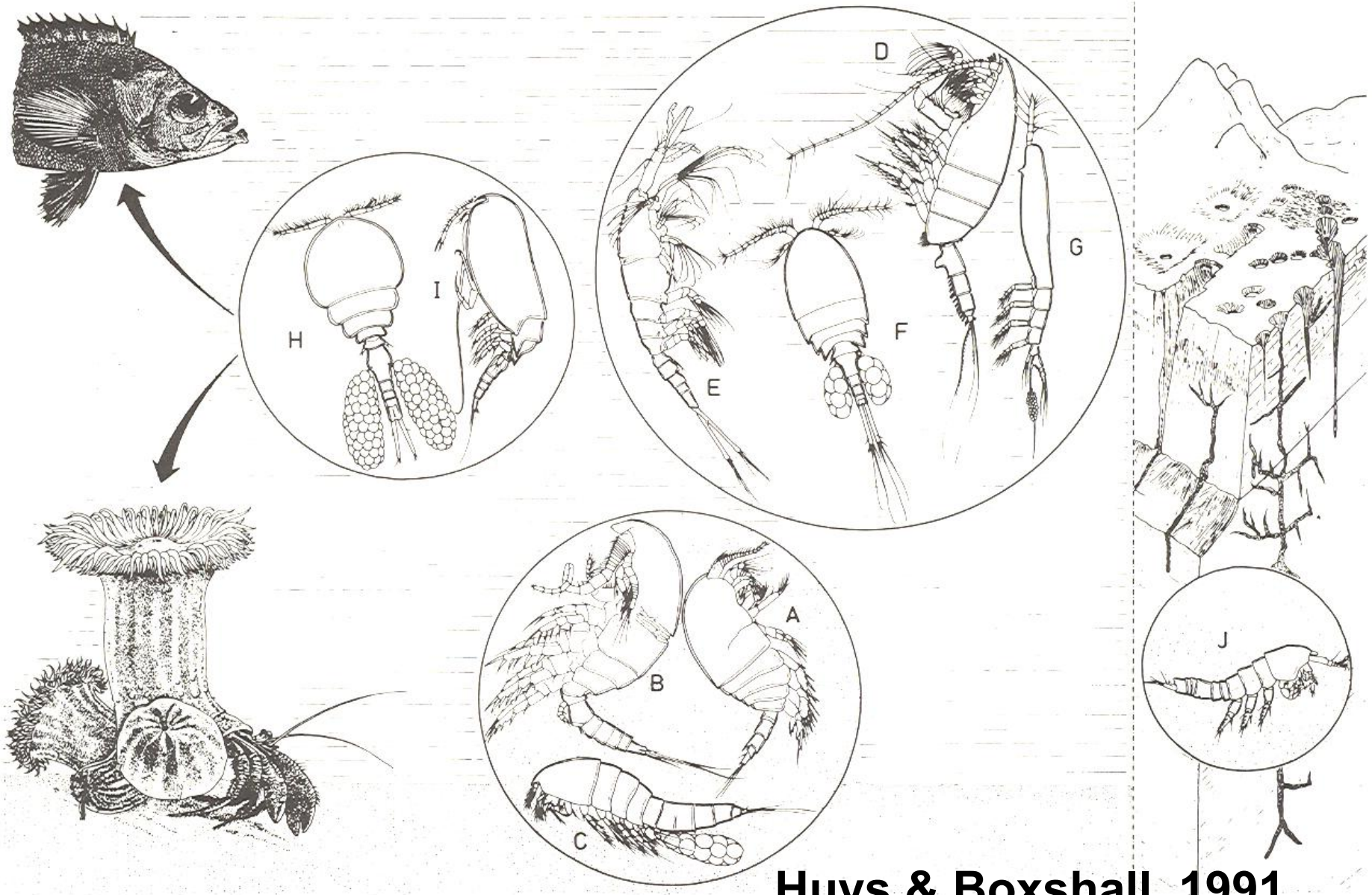
Diversity of Copepoda

Wonchoel Lee

Department of Life Science,
Hanyang University

Seoul, Korea



Huys & Boxshall, 1991

Figure 1.1. Copepod habitats: a schematic representation of the primary habitat of each of the ten copepod orders. **A**. Platycopioida. **B**. Misophrioida. **C**. Harpacticoida. **D**. Calanoida. **E**. Mormonilloida. **F**. Cyclopoida. **G**. Monstrilloida. **H**. Poecilostomatoida. **I**. Siphonostomatoida. **J**. Gelyelloida. [**A-C**, benthic; **D-G**, planktonic; **H** and **I**, associated; **J**, groundwater.]

Subclass Copepoda

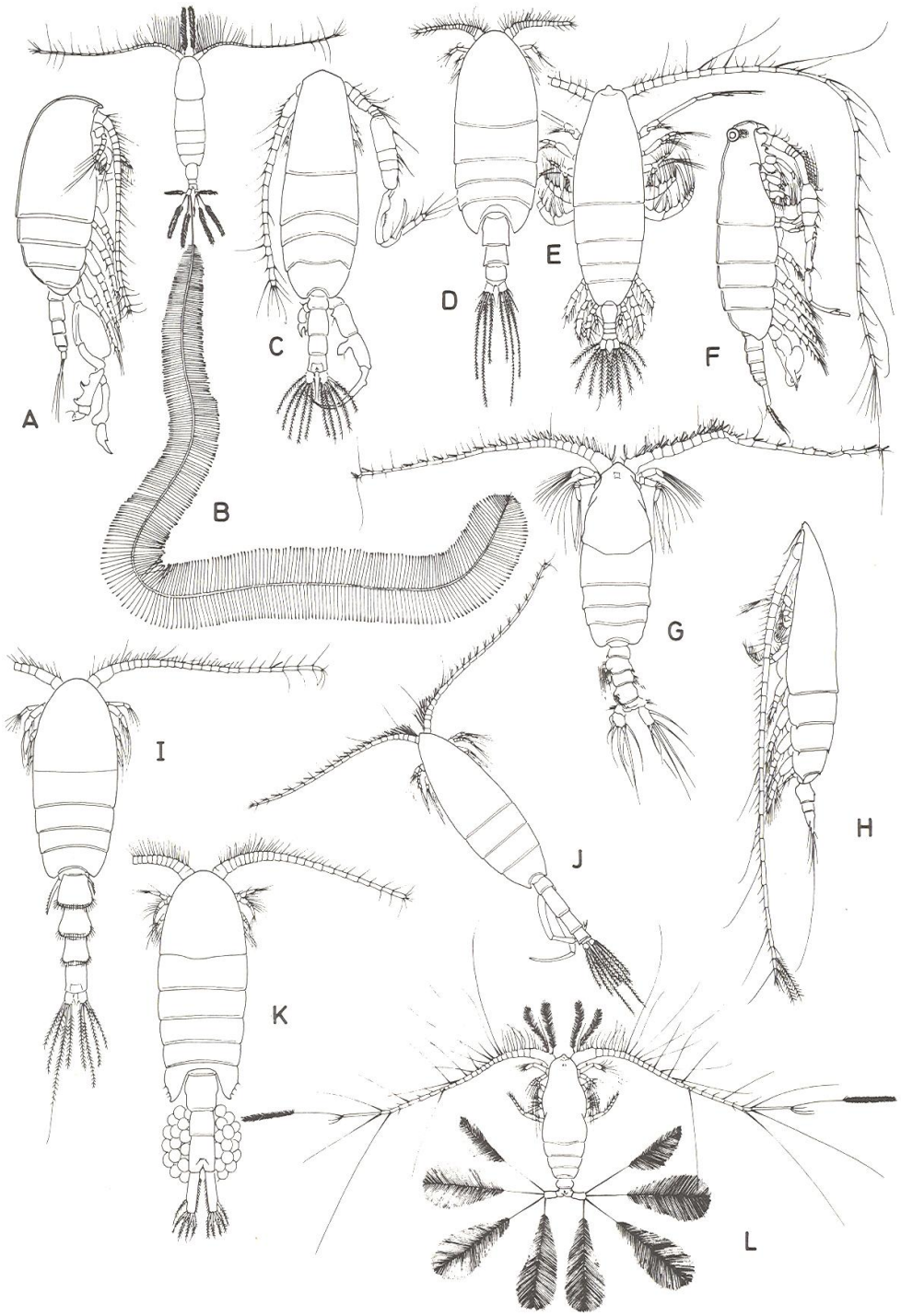
- About 12,000 species in ten Orders
- Diverse life forms: Plankton, Benthos, Parasite
- The most numerous animal except for single celled protozoan.
- Size small : <10mm

Plankton

- Calanoida
- Mormonilloida
- Cyclopoida

- Important food items for many marine animals.
- Active vertical migrator

Huys & Boxshall, 1991

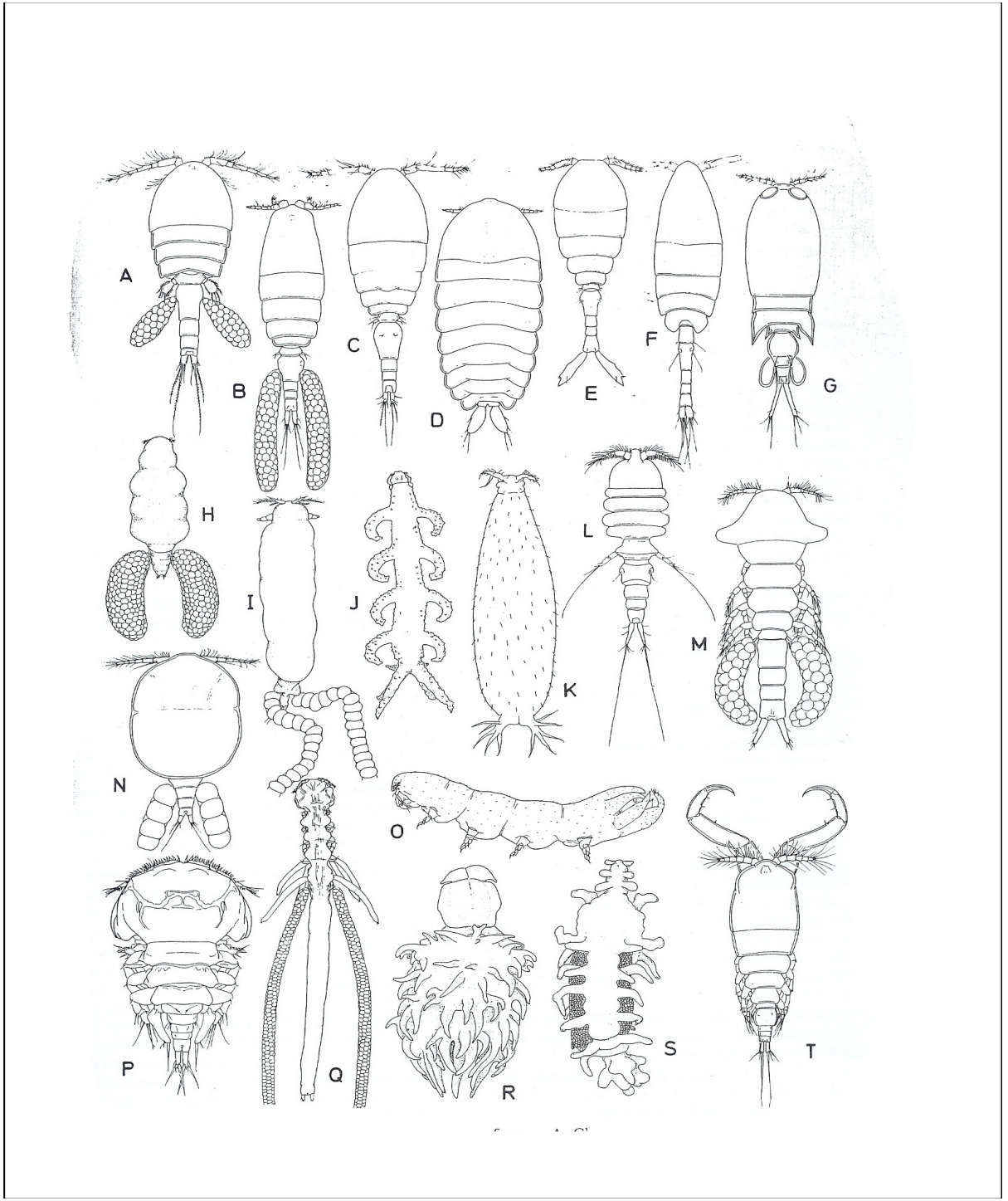


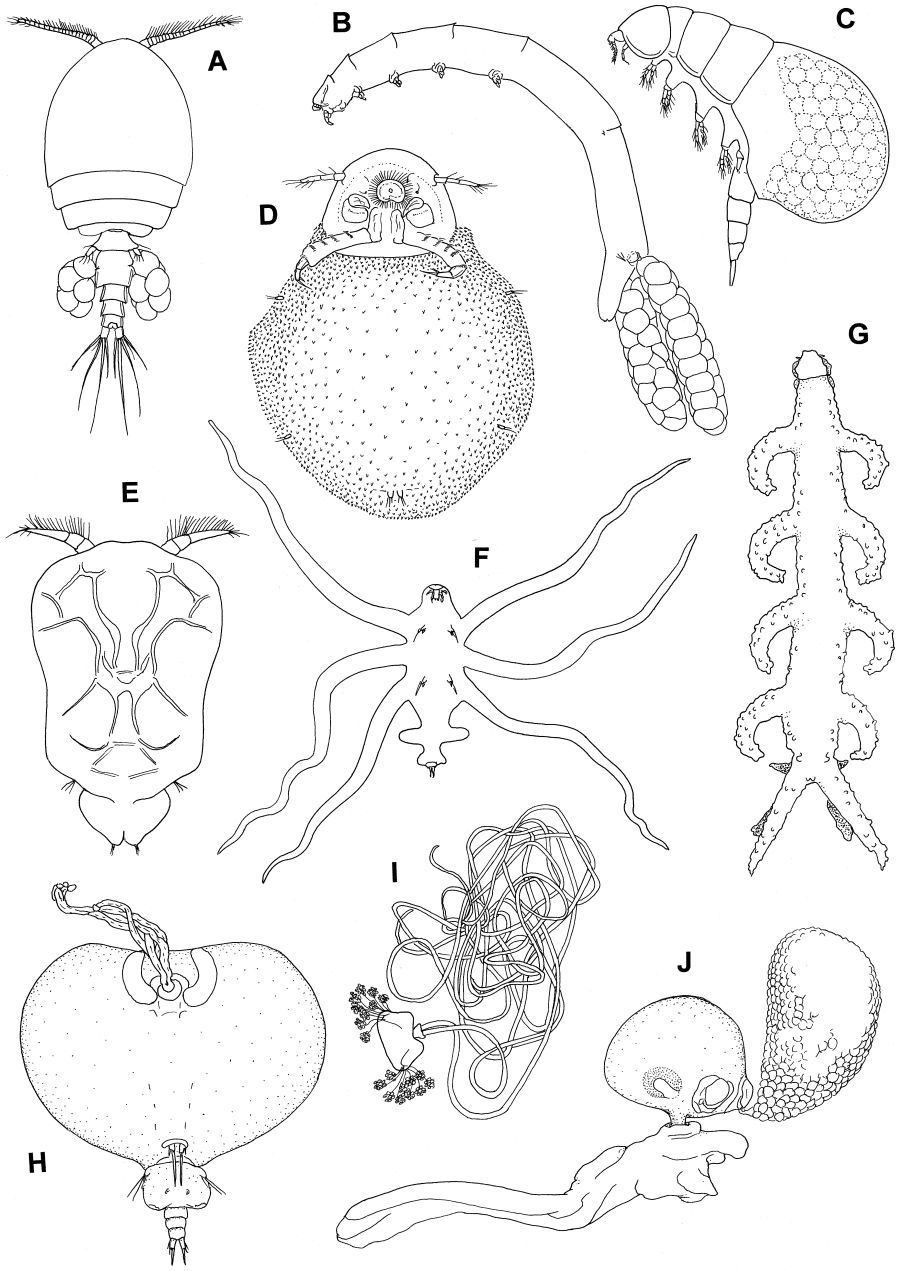
Parasites

- Cyclopoida♪
- Siphonostomatoida♪
- Monstrilloida♪

- Freshwater♪
- marine ♪
- parasites♪

Huys & Boxshall, 1991





Extreme variation in body form in parasites of invertebrate hosts

Huys & Boxshall, 1991

Benthos

- Platycopioida - near bottom
- Misophrioida - near bottom
- Gelyelloida - groundwater

- Harpacticoida - meiofauna
  - Marine more than 3,000 species, Freshwater about 950 species in the world
  - dominant among Meiofauna
  - Possible environmental indicator

Meiofauna

- Benthic Organisms passing through the sieve of 500㎛, and retaining on 42㎛
- High density up to more than 100,000 individuals / 1㎡
- Good prey items to macrofauna and fishes and affected to their community structure
- Short life cycles, and response quickly to environmental variations





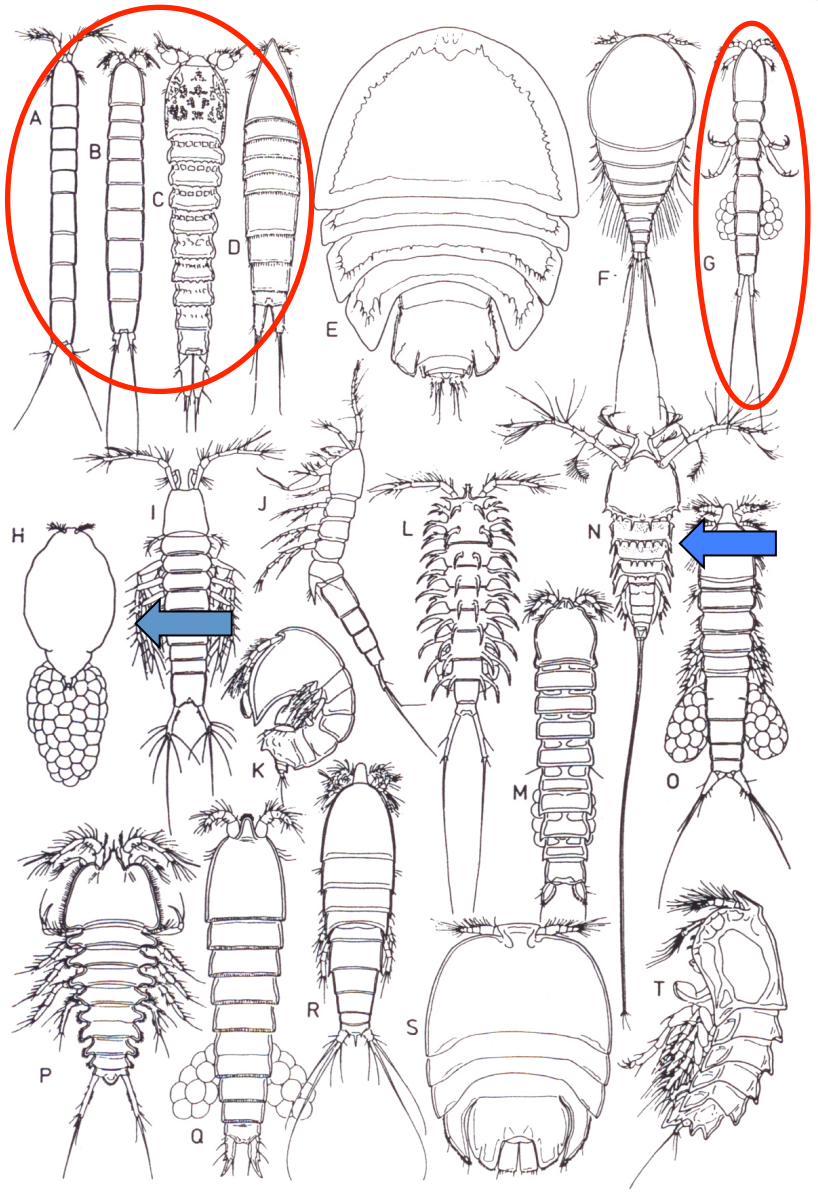
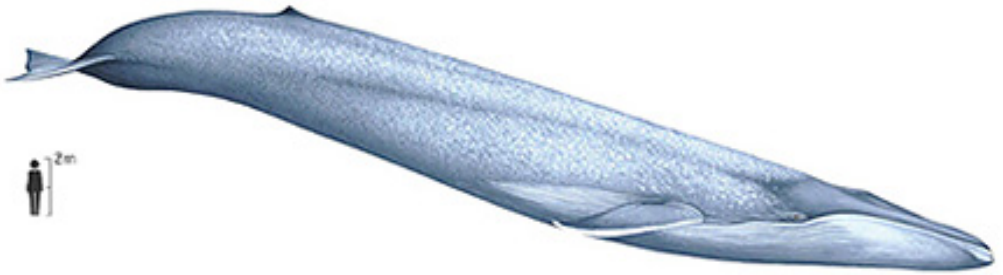
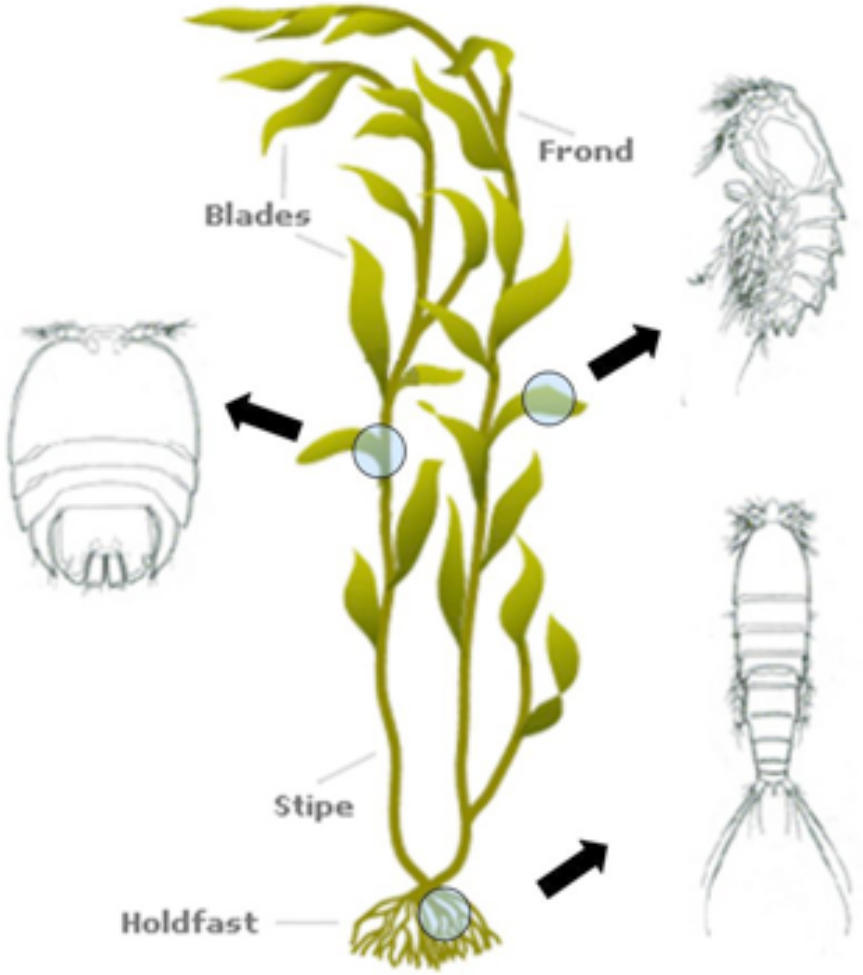


Figure 2.4.1. The diversity of harpacticoid body form. **A**. Cylindropsyllidae, Cylindropsyllinae. **B**. Darcythompsoniidae. **C**. Laophontopsidae. **D**. Ectinosomatidae. **E**. Hamondiidae. **F**. Metidae. **G**. Balaenophilidae. **H**. Tisbidae, Cholidyinae. **I**. Ameiridae, Stenocopiinae. **J**. Cylindropsyllidae, Leptastacinae. **K**. Tegastidae. **L**. Ancorabolidae. **M**. Cletodidae. **N**. Cerviniidae. **O**. Canuellidae. **P**. Ancorabolidae, Laophontodinae. **Q**. Huntemanniidae. **R**. Longipediidae. **S**. Porcellidiidae. **T**. Peltidiidae.

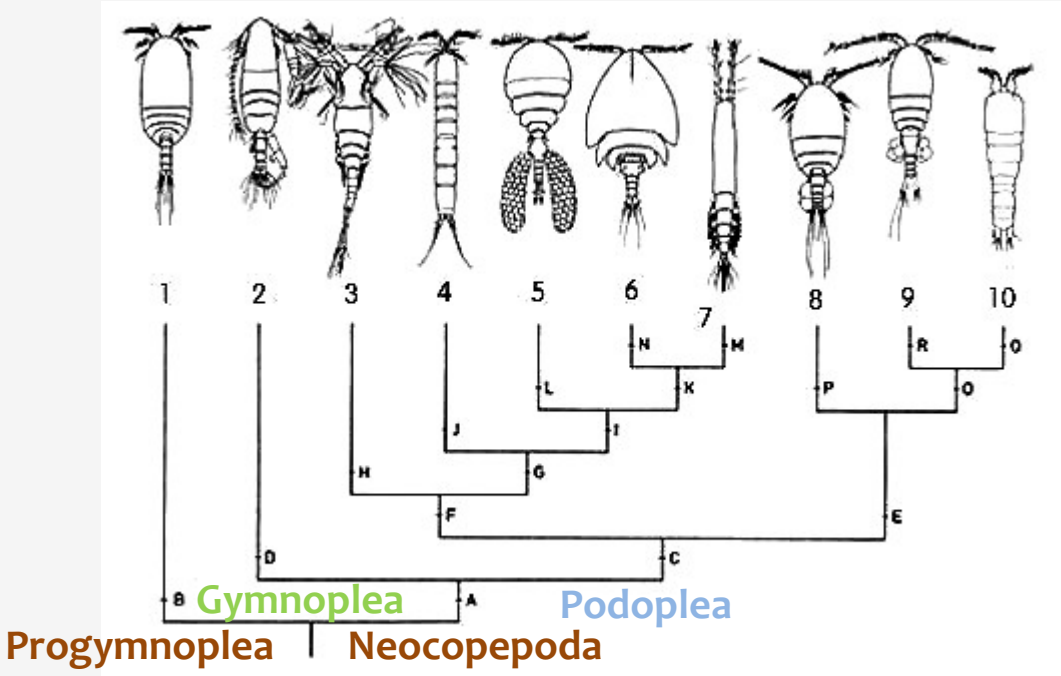
Huys & Boxshall, 1991





Copepod Orders

- Morphological and molecular evidence supports the monophyly of copepods
- Interordinal relationships continue to be debated



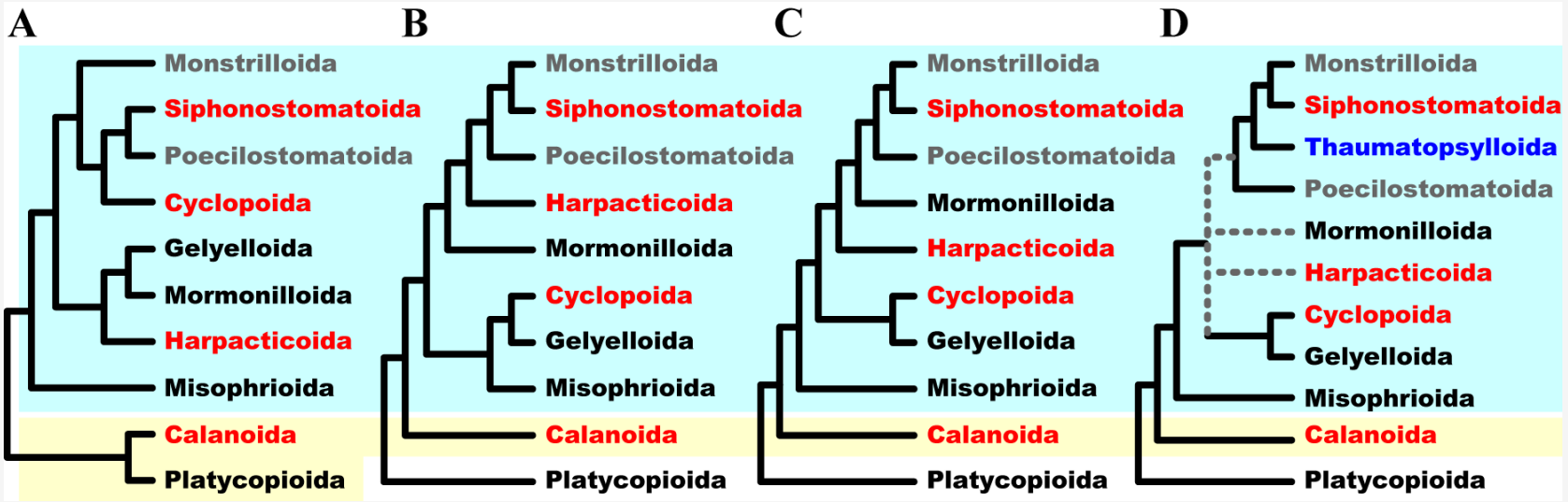
1. Platycopioida
2. Calanoida
3. Mormonilloida
4. Harpacticoida
5. Poecilostomatoida
6. Siphonostomatoida
7. Monstrilloida
8. Misophrioida
9. Cyclopoida
10. Gelyelloida

(Huys & Boxshall, 1991)

Produced by Eyun, 2017

Morphological Phylogeny

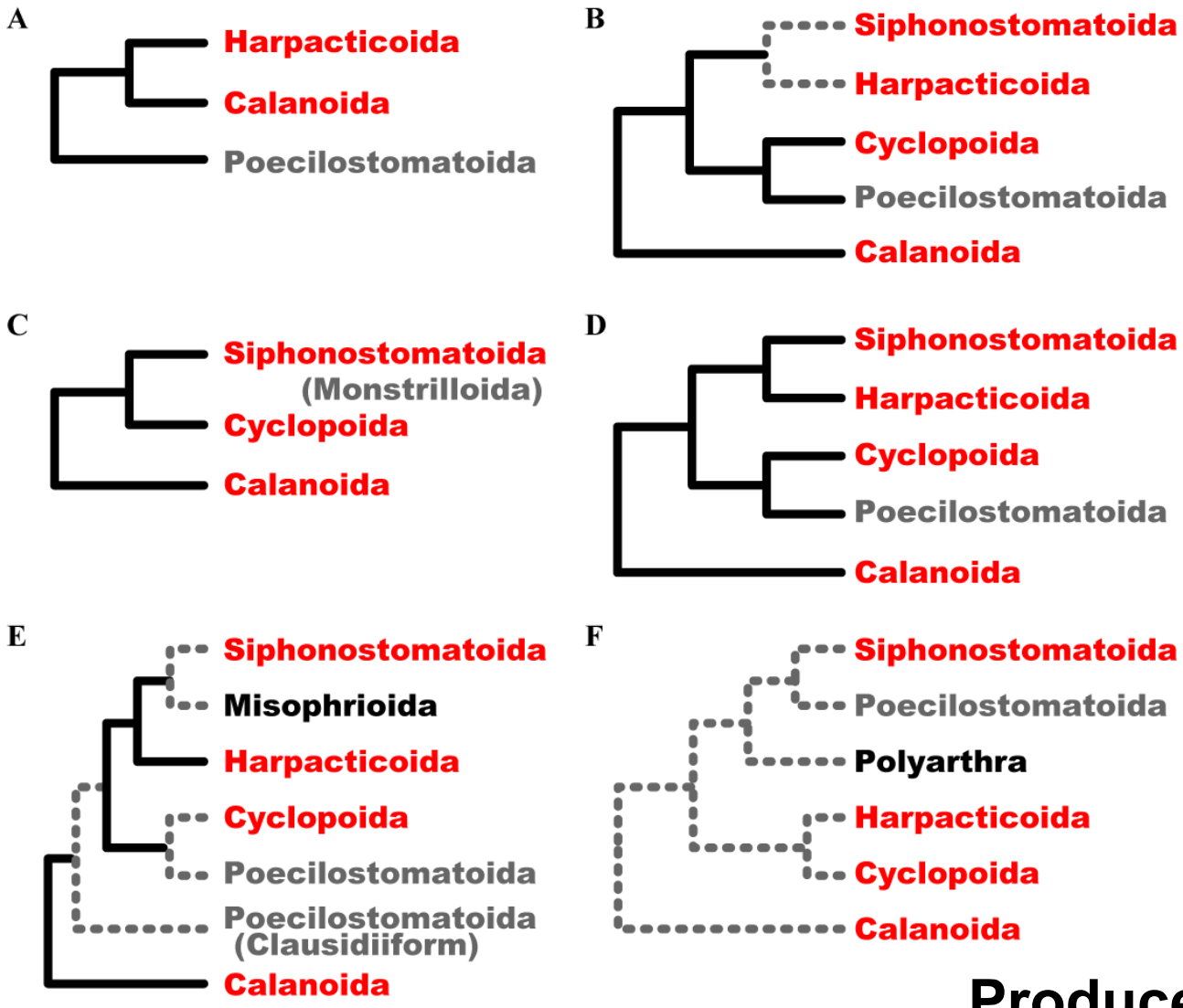
- The phylogenetic position of the order Harpacticoida is still ambiguous and inconsistent among studies



A) Ho (1990) B) Huys and Boxshall (1991) C) Ho (1994)
D) Ho et al. (2003)

Produced by Eyun, 2017

Molecular Phylogeny



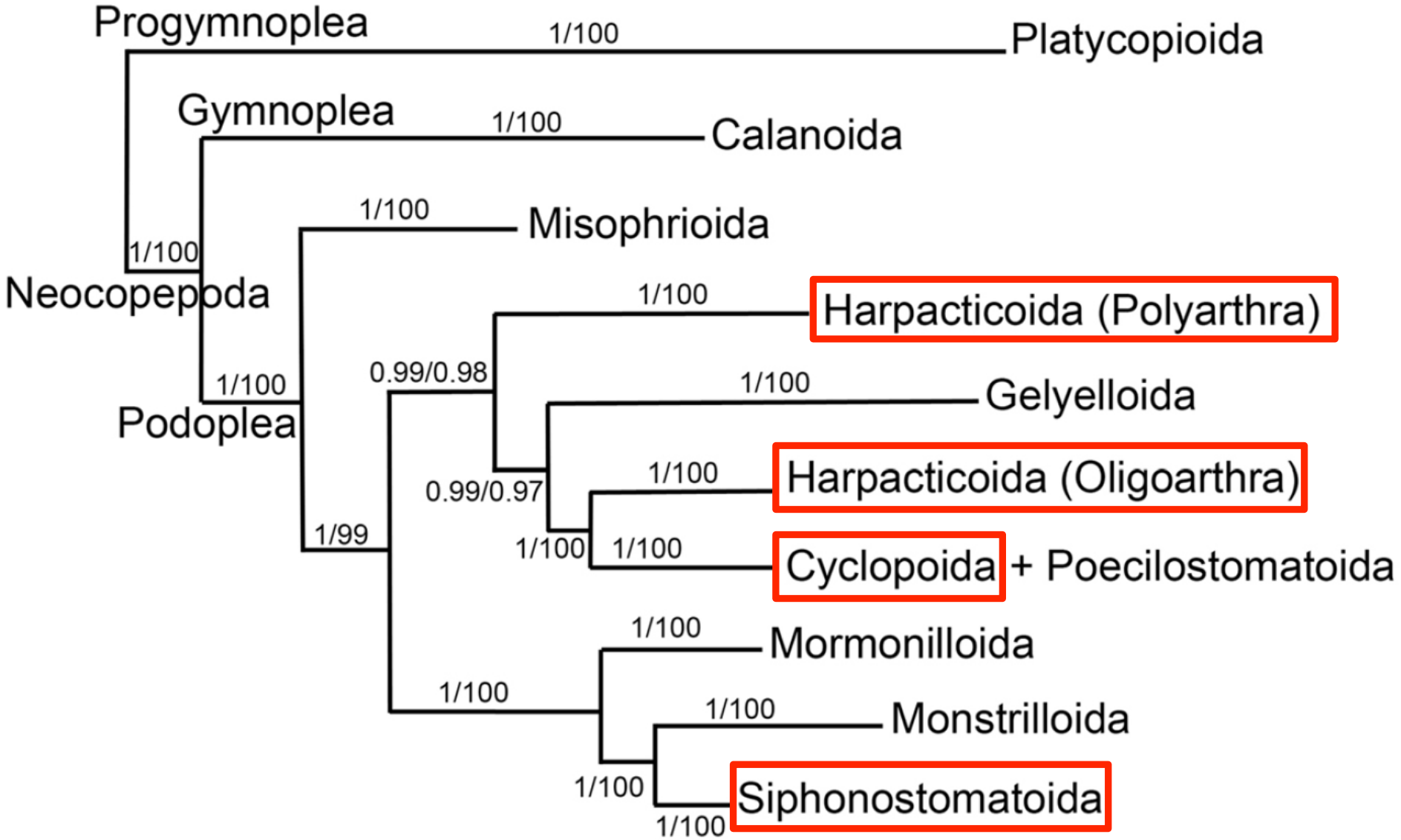
Harpacticoida is more closely related to Siphonostomatoida

Polyarthra taxa are more closely related to other copepods than to Oligoarthra (*Tigriopus*) (28S 505bp)

Produced by Eyun, 2017

A) Braga et al (1999), B) Huys et al (2006), C) Huys et al (2007), D) Minxiao et al (2011), E) Tung et al (2014), and F) Schizas et al (2015)

18S and 28S rRNA, mtCOI, and H3



Produced by Eyun, 2017

(Khodami et al., 2017)

World Copepoda Database (WoRMS 2018)

Subclass Copepoda has Ten orders

Harpacticoida → Cauelloida + Harpacticoida
Poecilostomatoida → Cyclopoida

Order Canuelloida (Polyarthra)
Family Canuellidae
Family Longipedidae

Order Harpacticoida (Oligoarthra): all others

Morphology of Harpacticoida

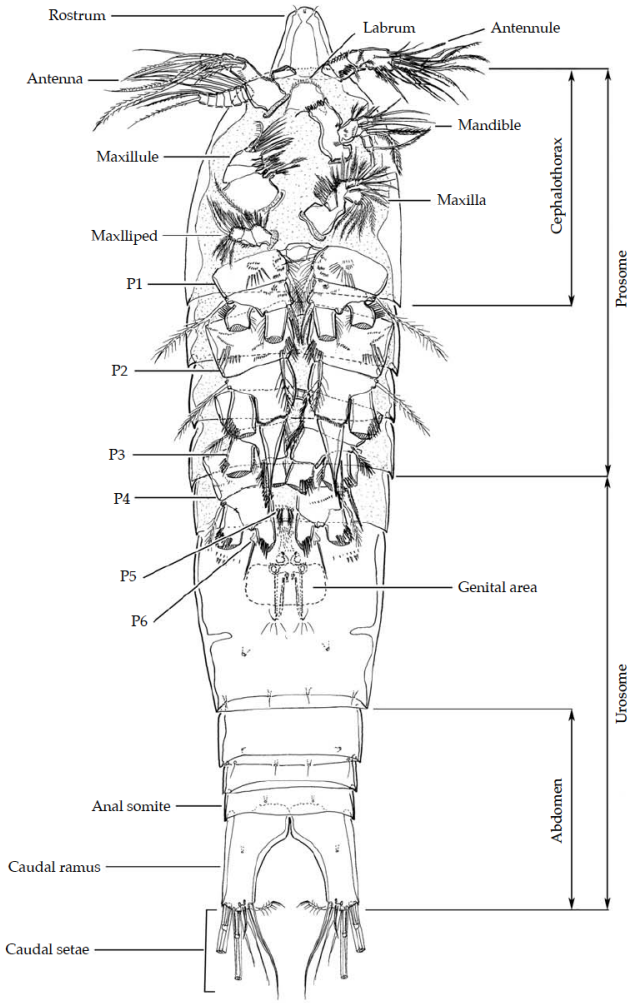
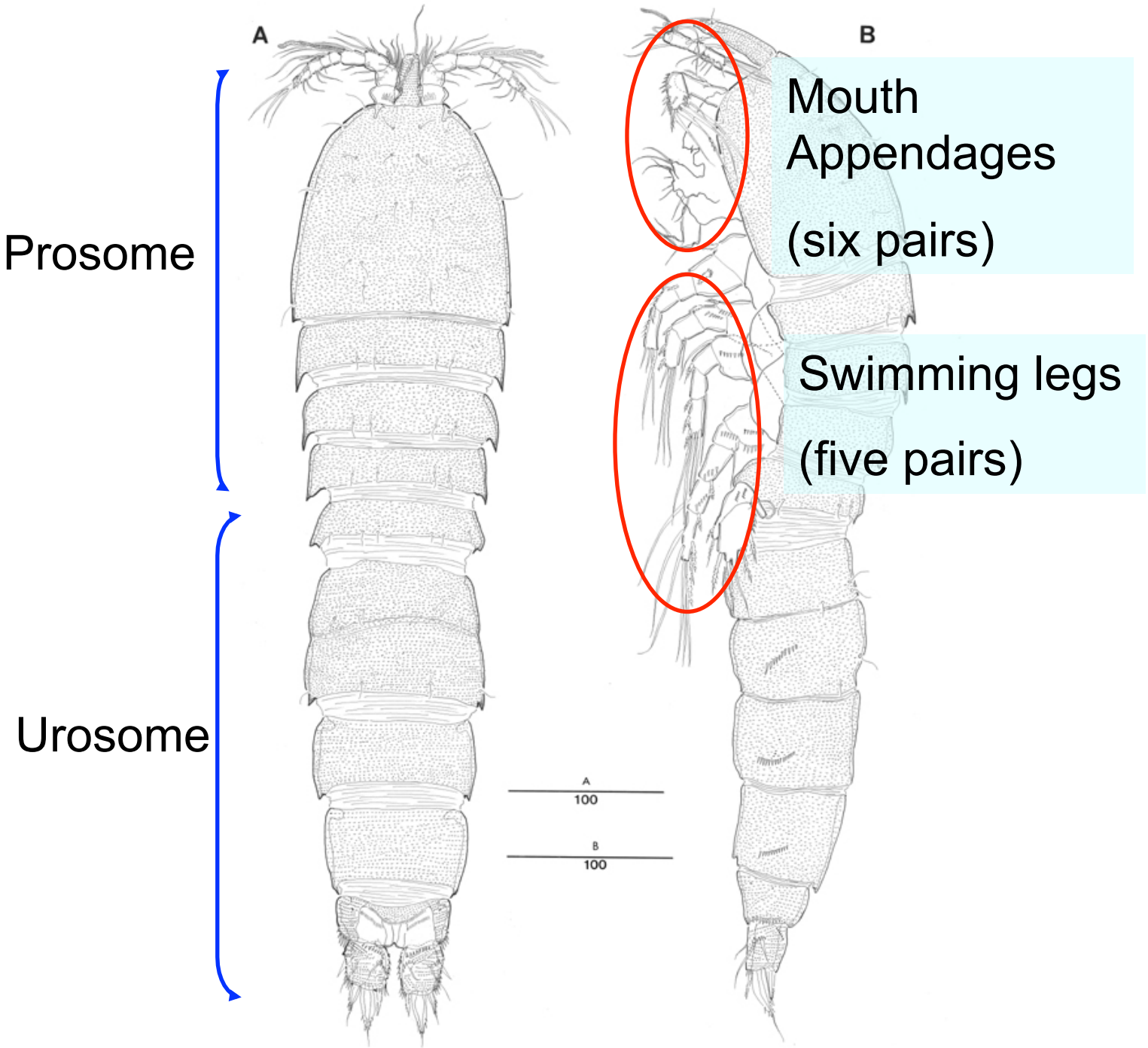
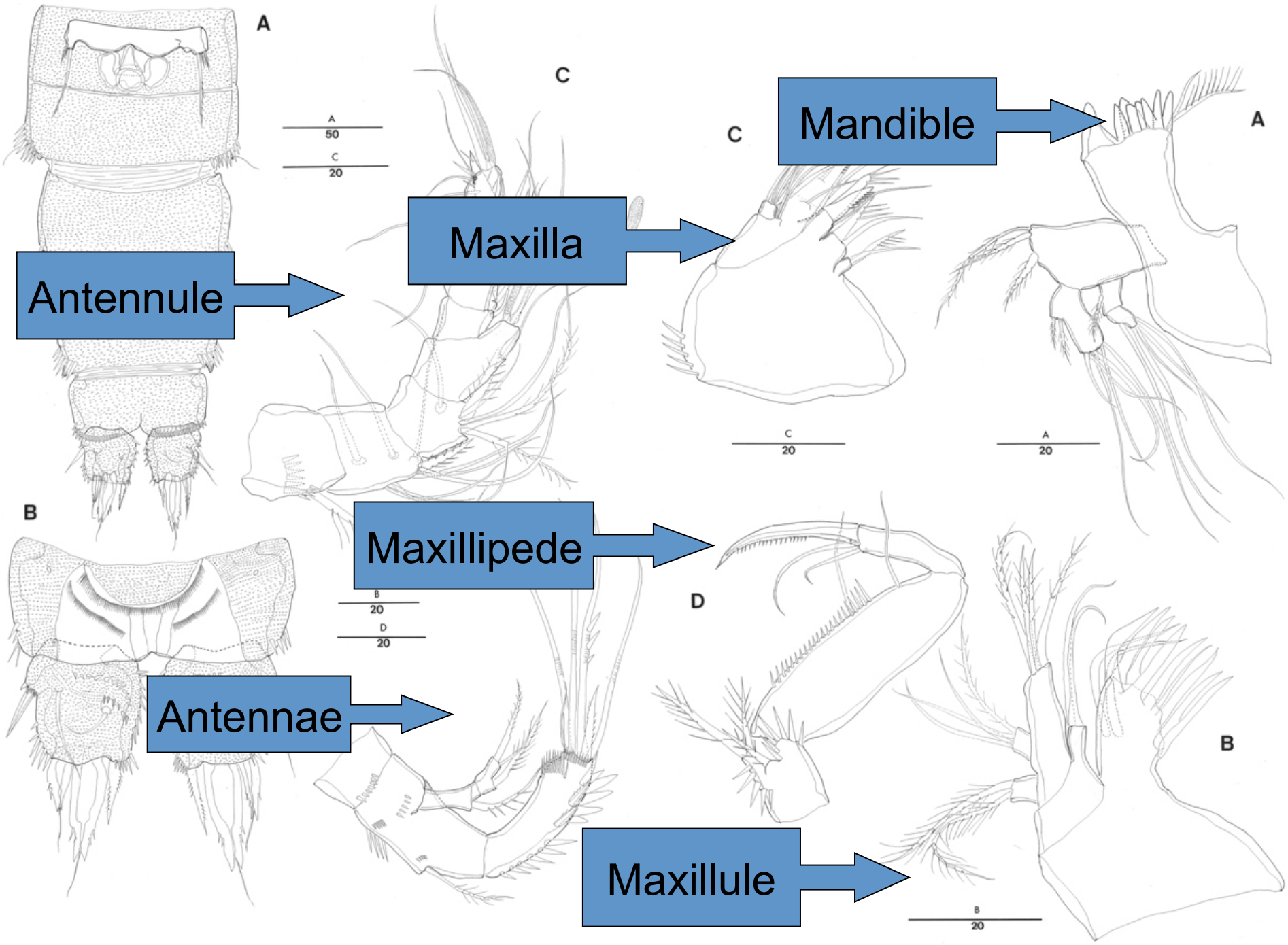
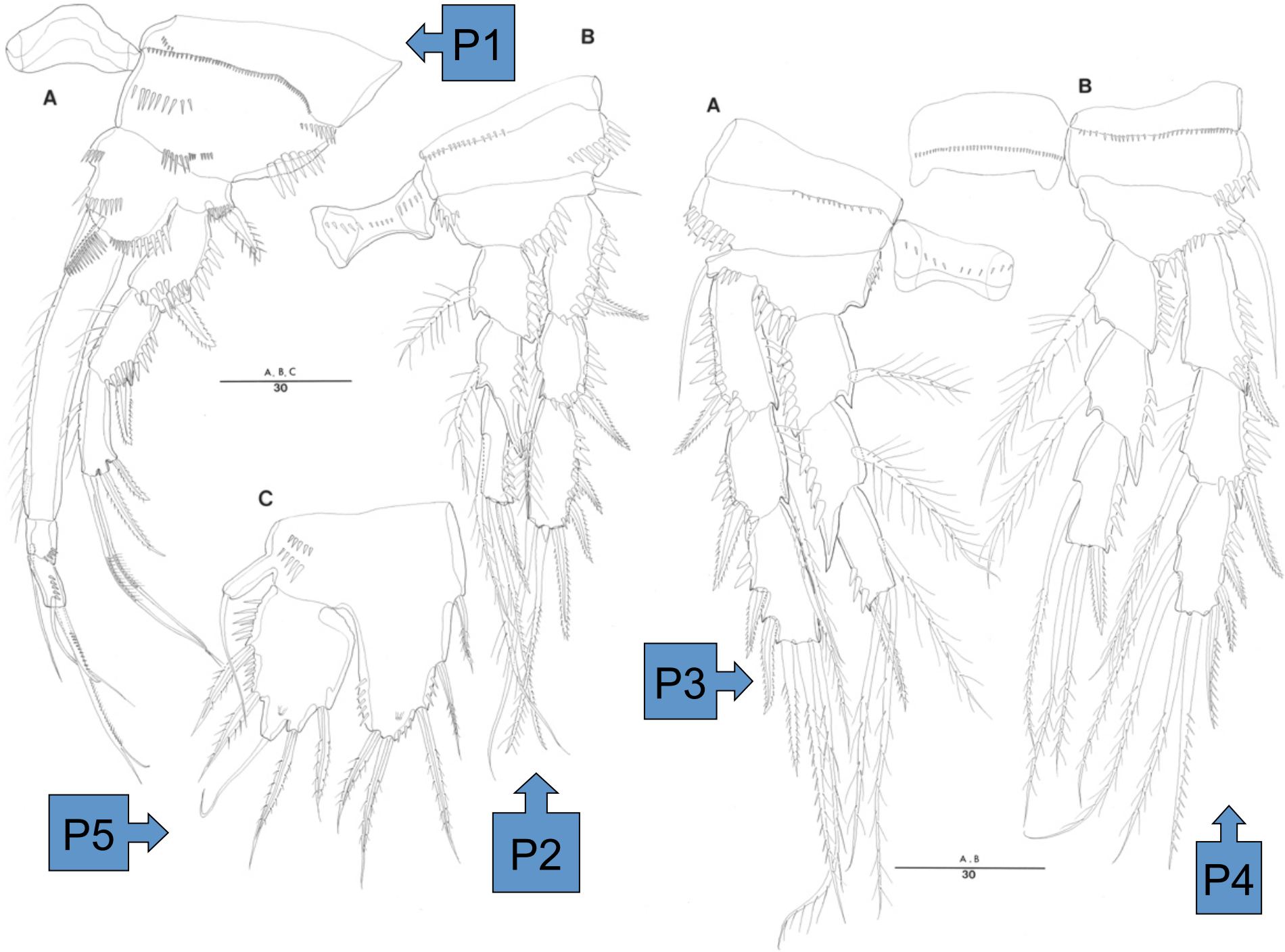


Fig. 1. General structure of harpacticoid copepod.

Lee, Park and Song, 2012

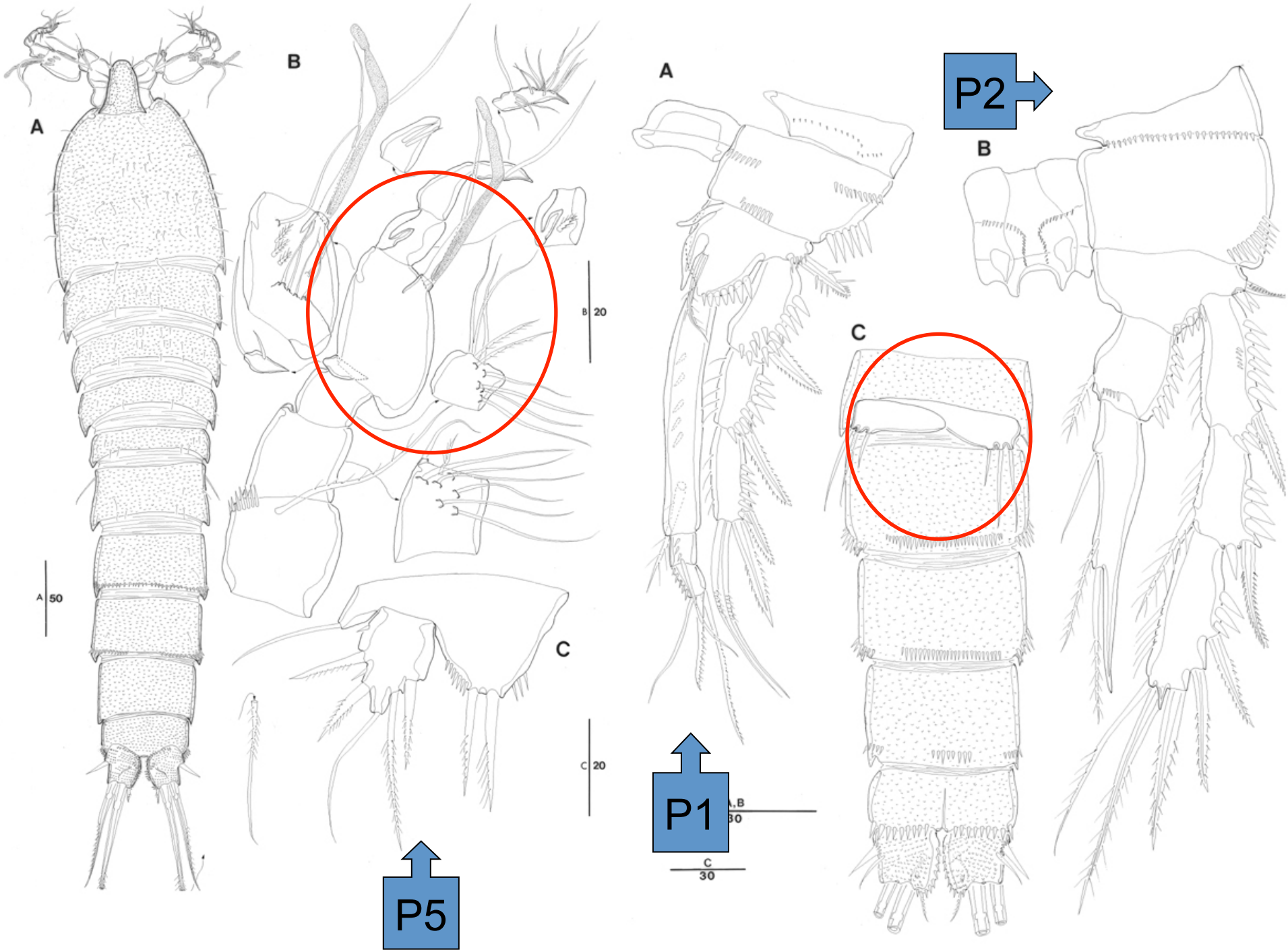

A
B
Prosome
Urosome
Mouth Appendages
(six pairs)
Swimming legs
(five pairs)
A
100
B
100


A
A
50
C
20
C
Antennule
Maxilla
C
Mandible
A
C
20
A
20
B
Maxillipede
B
20
D
20
D
Antennae
Maxillule
B
B
20


P1
A
B
A, B, C
30
C
P5
P2
P3
A
B
A, B
30
P4

Sexual dimorphism

- Related to reproduction
  - Antennule
  - P1 - P5
  - Genital field
  - Size
  - Mouth parts


A
B
C
P5
P1
P2
A 50
B 20
C 20
A,B 30
C 30

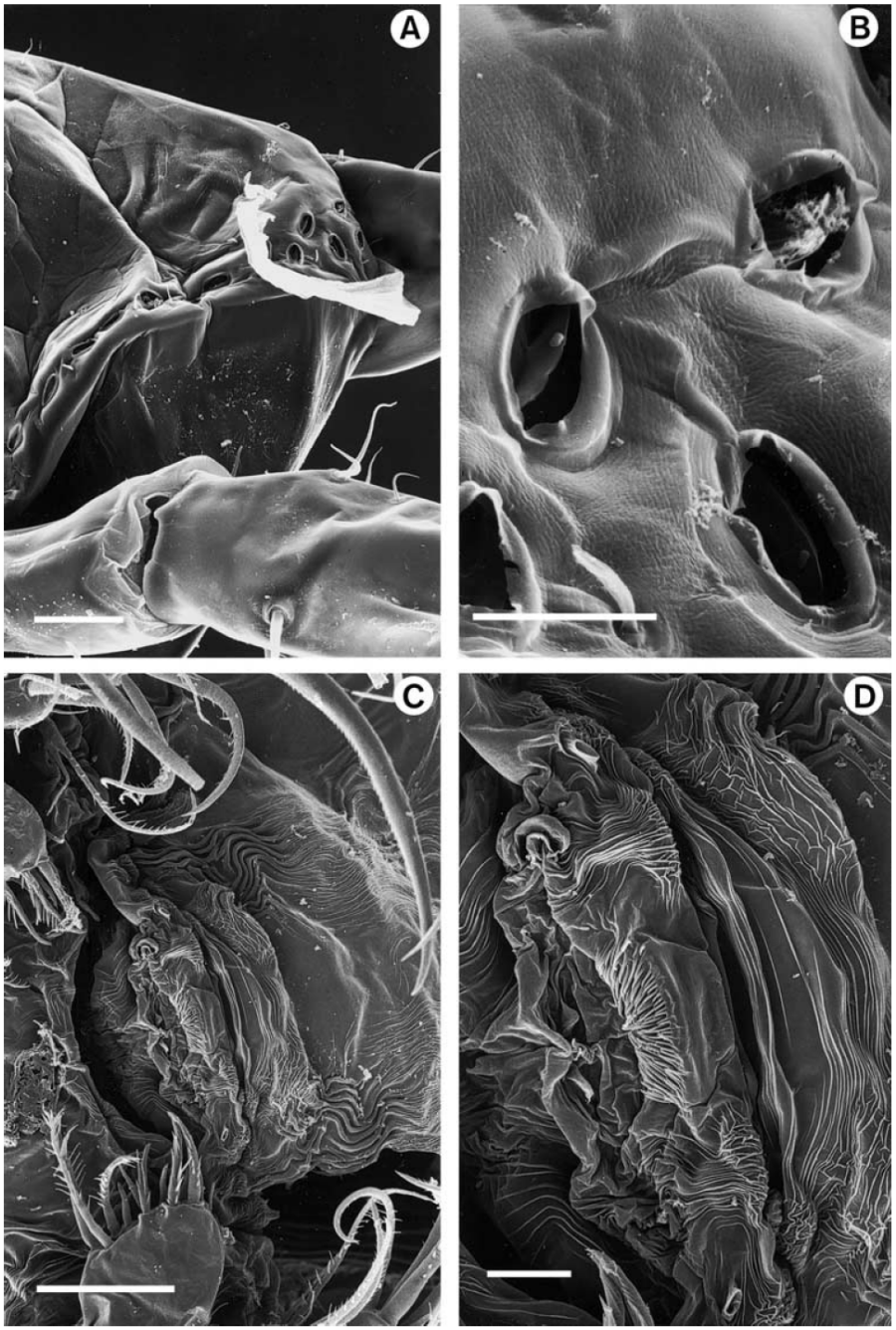
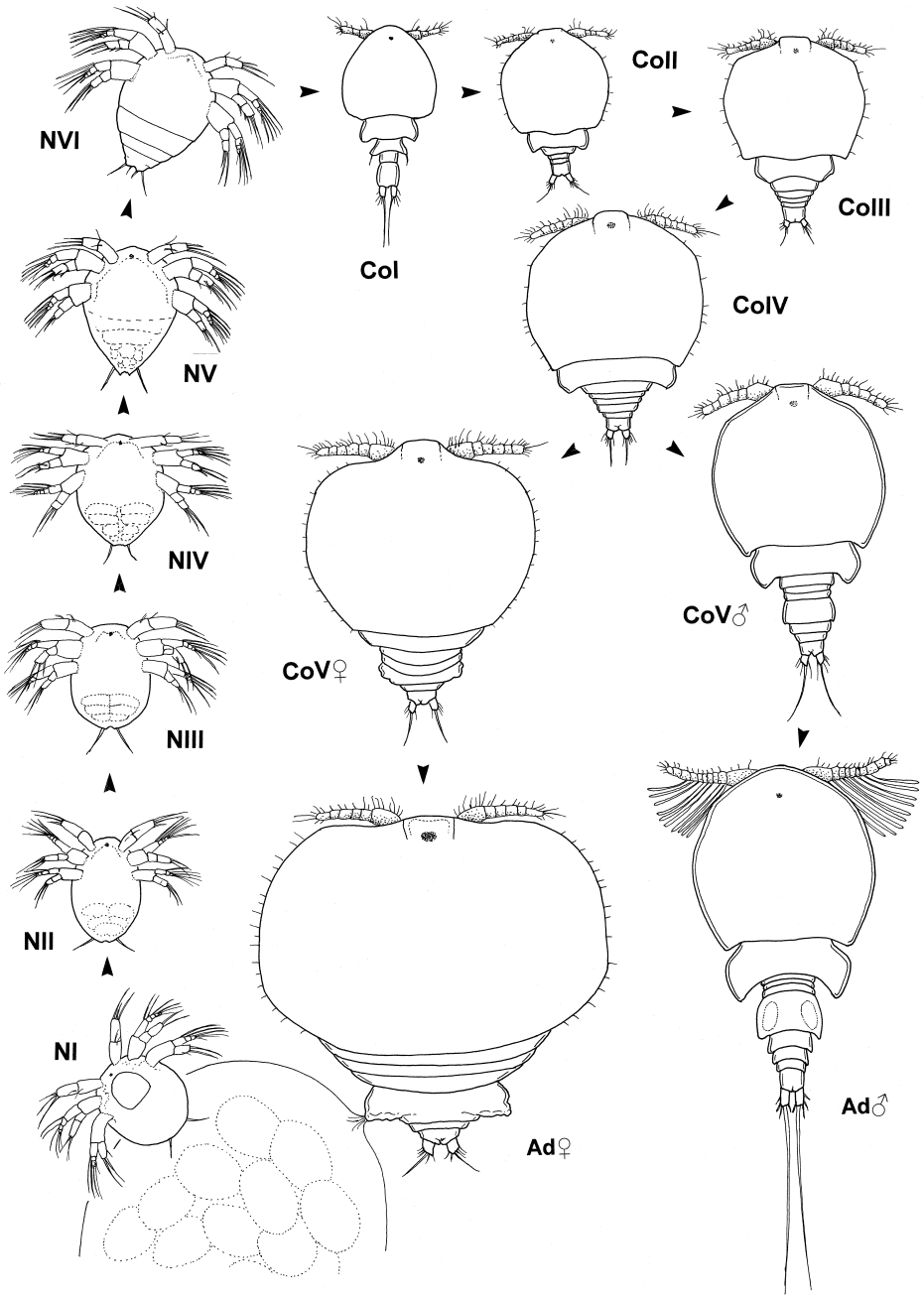


Figure 13. ***Nudivorax todai*** **gen.** et **sp. nov.** (♂). A, lateral view of cephalosome showing pore; B, detail of cephalosomic pores; C, oral area; D, detail of labrum. Scale bars: 20 µm (A, C), 5 µm (B), 10 µm (D).

Nudivorax **males are non-feeding with atrophied mouthparts**

mandibular coxal gnathobase, maxillulary endites and maxilla are all vestigial in adult male



Typical copepod life cycle comprises two phases: naupliar and copepodid

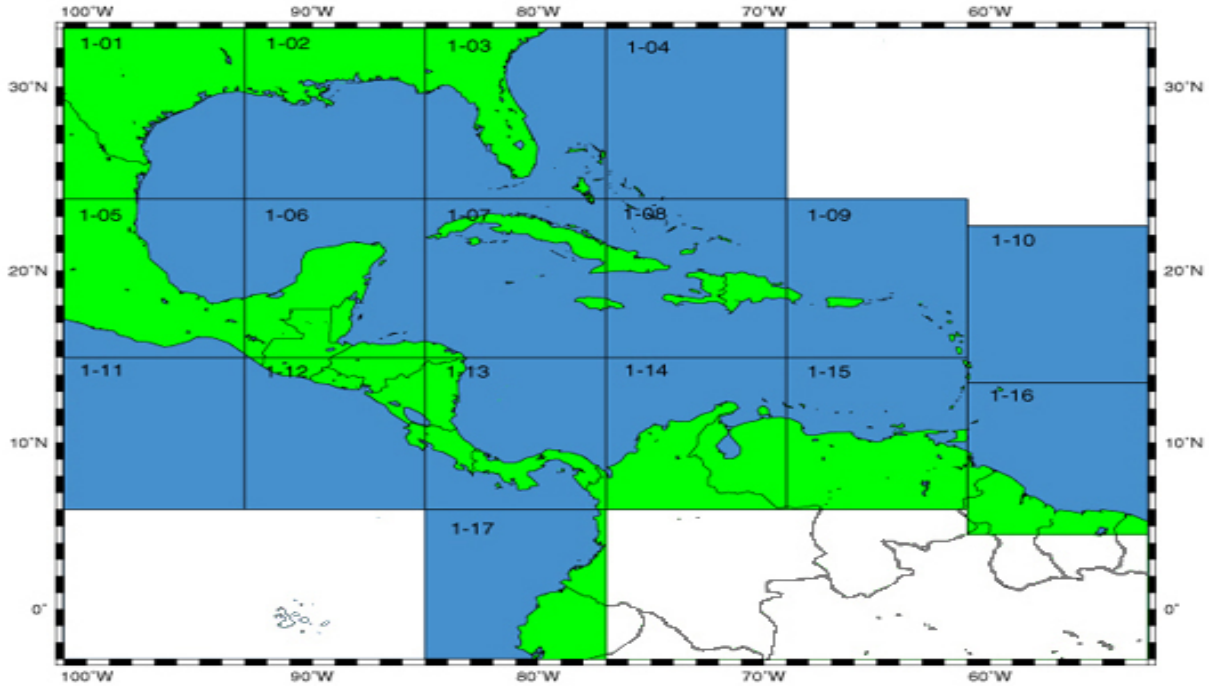
Each phase primitively has six stages:

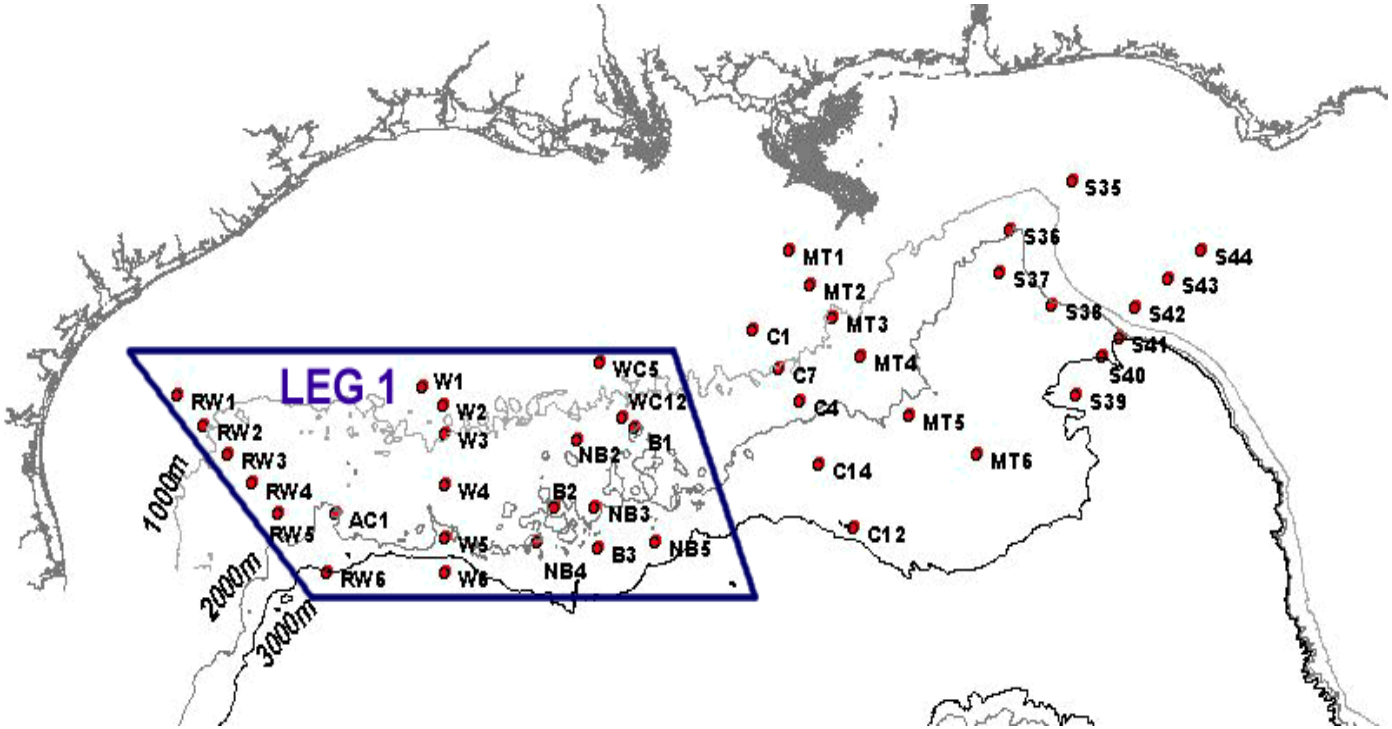
Nauplius 1 to VI and copepodid I-VI, of which the sixth is the adult

Produced By G. Boxshall

Identification of Harpacticoids from the Gulf of Mexico

- To reveal the energy flux in the northern Gulf of Mexico (DeGOM)
- Survey on the community structure in the region (May - July 2000)
- Diversity of harpacticoids


100°W
90°W
80°W
70°W
60°W
30°N
20°N
10°N
0°
1-01
1-02
1-03
1-04
1-05
1-06
1-07
1-08
1-09
1-10
1-11
1-12
1-13
1-14
1-15
1-16
1-17


LEG 1
1000m
2000m
3000m
RW1
RW2
RW3
RW4
RW5
RW6
AC1
W1
W2
W3
W4
W5
W6
WC5
WC12
B1
NB2
B2
NB3
B3
NB4
NB5
C1
C7
C4
C14
C12
MT1
MT2
MT3
MT4
MT5
MT6
S35
S36
S37
S38
S39
S40
S41
S42
S43
S44

ELSEVIER

Journal of Experimental Marine Biology and Ecology 330 (2006) 327–341

Journal of EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY

www.elsevier.com/locate/jembe

Spatial and bathymetric trends in Harpacticoida (Copepoda) community structure in the Northern Gulf of Mexico deep-sea

Jeffrey G. Baguley [a,*,1], Paul A. Montagna [a], Woncheol Lee [b], Larry J. Hyde [a], Gilbert T. Rowe [c]

[a] *The University of Texas at Austin, Marine Science Institute, 750 Channel View Drive, Port Aransas, TX 78373, United States*
[b] *Hanyang University, Department of Life Sciences, Seoul, 133-791, Korea*
[c] *Texas A&M University at Galveston, Department of Marine Biology, Galveston, TX 77553, United States*

Received 27 May 2005; received in revised form 25 November 2005; accepted 15 December 2005

Table 1
Percent contribution of Harpacticoida families to total harpacticoid abundance

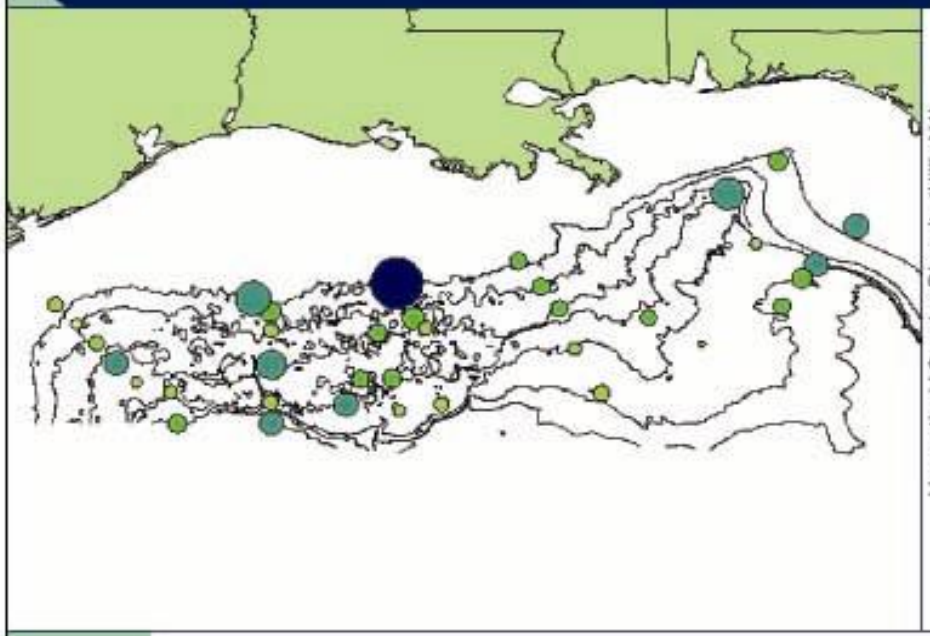
Family	AA	Contrib.%	T%
Tisbidae	40.19	32.98	32.98
Ectinosomatidae	24.12	13.27	46.24
Diosaccidae	19.74	9.84	56.09
Ameiriidae	15.71	8.24	64.33
Argestidae	11.00	8.08	72.41
Paranannopidae	9.15	6.50	78.91
Canthocamptidae	12.38	6.03	84.95
Paramesochriidae	6.73	4.15	89.10
Cletodidae	6.62	3.42	92.52
Neobradyidae	2.73	1.39	93.91
Thalestridae	2.34	1.09	95.00
Normanellidae	2.41	1.09	96.08
Cerviniidae	2.55	1.05	97.13
Danielssenidae	3.55	0.93	98.06
Huntemannidae	1.70	0.93	98.99
Unid. family	1.79	0.61	99.60
Ancorabolidae	1.21	0.32	99.93
Laophontidae	0.42	0.03	99.96
Canuellidae	0.28	0.03	99.99
Darcythompsonidae	0.19	0.01	100.0
Longipedidae	0.16	0.00	100.0
Euterpinidae	0.05	0.00	100.0

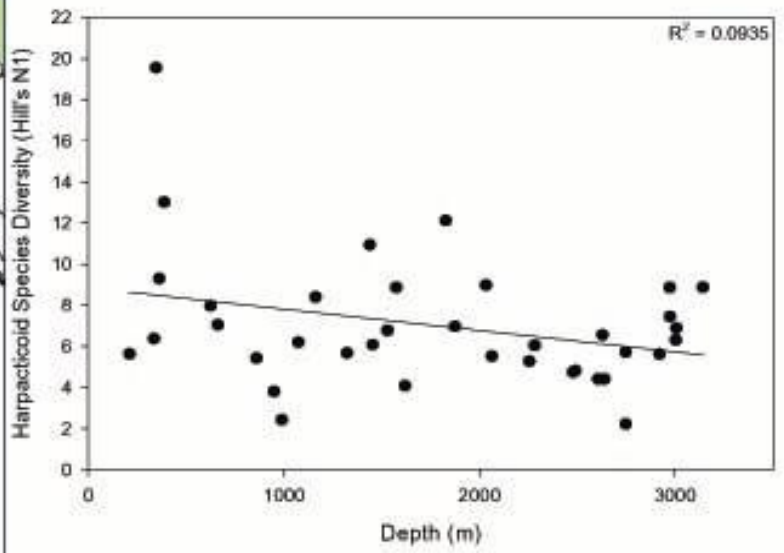
AA=Average abundance, Contrib.%=percent contribution of family, T%=cumulative percent contribution of families.

696 species
175 Genera
22 Families

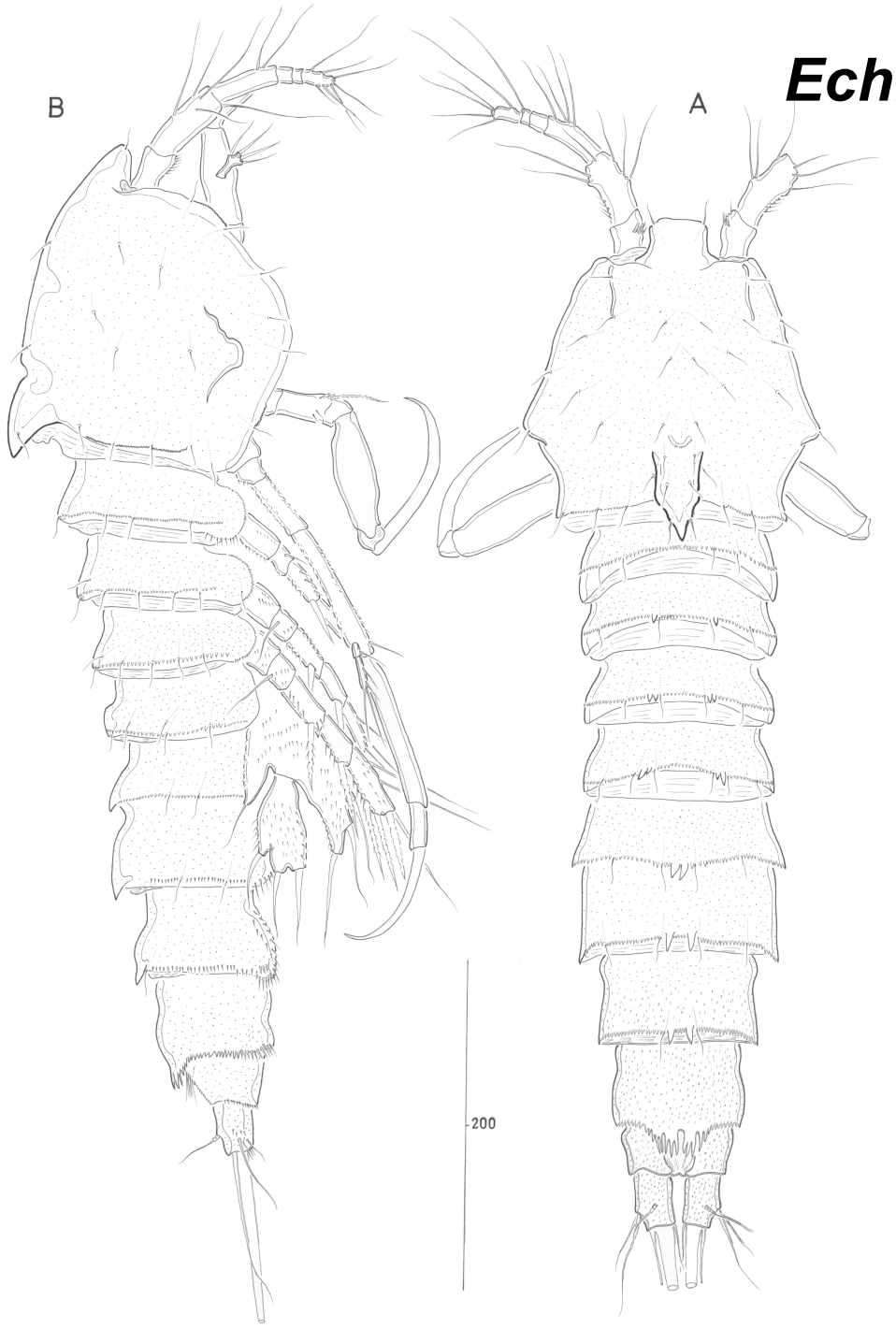
The most abundant group: Tisbidae → Zosimidae

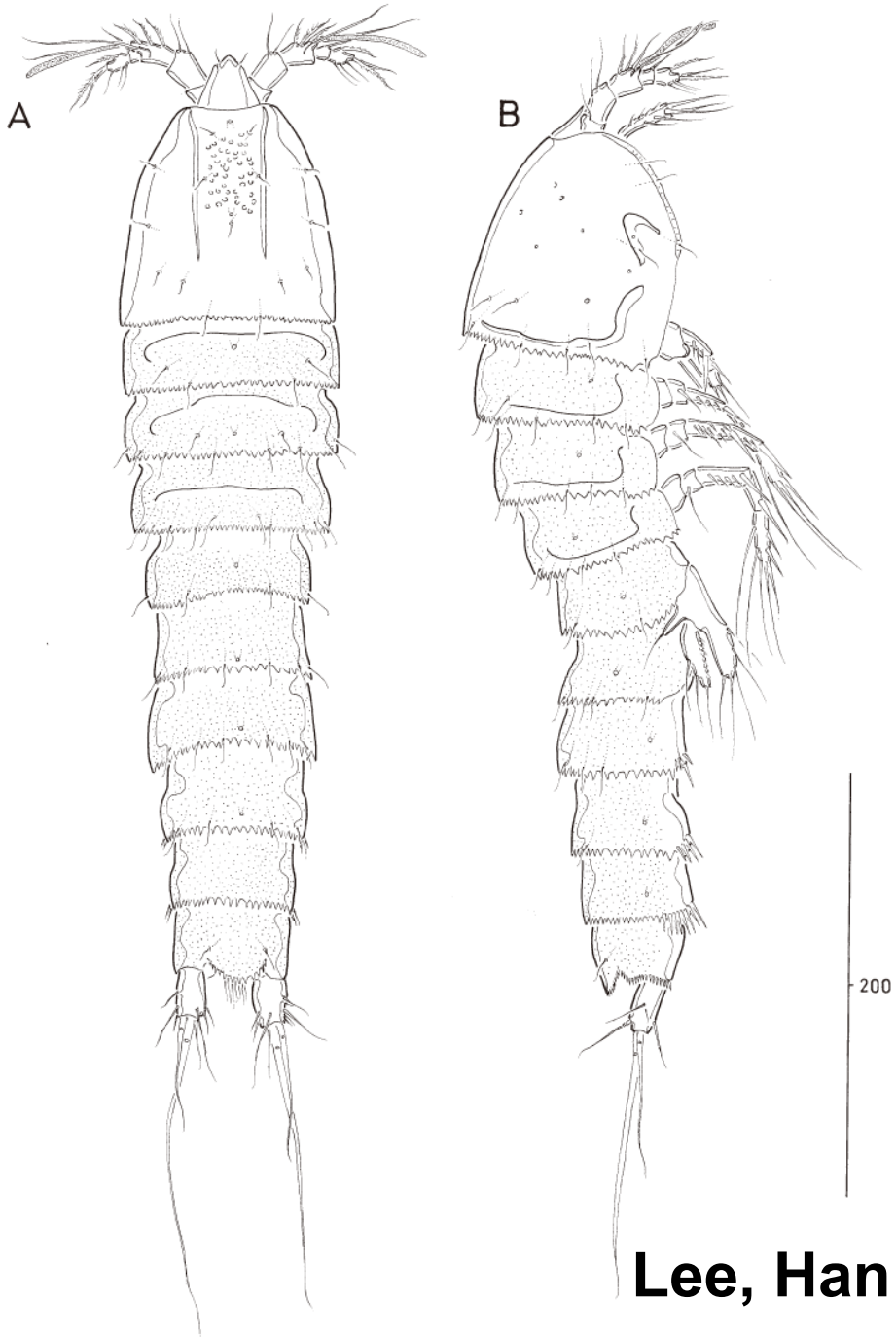
Harpacticoid Species Diversity (N1)





Echinolaophonte armiger

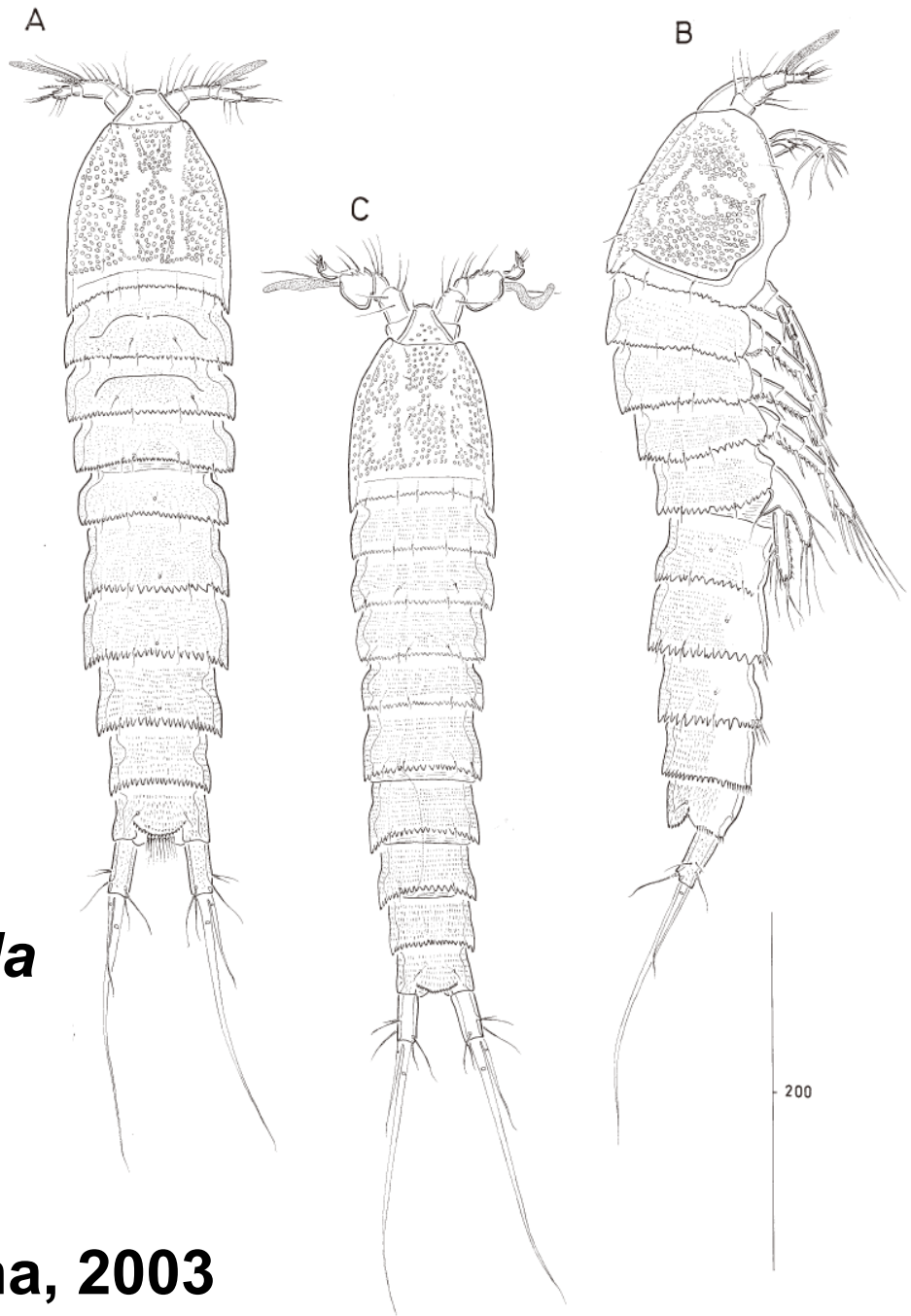




Normanella texana

Lee, Han and Montagna, 2003

FIG. 1. *Normanella texana* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus, lateral.



Normanella brevicauda

Lee, Han and Montagna, 2003

FIG. 7. *Normanella brevispina* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus, lateral; (C) habitus, dorsal (♂).

Normanella chanhoi

Lee, Han and Montagna, 2003

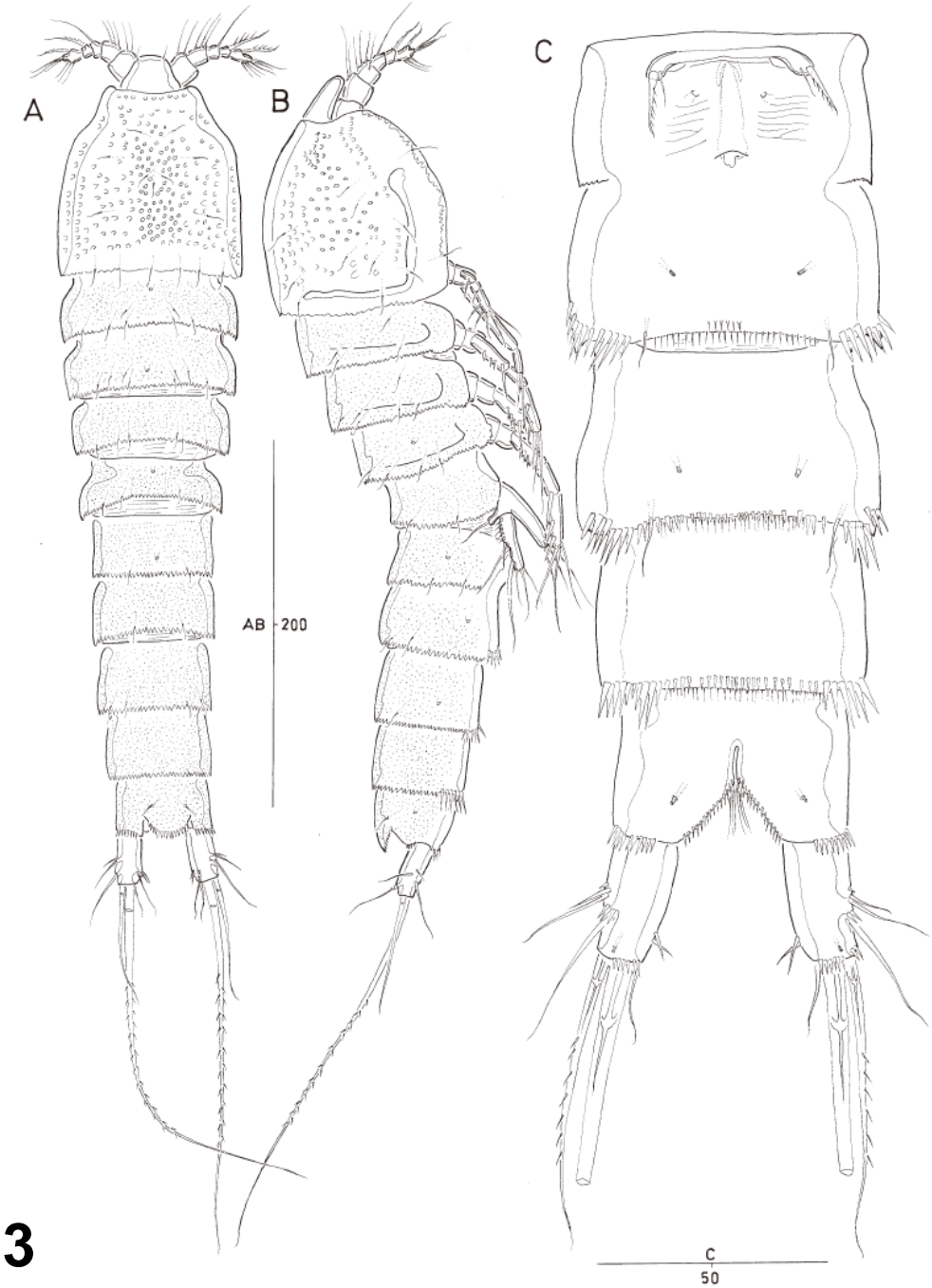


FIG. 11. *Normanella chanhoi* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus, lateral; (C) urosome (excluding P5-bearing somite), ventral.

Pseudostenhelia wellsi

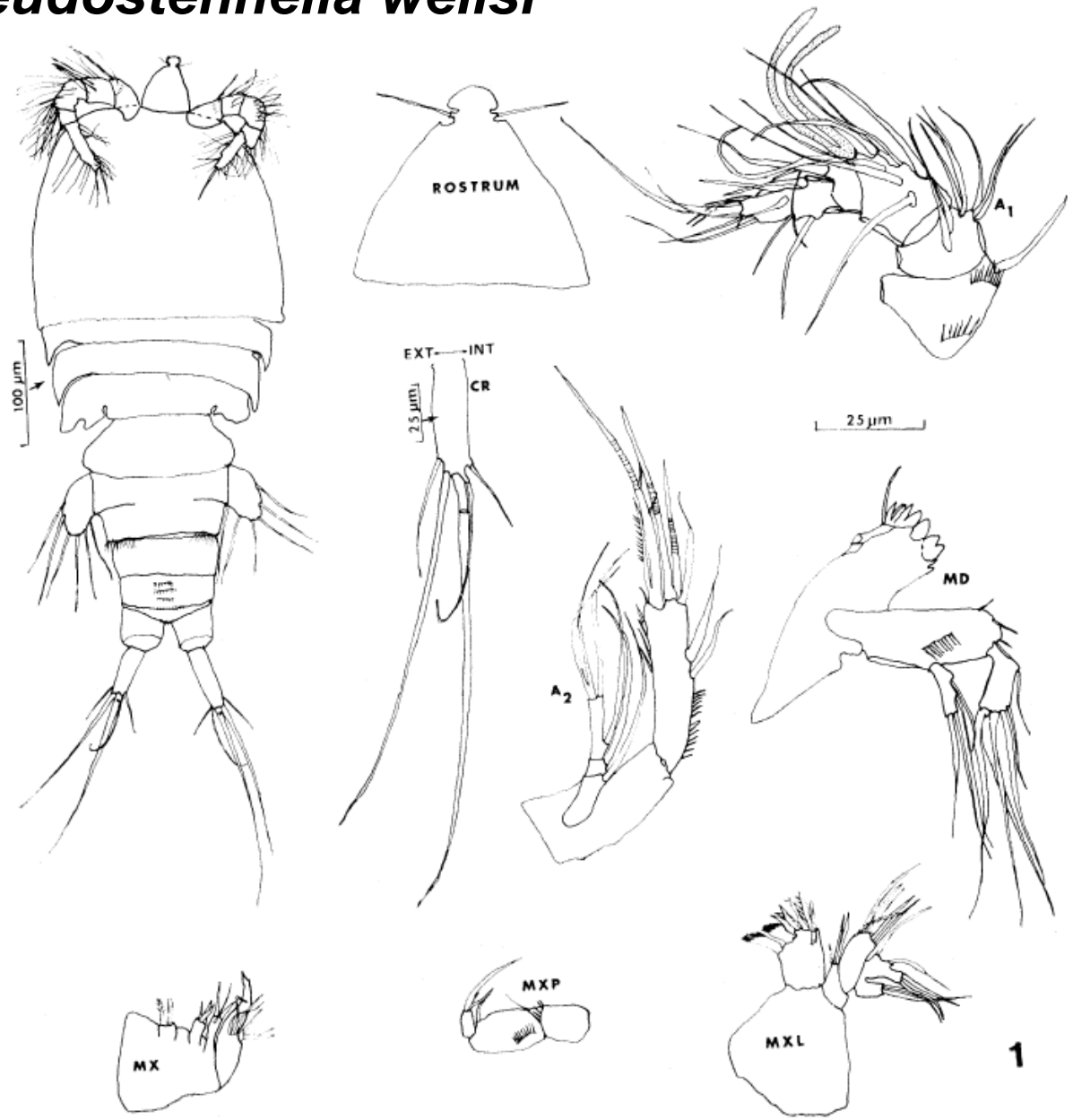


FIG. 1. *Pseudostenhelia wellsi* n. sp.: ♀.

Coull & Fleeger, 1977

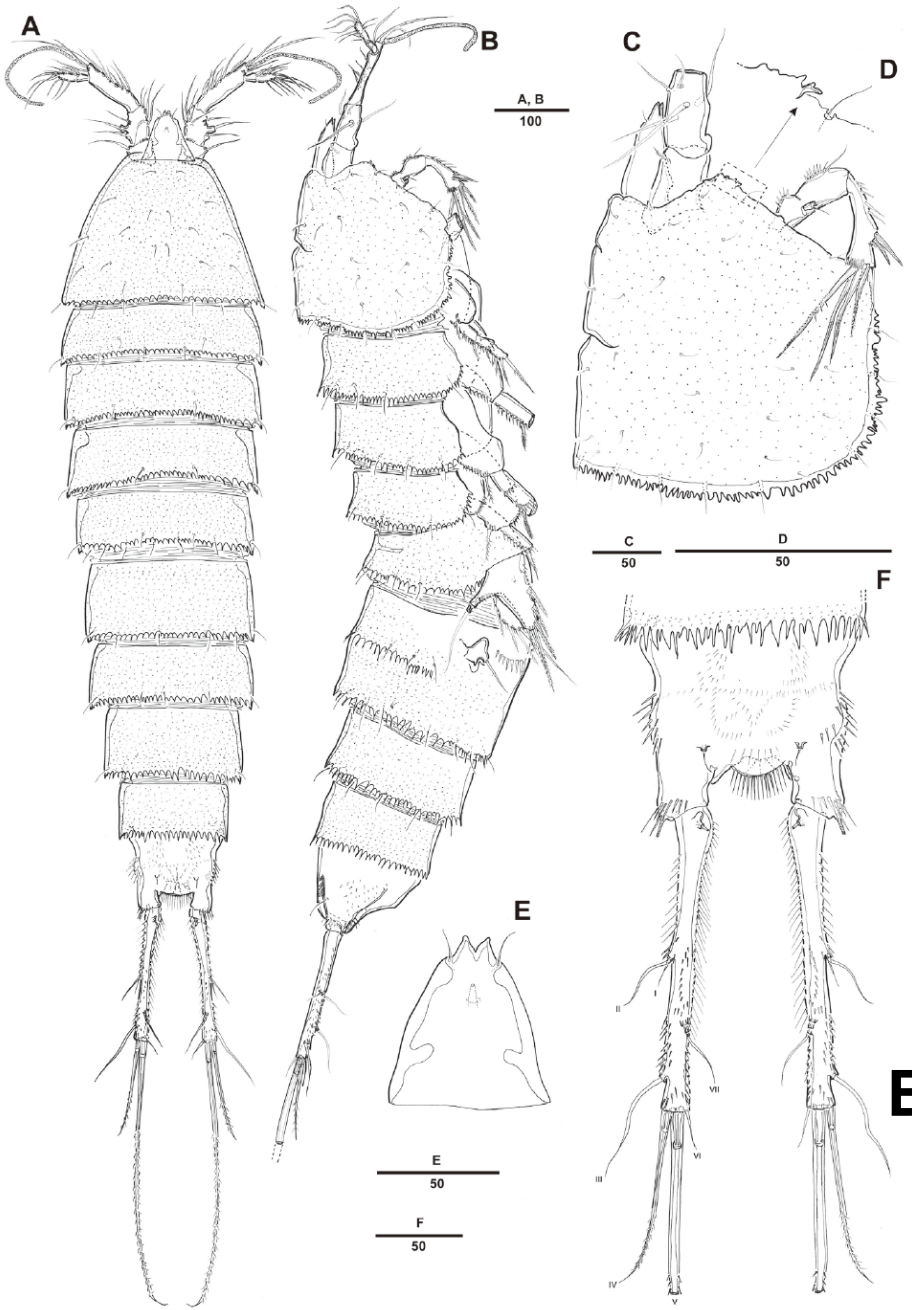


Figure 1. *Pentacletopsyllus montagni* gen. et sp. n. female: **A** habitus, dorsal **B** habitus, lateral **C** cephalothorax, lateral **D** tooth-like process of cephalothorax lateral anterior margin **E** rostrum, dorsal **F** caudal ramus, dorsal.

Peptacleptopsyllus montangni

-1590m

Bang, Baguley and Moon, 2014

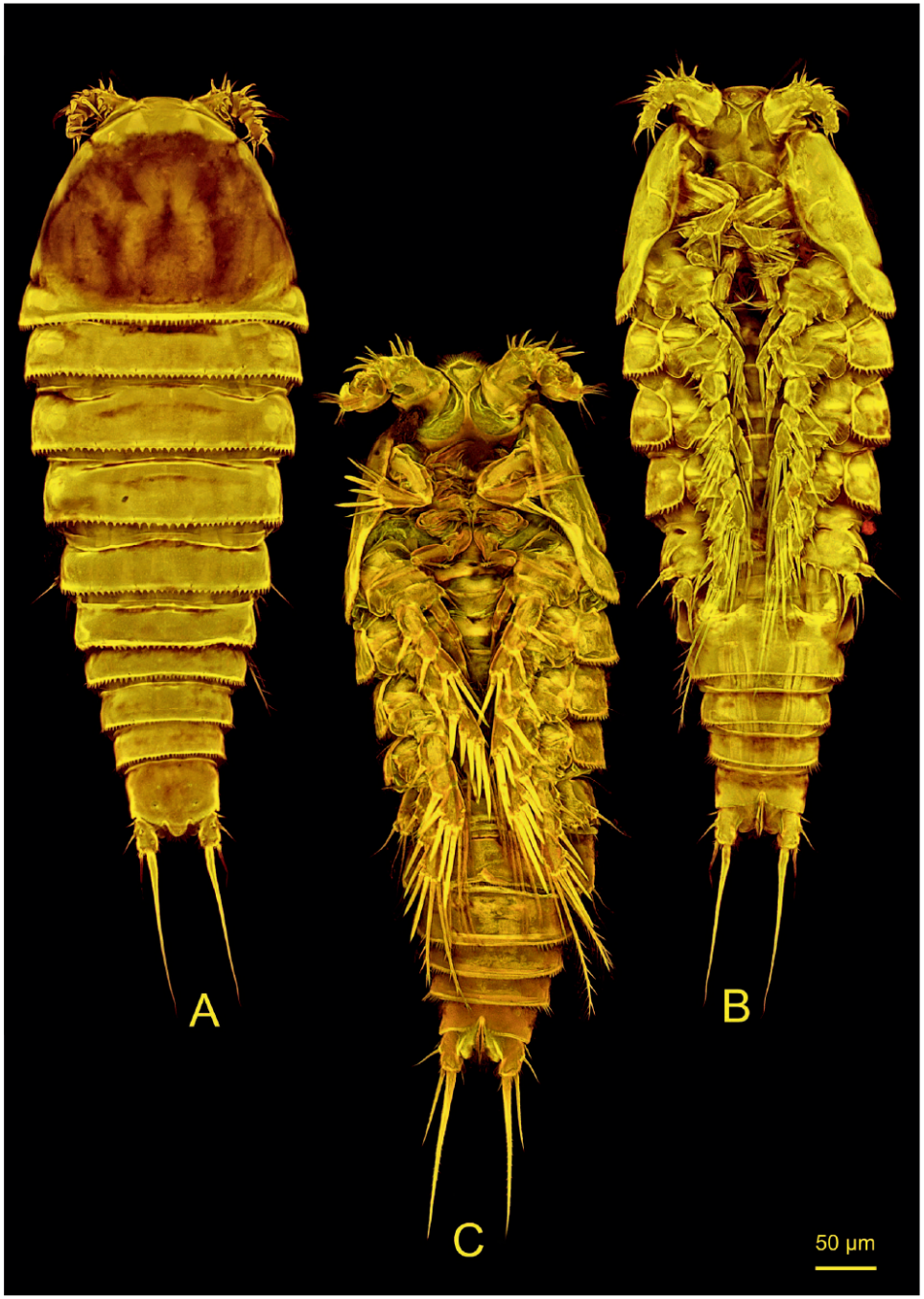
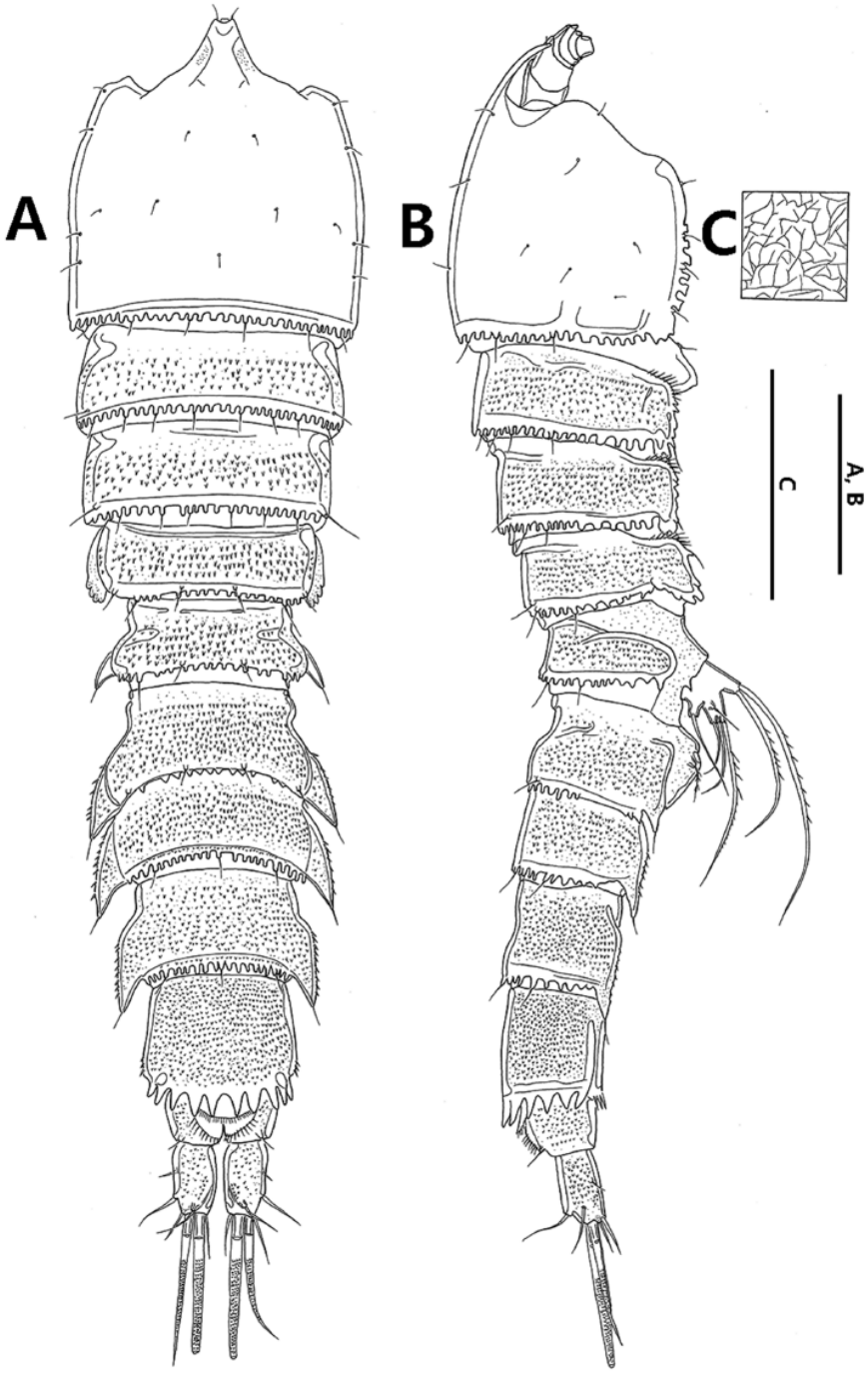


Fig. 1. *Nannopus ganghwaensis*. Female. CLSM images. A, habitus, dorsal; B, habitus, ventral. Male. C, habitus, ventral.

Nannopus palustris

Vakati, Kihara and Lee, 2016



Zosimiidae

Zosime spp. ~10 species

Kim, Jung and Yoon, 2016

Suarez-Morales, E., Fleeger, J.W. & Montagna, P.A. 2006. Free-living copepods of the Gulf of Mexico. *In:* Gulf of Mexico Biota. University of Texas.

Copepoda 406 species

Harpacticoida 71 species 54 genera 21 families

Zootaxa 1285: 1–19 (2006)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

1285

A checklist of the marine Harpacticoida (Copepoda) of the Caribbean Sea

EDUARDO SUÁREZ-MORALES[1], MARLEEN DE TROCH [2] & FRANK FIERS [3]

[1]*El Colegio de la Frontera Sur (ECOSUR), A.P. 424, 77000 Chetumal, Quintana Roo, Mexico; Research Associate, National Museum of Natural History, Smithsonian Institution, Wahington, D.C.*
E-mail: esuarez@ecosur-qroo.mx
[2]*Ghent University, Biology Department, Marine Biology Section, Campus Sterre, Krijgslaan 281–S8, B-9000 Gent, Belgium. E-mail: marleen.detroch@UGent.be*
[3]*Royal Belgian Institute of Natural Sciences, Invertebrate Section, Vautierstraat 29, B-1000, Brussels, Belgium. E-mail: frank.fiers@naturalsciences.be*

178 species 94 genera 33 families
Dominant taxa: Miraciidae, Laophontidae, Tisibidae

Thank you very much for your attention!

Special thanks to:

Paul A Montagna

& Organizing committee