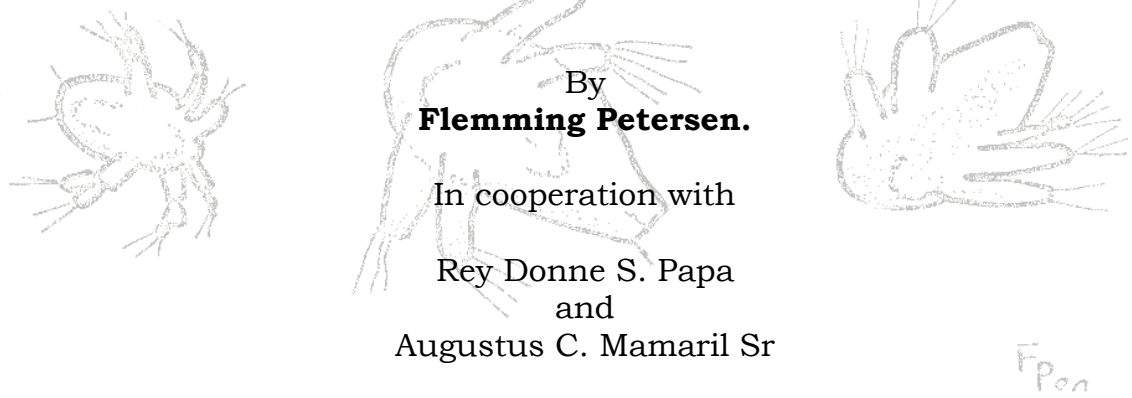
An Illustrated Key To the Philippine Freshwater Zooplankton.

Including some brackish water species from Laguna de Bay.

With ecological notes.

Now with research results from the Laguna de Bay studies.



By
Flemming Petersen.

In cooperation with

Rey Donne S. Papa
and
Augustus C. Mamaril Sr

2018

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PART 1.
Introduction and Key

An Illustrated Key
to the Philippine
Freshwater Zooplankton.
Including some brackish water species from Laguna de Bay.
With ecological notes.
2014.

By

Flemming Petersen[1].,MS
In cooperation with
Rey Donne S. Papa[2], MS
and
Augustus C. Mamaril[3], MS

Photos from **1979-83** (Greyscale pictures of specimens from **1980**) & **2013** by
Flemming Petersen, M.S.,

and

Photos from **2007** and **2013** by
Rey Donne S. Papa, M.S.



To the Filipino Fisherman.

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2. Introduction

If one follows the food web from man through fishes one may eventually reach the plankton[4] of fresh- and brackish waters. Of the plankton organisms, the zooplanktons are important for many fishes, including some of the species that are cultivated in ponds, pens and cages all over the Philippines (Aquino, 1982, Aquino et Nielsen, 1983, Fernando, 2002a, Hartmut, 2003, Nielsen, 1983, SOGREAH-Report, 1974, Papa, 2008a and Briones, 2012) - just take a view over Laguna de Bay and bee convinced (try Google Earth[5]).

Zooplankton in the food chain.

Zooplankton constitutes the main food of most fish species when these are at their young, post-larval stage. Insects and other organisms from the littoral zone supplement the zooplankton. Some fishes like the herbivorous cichlids switch from being zooplanktivory to plant diet at a very early age (Fernando, 2002a). The invasive Mosquito fish, *Gambusia affinis*, is widespread and common in canals, creeks, swamps, ponds, and shallow areas of lakes. It feeds on zooplanktons, small insects, and detritus (Joshi, 2006). One of the major reasons why larger fish abandon this food source is that it becomes too small relative to their body size and is too dispersed in the water to be profitable. Practically the only way for larger fish to obtain sufficient quantities is by filter feeding (e.g. bighead carp). Nevertheless, the larger plankters are normally scarce in or absent



Mr. Celestre feeding Tilapia in Fish Cage, 1980

[4] Zooplankton is defined as the animal component of the planktonic community (i.e. animals that cannot swim independently from strong water currents and tides). See UST, 2013

[5] Coordinates of BRS laboratories at SEAFDEC: 14° 24' 44" N, 121 ° 12' 57" E

from the diets of phytoplanktivorous fish such as milkfish and tilapia. These fish move to slowly through the water when filtering than zooplanktivorous fish do, allowing the larger plankton to escape (Richter, 2001).



Bighead Carp, a zooplanktonfeeder, 1980

Sustainable fisheries development thus partly depends on the availability of adequate zooplankton as principal food items of early life history stages of economically important fish species as well as of the adults of some species (Mamaril, 2001a). The cultured bighead carp, *Hypophthalmichthys nobilis* (Richardson, 1845) feed on zooplankton mechanical filtering of the water through the gillrakers with an interrraker distance of 60-100 µm, it can select especially copepodites from the water in Laguna de Bay, shown by Petersen (1981e) and Santiago (2004). The catadromous milkfish *Chanos chanos* (Forsskål, 1775), that breed in the sea, feed on the abundant zooplankton there and then enter freshwater to take advantage directly or indirectly of the year-round food supply and the high primary production (Gross et al. in Fernando, 2002a).



Milkfish 1980

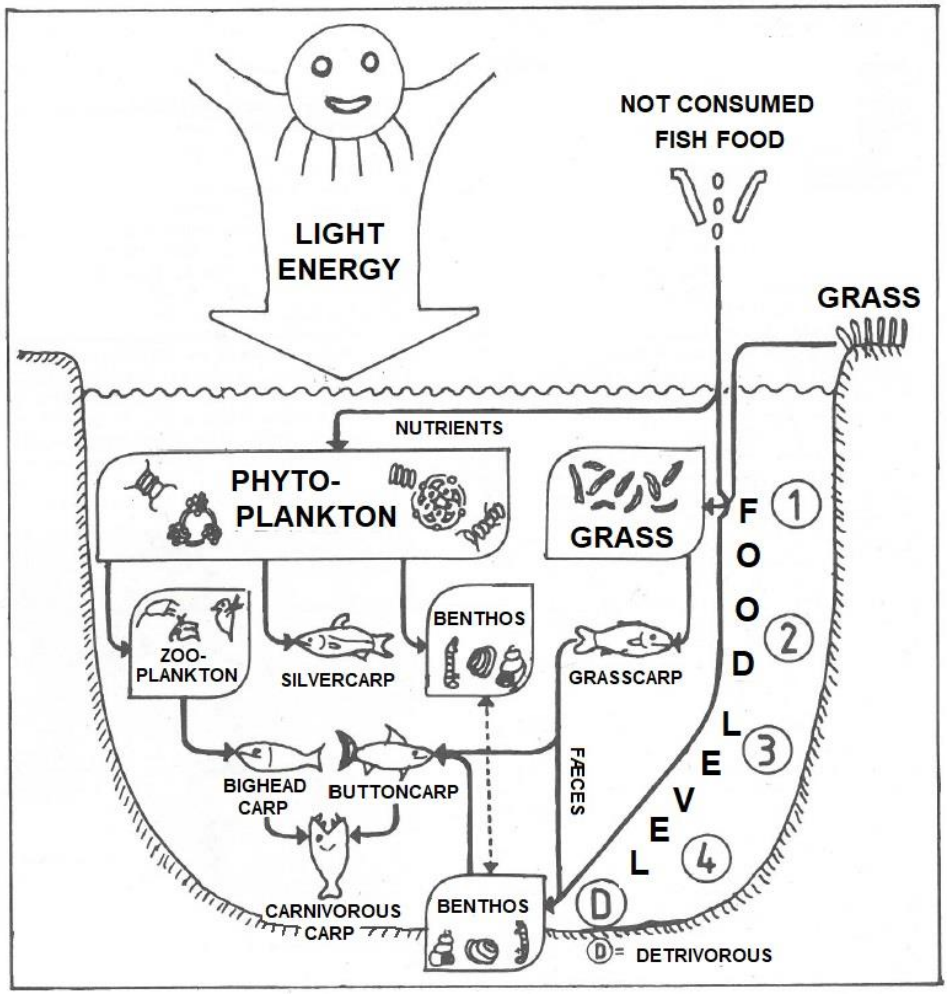
In Lake Taal in Batangas the clupeid freshwater sardine *Sardinella tawilis* (HERRE 1927) exhibit surface filter feeding with particulate filtering capacity. Periodically *it has a* planktivorous diet of zooplankton such as ostracods, cladocerans (*Bosmina* sp., *Moina* sp., *Diaphanosoma* sp., *Ceriodaphnia* sp. and *Simocephalus* sp.) copepods (Cyclopoids and Calanoids), and rotifers *(Brachionus* spp.). In a more recent study *Bosmina* sp. had the highest occurrence items in the stomachs of *tawilis* purchased from the market. Papa et al (2008a)

found that this freshwater sardine is a main predator of copepods, since up to 90% of its stomach content has been found to be composed of large-bodied adult copepods, mainly calanoid *Arctodiaptomus dorsalis*.



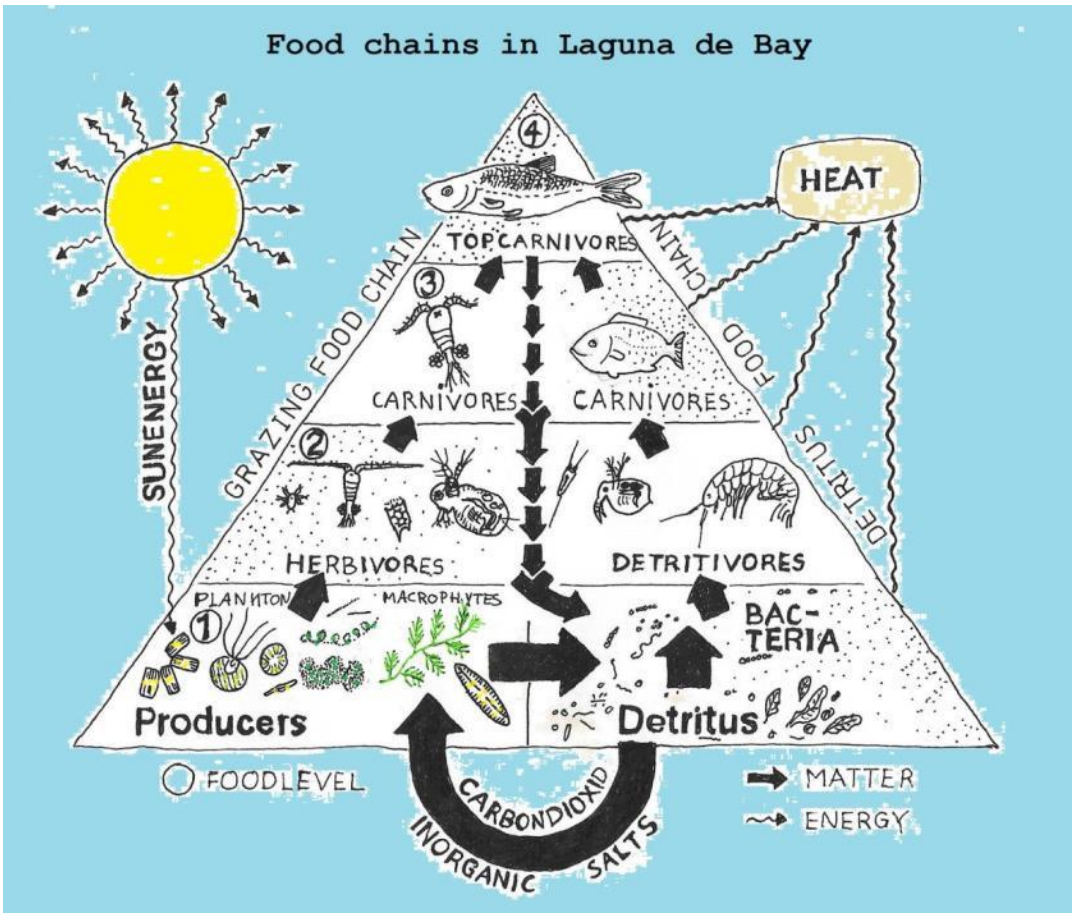
"Tawilis" sold at the Binangonan Market. Photo Flemming Petersen, 2013

To evaluate the importance of zooplankton as fish food knowledge of zooplankton in the fish diet must be studied. As mentioned the zooplankton diet of the freshwater sardine, Sardinella tawilis in Lake Taal has been studied by Papa (2005a). The long-term changes can be studied by monitoring the stomach content for zooplankton for a longer period (Briones et al, 2015). Polycultures of fish may be more efficient in utilizing the natural food. Polycultures has been having been sophisticated in the Chinese aquaculture tradition. The zooplankton play a role in this kind of management, as seen on the following schematically figure:



Food level in a Chinese polyculture pond. After Petersen (1980b)

Planktivorous fishes may have a direct effect on these large zooplankton groups (Papa, 2008a, Papa et al. 2011b) and the cladocerans even almost eliminated by fish (Fernando, 2002a). The freshwater sardine is thus an important example of the importance of zooplankton as a trophic link between phytoplankton and fishes. Visually guided planktivorous fish can thus exert strong predation pressure, which zooplankton avoid by migrating downwards to a depth where low irradiance prevents detection (Papa, 2008a, Carlos 1982.).



An example of a food web in a lake. After Petersen 1981e

In at study of vertical distribution during daylight, copepods with eggs where thus primarily found near the bottom of the shallow, but turbid lake Laguna de Bay, invisible for the zooplanktivorous fishes (Petersen, 1981e). The high predation from zooplanktivorous fishes and fish-larvae, the competition from phytoplanktivorous fishes are reducing the diversity of zooplankton of tropical freshwater (compared with temperate waters), the size of zooplankton animals and the total biomass. Consequently, the zooplankton of the tropical lakes does not control phytoplankton biomass (Fernando, 2002a) as seen in many temperate lakes. In the Danish Lake Esrom, *Daphnia sp.*, which is rare in the tropical freshwaters, controlled the phytoplankton-biomass in the warm summer period (Petersen, 1983).

Other factors can influence the composition of zooplankton in a lake. In general, the zooplankton community structure, population dynamics, and production are strongly influenced by lake productivity, and zooplankton is of this reason a useful indicator of eutrophication of lakes. (Papa et al. 2011b). Difference in diversity and distribution of the zooplankton within a lake may be influenced by anthropogenic eutrophication, like the 10.000 fish cages in the Northern basin of Taal lake (Gulati 2009). Further weather conditions can have an impact on the zooplankton distribution; this is especially the case for tropical zooplanktons, since their relatively smaller size (Papa et al. 2011b). Studies have shown that physico-chemical parameters can be correlated to zooplankton abundance, species number and diversity. The study by the Papa and his group (Lazo, 2009a) has revealed a moderate to high correlation to rotifers population in Pasig River to the dissolved oxygen in the river.

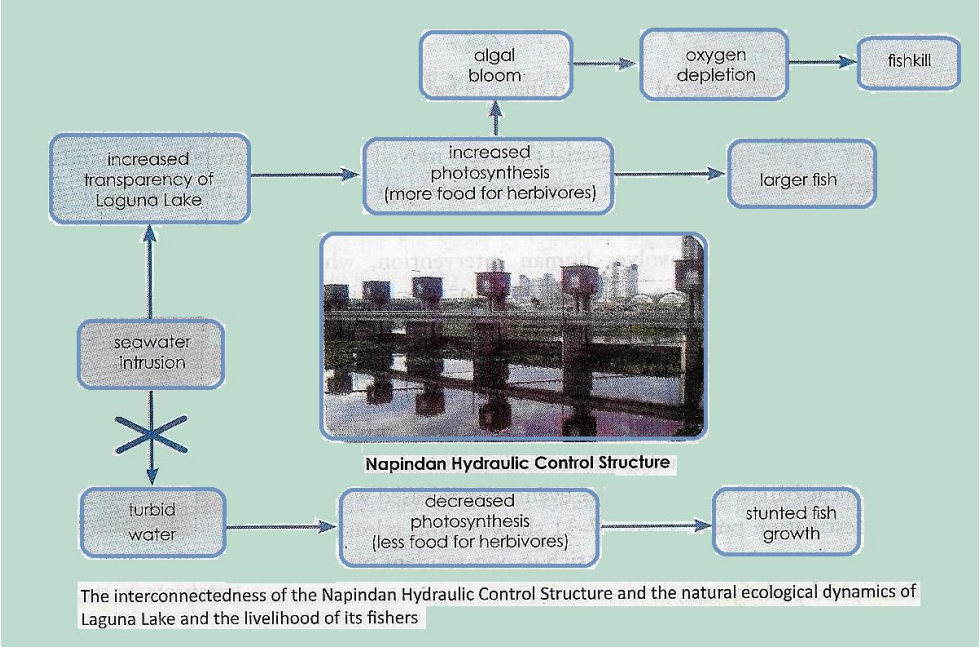
The most dominate zooplankton in **Laguna de Bay** before 1980 was cladocerans followed by copepods and then rotifers. This was about the time when the total fish pen area was at its maximum (ca. 30,000 ha). Declining zooplankton biomass has been marked between 1982 and 1983. The expanding fish pen industry, the operation of the Hydraulic Control Structure (HCS) across the Napindan channel had become operational in regulating the flow of water in and out of the lake via the Pasig River, and lake pollution had separate adverse effects on the zooplankton. Shifts in the structural features of zooplankton communities became apparent seven year after the operation of the HCS, or 4 to 5 yr. after the demolition of fish pens. Copepods became dominant over the cladocerans and rotifers in that order (Nielsen, 1983, Tamayo-Zafaralla et al., 2002). Furthermore, a shift towards a high biomass in younger stages of copepods caused



Fishpen in Laguna de Bay 1980

by heavily predation pressure on adult stages by fish larvae and planktivorous species, in and outside fish pens, has been found in Laguna de Bay (Papa, 2012a).

The interconnectedness of the Laguna Lake has been described by the awarded scientist and teacher, and my former colleague, Joy Ferriols-Pavica in this figure:



Interconnectedness of the Laguna Lake, Ferriols-Pavica (2017)

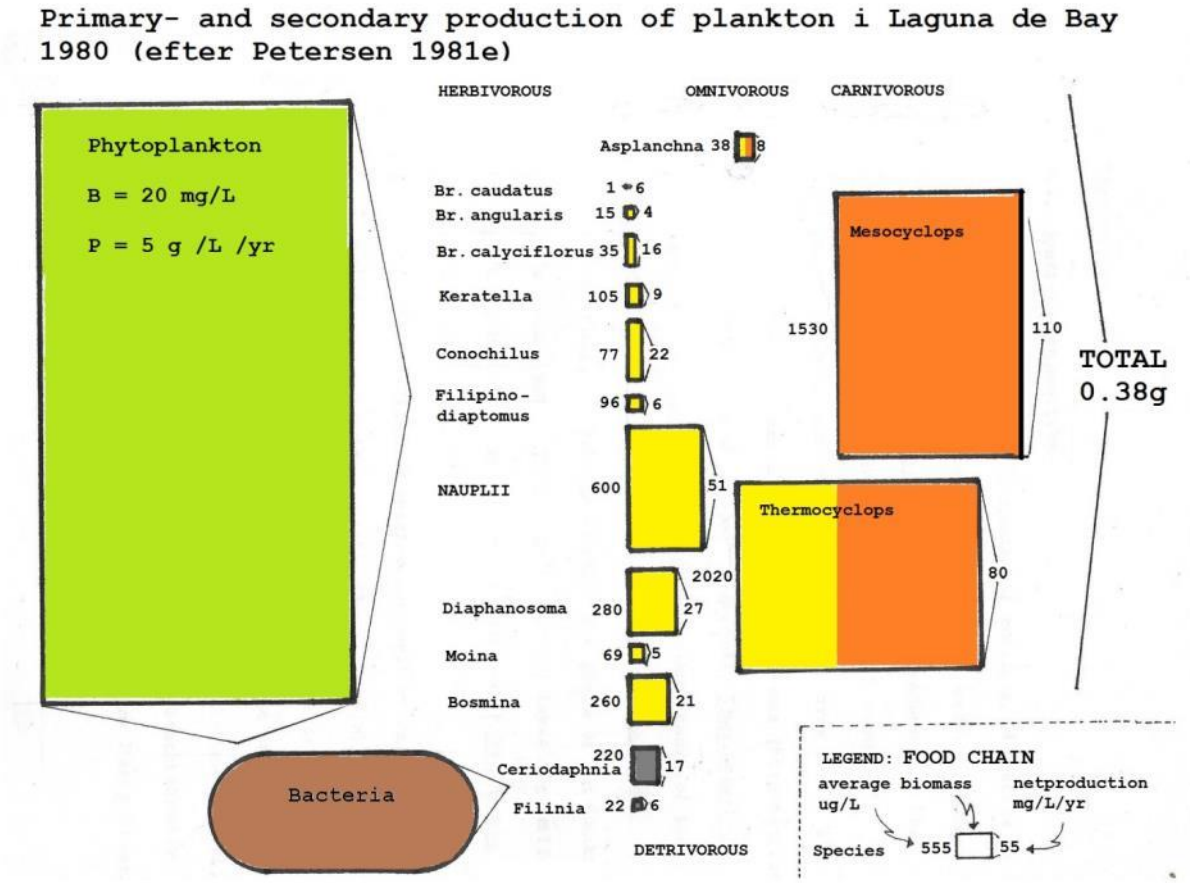
There is no doubt that zooplankton enters the diet of different species and stages of fish, but the role of Cladocerans, Copepods and Rotifers in the food of these fishes is only recently being investigated. (Fernando, 2002a, Papa 2008a, Petersen, 1981e, Richter, H. 2001, Santiago et al., 2004). It is the hope of the author, that this key will help in intensifying the research about this problem, finding the per capita ration of zooplankton (and other animals) necessary for raising a fish to recruitment stage in fishery or to fingerling stage for fish culture, as one of the most important ways of getting more animal protein at less cost.



Fish from Laguna de Bay (covered by water hyacints) 1980

Zooplankton studies of secondary production has been done in Laguna de Bay (Petersen 1981e, Nielsen 1983). These studies were part of ecological investigations including

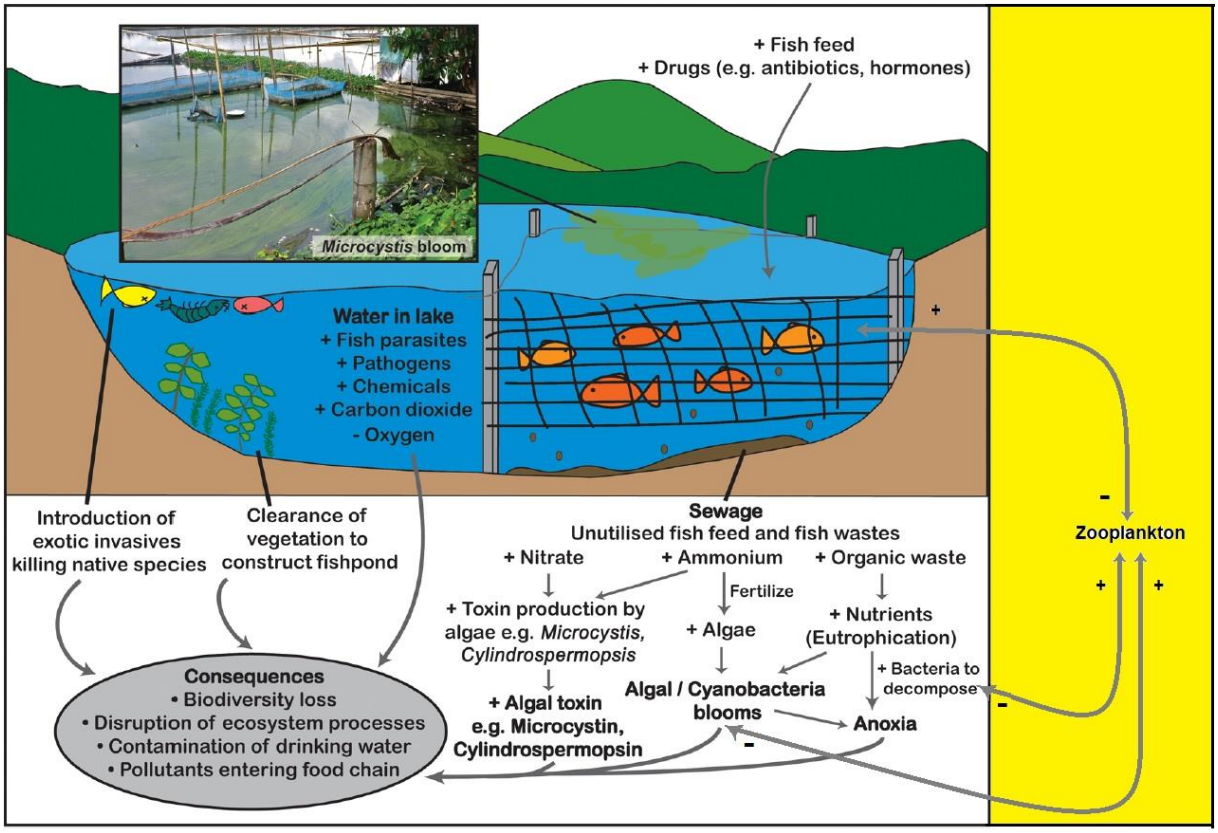
measurement of primary production and important physical and chemical parameters and gave a further insight in the factors determining the fish production, modifying the conclusions from the SOGREAH-report (1974). As pointed out in Nielsen et al. (1981) and Nielsen (1981), the limiting factors for fish production varied between inorganic turbidity (November-May), self-shading (May-August) and phosphorous (not nitrogen as stated in the SOGREA-report (1974)) in September to October. The period of self-shading of phytoplankton, was the period of high primary production, followed by a period of high biomass and secondary production of zooplankton. And a documented maximum in growth rate of Tilapia in fish pens from May to August. The total annual primary production was found to be 5 $g*L^{-1}*yr^{-1}$ (wet weight) giving rise to a secondary production of zooplankton of 0.38 $g*L^{-1}*yr^{-1}$ (Divided by Rotifers: 17 %, Cladocera: 19 % and Copepods: 64 %). To make decisions about sustainable aquaculture management in the Philippine Freshwaters, research projects like these, must be considered in the future.



Example of productivity of plankton in a lake. Here Laguna de Bay 1980. (after Petersen 1981)

To learn about climate and human-induced changes to lake ecosystems it has been suggested to make more systematic monitoring of changes in the zooplankton communities of lakes in the Philippines, since the zooplankton act as the sentinels of the status of the lake ecosystem (Papa and Briones, 2014c).

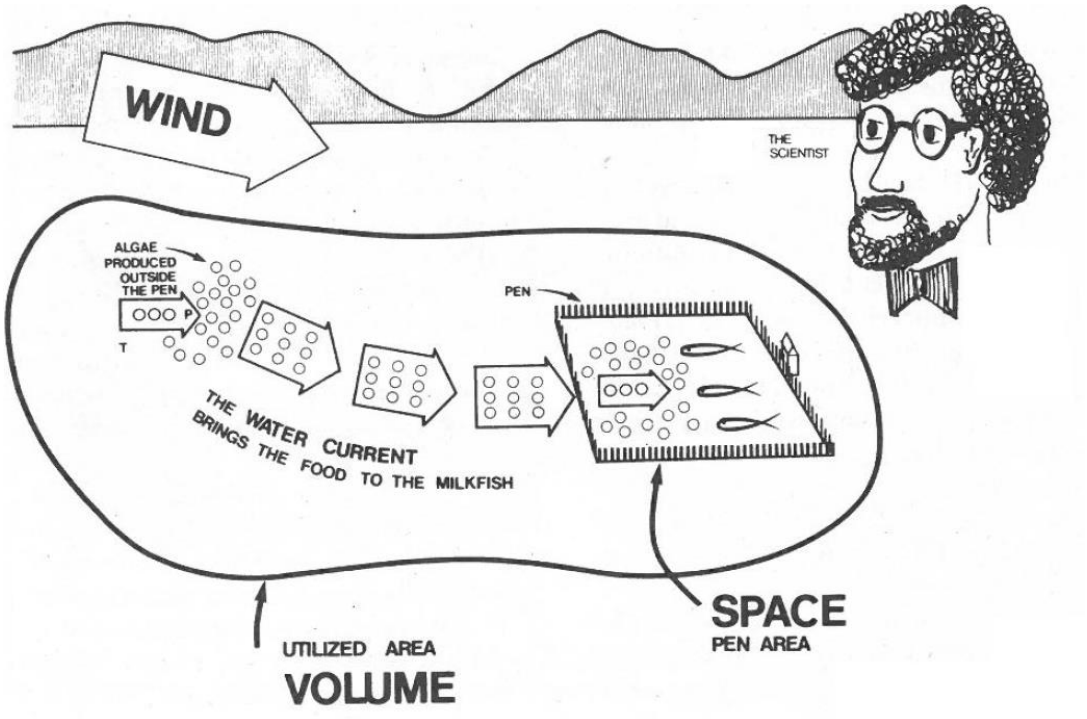
The role of zooplankton in the freshwater environment and the water quality of those freshwater bodies where fish farming has been implemented would be fruitful to study in cases where fish are depending of zooplankton as supplemented food supply. Legaspi et al. (2015b) review the problems of fish farming and call for a more ecologically sustainable lake-based aquaculture, and refer to a study of this kind, including research on zooplankton, which has been done in one of the Seven Lakes (Volcano crater Lakes in and near San Pablo City.) The environments impact of fish farming was shown schematically (Legaspi et al., 2015b), here with zooplankton included in the figure.



Schematic representation of fish farming and its environmental impact, including the role of zooplankton. Modified from Legaspi et al, 2015b.

The main task in zooplankton research in aquaculture might be to find the production of the zooplankton in the total water body. In closed systems, like fish ponds, this will give an estimate of the possible fish production of fish depending of zooplankton food. In open systems, the estimate will be again give an

estimate of the total production in the whole water body. However, the fish pens and cages will have to supplied with food of zooplankton as well as phytoplankton from a volume outside the pen or cage - the utilized area. Therefore, research could avoid a situation seen in the past in the Seven Lakes: A year with high production of fish in one or few fish cages in a lake was followed by a second year with very low fish production in several fish cages. The newly constructed fish cages were placed in the utilized area of the former cages and the fish had to compete of the natural food. In this case the fish cages filled up the utilized volume. Imagine what will happened to the fish production, if the total utilized area/volume was filled up with fish pens on this drawing?



The production in fish pens are depending not only on the food produced or supplemented inside the pen, but also on the primary and secondary production outside the pen. (After Petersen, 1983b)

Systematic studies.

Since the earliest report of a Philippine rotifer zooplankton species (Semper, 1872, 1875), the first publications about systematics of about Philippine freshwater zooplankton species are mainly written in

the German language (Brehm 1933a, 1937, 1938, Kiefer 1928b, 1930a, 1939a, 1939b, Woltereck 1941a) and a few in English (Marsh 1932, Wright 1928a, 1928c, 1937). Woltereck's paper (1941a) is very extensive, including zooplankton as well as records of phytoplankton, mollusks, some macro crustaceans, and fishes from major lakes in the Philippines, together with Hydrobiological notes. Ueno (1966) included further 6 species to the list from his collections in Luzon.



Fishpens in Laguna de Bay 1980

The first comprehensive papers are the studies by Mamaril and Fernando (1978a, b, 1986a) who noted that there are around 125 species of freshwater zooplankton belonging to Rotifera, Cladocera and Copepoda. Of the total, 61 species belong to Rotifera, 49 to Cladocera and 15 to Copepoda. Mamaril's papers mainly describe species collected from the shorelines of the sampling localities. In this way of sampling, primarily species found in ponds and the littoral zone of lakes have been recorded and some pelagic zooplankton species was not included.



Laguna de Bay, Fish pens and Manila Skyline, 2013

Lai, Mamaril and Fernando (1979a) had revised the freshwater calanoid copepods of the Philippines and created a new genus (*Filipinodiaptomus*) for an endemic species of the Philippines. My own studies revealed a few more records for the Philippines through a one-year ecological study of Laguna de Bay, mainly (Petersen 1981e, Petersen and Carlos 1984a).

Korovchinsky (1913) review the research on Cladocera exploration of taxon richness in the Philippines in the following matter: *"A more extensive, though rather routine, investigation was made on the Cladocera of the Philippines, with 49 species recorded by Mamaril and Fernando (1978). This survey was the last for these islands (for cladocerans). The species list published later (Mamaril, 2001), fully repeated the list from the previous publication. Other studies concerned only individual water bodies (Papa et al., 2011, 2012)." The paper by Pascual et al. (1914) implies that research on Cladocera is still going strong.*

The planktonic cyclopoid copepods of the Philippines has recently been studied and revised by Papa and Hołyńska (2013) and Paz et al. (2016b). A new species was found in Lake Siliton (Mindanao) and named *Mesocyclops augusti*, after the Philippine nestor of zooplankton studies: Augustus Mamaril.

Recently the Rotifers have been further studied (Tuyor and Segers, 1999). In a study by Berbano *et al* (2001c) 6 species of Rotifera, 8 species of cladocerans and 6 species of copepods were found in Lake Taal where the *Keratella procurva*, *Diaphanosoma sarsi* and *Eucyclops "serrulatus"* were the most abundant rotifer, cladoceran and copepod, respectively. The literature about Taal Lake has just been reviewed by Papa and Mamaril (2011a) and species composition updated by Papa et al. (2012b). Further the composition, abundance, and distribution in space and in time of the rotifers of Pasig River has been investigated by Papa and his team (Lazo et al, 2009a). Factors as dissolved oxygen, temperature and salinity affected the abundance of the species, among which pollution tolerant and indicator species from *Brachionus (e.g. B. caudatus)*, *Keratella (e.g. K. tropica)* and *Filinia* were among the most common rotifers. The Philippine species of *Diaphanosoma* are investigated and revised by Korovchinsky (1986, 1991, 1998a, 2000a+b)). The mainly marine calanoid copepods of the genus *Pseudodiaptomus* was studied by Walter (1986b) and Walter et al (2006).

Very recently samples of cladocerans collected from 86 freshwater ecosystems in 2006 to 2013 were investigated with modern anatomical techniques revealed of 16 species. Bosminids were mainly collected

from the islands of Luzon and Mindanao, rarely in the Visayans, while Sididae and Chydoridae were distributed throughout the archipelago (Pascual et al. 2014)

Fernando, (1979) writes about the characteristics of tropical zooplankton: "A contrast between temperate and tropical Cladocera, Copepoda and Rotifera zooplankton fauna shows a markedly different size composition and species diversity. There are fewer species, and these are generally smaller in the tropics than in either the North or South Temperate Zones. Larger species of the genera *Daphnia* and *Simocephalus* are relatively rare [or absent] in the tropics, while members of *Eurycercus* and *Saycia* are absent. The genera *Diaphanosoma* and *Moina* substitute these species in the limnetic niche in the tropic waters of the Philippine like Taal Lake (Papa et al., 2012b). Members of the families Holopedidae, Leptodoridae and Polyphemidae increase in abundance toward the temperate regions. Two small cyclopoid copepods are common in tropical zooplankton, while many of the common larger species of other regions are absent or very rare. The chief rotifer components are *Keratella tropica* and species of *Brachionus*. Species of non-indigenous zooplankton like *Brachionus havanaensis* and *Arctodiaptomus dorsalis* have recently been introduced to the Philippine lakes. One factor favoring this introduction of invasive species is the introduction of aquacultures as seen in Laguna de Bay and Lake Taal (Papa et al., 2012b) who states: "As the under-regulated aquaculture practices and the introduction of alien [fish-] species continue in many lakes in the archipelago, more alterations to the native limnetic fauna may occur".

Papa et al. discovered an invasion by the Neotropical *Arctodiaptomus dorsalis* in 18 out of 27 lakes in the archipelago. Further they only found four of the 12 previously recorded native and endemic calanoids in the lakes. This may indicate a displacement by *A. dorsalis* eventually boosted by a general deterioration of water quality of the lakes.



Fishing from shoreline in Laguna de Bay 1980

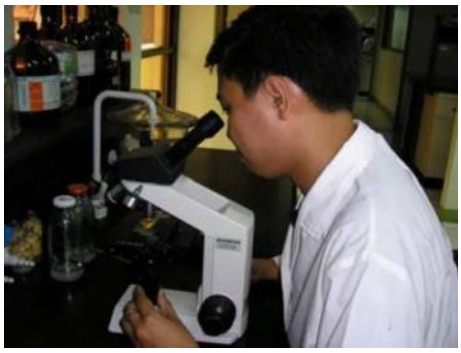


The key

The aim of this work is to give the researcher of the Philippines[6] a key is to overcome one of the main constraints in doing ecological-aquaculture studies of zooplankton in the Philippine freshwaters - the key literature for determination of species.

The key will hopefully be useful in zooplankton studies, which might be planned in ecological and limnological studies in connection with aquaculture. Although primarily a systematic paper, rather it is intended as a handbook of the freshwater zooplankton ecologist and is though included some ecological notes. For further reading se Fernando (2002a).

The key includes information from the published literature to which I have access to (see list of literature) and personal observations about the zooplankton done during own ecological studies in the Philippines, primarily at SEAFDEC BRS in 1979-81 sponsored by the Danish Foreign Ministry, DANIDA-department. The list of species of zooplankton in the Philippines is still expanded with new records for the Philippines. Further research will, without doubt, recover more species to be added to the list. This is said to warn against not being open-minded for the possibility of finding still unknown species of zooplankton for the Philippines. In other words, do not try to fit not described species into the key. Some benthos species may also occasionally be sampled. See Fernando, 2002a for worldwide keys of tropical zooplankton.



Rey Donne S. Papa studying zooplankton in microscope.

[6] Use of the key outside the Philippines shouldn't be done isolated from keys for the local areas (e.g. Jose & Sanalkumar (2012). A good supplement would be Fernando (2002b)

Sampling of zooplankton.

Included in the key are more than 80 species of euzooplankton, holoplankton or true zooplankton adapted to live in the limnetic or pelagic zone (Pelagic zone refers to the free water mass in the sea and in lakes, while limnetic zone refers to lakes only) of the lakes and those littoral forms, which are often found among the euzooplankton as visitors or tychozooplankton.

The recent paper by Papa and Mamaril (2008c): *Methods in Zooplankton Sampling, Ecology and Identification for General Biology Teachers* included this paper; gives a review of the basic methods of sampling zooplankton quantitatively. In ecological studies of zooplankton, a Sedgwick-Rafter counting chamber is necessary, or better (and more expensive) settling chambers used with an inverted microscope. Only if very large species (e.g. Diaphanosoma) are studied, stereo loupe will be sufficient in counting and measurements (Petersen 1983a).



Fishermen in Paoay Lake, 1979

To determine the species, the animals must be studied under microscope. Rotifers should be studied alive. They can be kept alive in a refrigerator for considerable periods of time. Some species, however, can be determined when preserved in 5% formalin (those with stiff shell). The diagnosis of some species is based on the detailed structure of the trophi (jaws). To study the trophi the specimen is irrigated with a dilute sodium hypochlorite under a cover slip on a glass microscope slide. The other tissues are dissolved away and the trophi can be conveniently studied. The cladocerans, which are transparent, can be studied without dissection, while the copepods must be dissected to determine the species. The 5th leg from the adult copepod (male or female) is an important morphological character. The use of the biological reagent “Polyvinyl Lactophenol” colored red with the biological stain Lignin Pink is often used for preparation of short time objects for determination. Se Brandl (2002a) for more information about methodology.

Type collection.

At the University of Santo Thomas, Manila, Rey D. S. Papa at the Research Center for the Natural and Applied Sciences, has established a Zooplankton Reference Collection from the Philippines. He and his students are in a process of collecting from lakes, rivers and other freshwater ecosystems and making systematic, and ecological, studies of the Philippine zooplankton, see UST (2013). The materials from these studies are assembled in a special laboratory for this purpose.



How to analyze the data.

After collection, counting etc. of the zooplankton, the data should be analyzed statistically. Papa et al (2011a) gives example of both simple at more complicated methods of analyzing the data. Here only two simple methods will be mentioned.

$Q_{B/T}$:

Sládeček (1983) found that the ratio between the number of species presents of the genera Brachionus and Trichocerca (i.e. Brachionus: Trichocerca quotient, $Q_{B/T}$) should be considered as an index of trophic levels – since Brachionus species mainly are found in eutrophic waters, while Trichocerca species prefer oligotrophic waters. The lake can thus be regarded as

oligotrophic, when $Q_{B/T} < 1$,
mesotrophic, when $Q_{B/T}$ is between 1—2, and
eutrophic when $Q_{B/T} > 2$. [7]

[7] If no species of *Trichocerca* is found then set the denominator to 1

Papa et al (2011a) found a $Q_{B/T}$ of 7 in Taal Lake in 2008, clearly indicating the lake as eutrophic.

$Q_{Cal/(Cla+Cyc)}$:

Gannon & Stemberger (1978) found that cladocerans and cyclopoid copepods are more abundant (in numbers) in eutrophic lakes, while calanoid copepods dominate oligotrophic lakes.
They found, from studies in the Great Lakes (North America), that a density of calanoid copepods comprises over 50% of the crustacean zooplankton or a ratio calanoids/ (cyclopoid + cladocerans) greater than 1 ($Q_{Cal/(Cla+Cyc)} > 1$) could be correlated with oligotrophy. "But caution must be exercised in establishing one-to-one causal relationships between zooplankton composition and trophic conditions since other factors, especially toxic pollutants, and size-selective predation, may exert considerable influence on changes in the community composition" (Gannon & Stemberger (1978).
Papa et al (2011a) found a $Q_{Cal/(Cla+Cyc)} < 0.5$ in Taal Lake, thus computed to quantify a zooplankton community characteristic for the eutrophic status found of the lake.

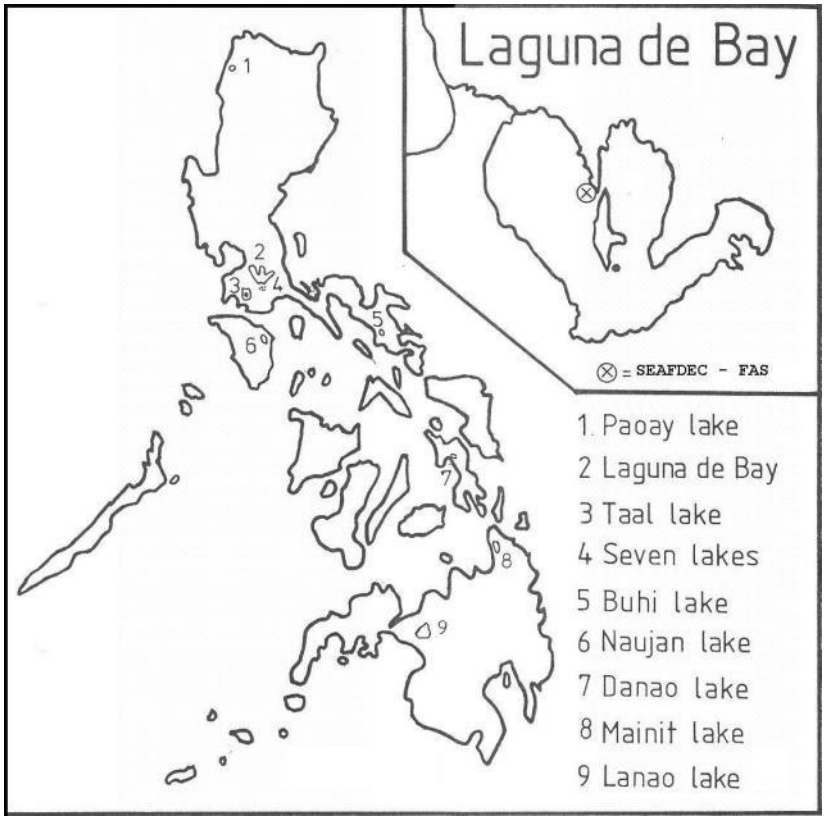
Research results from Laguna de Bay.

In the key is now included some results from the studies in Laguna de Bay (Petersen, 1981e). Graphs of fluctuation in population size, biomass and primary as well as secondary production and some physical-chemical factors are included for some investigated species or systematic groups.

How to use the key.

The presented key is ordinary "two-choose" (dichotomous) - rarely three-choose - key and is arranged, as much as possible, systematically according to the literature. The presented key is ordinary "two-choose" (dichotomous) - rarely three-choose - key and is arranged, as much as possible, systematically according to the literature. The main morphological and some ecological information are included in the key. It must be said that most investigations of the ecology of zooplankton has taken place outside the tropical region and can only be applied tentatively to the Philippine region. Exception is first of all the Lewis' (1979) opus on Lake Lanao zooplankton, a comprehensive analysis of the zooplankton

community of a tropical lake. It is advised as inspiration in the planning of any ecological zooplankton study. Petersen (1981e) estimated secondary productions of all major zooplanktons through one year in Laguna de Bay. Papa et al. (2007a, 2008c) studied in a five-month monitoring of Paoay Lake the impact of blooms of the colonial green algae *Botryococcus braunii* on the Zooplankton of Paoay Lake founding that both the composition and the abundance of zooplankton in Paoay Lake were negatively affected by the occurrence of *B. braunii*.



The localities of occurrence are primarily only mentioned for major lakes of the 59-70 Philippine lakes (Papa and Mamaril, 2011a). A figure of the location of some major Philippine freshwater lakes is modified from (1984a):

More information can be found in the literature (Woltereck 1941a, Mamaril and Fernando 1978b). The illustrations, following the key, are from two sources: Firstly, by copying from the literature by simple tracing technique (Flössner 1972, Kiefer 1978, Mamaril 1978a, Pontin 1978c, Ruttner-Kolisko 1972 (R-K)) and secondly from the original drawings by the author (1980, marked FP_{80}). The black bars in the illustrations equal 100 microns or 100 µm or 0.1 mm if no other measure is noted. Most of the original drawings are copied in the same scale to give the "beginner" in zooplankton studies a good chance to recognize the species and compare the dimensions relatively to the other species found in the samples. In some figures preserved specimens are included to show how they appear in fixed condition (e.g. 76a) and some are shown at different angles as might be observed in the counting chambers. Finally, some photos are added to the key to give a more visual impression of the animal as seen in the microscope. These photos are all original photos.

The numbers in the key (la, lb, 2a, 2b, etc.) correspond to the numbers in the illustrations. The key and the illustrations, therefore, can be crosschecked together.

The literature quoted in the key (after the species name) is given only as the year of publication. To find the reference it is necessary to find the author name in the chronological list of literature, and there upon enter the alphabetical list of literature.



Laguna de Bay: Tapao Point an Talim Island between Central (left) and West Bay 1979

The index gives key and illustration numbers for all species and groups. It must be noted that information about a species also can be found in the key for the genera. The Internet can often give further information about the species – use the **scientific name** as **key words** for the search.



From left: Me handing over my final report about the zooplankton production in Laguna de Bay, Joy Ferriols-Pavico, Station head Dr. Santiago, Jr., and Mr. Andy Santiago (M.S.), head of the Ecology Team.

Acknowledgements

The Binangonan Freshwater Research Station (SEAFDEC) at Tapao Point, Binangonan, Rizal, has given me a good opportunity to study the zooplankton populations in Laguna de Bay and other lakes (se 1984a) and made me realize the importance of zooplankton studies in aquaculture research.

Thanks to Dr. Santiago, Jr. (Former chief of SEAFDEC Aquaculture Department) for full-hearted support and to Mr. Andy Santiago (M.S.) for organization of the ecological/limnological teamwork, Joy Ferriols-Pavico, who was a part of the ecological chemistry team, and who I had the pleasure to meet again in Denmark in May 2017. A special thanks to Late Mr. Manuel Carlos for being a patient and inspiring counterpart, I sent my thoughts to his widow, Vergie Celebre Carlos. Mr. H. Segers (Belgium) for personal correspondence about the Philippine rotifers.

Further thanks to following persons being involved in different ways of the publishing of the key: Late Dr. J. B. Pantastico (SEAFDEC), Director Roger S. V. Pullin (ICLARM), Rey Donne S. Papa (University of Santo Tomas), Hanne Kamstrup my spouse, Mr. B. H. Nielsen (Denmark), Ole P. Udvang (Norway). This edition has not been, if not for the interest, discussions, and comments from Rey

Donne S. Papa (MS), a leading researcher in Philippine zooplankton, with a wide international network and being mentor for a new generation of zooplankton researchers. Finally, a very special thanks to Professor A. Mamaril (University of the Philippines) for reviewing the manuscript of the 1st edition of the key and for giving many good and professional advices and suggestions. This work would not be without his great expertise on what he calls "the little beasts" of the Philippine Lakes. They are lovely.



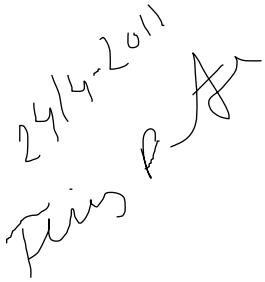
Augustus Mamaril, Sr.



Rey Donne S. Papa – 2008



Flemming Petersen 1979



Flemming Petersen
Denmark, 2014

2. Book Review

(Permission to include this book review in key is still awaited to be granted by A. Mamaril).

Augustus C. Mamaril, Associate Professor; M.S. The Institute of Biology of the University of the Philippines in Diliman, wrote following about the first version of the key (1981, before the present updating):

"A professor at the University of Waterloo[8] in Ontario, Canada, once remarked, "To study zooplankton, one must have a great capacity to get bored". That classic statement would most likely apply to aquatic biologists who attempt to do taxonomic studies of these little beasts.

"An Illustrated Key to the Philippine Freshwater Zooplankton" (1981) aims to fill in remaining gaps in Philippine zooplankton identification and perhaps to make available to those who have anything to do with freshwater zooplankton a key to identification. The provision of line drawings facilitates the use of the key, many of which were adapted from various sources and the rest done by FP. Unlike most keys (e.g., Edmondson 1959) and monographs (Bylov 1948; Dussart 1967, 1969), this work is blessed with a liberal dose of illustrations that include those of external morphological variations of several species, especially rotifers (brachionids, in particular). These variations were reported in the literature the author has had access to. The section on literature cited includes several of the significant and relevant works on Philippine freshwater zooplankton. Overall, this present work should serve the purpose for which it is intended, i.e., as a ready reference to the identification of freshwater zooplankton.
Already there seems to be an undercurrent of interest in zooplankton, including marine species. The present work cannot but help stir up more studies in Philippine waters. True, computer technology has made inroads into zooplankton identification and counting. In the final analysis, however, what a zooplanktonologist needs is a reliable and complete key. And, with the risk of being redundant, a great capacity to get bored. Mills (1981) summed it up: Those exciting little aquatic animals living at low Reynolds numbers deserve no less.

Augustus Mamaril
(17 August 1983)

[8] *The UW biology department has nurtured the likes of HBN Hynes (Ecology of Running Waters, Biology of Polluted Waters), C.H. Fernando, A.D. Harrison, and N.K. Kaushik)."

3. Methods in Zooplankton Sampling, Ecology, and Identification for General Biology Teachers.

by Rey Donne S. Papa and Augustus C. Mamaril. The Philippine BIOTA Vol. XLI No. 1 March 2008

ABSTRACT - Zooplankton studies may help students appreciate and better understand the role of these small organisms to the over-all health of aquatic environments and the inter-relationship of these organisms to those below and above it in the food web. This paper enumerates the techniques and methodologies which may be used by a biology teacher to help them and their students conduct proper techniques in 1) sampling zooplankton in the field, and 2) processing and analysis in the laboratory. This would make for a good outdoor and indoor laboratory activity in aquatic ecology classes.

Permission to include this book review in key is still waiting to be granted by Rey Donna S. Papa and A. Mamaril.
Instead I'm writing on a synopses of the methods I have used in achiving the results from the Laguna de Bay research included in this edition of the key, to be published as soon as possible.

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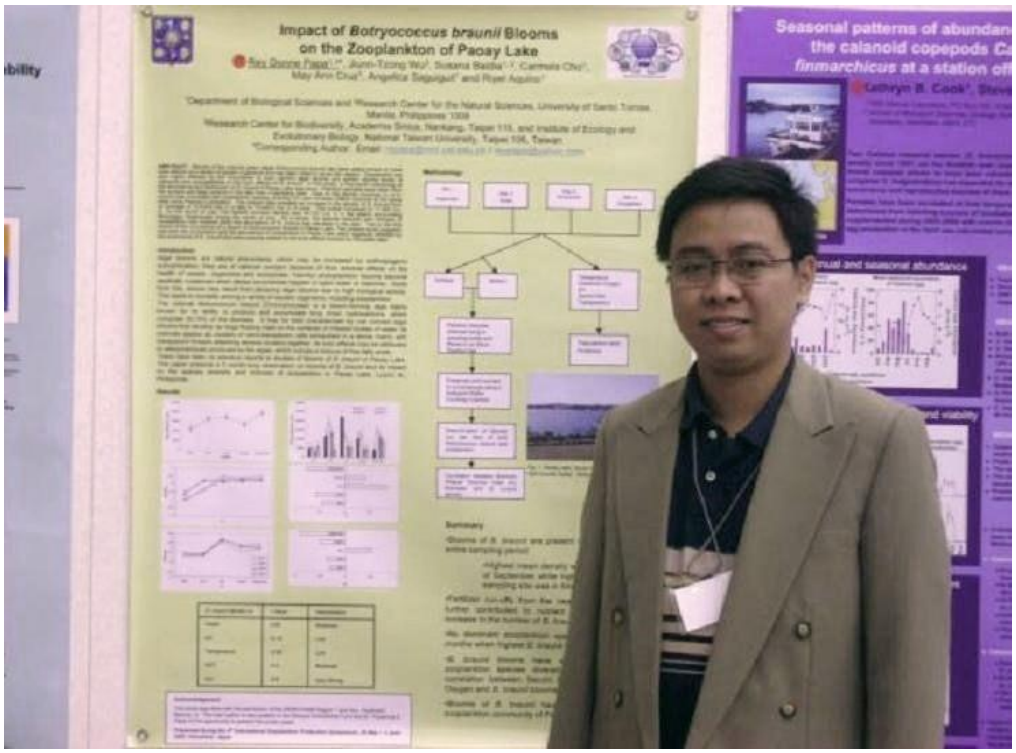
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Rey Donna Papa poster lecturing. 2008



Figure 1. After 6 years of virtual connection a F2F meeting between the author and Rey, was materialized in February 2013

4. An Illustrated Key to the Philippine Freshwater Zooplankton.

Back to content

1 a. Unicellular animal:

PROTOZOA, Protozoan (phylum);

Occur often in zooplankton, but are usually unrecorded, except from species with shells and other robust outer cover, which remain recognizable in preserved material. In Lake Mainit protozoans comprised 15-50 % of the total zooplankton biomass (Lewis, 1973). In Lake Lanao Lewis (1985) recorded an average of 1900 individual of protozoan per cm^3, corresponding to a volume of 260,000 μ^3/cm^3. Very small flagellates, dominating the larger flagellates, ciliates, and amoeboid forms, accounted for over 75% of individuals and of biomass.

Table 1. Average standing stock of protozans in Lake Lanao (1970–71) and Lake Valencia (1977–78).

Lewis (1985)	Number		Volume	
	indiv. per cc	%	$\mu m^3/cc$	%
Lake Lanao				
Small Flagellates	1763	92	212,000	81
Large Flagellates	120	6	40,000	15
Ciliates & Amoeboid Forms	28	2	9,000	4
Total Protozoa	1912	100	261,000	100
Lake Valencia				
Small Flagellates	18	5	2,000	2
Large Flagellates	4	1	2,000	2
Ciliates	218	62	98,000	90
Amoeboid Forms	111	32	7,000	6
Total Protozoa	351	100	109,000	100

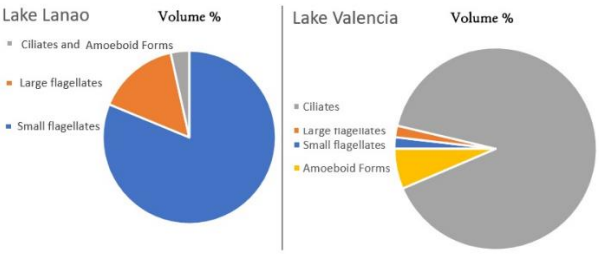
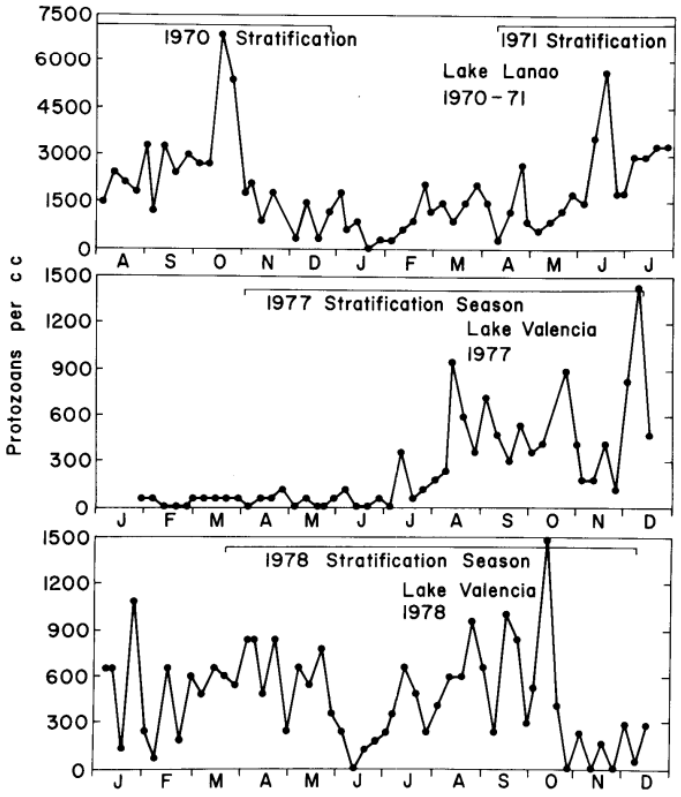


Diagram after data from Lewis (1985)

The protozoans mainly feed on bacteria in Lake Lanao, and thus constitute a link between the bacteria and the macro zooplankton. Their role in phytoplankton mortality was only small and the total consumption of phytoplankton by all protozoans did probably not exceed 15 % of the daily standing stock.



Abundance patterns of protozoans in the euphotic zone of Lake Lanao and Lake Valencia. From Lewis (1985)

The protozoans play an important role in the microbiological food web.

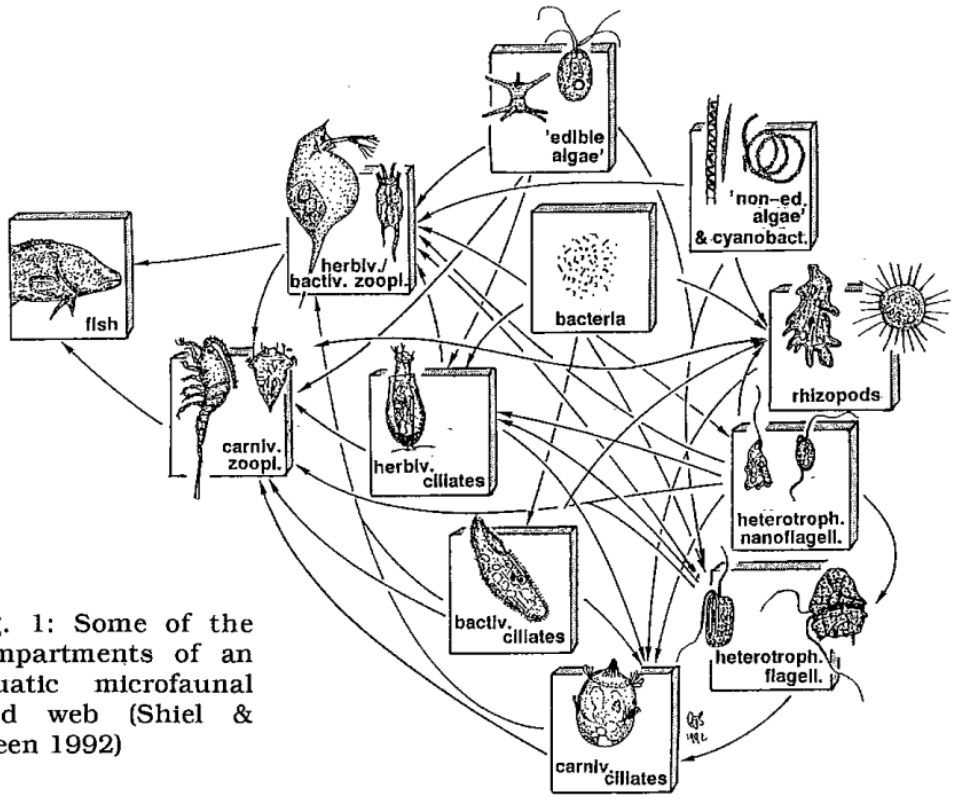


Fig. 1: Some of the compartments of an aquatic microfaunal food web (Shiel & Green 1992)

From Shiel, R. J. (1995))

SARCOMASTIGOTA (subkingdom)

AMOEBOZOA (phylum)

RHIZOPODA (class);

[1985]

TESTACEA, testacean rhizopods (subclass).

Characterized by having a shell: ARCELLIDAE (e.g. *Arcella*), CENTROPYXIDAE (e.g. *Centropix*), DIFFLUGIIDAE (e.g. *Difflugia*) (families). (Fig. 1a is test shells as seen in the counting chamber - FP_{80})



Arcella, dorsal view. From Laguna de Bay



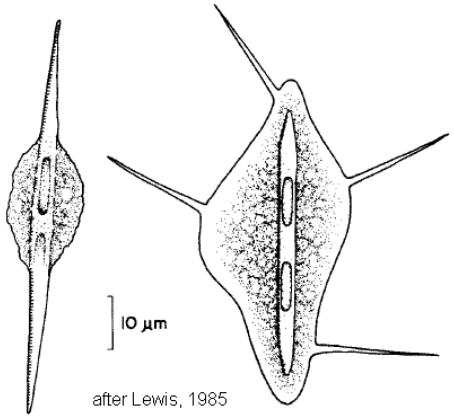
Difflugia from Laguna de Bay



Centropix, dorsal view. From Laguna de Bay

SHELLLESS RHIZOPODA

See Smirnov, A.V. (1999 and http://amoeba.ifmo.ru/guide.htm (Visited December 2014) for morphotyping **naked amoebae.** Can be found up to 100.000 individuals/L, in freshwater and seawater. Some species are infectious on fish (e.g. gills.). Lewis (1985) found direct evidence on predation on diatoms by amoeboid protozoans in Lake Lanao.



Amoeboid protozoans feeding on diatoms

Lewis (1985)

BICILIATA (subkingdom)

HELIOZOA. Sun animalcules. (Phylum)

Roughly spherical amoeboid with many stiff, microtubule-supported projections called axopods radiating outward from the cell surface. (Cited after Wikipedia). *Actinophrys sol* EHRENBERG is a common species among water plants and in zooplankton in South-East Asia.

ALVEOLATA (subkingdom)

CILIATA, CILIOPHORA, Ciliates (phylum):

Size 20-500 µm. Lewis [1985] found ciliate dominating the picoplankton (protozoans) in Lake Valencia.
Esquivel et al. (2016) found the ciliates to be an important factor of tropical microbial webs because of their role as dominant picoplankton grazers which channel picoplankton production into the uppermost part of the food web.
Plankton ciliates have been found to play an important role in the survival of fish larvae in a eutrophic tropical Mexican lake, since ciliates acted as prey for the first-feeding fish larvae of the species that sustained the local fishers.

OLIGOHYMENOPHOREA (class).

PENICULIDA (order).

e.g. *Paramecium* O.F. Müller, 1773.

SESSILIDA (order)

e.g. *Vorticella*, "Bell-animal". Often

attached to freshwater crustacean.

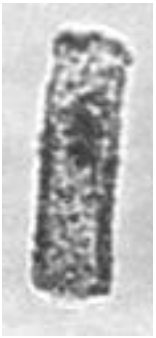
SPIROTRICHEA (class)

TINTINNIDA (order)

Tintinnida etc.

From less than 1 to 300 individuals/mL in plankton. Food: mainly bacteria. Ciliates tend to be benthic or epiphytic, although some can be found in large numbers in the plankton. (Richter, H. 2001)

- Laguna de Bay



Tintinnidae from Laguna de Bay

EXCAVATA (subkingdom), True flagellates,

Loukozoa (phylum), *Percolozoa* (phylum), *Euglenozoa* (phylum)

Other hetero- and mixotroph nanoflagellate orders (from Hansen et al., 1992):

"Zoomastigophora":

Choanoflagellida, "collar-animals" (order),

e.g. Acanthoecidae

Bicoecida (order),

Kinetoplastida (order),

"Phytomastigophora" – forms without chloroplast:

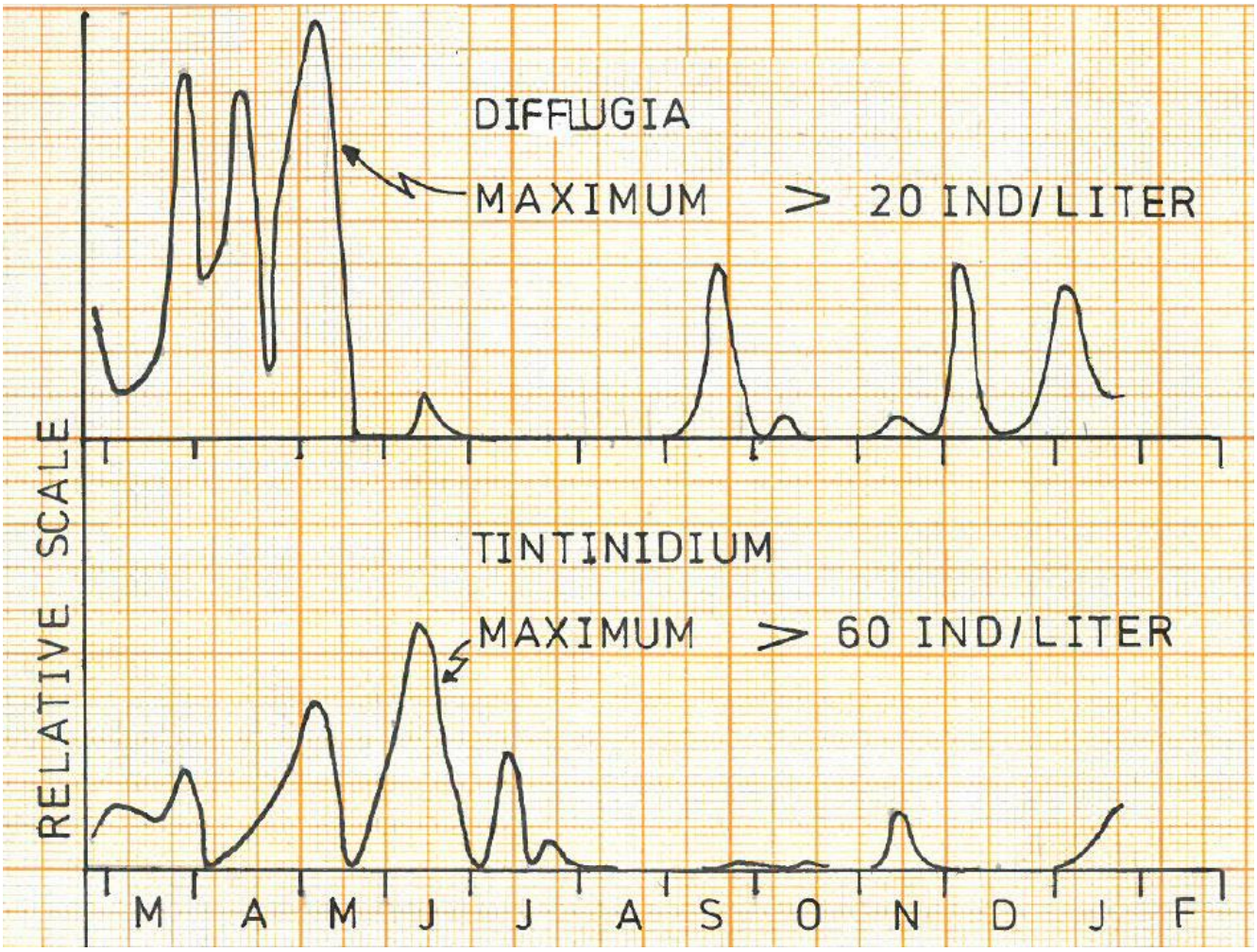
Euglenida (order),

e.g. Euglenophyceae

Chrysomonadida(order),

e.g. Chrysophyceae

Cryptomonadida (order),
e.g. Chryptophyceae
Prymnesiida (order).
Lewis divided flagellates into small (< 10 µm) and large flagellates (>/= 10 µm).
[Lewis, 1973, 1985]



***Difflugia and Tintinidium.* population size fluctuations in Laguna de Bay in 1980.**
(Petersen, 1981e).

1 b. Multicellular animals, METAZOA, Metazoans.....2

2 a. Body with radial symmetry:

COELENTERATA or **CNIDARIA** (phylum);

HYDROZOA (class)

Craspedacusta, Freshwater medusae

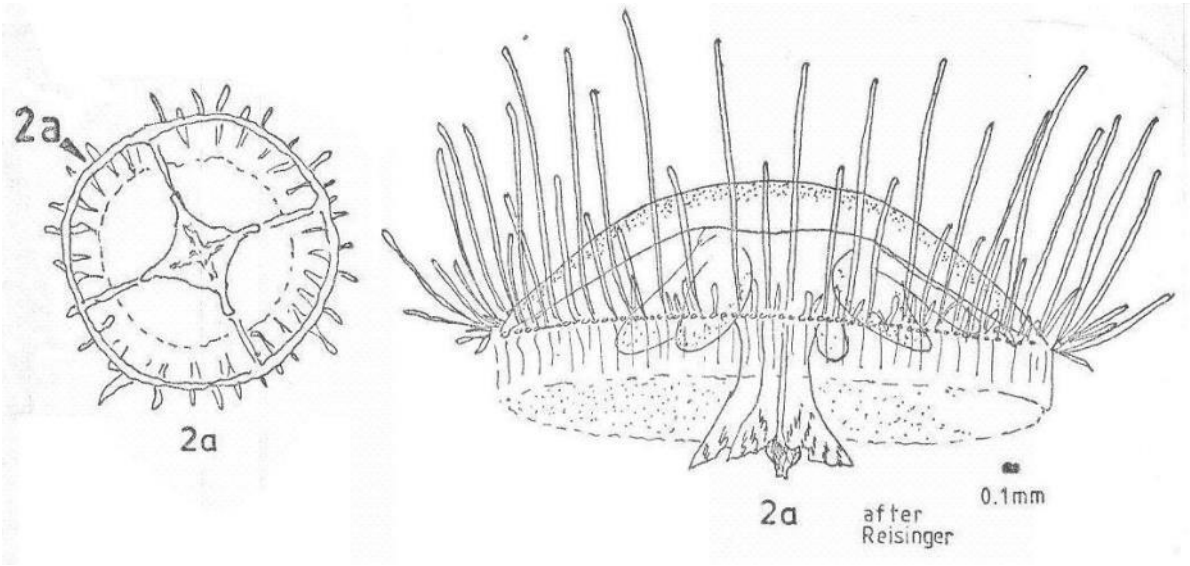
With small solitary polyps and free-swimming medusae. In freshwater. Size 20000 µm (20 mm). Food of polyp and medusae: *Asplanchna*, copepods. Although no recent records are known, it might still be found (Terry L. Peard, Ph.D. personal communication).

Se lifecycle from (http://www.jellyfish.iup.edu/).

Craspedacusta sowerbyi, (LANKESTER)

(syn. ***Craspedacusta sowerbii***)

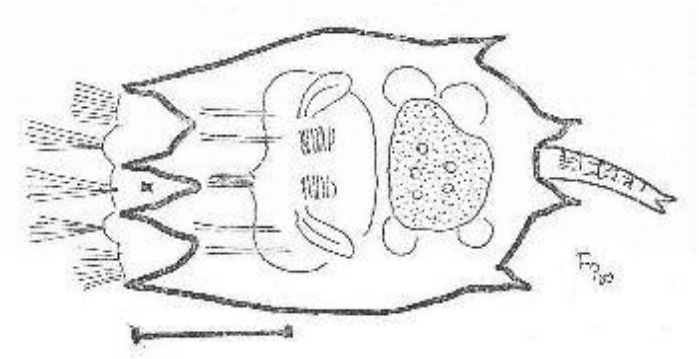
[Roxas 1936, in Reisinger 1972]



2 b. Body with bilateral symmetry.....3

3 a. Small animals with ciliated crown or Wheel organ (corona). Body without segments. No legs present, with or without tail like foot. Suspension feeding via coronal cilia. Food: Bacteria, algae, detritus. Planktonic or benthic:

ROTIFERA, Rotifers or Wheel animalcules (phylum).....7



3 b. Body external segmented (with metamery), with legs:

ARTHROPODA, Arthropods (phylum).....4

3 c. Body internal segmented.

VERTEBRATA, CUVIER, 1812, vertebrates (subphylum).

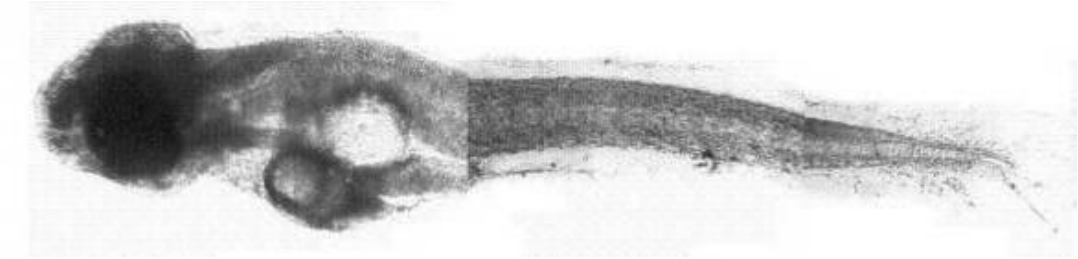
Without legs. Tail and fins present.....

OSTEICHTHYES, HUXLEY, 1880, Bony fishes (class).

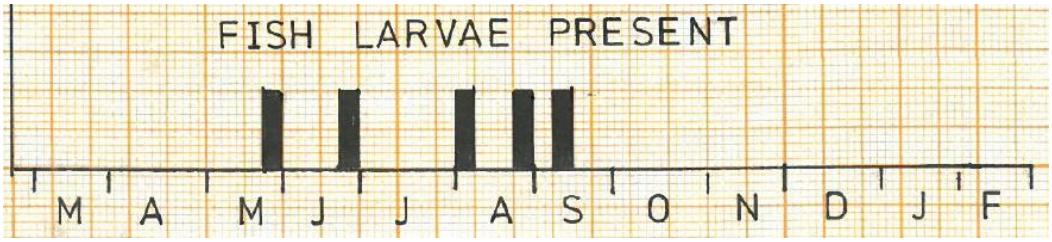
Most freshwater fish larvae are feeding on zooplankton and might therefore be found in zooplankton samples.

See "Fish base" for information about species and keys: http://www.fishbase.org/search.php (Visited December 2014)

Found in few specimens in the period with high primary production in Laguna de Bay in 1980.

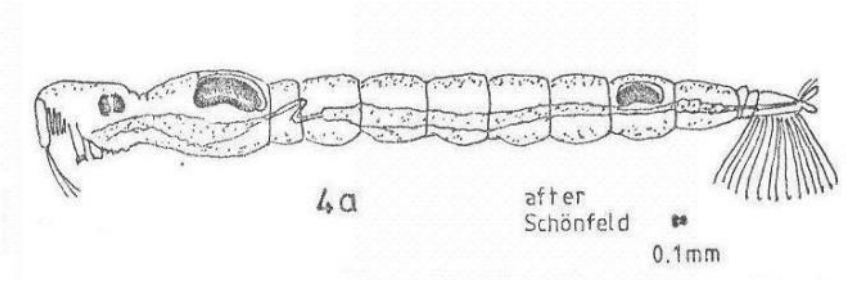


Fish larvae from Laguna de Bay (3 pictures)



***Fish larvae* present in Laguna de Bay in 1980. (Petersen, 1981e).**

4 a. Without jointed legs, transparent larvae, except for the black air sacs, of which one pair lies in thorax and one pair lies near the end of abdomen. As figure 4a.
INSECTA, (here only some LARVAE), Insect (Class)
(Adult insects has, of course, 6 legs)
DIPTERA (LARVAE), True flies (order)



CHAOBORUS (syn. *Corethra*), Phantom midge-larvae, Lake-fly.
Third and fourth larval instars planktonic during night, benthic during day. With vertical migration. Food: zooplankton and midge-larvae (Chironomids). In Lake Lanao *Chaoborus* is responsible for the major mortality of its pry (*Thermocyclops*,

Tropodiaptomus, Diaphanosoma, Moina, Bosmina and *Keratella*).
Also used for making Lake-fly cake. In lakes.
- Lake Lanao (C. sp. = Ekstein 1)

Chaoborus manilensis, (SHINER)

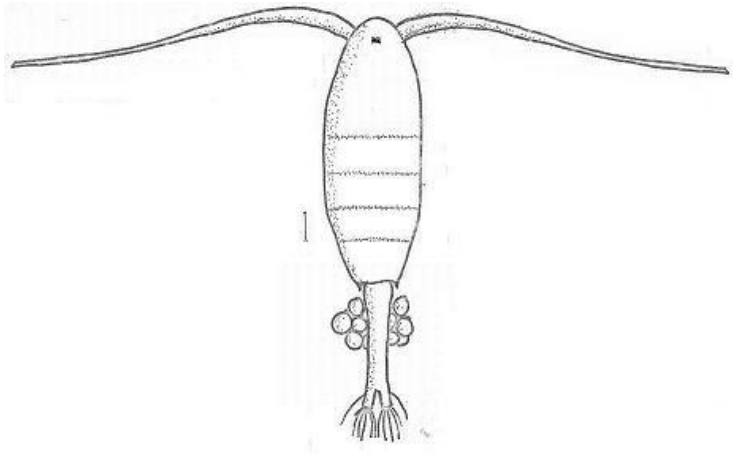
[Senior-White, 1923, 1969, Lewis 1977, 1979b]

4 b. With legs.

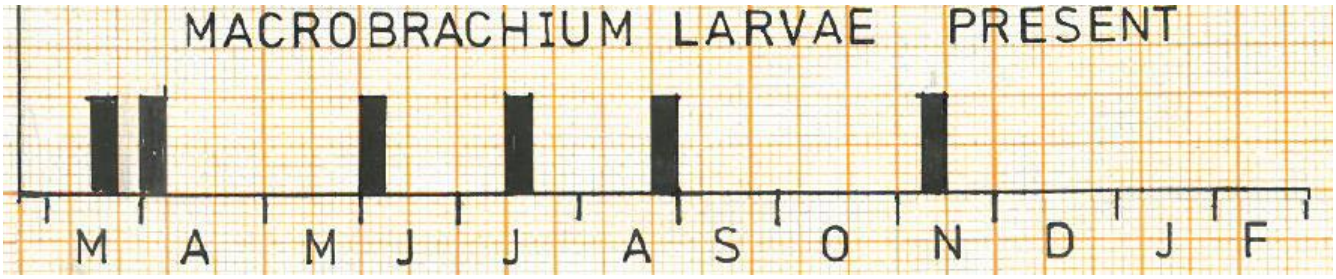
CRUSTACEA, Crustaceans (subphylum/class).....5

5 a. Without a shell-like covering of the body, with up to five pairs of 2-branched swimming legs (might have a 6th rudimentary pair of leg). Abdomen without appendages. Size 100-2000 µm. Filtratory and/or raptorial. Food: Algae, detritus, and zooplankton.

COPEPODA, Copepods (subclass).....100



Larvae of the decapodan crustacean, *Macrobrachium*, was found in Laguna de Bay in zooplankton samples in 1980.



***Macrobrachium* present in Laguna de Bay in zooplankton samples in 1980. (Petersen, 1981e).**

5 b. With a shell-like covering, which may or may not entirely cover the body.....6

6 a. Bivalve shell enclosing the entire body. Body not distinctly segmented. Legs not leaf-like. Size 100-1000 µm. Planktonic species, omnivorous, feeding on algae and detritus. (Fig. 6a: anatomy of ostracods and sample from Laguna de Bay).

OSTRACODA, Mussel shrimps (class).
Only few records. Victor (2002a) gives a key to 17 genera likely to occur in Western tropical freshwaters. Following has now intention to be complete overview of the Philippine mussel shrimps:

CYPRIDIDAE, BAIRD 1845 (family)
STRANDESIA, VAVRA, 1895.

- Lake Lanao, rice fields.
Strandesia wolterecki, TRESSLER 1937.
(syn. *Strandesia chondropherusa* Rome, 1965)
(syn. *Strandesia regularis* Rome, 1962)

[1937d, 1981a, 1981b, 2005b(key)]

- Ponds in Bocolod Chico, Mindanao.

Strandesia wierzejskii (Grochmalicki, 1915)

[1981a]

Other species of Strandesia found in the Philippines:

Strandesia calapanensis Tressler, 1937

Strandesia complexa Victor and Fernando, 1982

Strandesia sexpunctata Klie, 1932

Strandesia purpurascens (Brady, 1886),

(see 1981a, 2005b(key))

STENOCYPRIS, SARS 189

Carapace elliptical shape. Furca with asymmetric ramus, serrate in distal part, left ramus shorter than right. Distal seta long, proximal seta absent (Dang, 2015).

Endemic species in

- Laguna de Bay

Stenocypris derupta VAVRA

[1981e, 2002a]

CYPRIA, ZENKER 1854

Adapted for benthic life, but frequently appearing in plankton collections

- Mindanao

Cypria (Cypris) spinifera, TRESSLER, 1937

[1981a, 2002a]

EUCYPRIS Planktonic genus.

Endemic species.

- Laguna de Bay [type locality].

Eucypris bayensis, TRESSLER, 1937

and

- Roadside ditch on Camaguin Island, 1932 [type locality].

Eucypris orca, TRESSLER, 1937

[1941a, 1981a,b]

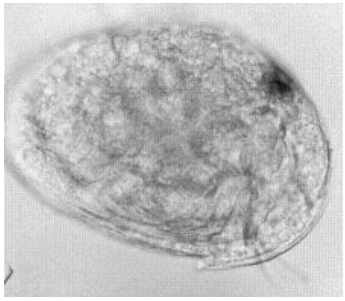
HETEROCYPRIS, CLAUS 1892.

Dominating the invertebrate fauna together with *Eucyclops serrulatus* in IRRI (International Rice Research Institute, Los Baños, and Luzon. In wetland rice fields it has a limiting effect of grazing on Inoculation of non-indigenous Blue Green Algae strains was establishment, but other factors were involved.

- Rice field floodwater, IRRI.

Heterocypris luzonensis Neale, 1981.

[1981d, 1998b]

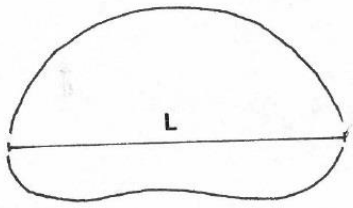


Ostracod (Heterocypris?) from Laguna de Bay

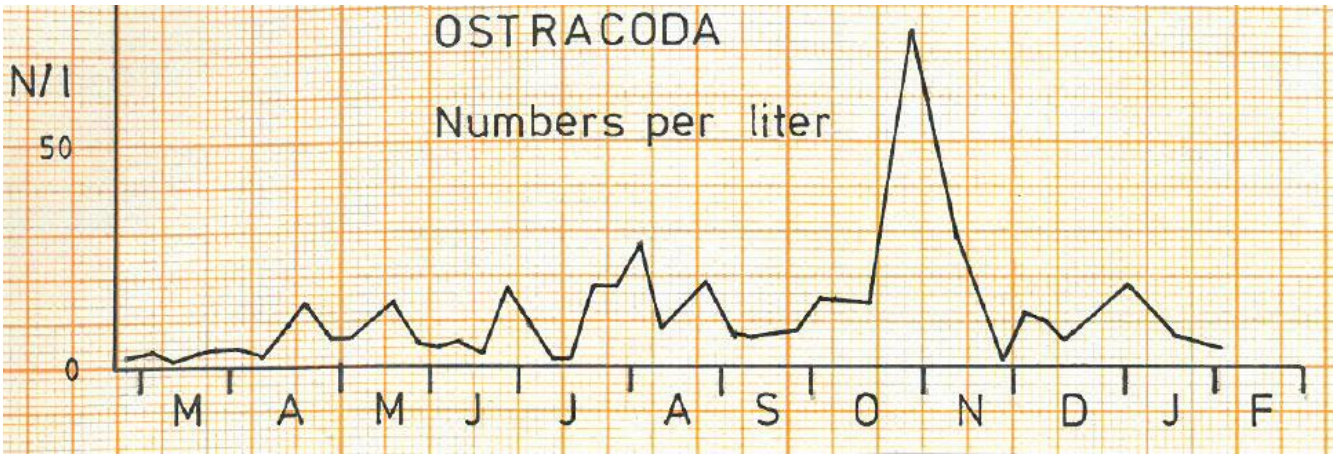
LENGTH-WEIGHT-RELATIONSHIP FOR OSTRACODA (WET WEIGHT)

FORMULA USED: $W = 2.7 \times 10^{-6} \times L^{2.48}$ (W = wet weight in ug, L = length in um)

Length	Weight
100	0.25
110	0.31
120	0.39
130	0.47
140	0.57
150	0.67
160	0.79
170	0.91
180	1.05
190	1.20
200	1.37
220	1.73
240	2.10
260	2.60
280	3.10
300	3.70
320	4.40
340	5.10
360	5.90
380	6.70
400	7.60
420	8.60

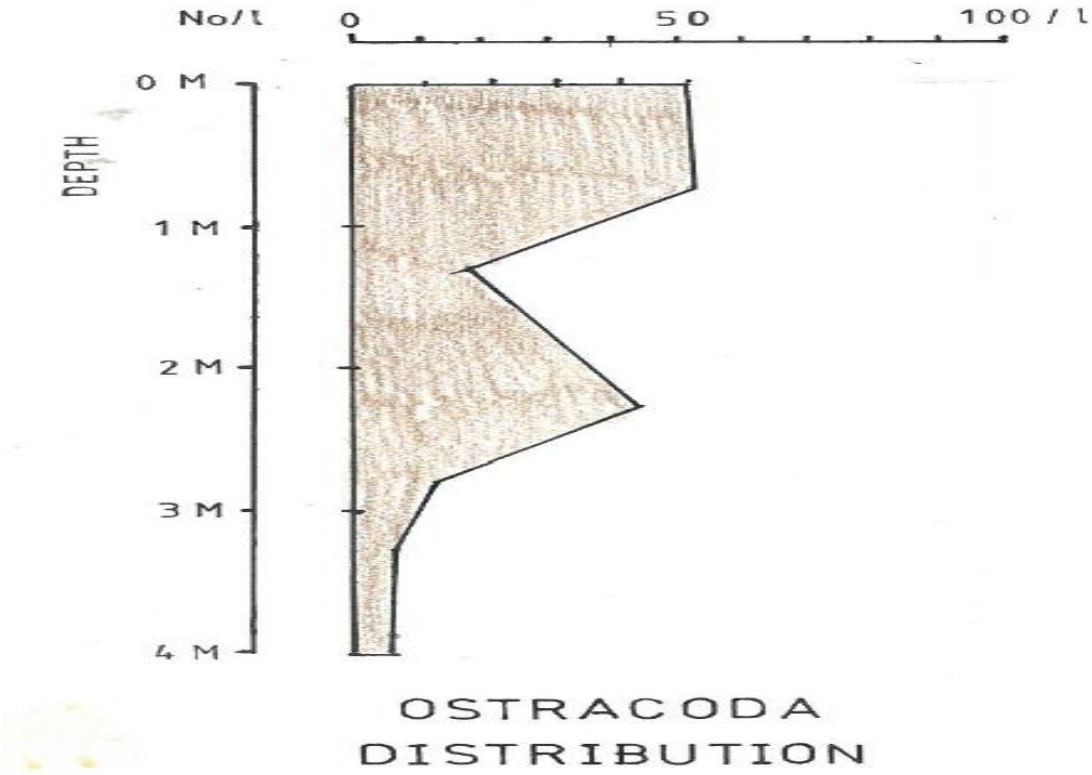


Ostracoda spp. **Was sampeled all months in 1980 in Laguna de Bay. Se graph below.**



Ostracoda spp. **population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

The vertical distribution ostracods in Laguna de Bay in July 23th 1980 was found to be in the upper part of the water column at the 4 m deep sampling station. Se the following graph.



Vertical distribution of *ostracoda* at Central bay sampling station in Laguna de Bay , July 23th in 1980. (Petersen, 1981e).

6 b. Bivalved shell (carapace) covers the body but leaves the head free. Legs leaf-like. Size 200-1500 µm. Filtrators, with filter setae on the legs. Food: Algae, bacteria and detritus.

BRANCHIOPODA, Branchiopods (subclass).

CLADOCERA, Water fleas (order)

(Tagalog: Kutung tubig).....78

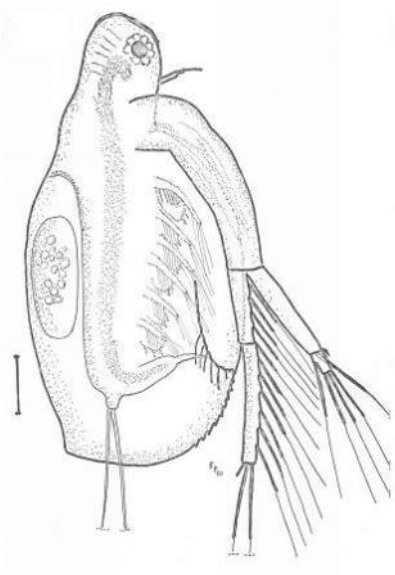


Table: Characteristics of the main groups of freshwater zooplankton. Excerpt mainly after Brandl (2002a)			
	Rotatoria	**Cladocera**	**Copepoda**
Reproduction mode	Parthenogenetic (mostly)	Parthenogenetic (mostly)	Sexual
Typical adult length µm	200 - 600	200-1500	100-2000
Food size µm	1 -20	1 - 50	5 - 100
Mode of feeding	Suspension feeding via coronal cilia	Filtratory feeding via thoracic appendages	Filtratory and/or raptorial
Susceptibility to fish predators	Very low	High	Low
Susceptibility to invertebrate predators	Low	Moderate	Moderate to high

6 c. Other groups of animals that can be found as cosmopolitans in tropical freshwater zooplankton samples are only mentioned briefly, See Fernando (2002a) for further details. The most important are:

Bryozoans or **Ectoprocts**: (e.g. *Plumatella philippinensis* KRAEPELIN, 1887, Freshwater Philippines, as floato-blasts). http://www.nhm.ac.uk/hosted_sites/iba/bryozoa_home_page/phylactolaemata/plumatellidae/plumatella.html (Visited May 2007)

Gastrotricha, Freshwater aschelminths: (e.g. *Chaetonotus*, in shallow ponds).

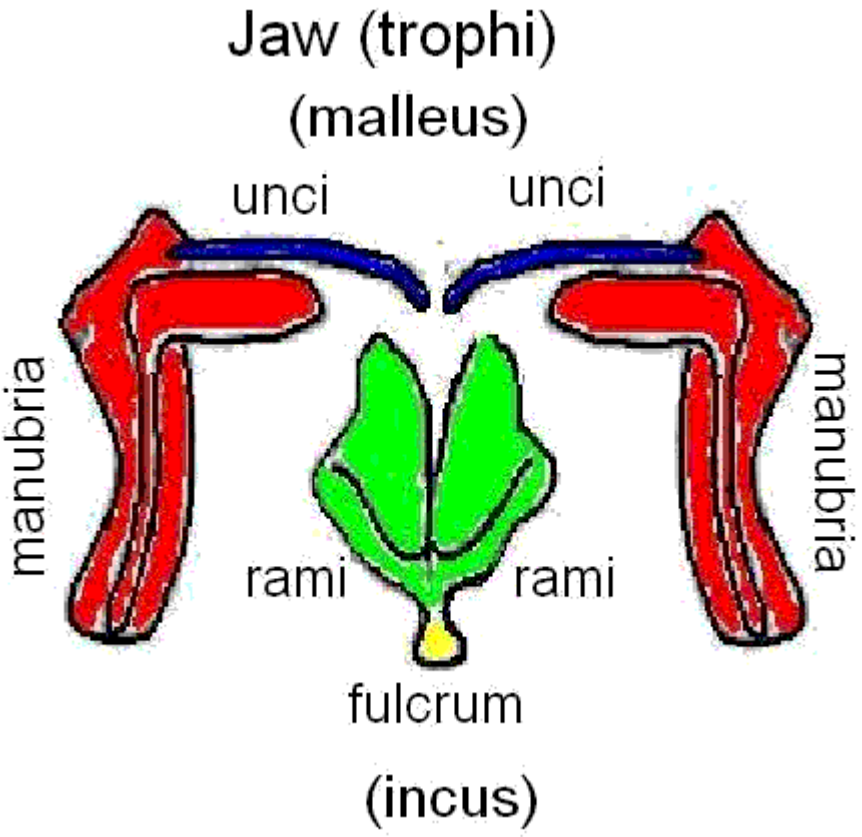
Neorhapdocoela: Turbellaria flatworms or Platyhelminthes: (e.g. *Mesostomum*).

Hydrocarina, Water mites, (Arthropoda): (e.g. *Limnesia*).

Mollusca: Bivalve Mollusks: gill lice (mussel glochidia – larvae able to attach to skin or gills of fish) (*Cristaria plicata* (LEACH, 1814). Very rare, in zooplankton samples in post-parasitic stage. Invasive in the Philippines. - Luzon, fishponds. Cagauan (2006)).

ROTIFERA, Rotifers or Wheel animalcules (phylum)

Wormlike animals. No legs present. With or without tail like foot. With anterior wheel organ, corona, which bears a usually double ciliated ring, the "cingulum" and the "trochus".
This serves both for progression and for bringing up food.



The jaw (trophi) is situated in the mastax and consists of five sets of elements: An unpaired median **fulcrum** (yellow) connects two **rami** (green) at their joint. The rami are hollow, triangular structures. Fulcrum and rami are joined in a functional unit, the incus. The **unci** (blue) are plates formed by connection of a variable number of teeth into one rigid structure. The teeth are mostly unequal, with the ventral ones the largest. The **manubria** (red) are crescent-shaped and compartmented supports of the unci with (Plioma) or without (Flosculariaceae) an elongate shaft. Unci and manubria

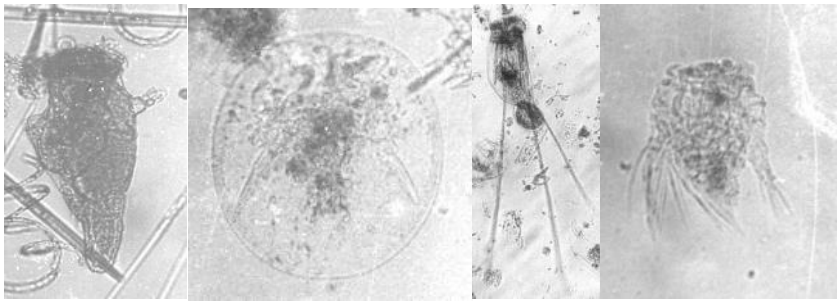
together form the malleus of the trophi. Monogononts have seven different trophi types:
Malleate, malleoramate, virgate, forcipate, incudate, uncinate. Se Fontaneto (2007) for further descriptions.
Lorica present, i.e. cuticle thickened to form a stiff shell, which retain its well after preservation can be present or absent i.e. cuticle thin and flexible, not retaining its shape well after preservation.
No legs present, with or without tail like foot.
Food: Bacteria, algae, detritus, or small zooplankton organism.
Planktonic or benthic.
A positive correlation between dissolved oxygen and population size of rotifers has been found in Pasig River [2009a]
See Wallace et al. (2006) further details about biology and ecology of rotifers.

ROTIFERA, Rotifers. Key to the families of Philippine rotifers.

(Key to genera and species→**15**)

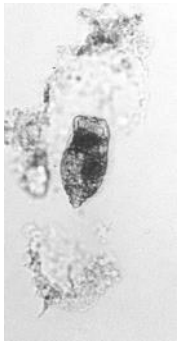
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7 a. Wheel organ (corona) of ***Conochilus*** or ***Hexarthra*** type FLOSCULARIACEA (order).....14



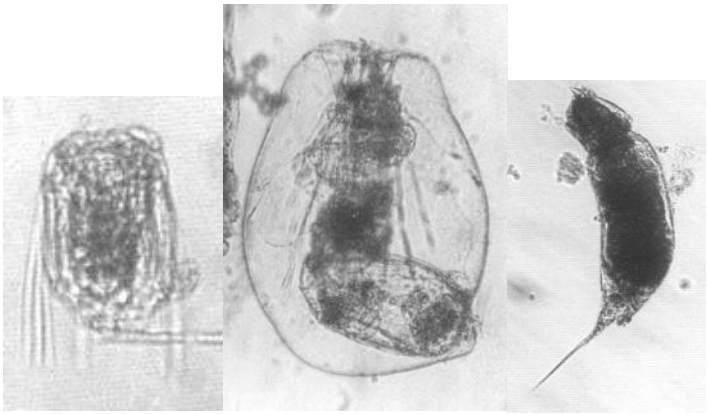
7 b. Wheel organ (corona) not of ***Conochilus*** or ***Hexarthra*** type.....8

8 a. Jaws (trophi) uncinate. Fulcrum short, rami more or less triangular, flat, all trophi elements except the unci strongly reduced. Not important since the food is already pre-digested.
COLLOTHECACEA, COLLOTHECIDAE (order, family → *Collotheca*)....77



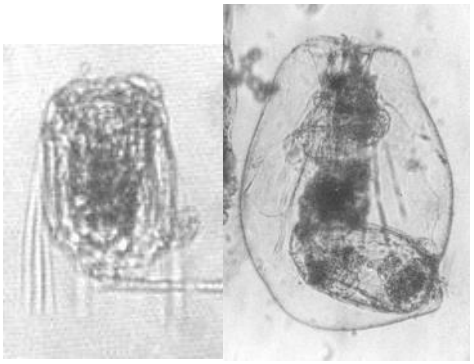
8 b. Jaws (trophi) not uncinated
PLIOMA (order)..... 9

9 a. Wheel organ (corona) of ***Asplanchna*** type.....10



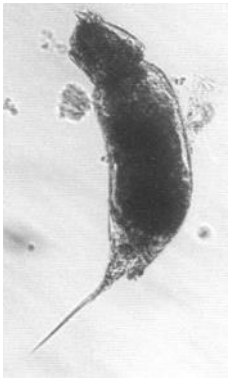
9 b. Wheel organ (corona) not of ***Asplanchna*** type.....12

10 a. Jaws (trophi) symmetrical.....11



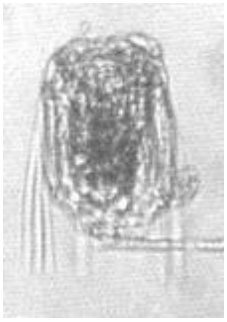
10 b. Jaws (trophi) asymmetrical

TRICHOCERCIDAE (family → Trichocerca).....60



11 a. Jaws virgate. All four parts present, fulcrum is long, asymmetric and the rami pointed bent towards dorsally. Piercing and sucking. Here it consists of thin, hence hardly discernable elements.

SYNCHAETIDAE (family → Polyarthra).....66

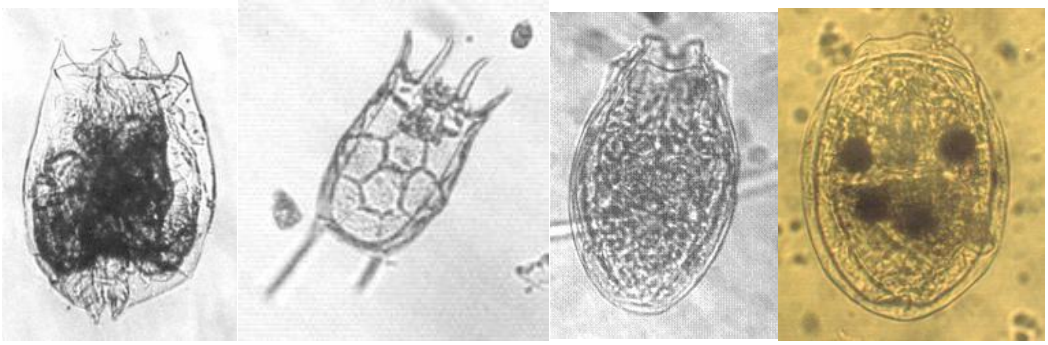


11 b. Jaws incudate. Curved, elongate sharp-pointed rami, like pincers. Seizing type (*Asplanchna*).

ASPLANCHNIDAE (family → Asplanchna, Asplanchnopus).....64



12 a. Wheel organ (corona) of typical ***Euchlanis–Brachionus*** type.....13



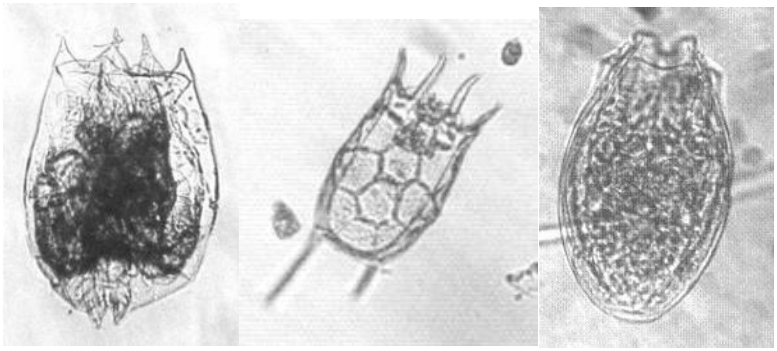
12 b. Wheel organ (corona) simple, not ***Euchlanis–Brachionus*** type

LECANIDAE (family → Lecana).....59



13 a. Anterior and/or posterior end with spines

BRACHIONIDAE (super-family → Brachionus, Plationus, Platyias, Keratella, Anuraeopsis, Euchlanis, Mytilina, Lepadella, Colurella, Trichotria).....35



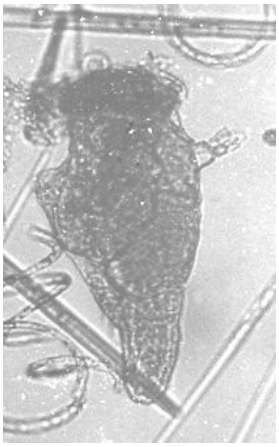
13 b. Anterior and posterior end without spines

GASTROPODIDAE (family → Ascomorpha).....63



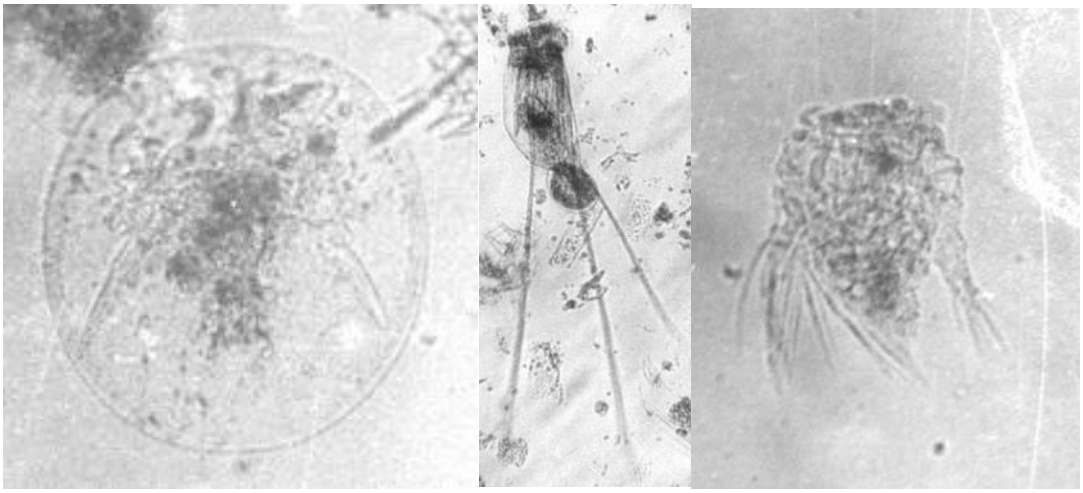
14 a. Wheel organ (corona) of ***Conochilus*** type

CONOCHILIDAE (family → Conochilus).....74



14 b. Wheel organ (corona) of ***Hexarthra*** type

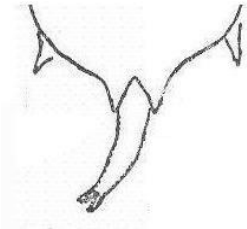
TESTUDINELLIDAE (incl. HEXARTHRIDAE) (families → Testudinella, Pompholyx, Trochosphaera, Filinia, Hexarthra).....68



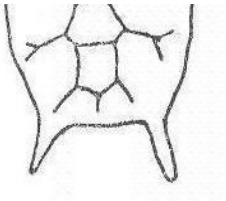
ROTIFERA, Rotifers.

Key to genera and species of Philippine rotifers.

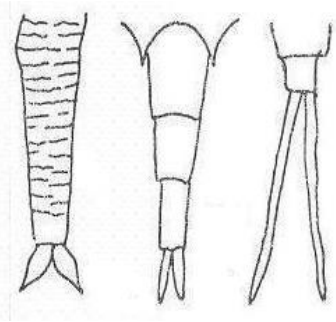
15 a. Foot and foot opening present (foot often retracted up into the body on formalin preserved specimens).....16



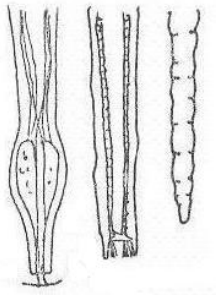
15 b. Foot absent.....28



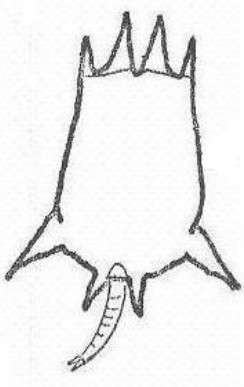
16 a. Foot with toes.....17



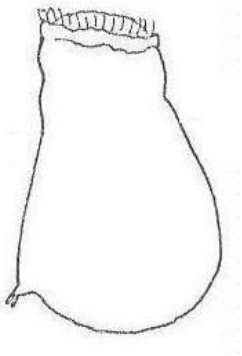
16 b. Foot without toes, foot ends in a holdfast or in a circle of cilia or neither.....26



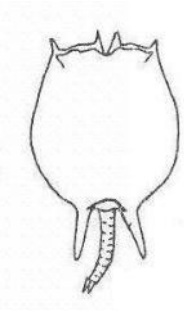
17 a. Lorica present, i.e. cuticle thickened to form a stiff shell which retain its well after preservation.....18



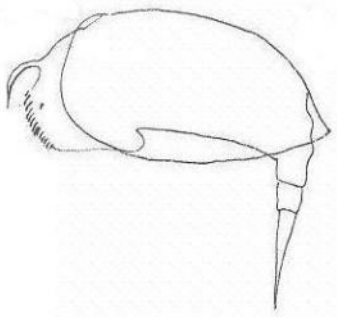
17 b. Lorica absent, i.e. cuticle thin and flexible, not retaining its shape well after preservation. Semi planktonic, littoral.
Asplanchnopus.....64



18 a. Lorica flattened dorsoventrally or not flattened.....19



18 b. Lorica more or less flattened laterally.....25

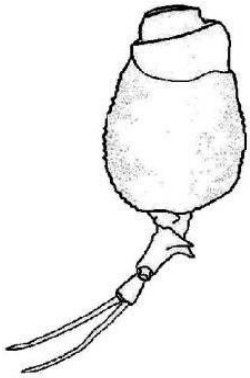


19 a. Lorica not flattened, asymmetrical, more or less cylindrical. Foot short with toes of unequal length, often with one toe almost reduced or absent. Most species littoral.

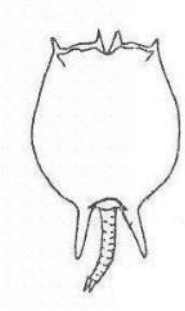
Trichocerca.....60



19 b. Lorica vase-shaped, longer than broad.....56

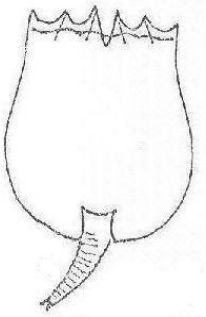


19 c. Lorica flattened dorsoventrally.....22

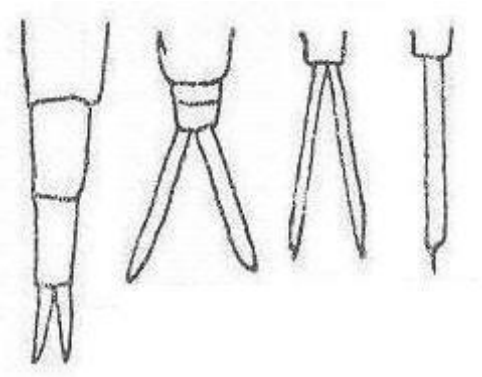


20 a. Foot wrinkled, wormlike, long flexible, and retractile. Lorica more or less flattened dorsoventrally, with 2, 4 or 6 anterior spines and with posterior rounded or with 2 or 4 spines.

Brachionus.....35

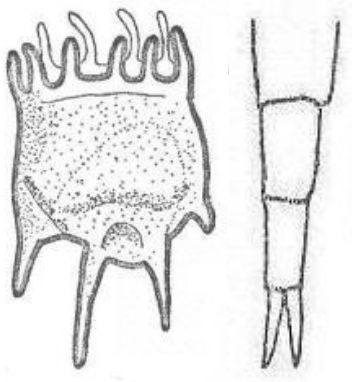


20 b. Foot not wrinkled, 1-4 sections.....21

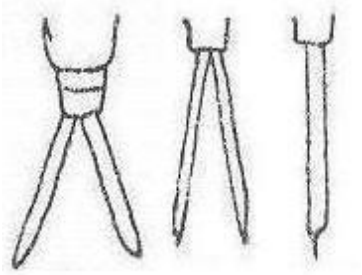


21 a. Brachionus-like. Foot long, with 3 sections. Lorica granulated, with 6 anterior spines.

Plationus.....47

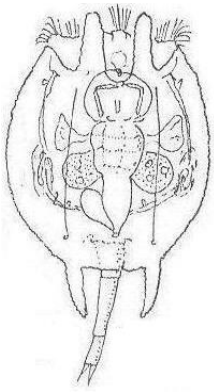


21 b. Foot fairly short, not fully retractile.....22

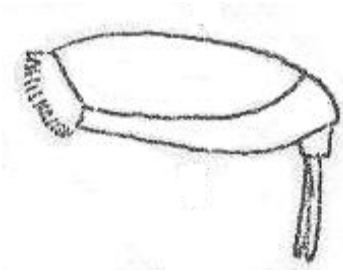


22 a. Lorica more or less flattened dorsoventrally, with spines on anterior border and posterior corners. Foot with 3 sections. Littoral among plants.

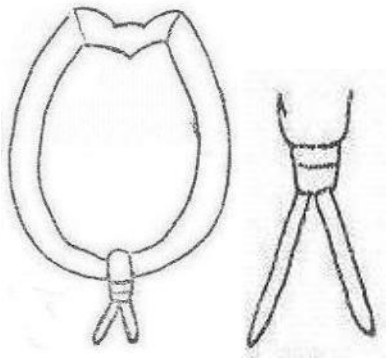
Platyias.....48



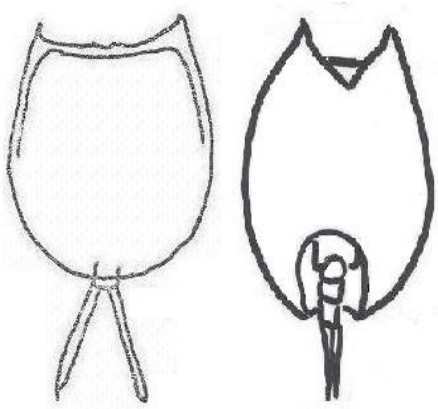
22 b. Lorica oval to shell-shaped, often without spines, or with short spines at anterior corner. Foot with 1 or more sections, and 1 or 2 long toes.....23



23 a. Lorica with flattened ventral surface, dorsal surface convex. Foot with 2-3 sections. Most species littoral, only planktonic species in shallow lakes.
***Euchlanis (incl. Tripleuchlanis)* and *Dipleuchlanis*.....53**

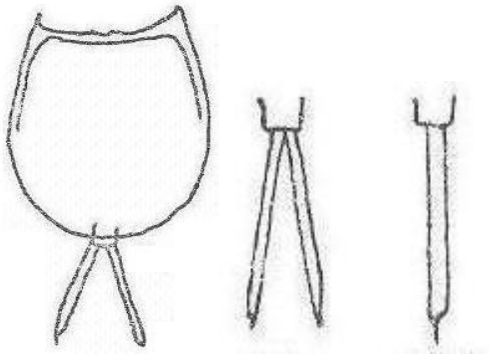


23 b. Lorica more or less flattened dorsally and ventrally.....24



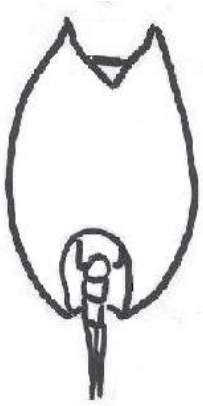
24 a. Lorica oval, pear- or shield-shaped. With dorsal and ventral plate. Anterior opening of lorica broad. Foot very short, toes long, eventually fused to one. One eye. Littoral, tychoplanktonic i.e. migrated from the littoral to the pelagic (or limnetic) part of the lake.

Lecane.....59



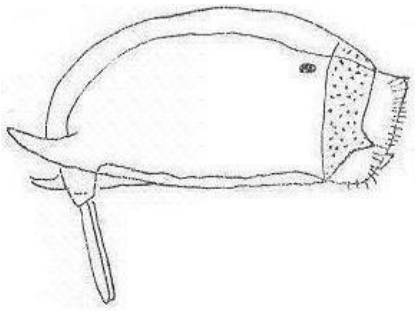
24 b. Lorica oval, egg- or pear-shaped, of 1 peace. Anterior opening of lorica narrow, semicircular. Foot opening deeply incised, foot with 3-4 sections. Two eyes. Littoral, tychoplanktonic.

Lepadella.....58



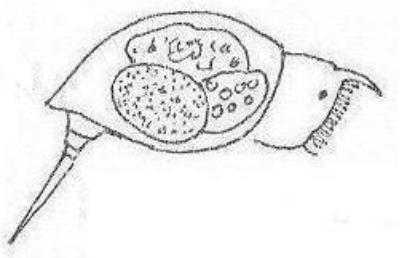
25 a. Lorica fairly stout. Posterior and anterior corners of lorica with spines. Littoral, tychoplanktonic.

Mytilina.....55



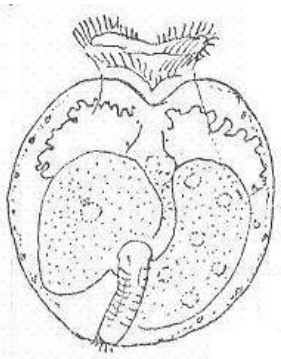
25 b. Lorica shell-shaped, rounded or truncated posteriorly rounded or extended into a point. Littoral, tychoplanktonic

Colurella.....57

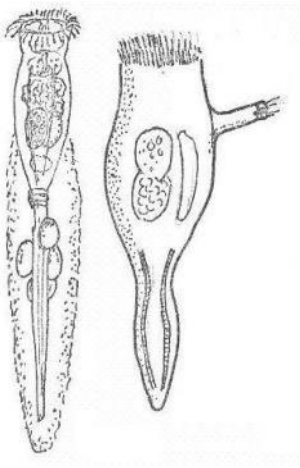


26 a. Lorica present, i.e. cuticle thickened to form a stiff shell (lorica), which retain its shape well after preservation. Lorica strongly flattened, circular in outline, foot opening ventral, and foot ends in circle of cilia (se 16b)

Testudinella.....68

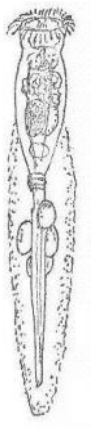


26 b. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. A gelatinous, transparent case around foot and part of the body.....27

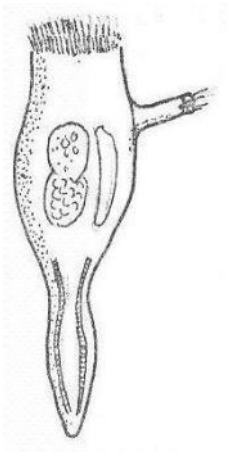


27 a. Head more or less funnel-like. Foot long and slender, stalk-like. Single animal in very transparent gelatinous case, usually contracted. Most species littoral, few planktonic species.

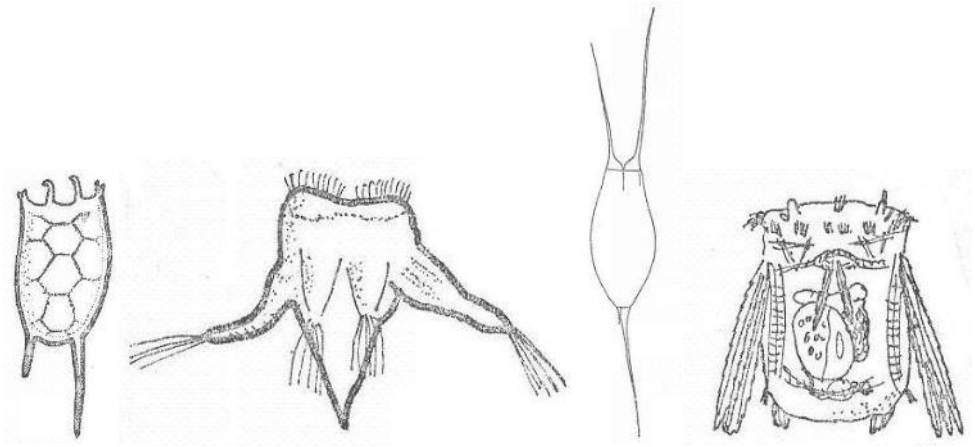
Collotheca.....77



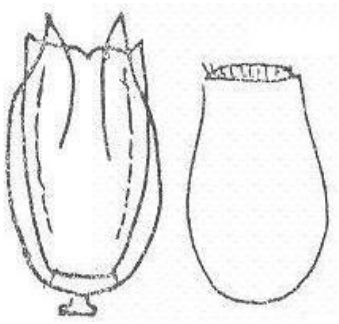
27 b. Head not funnel-like. Foot fairly stout. Solitary (***Conochiloides***) or in colonies (***Conochilus***). Formalin-preserved specimens separated from gelatinous case. Formalin-sugar-preserved specimens still in gelatinous case, usually strongly contracted. Antenna present, planktonic. ***Conochilus*** (incl. ***Conochiloides***).....74



28 a. Body with spines or with blade-like or arm-like processes.....29

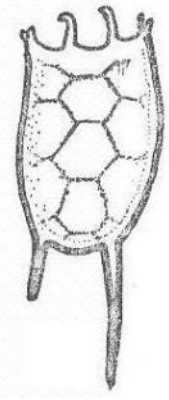


28 b. Body without this.....32

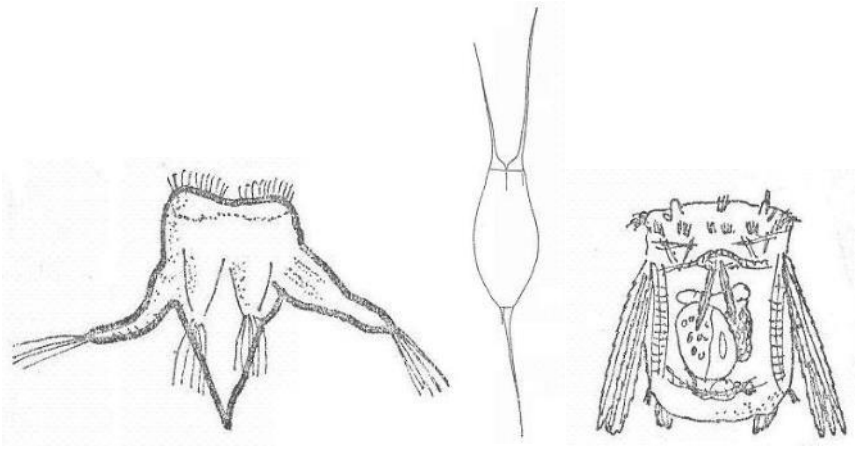


29 a. Cuticle thickened to form a stiff shell (lorica) retaining its shape well after preservation. Often ornamented with ridges or striations. Body with anterior and usually 1 or 2 posterior spines. Planktonic.

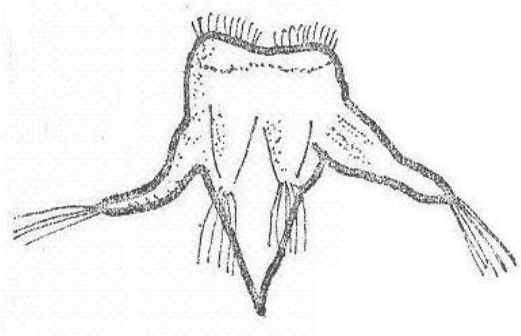
Keratella.....49



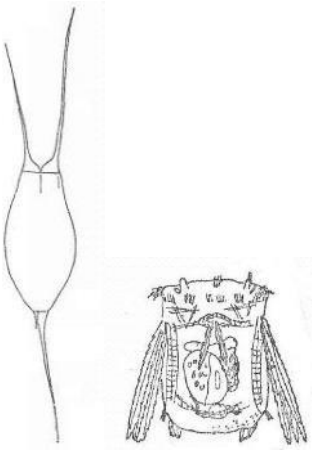
29 b. Cuticle thin, transparent, not usually retaining its shape well after preservation.....30



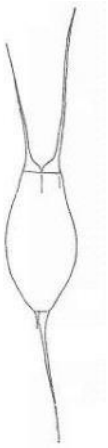
30 a. Body with 6 arms with setae. Nauplius-like. Planktonic. ***Hexarthra***.....73



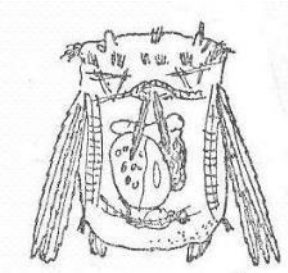
30 b. Body with spines or feathers.....31



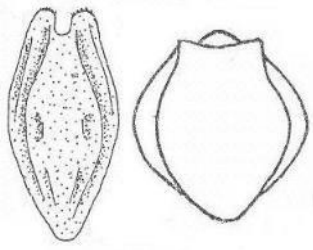
31 a. Body with long spines, 2 anterior and 1 (***Filinia***) or 2 (***Tetramastix***) posterior spines. Planktonic.
Filinia (incl. ***Tetramastix***).....71



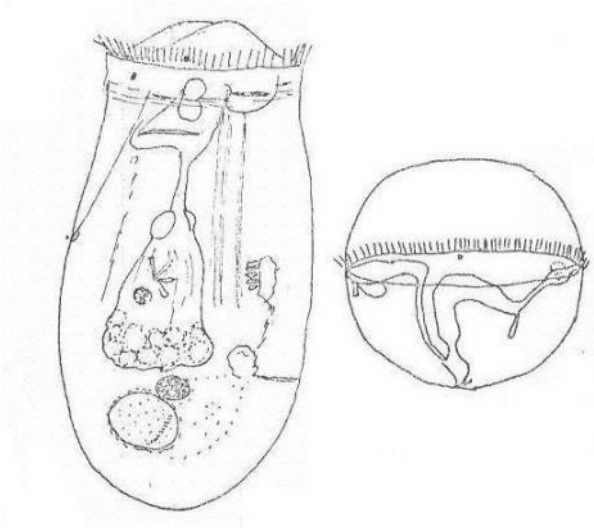
31 b. Body with 12 blades or feathers in 4 groups of 3 blades, 2 groups dorsoventrally and 2 groups ventrolaterally. Planktonic.
Polyarthra.....66



32 a. Lorica present, i.e. cuticle thickened to form a stiff shell (lorica), which retain its shape well after preservation.....33

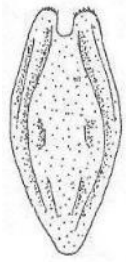


32 b. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. Rather big viviparous rotifers.....34



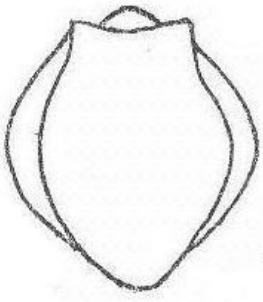
33 a. Lorica oval to boat-shaped, with fold down the sides where dorsal and ventral plates meet. Tear-drop-shaped eggs attached to egg carrier. Planktonic.

Anuraeopsis.....52



33 b. Lorica oval, 4 loped in cross section. Planktonic.

Pompholyx.....69



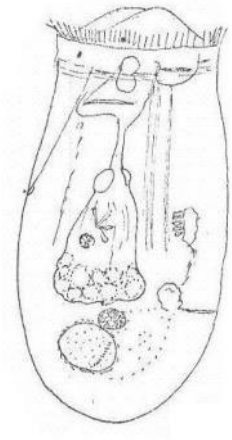
33 c. Small oval-sac shaped, with 4 dark masses. Yellow-green colored.

Ascomorpha.....63



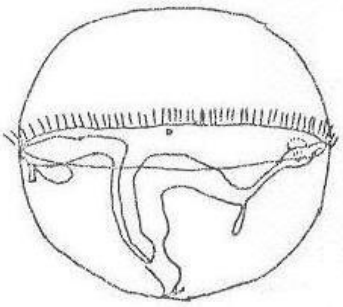
34 a. Large sack-shaped, with wheel organ (corona) anteriorly. Intestine and anus absent. Planktonic. (See also *Asplanchnopus*)

Asplanchna.....65



34 b. Large, spherical, with wheel organ (corona) in equator of body.

Trochosphaera.....70



To 35a

Table 1. The genera in this key ordered after habitat (after Ruttner-Kolisko, 1972.)			
	Genera with some planktonic or semi-planktonic members	**Littoral or periphytic (or epibiontic) genera, sometimes collected in plankton**	**Littoral, periphytic or benthic genera rarely or never in plankton**

Brachionidae	Brachionus Keratella Anuraeopsis Plationus	Platyias Brachionus rubens	
Euclanidae	Euchlanis Dipleuchlanis		Tripleuchlanis
Mytilinidae		Mytilina	
Trichotriidae			Trichotria
Lepadellidae	Colurella	Lepadella	
Lecanidae		Lecane	
Trichocercidae	Trichocerca		
Gastropodidae	Ascomorpha		
Asplanchnidae	Asplanchnopus Asplanchna		
Synchaetidae	Polyarthra		
Testudinellidae	Testudinella Pompholyx Trochosphaera		
Filiniidae	Filinia, (Tetramastix)		
Hexarthridae	Hexarthra		
Conochilidae	Conochilus, (Conochiloides)		
Collothecidae	Collotheca		

ROTIFERA, Rotifers or Wheel animacules

(phylum)

MONOGONONTA, WESENBERG-LUND 1899 (class).

PSEUDOTROCHA KUTIKOVA, 1970 (Superorder)

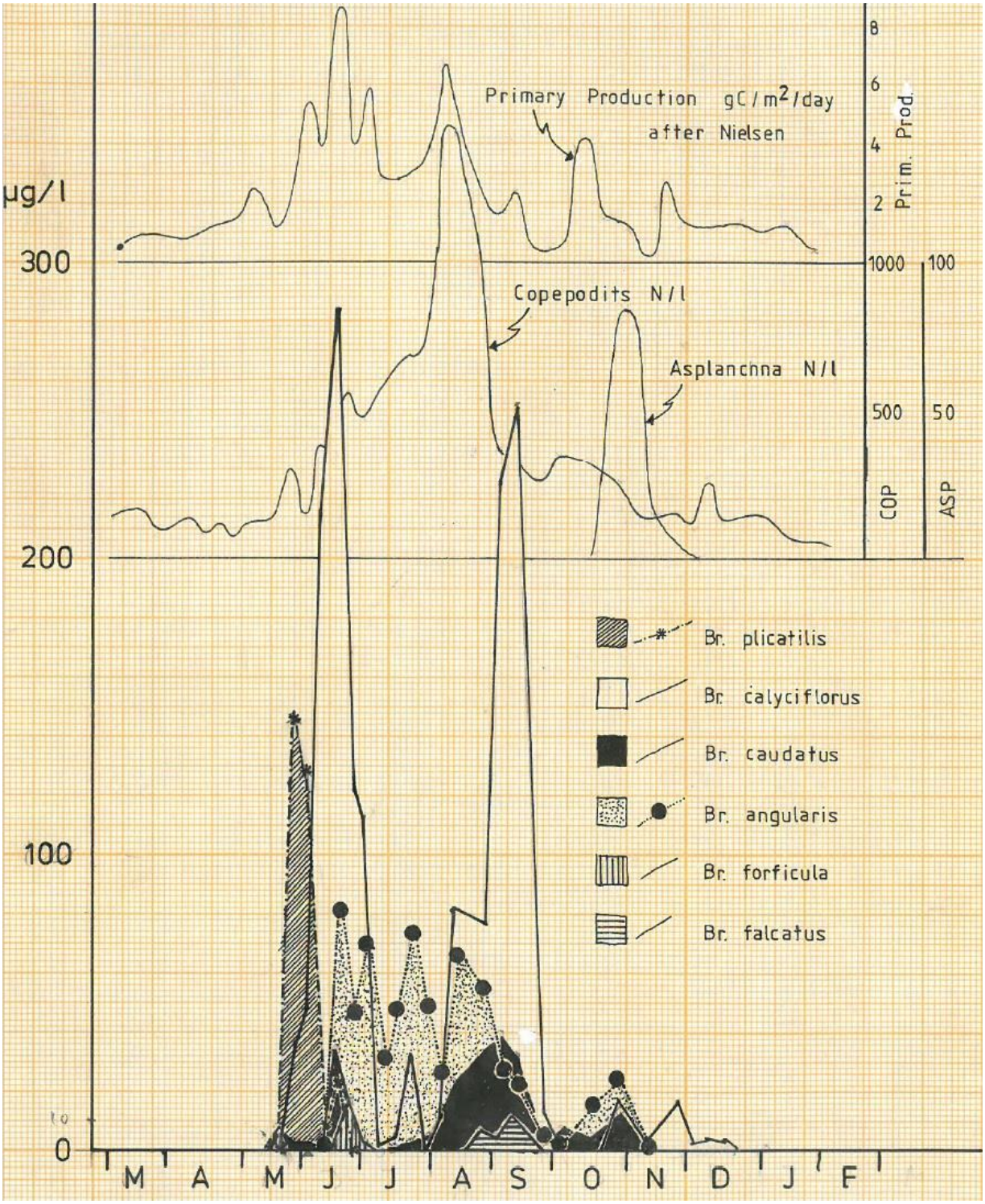
PLIOMA, HUDSON and GOSSE 1888 (order).

BRACHIONIDAE, HUDSON and GOSSE 1888 (family)

Jaws malleate, planktonic as well as littoral species

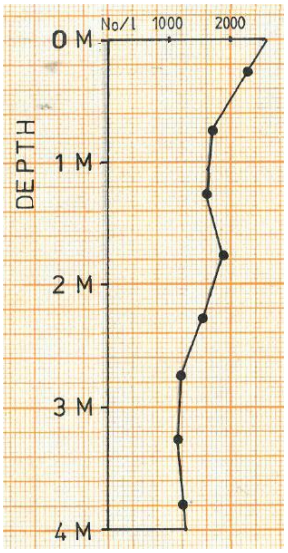
BRACHIONUS, PALLAS 1766, (syn. Schizocerca)

Foot and foot opening present (foot often retracted up into the body on formalin preserved specimens). Foot wrinkled, wormlike, long flexible, and retractile. Lorica more or less flattened dorsoventrally, with 2, 4 or 6 anterior spines and with posterior rounded or with 2 or 4 spines. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. Large sack-shaped, with wheel organ (corona) anteriorly. Rather big viviparous rotifers Planktonic family. Jaws incudate. Curved, sharp-pointed rami like pincers. Of seizing type. Intestine and anus absent. Rather thermophile group, common in tropical waters (Segers 2001b).The genus is abundance among the plankton in polluted biotopes like Pasig River (2009a). *Asplanchna* releases a waterborne signal that induces spine formation in several *Brachionus* species (Snell, 1998). The presence of Asplanchna could then be responsible for the development of spines. Rather thermophile group, with several species in tropical waters (Segers 2001b), which may influence the interpretation of the Brachionus: Trichocerca quotient, $Q_{B/T,}$ in tropical waters. Prefer alkaline waters (Sládeček 1983). Planktonic. The biomass of Brachionus species in Laguna de Bay was highest in May to September in 1980, namely in the period of high primary production. Also, predation pressure expressed by cyclopoid copepodites and the carnivorous rotifer *Asplanchna sp.* seems to have influenced the biomass of B. Se following figure showing the biomass in microgram per liter of *Brachionus* spp. In Laguna de Bay compared with primary production ad predators.



Brachionus biomass in Laguna de Bay in 1980. Se text for explanation. (Petersen, 1981e).

The vertical distribution of rotifers in Laguna de Bay in July 23th 1980 was found to be almost equal in the 4 m deep sampling station. However, *Keratelle tropica* were more abundant in the surface layers. Se the following graphs.



Vertical distribution of all rotifers at Central bay sampling station in Laguna de Bay, July 23th in 1980. (Petersen, 1981e).

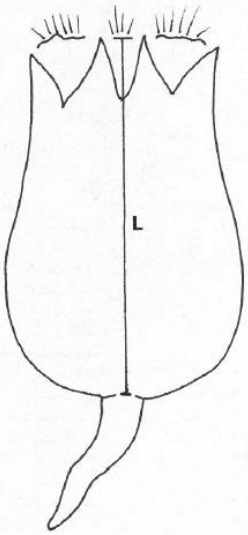


Vertical distribution of different species of rotifers at Central bay sampling station in Laguna de Bay, July 23th in 1980. (Petersen, 1981e).

LENGTH-WEIGHT-RELATIONSHIP OF BRACHIONUS. (wetweight)

FORMULA $W = 0.132 \times 10^{-6} \times L^3$ (W =weight in µg, L=length in µm)

Length	Weight
70	0.05
80	0.08
90	0.10
100	0.13
110	0.18
120	0.23
130	0.29
140	0.36
150	0.45
160	0.53
170	0.65
180	0.77
190	0.91
200	1.1
220	1.4
240	1.8
260	2.3
280	2.9
300	3.6
320	4.3
340	5.2
360	6.2
380	7.2
400	8.4
420	9.8
440	11.2
460	12.8
480	14.6
500	16.5
520	18.6
540	20.8
560	23.2
580	25.8
600	28.5



35 a. 6 anterior spines on lorica.....36

35 b. Less than 6 anterior spines on lorica.....37

36 a. Always 6 short, conical anterior spines on lorica. Body oval, slightly compressed dorsoventrally.

URCEOLARIS GROUP.....38

36 b. 6 long, pointed dorso-anterior spines on lorica, median or rarely lateral spines longest.
QUADRIDENTATUS GROUP.....41

36 c. Submedian spines longest (se 45a).....37

37 a. Always 4 pointed anterior spines of varying length and shape present on lorica. Body sacciform.
CALYCIFLORUS GROUP.....42

37 b. 2 small, pointed or blunt median anterior spines present, or,
4 anterior spines present: 2 small, pointed median spines, and 2 long, pointed lateral spines, or,
6 anterior spines present, with 2 exceptionally long Submedian spines present (see 45a). Body oval, slightly compressed dorsoventrally.
ANGULARIS GROUP.....43

URCEOLARIS GROUP

38 a. Each anterior spine smooth and symmetrical. Lorica thin, but with distinct dorsal and ventral plates.....39

38 b. Each anterior spine on lorica asymmetrical, with shoulder on one side.....40

39 a. Dorsal surface of lorica smooth. Size 200-300 µm. Mainly benthic - often attached to the substrate, but also in open water. In ponds, lakes, running water. In freshwater but also in saline water. Appears to be confined to alkaline eutrophic waters [2003b]. Indicator of mesotrophic and eutrophic waters (Sládeček 1983). Feeds on unicellular green algae. Rare - Muntinglupa, Roadside ditch in Tamparan: Lanao del sur, Pasig River (rare), Taal Lake.

Brachionus urceolaris, MULLER 1773

[1978a+b, 1986a, 2009a, 2001a, 2011a]

39 b. Dorsal surface of lorica with longitudinal striations and pitting on well set-off basal piece. In dystrophic and acid waters – can also grow at neutral pH in the laboratory [2000]. - Calamba River, IRRI Rice field.

Brachionus sericus, ROUSSELET 1907

(syn. Brachionus urceolaris var. sericus)

[1999]



Rice terraces Ifugao province 1980

40 a. Lorica thin, but with distinct dorsal and ventral plate. Size 150-200 µm. Food mainly unicellular algae: Chlorococcales, Euglenoides, but also detritus and bacteria. Epizoic, often found attached as phoretic epibionts to *Moina micrura, Diaphanosoma sarsi* and *D. excisum* (Cladocera) (Sharma, 1983), using Cladocera as an easy means of transport, but is not a parasite. Eutrophic indicator

(India) and general indicator of eutrophic and polytrophic waters (Sládeček (1983). Known for sporadic blooms in the rural areas of peninsular India. Occurrence often coincides with the blooming of the cyanobacterium (blue green algae) *Microcystis aeruginosa*. Ability for co-existence of Brachionus species with cyanobacteria is considered a pre-supposition for survival in tropical lakes. Frequently found to be infested with thick growths of Chlorococcales (Sharma, 1983). Predate on flagellates etc. (Wallace et al., 2006). In eutrophic ponds, also free swimming in open freshwater, sporadic in brackish water.

- Fishpond in Los Baños, Calamba River, Laguna de Bay, Pasig River (rare), Calamba River, IRRI Rice field.

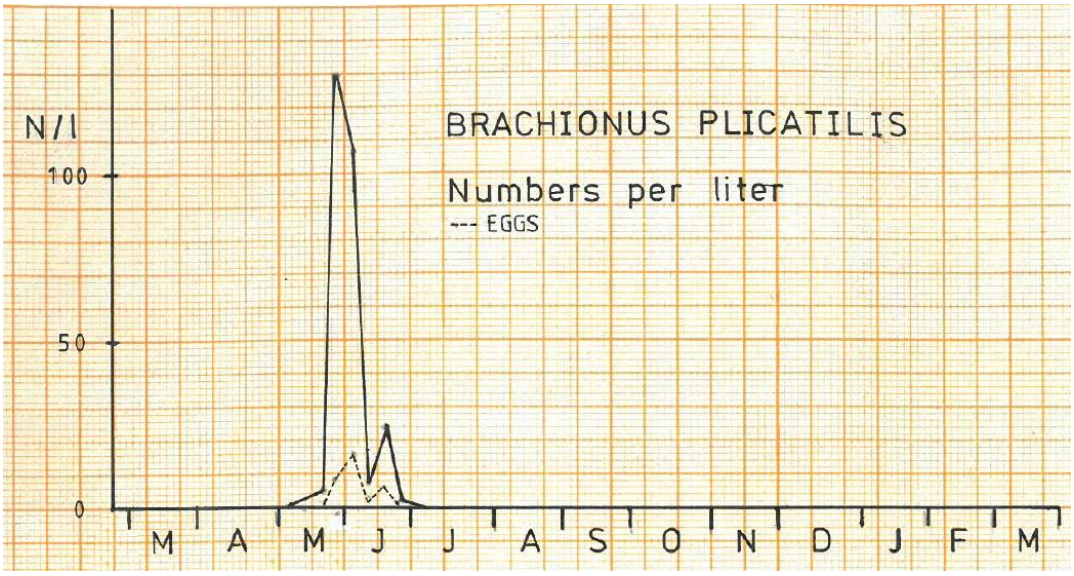
Brachionus rubens, EHRENBERG 1838.

[1984a, 1999, 2009a]

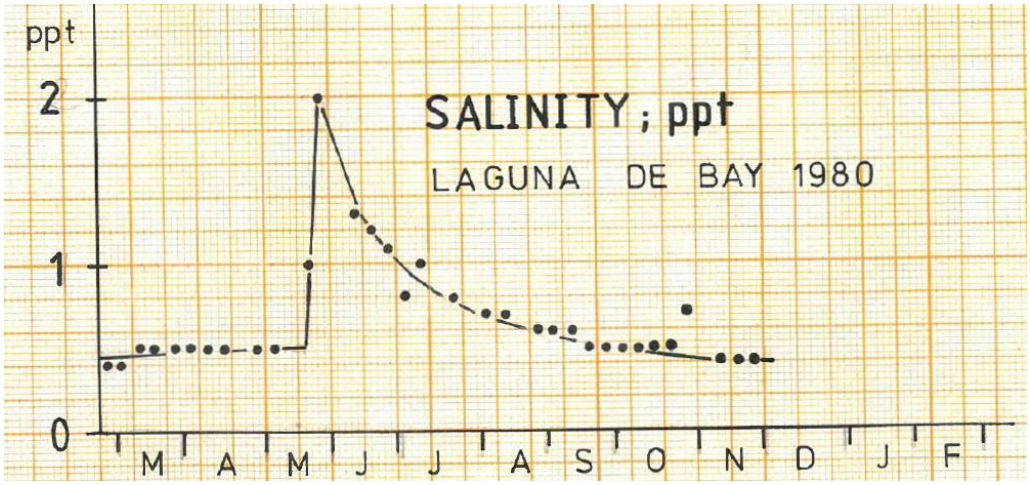
40 b. Lorica soft, dorsal, and ventral plates not distinguishable. Size 150-300 µm. Food unicellular algae: Cyanophyta, *Dunaliella*. In brackish and inland salt water. Indicator of pollution in brackish water with low alkalinity (Sharma, 1983). Planktonic.
Two strains existing: *Brachionus rotundiformis* or small (S-type[9]) rotifers with a lorica length of 100 to 210 µm (average 160 mm) show pointed spines and *Brachionus plicatilis* or large (L-type) rotifers with lorica length ranging from 130 to 340 µm (average 239 mm) has obtuse angled spines. The S-type has an optimal growth at 28-35°C, while the L-type reaches its optimal growth at 18-25°C. (Lavens and Sorgeloos, 1996). Small tropical forms are usually S-forms, like the "p-ot" marine strain from the Philippines (Kotani, 2005c). The average size of lorica in Laguna de Bay is 220 µm, which suggest the L-form (Br. plicatilis), however, the pointed spines on lorica suggest the strain to be the S-form (Br. rotundiformis).

[9] S=Small (size)

In Laguna de Bay B. occurred in high number during the period with high salinity in 1980. Compare the salinity with occurrence of B. Placitilis of the following figures:



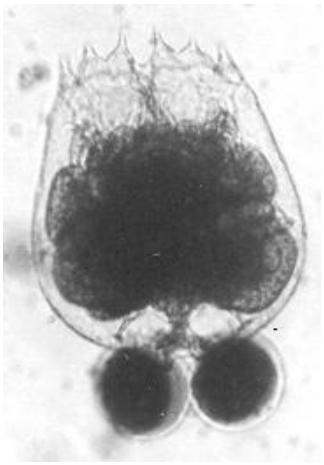
B. plicatilis **population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



Fluctuation of sality in Laguna de Bay in 1980. (Petersen, 1981e).

- Laguna de Bay (during periods with high salinity),
  Pasig River, (culture with water from) Manila Bay , Taal Lake.

Brachionus plicatilis, MÜLLER 1787 (L-form) and
Brachionus rotundiformis (TSCHUGUNOFF, 1921) (S-form)
[1941a, 1974, 1984a, 2001a, 2005c, 2009a, 2011a (plicatilis)]



***B. plicatilis* from Laguna de Bay**

QUADRIDENTATUS GROUP

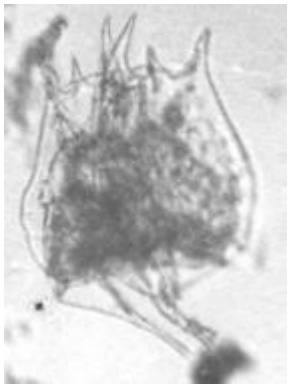
41 a. Lorica smooth or faintly striped. Foot opening tube-shaped. Body very broad and flat. Median anterior spines long, more, or less curved. Lorica tuberculate, with regular pattern of facets. Highly polymorphic.
§ Posterior spines absent, lorica posterior rounded (form cluniorbicularis, SKORIKOV, 1894)
§§ Posterior spines present: short, length less than 1/3 of lorica (form *brevispinus*, EHRENBERG, 1832, form *rhenanus*, (LAUTERBORN, 1893))
§§§ Posterior spines present: long, length more than 1/3 of lorica (form *longispinosus*, KOEPPEL, 1940).
Size of lorica 150-400 µm. Planktonic, also littoral between plants. In lakes, reservoirs, ponds, rice fields and running water. Also in brackish and saline water. Indicator of mesotrophic waters (Sládeček 1983). Very common.

- Laguna de Bay, Pasig River, Calamba River, IRRI rice field, Taal lake.

Brachionus quadridentatus, HERMAN, 1783.

(syn. *Brachionus bakeri*)

[1941a, 1978a+b 1980, 1984a, 1986a, 1999, 2001a, 2009, 2011a+b+c]



***B. quadridentatus* from Laguna de Bay**

41 b. Lorica stiff, clearly granulated, and striped. With basal plate set off from the dorsal plate. Lateral anterior spines longer than the median spines. Spine length variable. Size 180-550 µm. Probably littoral.

- IRRI rice field.

Brachionus bidentatus ANDERSON 1889

(syn. *Brachionus bidentata*)

[1999]

41 c. Lorica very strong, clearly granulated and sometimes with fields. With basal plate. Foot opening not tube shaped, with 3 spines. Median anterior spines short. Posterior corners without spines. Size up to 340 µm.

Semi planktonic. Indicator of mesotrophic waters (Sládeček 1983). Rare.

- In ponds, lakes, and rivers (Pasig River). Also in brackish and

saline water.

Brachionus leydigii, (COHN, 1862)

[1978a+b, 1986a, 2009a]

CALYCIFLORUS GROUP

42 a. Anterior spines long, pointed, emerging from a broad base. Polymorphic:

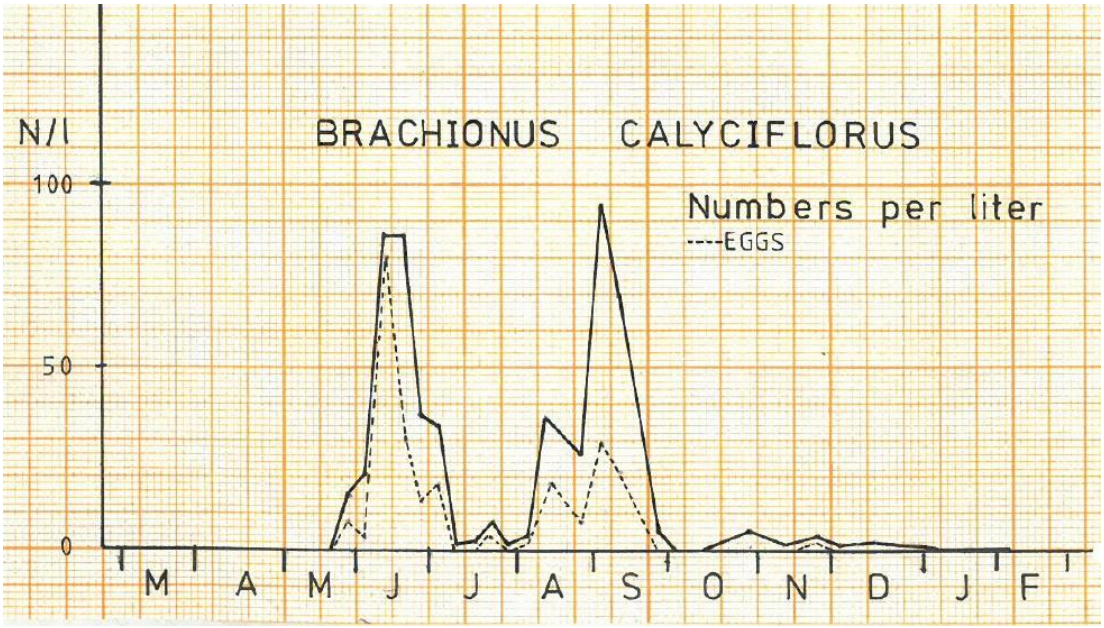
$ Spines on posterior margin absent (form *calyciflorus, form dorcas*)

$$ Spines present (form *amphiceros* (long), form ***borgerti*** (short) (syn. var. *hymani*).

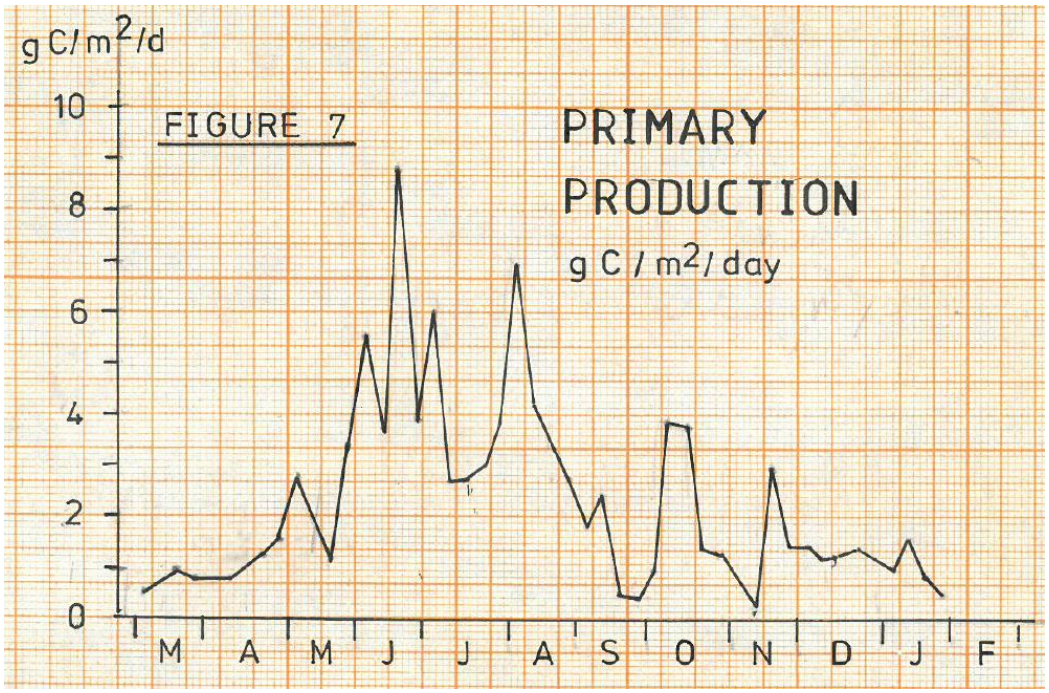
Form *borgerti* distributed in oriental region (Kutikova, 2002). With or without spines on foot opening. Spines are stiffened and spread apart when attack by predator e.g. *Asplanchna.* The same *Asplanchna* is shown to induce spine formation by *B. calyciflorus* with a still unknown chemical factor. (Wallace et al., 2006.) Size 200-500 µm. Very polymorphic. Food mainly algae (Chlorococcales (+/- *Chlorella*), Volvocales, Euglenoides) with a size less than 18 µm diameter, including *Anabaena*, which is eaten from the end. It shares the same food niche as *B. angularis*, and will without predation, e.g. from *Mesocyclops thermocyclopoides*, win the interspecific competition (Kumar and Rao, 2001.) *B. calyciflorus* is a eutrophic indicator (India). Occurrence often coincides with the blooming of the cyanobacteria (blue green alga) *Microcystis aeruginosa*. Ability for co-existence of Brachionus species with cyanobacteria is considered a pre-supposition for survival in tropical lakes (Sharma, 1983). Often found to be infested with thick growths of Chlorococcales (Sharma, 1983). Predate on flagellates etc. (Wallace et al., 2006).

Planktonic in large and small waters, reservoirs, and large rivers. Also in brackish waters. Indicator of eutrophic

waters (Sládeček 1983).Common. Common in Laguna de Bay during period with high primary production. Compare following figures of occurrence of B. calyciflorus and primary production in Laguna de Bay in 1980.



***B. calyciflorus* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



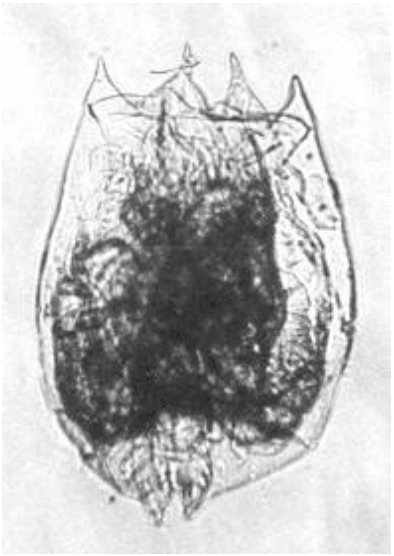
Fluctuation in primaryproduction in Laguna de Bay in 1980. (Petersen, 1981e).

-Laguna de Bay, Pasig River, Bunot Lake, Calibato Lake (f. borgerti), Tadlac Lake, Taal Lake, Lake Mainit.

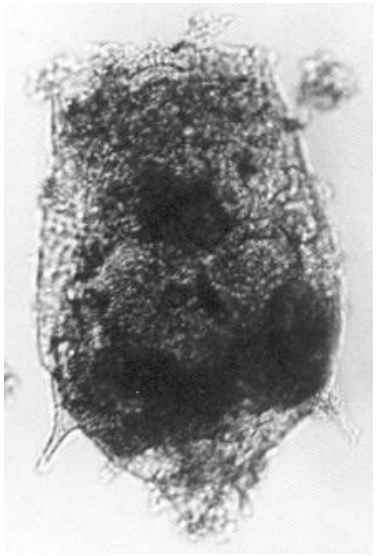
Brachionus calyciflorus, (PALLAS, 1766)

(syn. Brachionus pala)

[1941a (f. dorcas), 1966, 1978a+b, 1980, 1984a, 1986a, 1999, 2001a, 2009a, 2011a+b+c, 2012a]



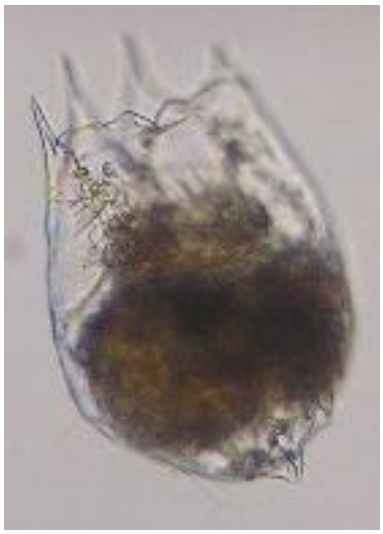
***B. calyciflorus* from Laguna de Bay**



***B. calyciflorus borgerti* from Calibato Lake**



B. calyciflorus from Laguna de Bay (Photo: Flemming Petersen, 1980)



B. calyciflorus (Photo: Rey Donne S. Papa, 2007)

42 b. Anterior spines emerging from a narrow base, crooked. Lorica with more or less pronounced folds, no posterior spines present. Size 92-200 µm. Mainly in freshwater. Indicator of mesotrophic waters (Sládeček (1983).
- Laguna de Bay, Pasig River.

Brachionus budapestinensis, DADAY, 1885

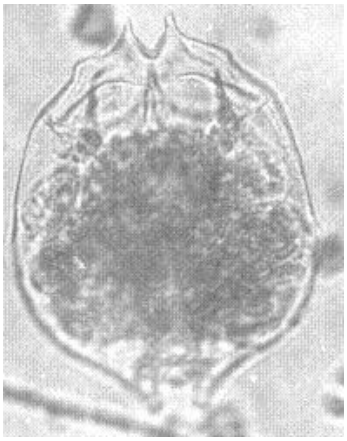
[1941a, 2009a]

ANGULARIS GROUP

43 a. With two median anterior spines present. Lateral and submedian spines absent.....44

43 b. Lateral spines present together with median spines.....45

44 a. Body flat, dorsal, and ventral lorica separate, more or less granulated and with folds. Pincer-shaped median spines. Lateral spines reduced or absent. Size less than 115 µm.
Dwarf form of ***Brachionus caudatus***.....46 d.



B. caudatus **dwarf form** from Laguna de Bay



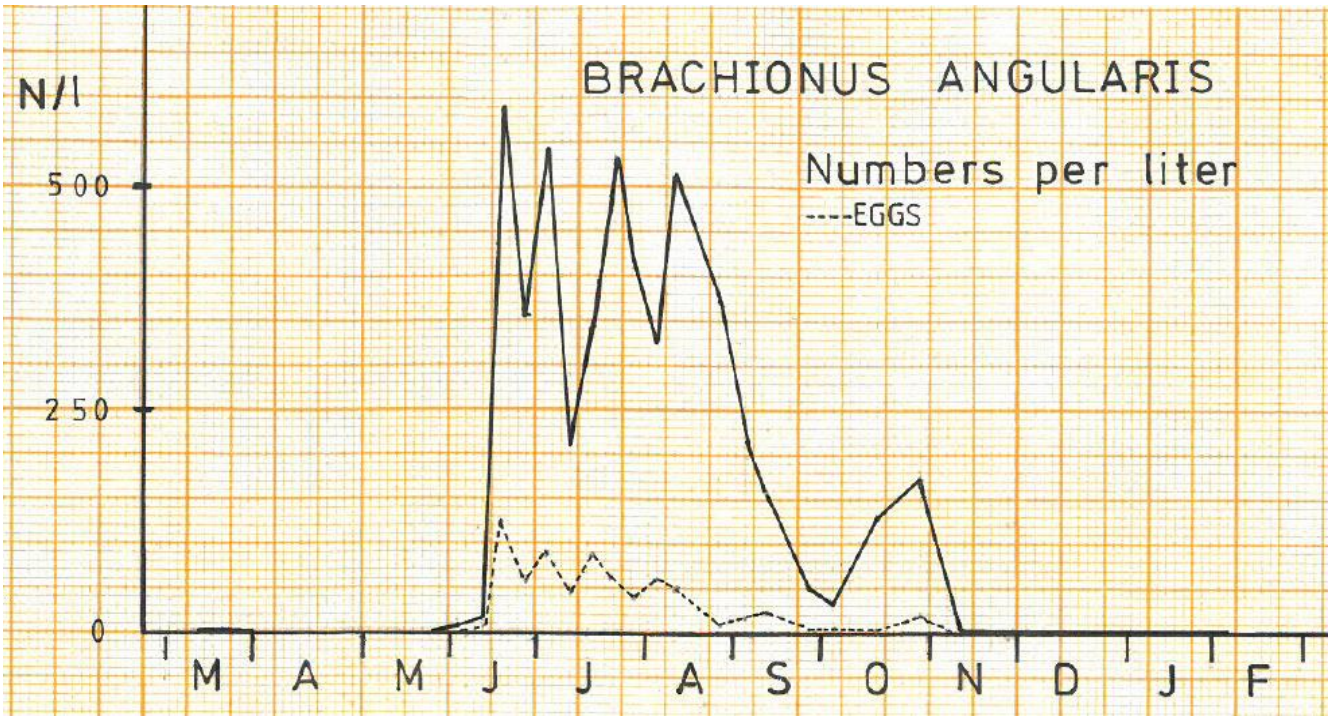
B. caudatus dwarf form from Laguna de Bay
(Photo: Rey Donne S. Papa, 2007)



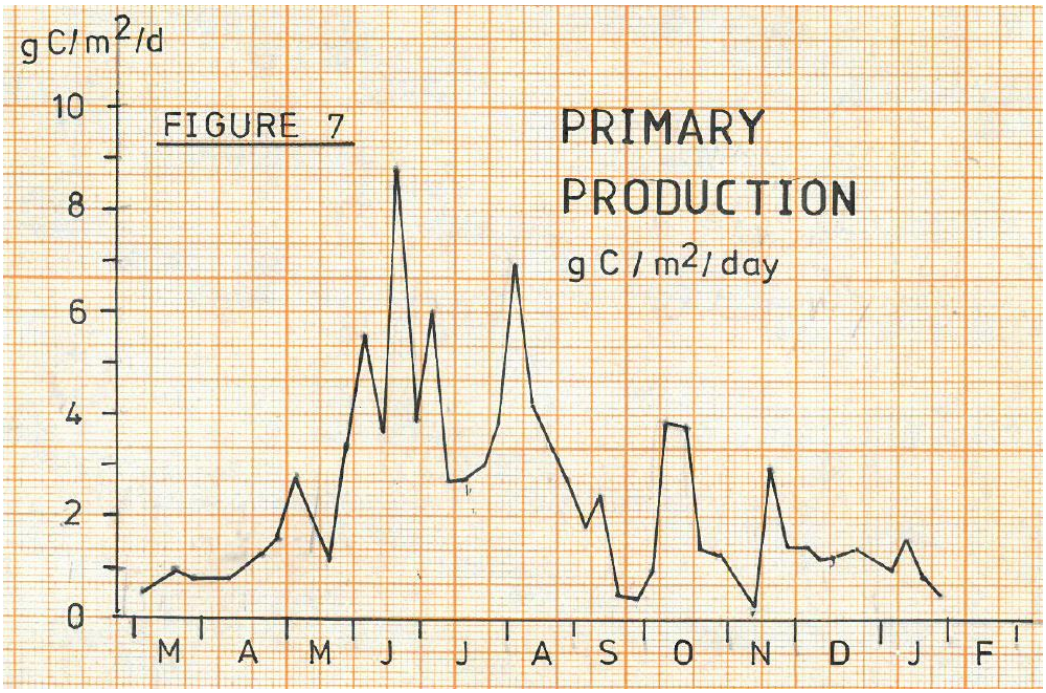
B. angularis from Laguna de Bay

44 b. Body lentiform. Lorica strong stippled and with folds. All spines except the small median ones, reduced and absent. Highly polymorphic. Size 100-200 µm. Eutrophic indicators (India). Frequently found to be infested with thick growths of Chlorococcales.

Food detritus, bacteria, and algae. It shares the same food niche as *B. calyciflorus* and will be outcompeted from this species if it is not predated upon e.g. by *Mesocyclops thermocyclopoides* (Kumar and Rao, 2001.)
Planktonic in lakes and ponds,
also in brackish water. Indicator of mesotrophic and eutrophic waters (Sládeček 1983). Rare.
In Laguna de Bay it occurs in the period of high primary production. See the high coincidence of the following graphs.



***B. angularis* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



Fluctuation in primaryproduction in Laguna de Bay in 1980. (Petersen, 1981e).

-Laguna de Bay, Pasig River, Paoay Lake, La Mesa Dam, Calibato Lake, Taal Lake, IRRI rice field, Lake Danao(Leyte/Cebu?).

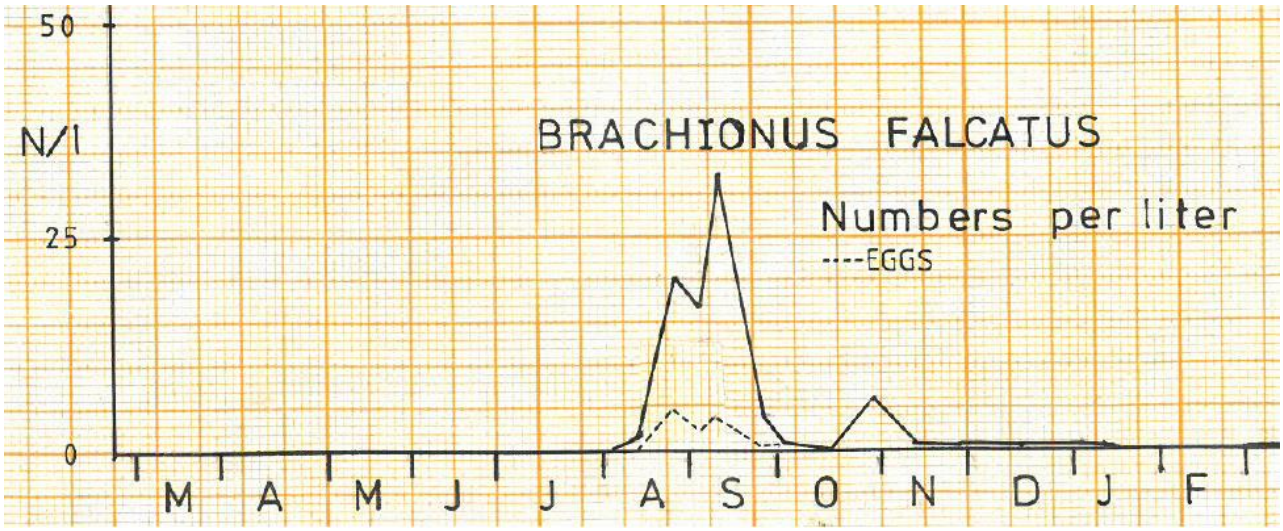
Brachionus angularis, (GOSSE, 1851)

[1941a, 1966, 1978a+b, 1980, 1984a, 1986a, 1999, 2001a, 2009a, 2011a+b+c, 2012a]

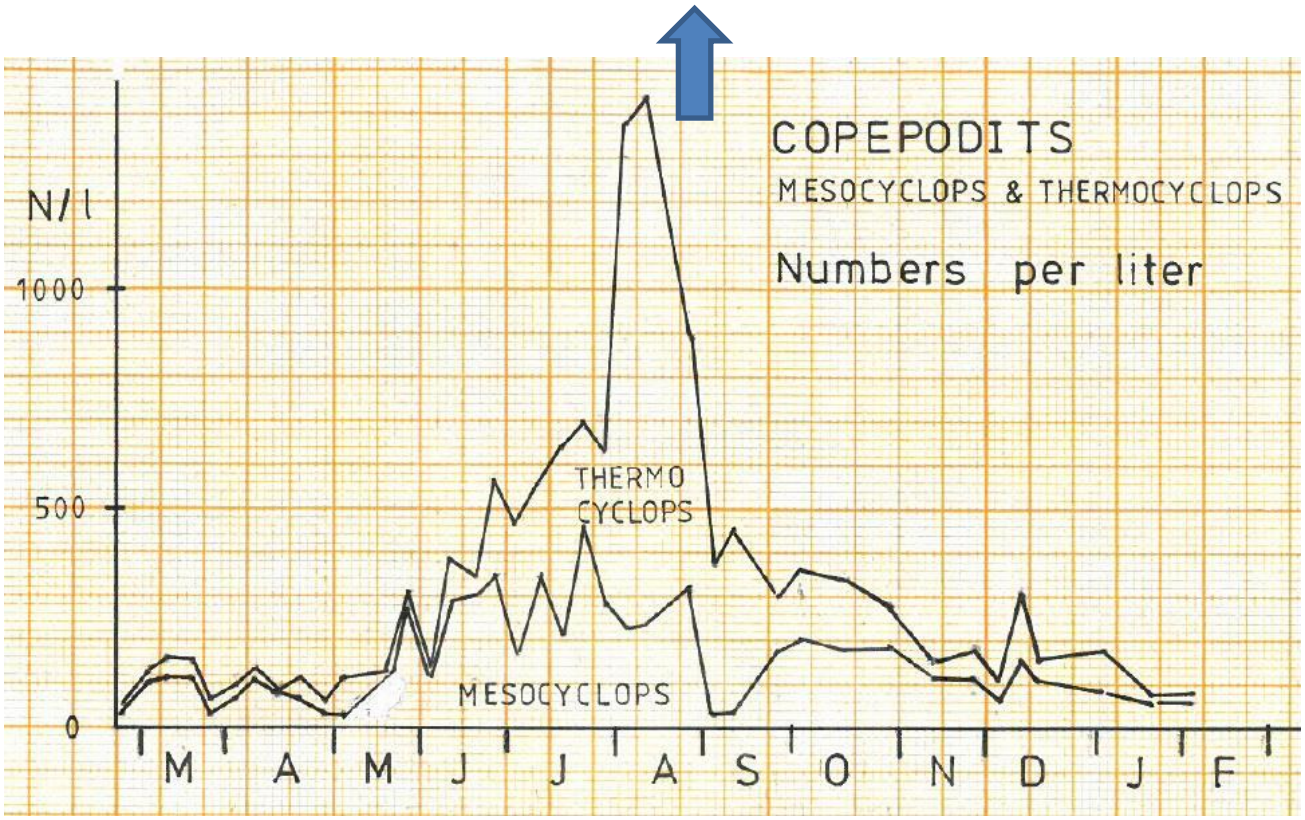


Taal Lake and Volcano, 1980

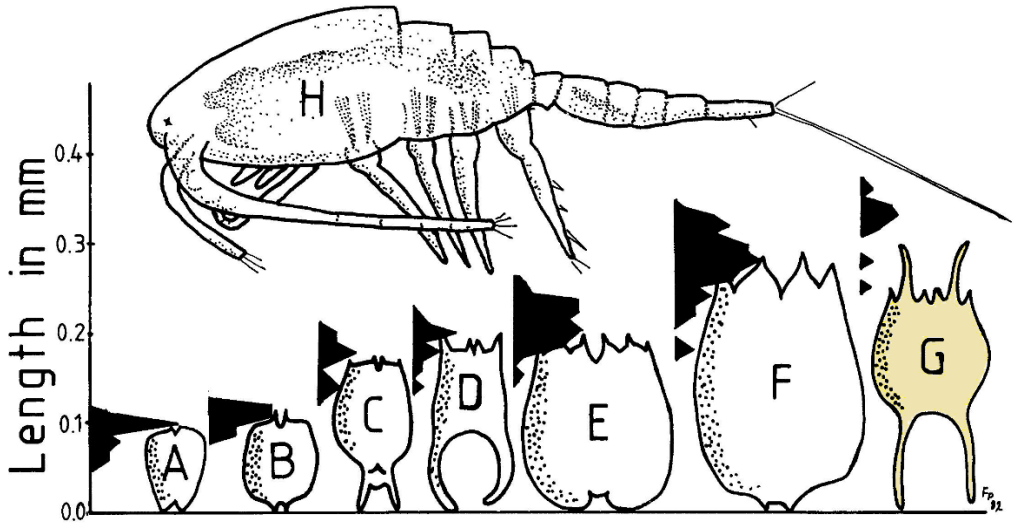
45 a. Submedian anterior spines present and exceptionally long. Posterior spines very long. Size 200-400 µm. Planktonic in lakes, and epiphytic on floating leaves. Affected negatively by bloom of green algae *Botryococcus braunii* blooms in Paoay Lake (Papa et al., 2007a, 2008d).
In Laguna de Bay it occurred in a short period just after a period with a high predation pressure from cycloid copepodites. The long spined rotifer species might have an advance by this against predation compared to other "short" spined species.



B. falcatuss **population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



The number of cyclopoid copepodites (*Mesocyclops thermocyclopoides* and *Thermocyclops crassus*) in Laguna de Bay in 1980. (Petersen, 1981e).

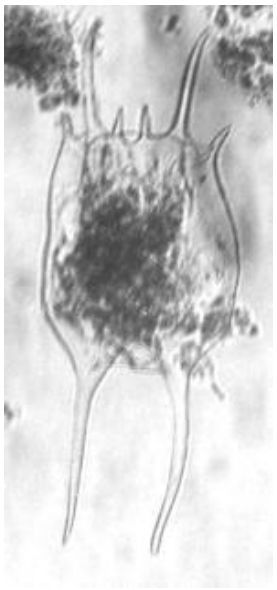


Size-frequency diagrams of the total length (in mm) of *Brachionus spp*. from Laguna de Bay. A: *Br. angularis*, B: *Br. caudatus* dwarf-form, C: *Br. caudatus* normal form, D: *Br. forficula*, E: *Br. rotundiformis*, F: *Br. calyciflorus*, G: *Br. falcatus*, (H: *Mesocyclops* - a common zooplankton predator from Laguna de Bay in 1980). After Petersen (1981e).

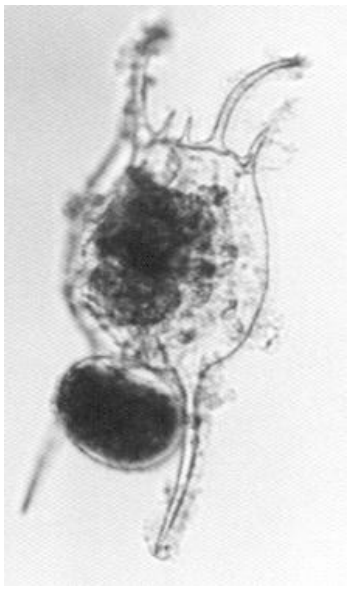
- Laguna de Bay, Pasig River, Paoay Lake, Sampaloc Lake, Lake Mainit, Taal Lake.

  Brachionus falcatus ZACHARIAS 1898.

  [1941a, 1973, 1980, 1984a, 2001a, 2008b, 2008d, 2009a, 2011a+b+c, 2012a]



***B. falcatus* from Laguna de Bay**



***B. falcatus* from Sampaloc lake**

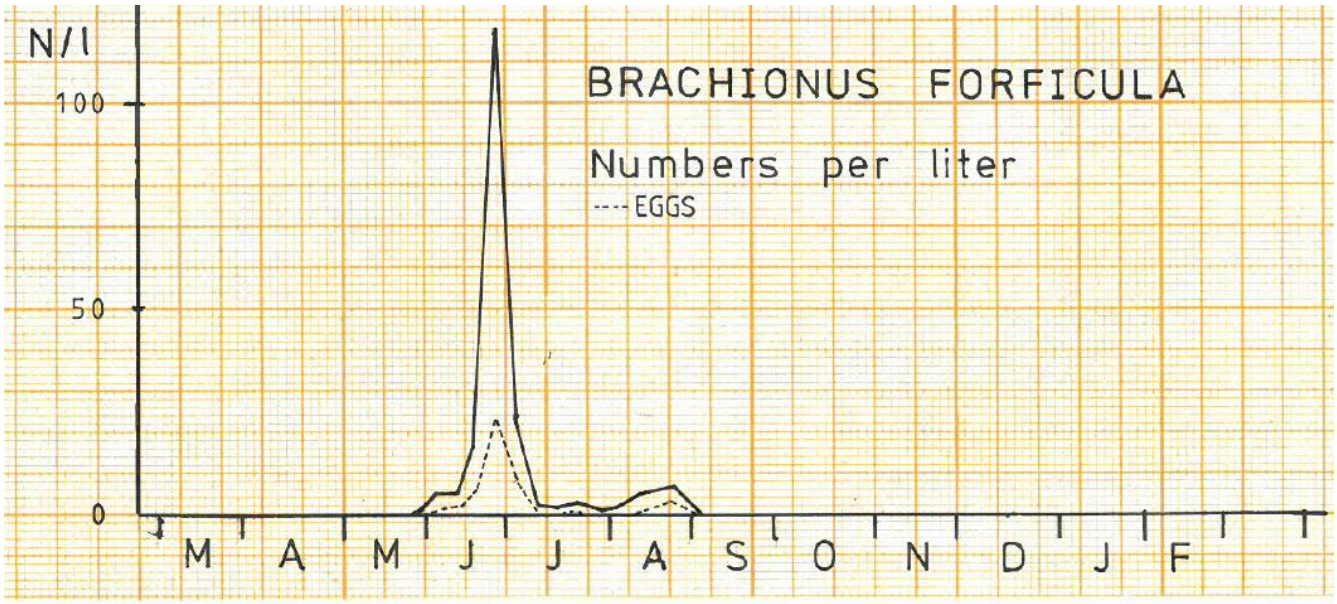


B. falcatus
(Photo by Rey Donne S. Papa, 2007)

45 b. Submedian anterior spines absent (45b-1) or short (45b-2) 46

45 b-1. Submedian anterior spines absent.....46a + 46b

46 a. Submedian anterior spines absent. Lateral anterior spines well developed. Spines at the foot opening very large, thick, and bent inwards. Lorica with more or less marked ridges and dots. Size 100-250 µm. Very polymorphic. In sub- and tropical lakes in Africa and Asia.
In Laguna de Bay it occurred in a short period with relatively high primary production.



B. forficula **population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

- Laguna de Bay, Pasig River, Paoay Lake, Bunot Lake, Calibato Lake, Sampaloc Lake, Tadlac Lake, Taal Lake, Naujan Lake, Lake Lanao.

Brachionus forficula (WIERZEJSKI, 1891).

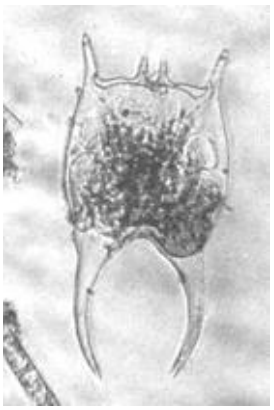
[1941a, 1980, 1984a, 2001a, 2008b, 2009a, 2011a+b+c]



***B. forficula* from Laguna de Bay**



***B. forficula* from Laguna de Bay**



***B. forficula* from Paoay Lake**

46 b. Submedian anterior spines absent. Anterior lateral spines thin and elongated. Lorica large, flattened, and smooth. Posterior spines usually unequal of length (*f. homoceros* with spines of equal length). Body length is 200 - 550 µm, body width is 150 – 200 µm. Indicator of mesotrophic waters (Sládeček (1983) and is eurythermic = Adaptable to a wide range of temperatures (Segers 2001b).

- Candaba Swamp (Pampanga), Taal Lake (Luzon)

Brachionus diversicornis (DADAY, 1883)

[1988, 2001a+b+c]

45 b-2. Submedian anterior spines short.....(46c+46d)

46 c. Submedian anterior spines short. Lateral and median anterior dorsal spines of lorica longest.
Submedian spines are rarely present but reduced.
Posterior spines very long, usually bent backwards.
Body length is 135 - 350 µm, body width is 73 - 118 µm.
This endemic American species is probably spread from USA (type species from Illinois River, Havana, USA) to Vietnam and the Philippines in connection with military transport activities during the Vietnam war (Segers, 2001c).

Subic Harbor & Clark Air base?

- Laguna de Bay and nearby localities, Taal Lake

Brachionus havanaensis, ROUSSELET, 1911.

[2001a+c, 2011a+b+c, 2012a]



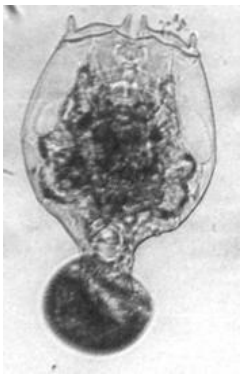
Br. havanaensis. (Photo by Rey Donne S. Papa, 2007)

46 d. Submedian anterior spines short. Lateral anterior spines small (or absent: dwarf-form, 44 a.). Spines at the foot opening present (or absent: dwarf-form, 34 a.) and of varying length, diverging. Highly polymorphic. Size 100-250 µm. Planktonic in lakes and epizoic on damselfly and dragonfly nymphs. (Sharma, 1983.). Rare.

- Laguna de Bay, Pasig River (very common)

Brachionus caudatus, (BARRIOS and DADAY, 1894)

[1941a, 1978a+b, 1980, 1984a, 1986a, 2009a, 2012a]



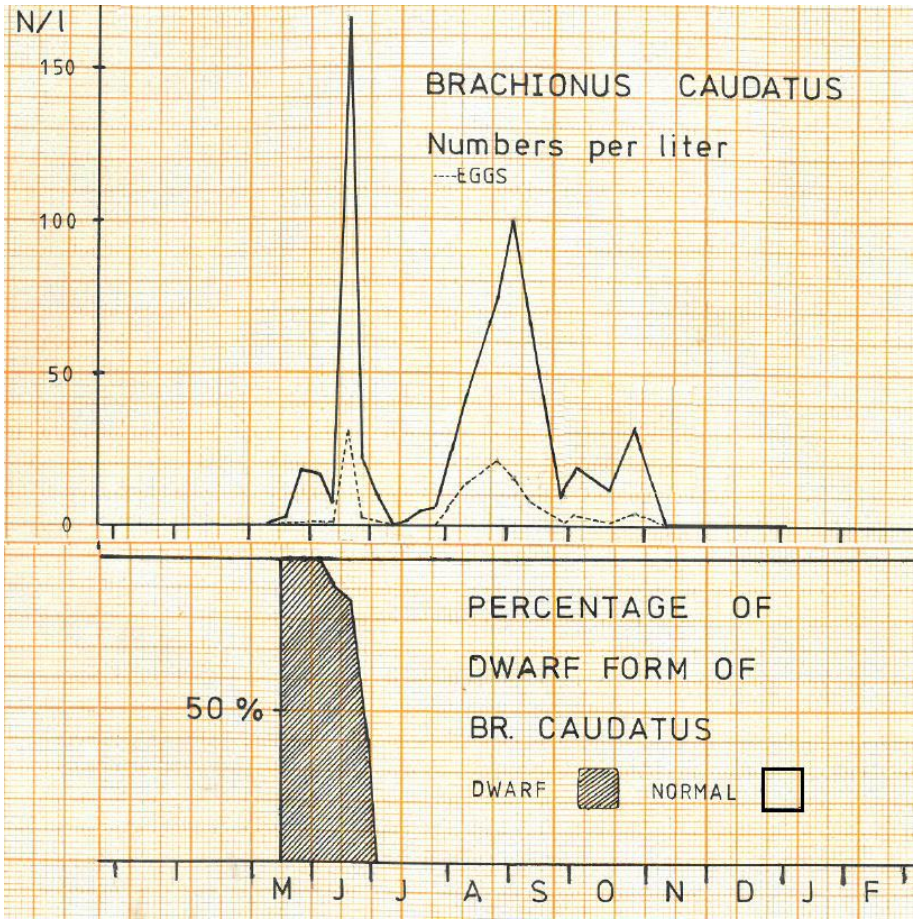
B. caudatus from Laguna de Bay



B. caudatus – dwarf form
from Laguna de Bay
(Photo: Rey Donne S. Papa, 2007)

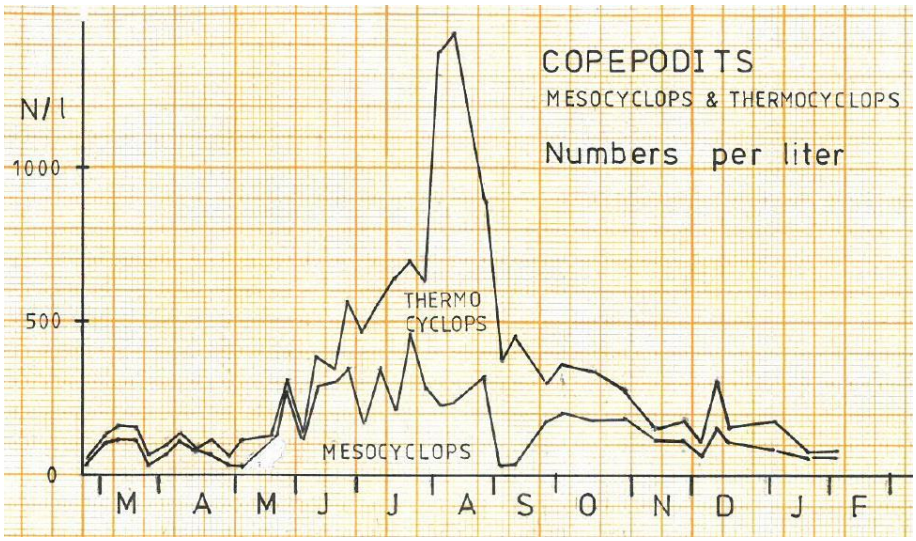
B. caudatus - dwarf-form (44 a.):

A dwarf is a mature individual that is smaller than usual for the species. A critical length, 115 µm has to be reached before spines develop to any extent on *B. caudatus*, (Green 1960). Some factors leading to dwarfing in tropical crater lakes (Africa) is high temperature, low ratio of drainage area to surface area of the body, low food supply, including *Microcystis*-bloom, high salinity, and size selective predation from cyclopoid copepods. *B. caudatus* produce successfully dwarfs more readily than other species of *Brachionus*.
In Laguna de Bay the dwarf form totally dominated the population when it occurred after increase in salinity after sea water intrusion in May 1980. After two months only the normal form was found. In the same period an increase in cyclopoid copepodites were found, which may have tricked the changed caused by the better predator prey size relationship. Se the following graphs.



Occurrence of *Brachionus caudatus* in Laguna de Bay in 1980.

The lower figure shows the percentage of the dwarf form. (Petersen, 1981e).



The number of cyclopoid copepodites (*Mesocyclops thermocyclopoides* and *Thermocyclops crassus*) in Laguna de Bay in 1980. (Petersen, 1981e).

PLATIONUS, SEGERS, MURUGAN and DUMONT, 1993

Brachionus-like. Foot long, with 3 sections.
Lorica granulated, with 6 anterior spines.

47 a. Ventral anterior margin of lorica with strong spines. Size 150-250 µm Mostly benthic. In ponds and lakes. A common member of the planktonic community and epiphytic on roots of *Eichornia* (Water hyacinth), (Arora and Mehra, 2003c). As a basal member of the food web, it plays an important role in nutrient cycling and provides food for higher trophic levels. 150-250 µm. Cosmopolite, thermophilic (Arora and Mehra 2003c). *Plationus patulus* was removed (Segers et. al 1993) from the genus *Brachionus* based on morphological characters of trophi. Very common.

- Laguna de Bay, Paoay Lake, Lake Lanao, Lake Leonard, IRRI rice field

Plationus patulus (O. F. MÜLLER, 1786)
(syn. Brachionus patulus),

(syn. Platyias patulus)

[1941a, 1978a+b, 1980, 1984a, 1986a, 1999]



***B. patulus* from Laguna de Bay**

PLATYIAS, HARRING 1913, (syn. Noteus)

Lorica more or less flattened dorsoventrally, with spines on anterior border and posterior corners. Foot with 3 sections. Littoral among plants.

48 a. Size 200-350 µm. Lorica tuberculate, with three central polygons. Lorica with regular pattern of facets. Anterior dorsal margin with two stout median spines with spinelets. Taper a little and bluntly rounded to nearly truncate at their tips. Front margin depressed toward the center and serrate. Lorica terminating posteriorly in two rather short and stout, parallel spines, a third to a half the width of the lorica apart. Lorica tuberculate, with three central polygons. Lorica with regular pattern of facets. In freshwater, brackish, and saline waters. Littoral, among macrophytes in lakes and ponds. Indicator of mesotrophic waters (Sládeček 1983). Cosmopolitan. Very common.

- Laguna de Bay, Paoay Lake, Lake Mainit, Lake Lanao, Calamba River, IRRI rice field.

Platyias quadricornis (EHRENBERG, 1832)

[1978a+b, 1980, 1984a, 1986a, 1999]



"Magtanim hindi biro" (Photo: Flemming Petersen, 1980)

48 b. Size from 250 µm. Dorsal plate of lorica without polygonal markings. Lorica oval, dorsoventrally flattened and anterior end broader than posterior. Anterior spines 2, long, curved outwards, acutely pointed with closely placed bases. Posterior spines long, pointed with widely separated bases. In some specimens, entire lorica stippled. Littoral and planktonic, tropical species.

- Calamba River, IRRI Rice field.

Platyias leloupi (GILLARD, 1957)

[1999]

KERATELLA, (BORY ST. VINCENT 1822) (syn. Anuraea.)

Foot absent. Cuticle thickened to form a stiff shell (lorica) retaining its shape well after preservation. Often ornamented with ridges or striations. Body with anterior and usually 1 or 2 posterior spines. Feeds on particles less than 10 µm (Sládeček 1983).

The genus is abundance among the plankton in polluted

biotopes like Pasig River (2009a).

Planktonic.

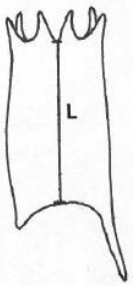
LENGTH-WEIGHT-RELATIONSHIP for KERATELLA (WETWEIGHT)

FORMULA USED: Keratella quadrata-group: $W = 0.22 \times 10^{-6} \times L^3$

Keratella cochlearis-group: $W = 0.02 \times 10^{-6} \times L^3$

(W = Wetweight in µg, L = Length in µm)

Length	Weight(K.quadrata-group)	Weight(K. cochlearis-group)
70	0.08	0.007
80	0.11	0.010
90	0.16	0.015
100	0.22	0.02
110	0.29	0.03
120	0.38	0.03
130	0.48	0.04
140	0.60	0.06
150	0.74	0.07
160	0.90	0.08
170	1.1	0.10
180	1.3	0.12
190	1.5	0.14
200	1.8	0.16
210	2.0	0.19
220	2.3	0.21
230	2.7	0.24
240	3.0	0.28
250	3.4	0.31
260	3.9	0.35
270	4.3	0.39
280	4.8	0.44
290	5.4	0.49
300	5.9	0.54





49 a. Insertion of the posterior spine terminal.

COCHLEARIS GROUP.

Lorica dorsal with median line. Size 150-300 µm.

Polymorphic:

§ Central line of lorica straight (*form tecta*)
with long-spined (*form macracantha*),
medium spined (*form typica*)
and spineless (*form tecta*) forms.
The reduction of the spine is correlated with
increasing eutrophy.

§§ Central line of lorica with a definite kink,
field pattern irregular (*form irregularis*), with
longspined to spineless forms. The irregular field

pattern is correlated with high temperature and is common in tropic waters (*var. javana*).

§§§ Lorica covered with small spines (*form hispida*), correlated with turbulent water.

An affinity for diatoms and blue-greens (cyanobacteria) as food has been found in Lake Lanao (Lewis 1979). Planktonic in large and small waters, reservoirs, also in brackish and saline water. Indicator of mesotrophic waters (Sládeček 1983). Rare.

- Laguna de Bay, Pasig River, La Mesa Dam, Lake Lanao, Paoay Lake.

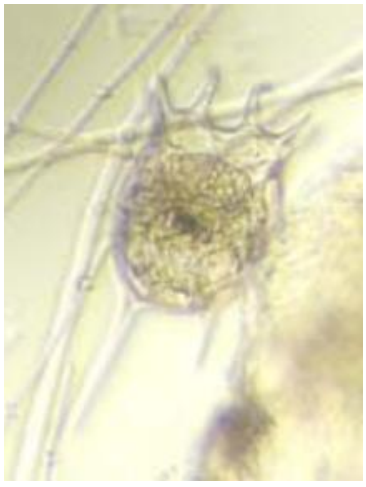
Keratella cochlearis {GOSSE, 1851)
[1941a, 1974, 1978a+b, 1979b, 1980, 1984a, 1986a, 1999, 2008b, 2009, 2012a]

With small spines on lorica.

- Laguna de Bay, Lake Danao (Leyte/Cebu?).

Keratella cochlearis var. ***hispida*** (LAUTERBORN)
[1980, 1999]

49 b. Insertion of posterior spines at the posterior corners.
QUADRATA GROUP.....50



***Keratella sp.*, Taal Lake (Photo: Rey Donne S. Papa, 2007)**

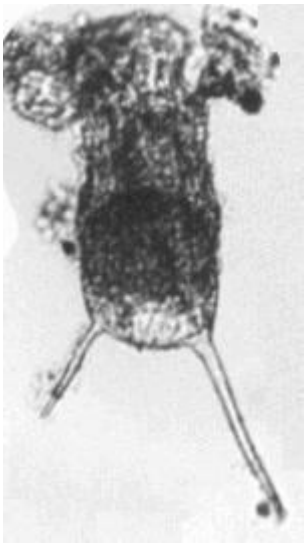
QUADRATA GROUP

50 a. Dorsal plate of lorica with 2 closed median fields and one open. Left lateral posterior spine always present. Size 150-300 µm. Very polymorphic. Feeds mainly on unicellular algae less than 10 µm. In large lakes with long spines (*form frenzeli*), or in ponds with thick lorica covered with spines. Indicator of mesotrophic waters (Sládeček (1983). -Laguna de Bay (?), Pasig River, Calibato Lake.

Keratella quadrata, (MULLER, 1786)

(syn. *Anuraea aculeata*)

[1941a, 1974, 2009a]



***K. quadrata* from Calibato Lake**

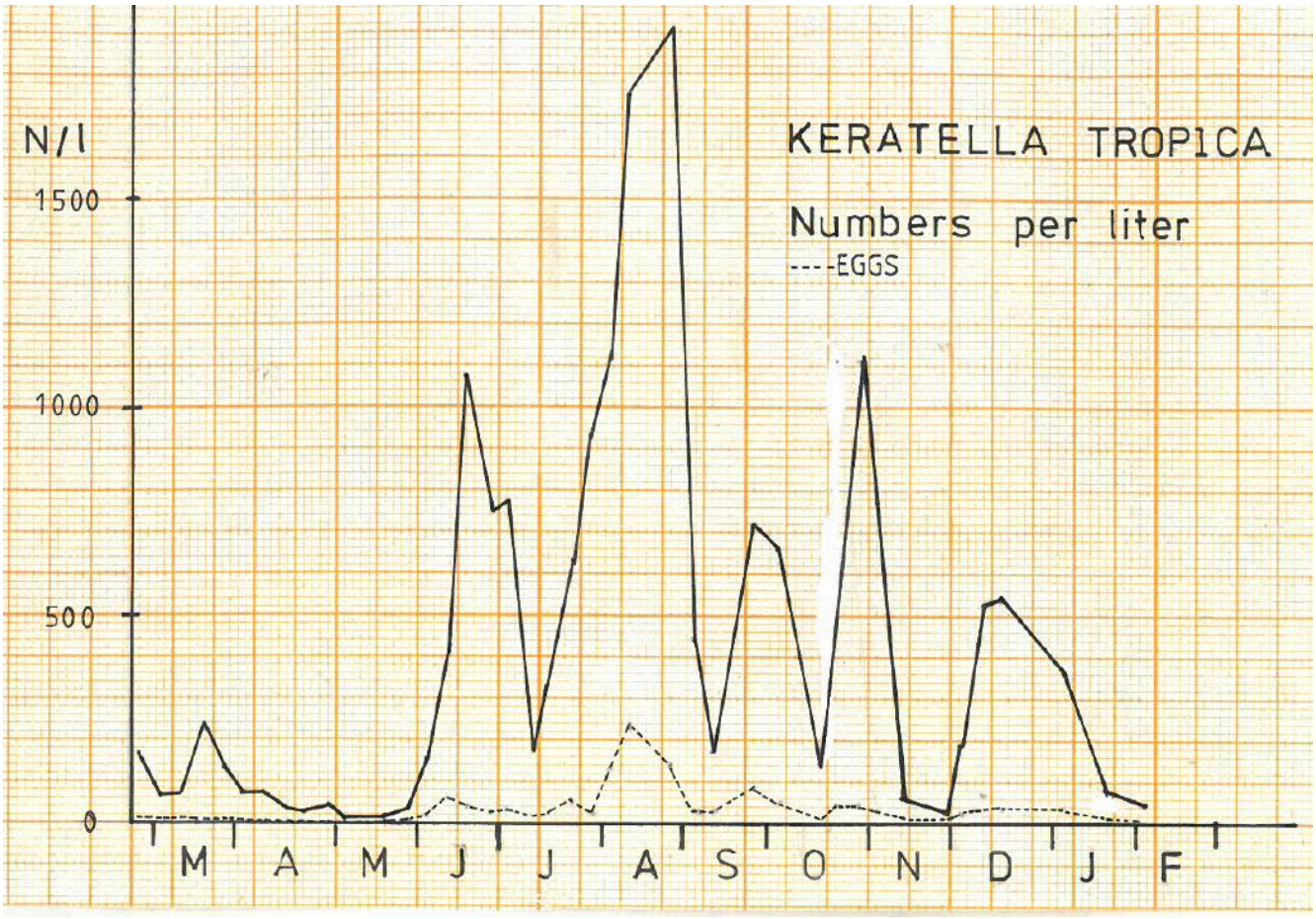
50 b. Dorsal plate of lorica with 3 closed median fields. Left lateral posterior spine more or less reduced.....51

51 a. Third median field hexagonal, closed by a transverse ridge. Size 250 µm. Dorsal plate of lorica with 5 clear marginal

facets (form *valga*[10] lack or has very indistinct marginal facets. Left lateral posterior spine reduced (*form typica*), strongly reduced (form *assymmetrica*) or absent (*form monstrosa*). Planktonic in tropical lakes, and epiphytic on roots of *Eichornia* (Water hyacinth) and floating leaves, (Arora and Mehra, 2003c). Warm-stenotherm. Affected negatively by bloom of green algae *Botryococcus braunii* blooms in Paoay Lake (Papa et al., 2007a, 2008d: record of *T. procurva* is re-determined to *T. tropica,* Aquino et al., 2008b). Abundance was higher in the Northern basin of Taal Lake, than the Southern basin, probably caused by the eutrophication effect of the fish gages in the area (Papa et al. 2011b).

In Laguna de Bay K. tropica was most abundant in periods with high primary production.

[10] ***K. valga*** is accepted as a separate species by some authors (E.g. Fernando 2002a). K. valga is thus distinguished from *K. tropica* by lack of or with very indistinct 5 clear marginal facets.



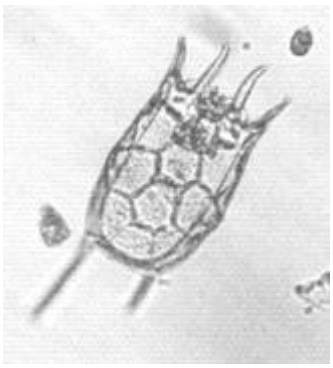
***K. tropica* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

- Laguna de Bay, Pasig River, Paoay Lake, Bunot Lake, Calibato Lake, Tadlac Lake, Taal Lake, Lake Mainit, Lake Lanao, IRRI rice field, Lake Danao (Leyte/Cebu?).

Keratella tropica (APSTEIN, 1907)

(syn. Keratella valga[11] tropica).

[1941a (valga + tropica), 1973, 1974 (valga) 1980, 1984a, 1999, 2008b, 2009a, 2001a, 2011a (valga), 2012a]



K. tropica from Laguna de Bay



K. tropica

(Photo by Rey Donne S. Papa, 2007)

51 b. Third median field pentagonal, terminating in a median ridge. Posterior spines divergent of unequal length. Shows affinity for the cyanobacteria (blue green algae) and dinoflagellates in Lake Lanao (Lewis 1979). In ponds, rice fields, and lakes. Rare.

- Lake Lanao, Laguna de Bay (Laguna Lake), Pasig River, IRRI rice field, Paoay Lake, Taal Lake.

Keratella procurva (THORPE, 1891)

[1977, 1978a+b, 1979b, 1986a, 1999, 2007a, 2007a, (2008d T. tropica, Aquino et al., 2008b), 2001a, 2009a, 2011a]

ANURAEOPSIS, LAUTERBORN 1900

Lorica present, i.e. cuticle thickened to form a stiff shell (lorica), which retain its shape well after preservation. Lorica oval to boat-shaped, with fold down the sides where dorsal and ventral plates meet. Tear-drop-shaped eggs attached to egg carrier. Planktonic. Typical inhabitants of warm pond plankton and some species prefer tropical habitats (Wallace et al., 2006).

[2009a]

LENGTH-WEIGHT-RELATIONSHIP OF ANURAEOPSIS (WETWEIGHT)

FORMULA: $W = 0.03 \times 10^{-6} \times L^3$ (W = Wetweight in µg, L = length in µm)

Length	Weight
50	0.005
60	0.01
70	0.01
80	0.02
90	0.02
100	0.03
110	0.04
120	0.05
130	0.07
140	0.08
150	0.10
160	0.12
170	0.15
180	0.18
190	0.21
200	0.24
210	0.28
220	0.32
230	0.37
240	0.42
250	0.47
260	0.53
270	0.59
280	0.66
290	0.73
300	0.81
310	0.89
320	0.98

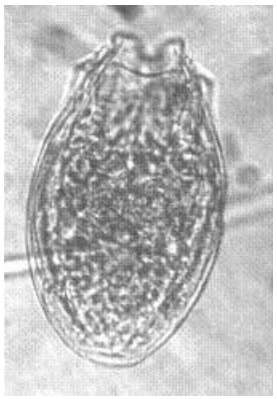


52 a. Shape ovate. Lorica not granulated, margin smooth. Size 90-120 µm. Efficient consumer of bacteria-sized particles and thus an important consumer within the microbial loop. Planktonic in ponds, sporadic in the littoral part of warm temperate, highly eutrophic, shallow lakes (Wallace et al., 2006). Sládeček (1983) refer *A. fissa* as an indicator of oligotrophic waters. Stenohaline, cannot handle a wide fluctuation in the salt content of water.

- Laguna de Bay, Lake Mainit, Buluan Lake.

Anuraeopsis fissa (GOSSE, 1851)

[1941a, 1973, 1980, 1984a]



***A. fissa* from Laguna de Bay**

52 b. Shape navicular. Lorica granulated, serrated at the margin. Very polymorphic. Planktonic in tropical lakes.
- Paoay Lake, Taal Lake

Anuraeopsis navicula (ROUSSELETE, 1910)
[1980, 1984a, 2011b+c]



***A. navicula* from Paoay Lake**



***A. navicula* from Paoay Lake**

EUCLANIDAE, EHRENBERG, 1838 (family)

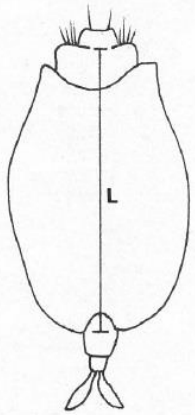
EUCHLANIS, EHRENBERG, 1832, (syn. Dapidia)
Inclusive **TRIPLEUCHLANIS** (MEYERS, 1930)
Lorica with flattened ventral surface, dorsal surface convex. Foot with 2 jointed segments. Most species littoral,

only one planktonic.

LENGTH-WEIGHT-RELATIONSHIP FOR EUCHLANIS

FORMULA $W = 0.1 \times 10^{-6} \times L^3$ (W = Wetweight in µg, L = length in µm)

Length	Weight
70	0.03
80	0.05
90	0.07
100	0.10
110	0.13
120	0.17
130	0.22
140	0.27
150	0.34
160	0.41
170	0.49
180	0.58
190	0.69
200	0.80
210	0.93
220	1.06
230	1.22
240	1.38
250	1.56
260	1.76
270	1.97
280	2.20
290	2.43
300	2.70
320	3.28
340	3.93
360	4.67
380	5.49
400	6.40
450	9.11



53 a. Dorsal plate of lorica in cross section not highly domed (high about 80-100 µm). Body usual green in color. Foot with 2 sections. Most species littoral. Length (dorsal plate) 155-320 µm. Toes 50-100 µm. In littoral among macrophytes. Very common.

- Paoay Lake, La Mesa Dam, Naujan, Lake Mainit, Lake Lanao, Calamba River, IRRI rice field, Pasig River (rare).

Euchlanis dilatata, EHRENBERG, 1832

[1941a, 1978a+b, 1986a, 1999, 2009a]

53 b. Dorsal plate of lorica in cross section markedly domed (high up to 200 µm). Body usual brown in color. Foot with 2 sections. Most species littoral. Length (dorsal plate) 246-315 µm. Toes 65-75 µm. In pelagic (limnetic) zone. Indicator of mesotrophic waters (Sládeček (1983).

- Laguna de Bay (form *lucksiana*, HAUER, 1931, planktonic),

Euchlanis lucksiana, HAUER, 1930

(syn. Euchlanis dilatata. var. lucksiana)

[1941a]

53 c. Similar to E. dilatata, but with high crested dorsal lorica plate and lateral extensions or "wings". Ventral planar. Dorsal anteroom-posterior keel prominent. Toes strong, pointed. Body oval shaped. The 'V' shaped notch at the posterior end of the dorsal plate is characteristic. Size 175-210 µm. Littoral.

- Calamba River.

Euchlanis incisa, CARLIN, 1939

(syn. *Euchlanis triquetra*)

[1999]

53 d. With double cuticular fields between lorica plates. With spine on tail, and three segments on foot. Mainly found in brackish and seawater. Littoral, rarely planktonic.

- Taal Lake.

Tripleuchlanis plicata, (LEVANDER, 1894)

[2001a, 2011a]

53 e. Foot with 3 jointed segments (***Dipleuchlanis)***.....54

DIPLEUCHLANIS, de Beauchamp, 1910

Foot with 3 jointed segments. Strictly littoral.

54 a. Dorsal plate concave and smaller than ventral. Lateral edges of the two plates nearly parallel. Toes very long and slender (Mamaril 1978a). A strictly littoral genus similar to Euchlanis, occasional in ponds and lakes.
- Laguna de Bay, La Mesa Dam, Lake Lanao, IRRI Rice field.
Dipleuchlanis propatula (GOSSE, 1886)
[1978a+b, 1986a, 1999]

MYTILINIDAE, HARRING, 1913 (family)

MYTILINA, BORY ST. VINCENT 1826,
(syn. *Diplacidium*, *Diplax*, *Salpina*)
Strongly loricated. Lorica fairly stout. Two dorsal ridges with a furrow between. Almost always with variable anterior and posterior spines at corners of lorica. Toes two, longer than foot. Prefer alkaline waters (Sládeček 1983).
Found among plants, littoral and benthic, only as guests in the plankton (tychoplanktonic): Pasig River.
[2009a]

55 a. Lorica transparent with three keels on the back. Frontal edge smooth and curved. Toes thin and straight ending in an acute point. Littoral in ponds and lakes. Indicator of mesotrophic waters (Sládeček 1983).Rare.
- Laguna de Bay, IRRI, Consolacion (Cebu)
Mytilina bisulcata (LUCKS, 1912)
[1978a+b, 1986a]



IRRI, Los Baños. (Photo: Flemming Petersen, 1980)

55 b. Lorica heavily stippled in anterior region. With small spines. Posterior ventral spines longer than the posterior dorsal spine. Two toes well developed with acute points. Size 170-225 µm. A fairly variable species. Littoral in pond and lakes. Common.
- Paoay Lake, Bustos Dam, Lake Lanao, Calamba River

Mytilina ventralis, EHRENBERG, 1832
[1978a+b, 1986a, 1999]

TRICHOTRIIDAE, HARRING, 1913 (family)

TRICHOTRIA, (BORY ST. VINCENT 1827)
Wheel organ (corona) of typical *Euchlanis-Brachionus* type. Anterior and/or posterior end with spines.

56 a. Lorica vase-shaped, longer than broad. Trunk, head, and foot clearly defined. Sturdy lorica facetted and pustulate, with ridges and spines. Foot with 3 segments, first with two dorsal triangular spines. Two slender toes about as long as foot. Eye single. Littoral, rarely or never in plankton, also epiphytic on roots of *Eichornia* (Water hyacinth),

(Arora and Mehra, 2003c). Common.

- Laguna de Bay, Bustos Dam, Roadside ditches along Lake Lanao.

Trichotria tetractis (EHRENBERG, 1830.)

[1978a+b, 1986a, 1999]

LEPADELLIDAE, HARRING, 1913 (family)

(syn. COLURELLIDAE Wesenberg-Lund, 1930) (Segers, 2002a)

COLURELLA, BORY ST. VINCENT 1824, (syn. Colurus)

Lorica shell-shaped, rounded, or truncated, posteriorly rounded or extended into a point. Littoral and tychoplanktonic. Small rotifers, size 60-120 µm. Benthic.

57 a. Marine and brackish/estuarine species.

Body oval, laterally compressed, with a rigid shell-shaped lorica and a head plate which, though slightly stiffened, can be retracted together with the anterior apart of the body. Foot in 3 segments, about one-fourth of the length of the body. Toes long and of equal length, sharply pointed, sometimes fused. Total length 70-90 µm, dorsal lorica length 60 µm, foot + toes 30 µm. Littoral in ponds. Rare.

- Laguna de Bay, Pasig River.

Colurella colurus, (EHRENBERG, 1830)

[1978a+b, 1980, 1984a, 1986a, 2009a]

57 b. Freshwater species.

Length of body 70, width 35-37. Length of foot and toes 27-30 µm.

- Calamba River, Lake Danao (Leyte/Cebu?).

Colurella obtusa (GOSSE, 1886)

[1999]

LEPADELLA, (BORY ST. VINCENT 1826), (syn. Metopidia)

Lorica oval, egg- or pear-shaped, of 1 peace. Anterior opening of lorica narrow, semicircular. Foot opening deeply incised, foot with 3-4 sections. Two eyes. Littoral, tychoplanktonic. Prefer acid waters (Sládeček 1983).

58 a. Benthic, 9 species. In ponds. Some species occasionally in ponds and lakes. Se Mamaril (1986a)

- Paoay Lake, La Mesa Dam, etc.

Lepadella sp.

[1978a+b, 1986a, 1999]

Occasionally in ponds, lakes, and rivers

- Calamba River

L. ovalis (MÜLLER, 1786) and

among vegetation, mosses and even in plankton. Prefer eutrophic waters (Sládeček 1983).

- Calamba River.

L. patella (MÜLLER, 1773),

are both planktonic species.

[1978a+b, 1986a, 1999 ,Kutikova, 2002a]

LECANIDAE, (BARTOS, 1959) (family)

Jaws malleate. Fulcrum short, rami more or less triangular or lyriform. Only littoral species.

LECANE, NITZSCH 1827, (syn. Monostyla)

Lorica oval, pear- or shield-shaped. With dorsal and ventral plate. Anterior opening of lorica broad. Foot very short, toes long, eventually fused to one. One eye. Littoral,

tychoplanktonic i.e. migrated from the littoral to the pelagic (or limnetic) part of the lake. Rather thermophilic group, with several species in tropical waters (Segers 2001b). Prefer acid waters (Sládeček 1983). Divided in to subgenus

59 a. A littoral genus, several species occurring between plants. 27 species recorded by Mamaril (1986a).
- Laguna de Bay, Pasig River, Calamba River, IRRI rice field, Danao Lake (Leyte/Cebu?), Lake Lanao, etc.

Lecane spp.

(syn. ***Monostyla***)

[1941a, 1974, 1978a+b, 1980, 1984a, 1986a, 1999, 2008b, 2009a]

2 toes on foot.....Subgenus *Lecane*

Planktonic species (Mamaril and Fernando, 1978b). Rice fields, ponds, lakes, and reservoirs. Stenohaline, so it cannot handle a wide fluctuation in the salt content of water. Common.
- La Mesa Dam

Lecane (Lecane) curvicornis (MURRAY, 1913).

Planktonic species (Kutikova, 2002a). Very common.
- Laguna de Bay

Lecane (Lecane) leontina (TURNER, 1892)

Planktonic species (Kutikova, 2002a). Very common.
- Paoay Lake, Laguna de Bay (se picture), Taal Lake

Lecane (Lecane) luna (MÜLLER, 1776)

[2001a, 2011a]



Lecane luna from Laguna de Bay

Planktonic species (Mamaril and Fernando, 1978b).
In all types of freshwater, except in running waters. Very common.
- Laguna de Bay

Lecane (Lecane) papuana (MURRAY, 1913).

Planktonic species (Mamaril and Fernando, 1978b).
In ponds, reservoirs, and lakes. Fairly common
- Lake Mainit, Lake Lanao.

Lecane (Lecane) ungulata (GOSSE, 1887).

1 toe on foot.....Subgenus *Monostyla*:

Planktonic species (Kutikova, 2002a). But normal inhabitants of the vegetation in the littoral of lakes, ponds, and pools. (Sládeček 1983).Very common.
- Paoay Lake, Taal Lake, IRRI rice fields.

Lecane (Monostyla) bulla (GOSSE, 1886)
[2008b, 2011b+c]



L. bulla (Photo by Rey D. S. Papa, 2007)

Planktonic species (Kutikova, 2002a). Common.

- Calamba River, Lake Danao (Leyte/Cebu?).

Lecane (Monostyla) closterceca (SCHMARDA, 1859)

Planktonic species (Kutikova, 2002a). In reservoirs and lakes. Stenohaline, so it cannot handle a wide fluctuation in the salt content of water. Common.

- Laguna de Bay

Lecane (Monostyla) stenroosi (MEISSNER, 1908)

Planktonic species (Fernando 2002a). In lakes.

- Taal Lake

Lecane (Monostyla) patella (MÜLLER 1773)

[2001a, 2011a]

[See 1978a+b, 1980, 1984a, 1986a, 1999 for further details]

TRICHOCERCIDAE, (REMANE, 1933) (family)

Jaws virgate. Mostly littoral and only a few planktonic species.

TRICHOCERCA, LAMARCK 1801, (syn. Diurella, Mastigocerca, Rattulus)

Lorica not flattened, asymmetrical, more or less cylindrical. Foot short with toes of unequal length (subgenus ***Diurella***), often with one toe almost reduced or absent (subgenus ***Trichocerca*** (s. str.)). Most species are littoral. Prefer oligotrophic and acid waters (Sládeček 1983).

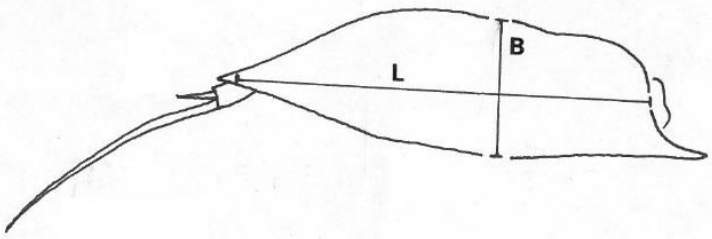
Trichocerca disappeared from Laguna de Bay in periods with increase in salinity showing sensitivity to the increased salinity. A decrease in mean density from 1.4 to 0.6 individual's m^{-3} was found in Pasig River from the outlet from the brackish water Laguna de Bay to the saline Manila Bay by Papa and his team (2009a).

LENGTH-WEIGHT-RELATIONSHIP for TRICHOCERCA (WETWEIGHT)

FORMULA USED: $W = 0.52 \times 10^{-6} \times L \times B^2$

(W = Weight in ug, L = Length in um, B = Wide in um)

Length (L)	Wide (B)										
70	30	40	50	60	70	80	90	100	110	120	130
70	0.03	0.06	0.09	0.13	0.18	0.23	0.29	0.36	0.44	0.52	0.62
80	0.04	0.07	0.10	0.15	0.20	0.26	0.33	0.41	0.50	0.60	0.70
90	0.04	0.07	0.12	0.17	0.23	0.30	0.38	0.47	0.57	0.62	0.79
100	0.05	0.08	0.13	0.19	0.25	0.33	0.42	0.52	0.63	0.75	0.89
110	0.05	0.09	0.14	0.21	0.28	0.37	0.46	0.57	0.69	0.82	0.97
120	0.06	0.10	0.16	0.22	0.31	0.40	0.51	0.62	0.76	0.90	1.05
130	0.06	0.11	0.17	0.24	0.33	0.43	0.55	0.68	0.82	0.97	1.14
140	0.07	0.12	0.18	0.26	0.36	0.47	0.59	0.73	0.88	1.05	1.23
150	0.07	0.12	0.20	0.28	0.38	0.50	0.63	0.78	0.94	1.12	1.31
160	0.07	0.13	0.21	0.30	0.41	0.53	0.67	0.83	1.01	1.20	1.41
170	0.08	0.14	0.22	0.32	0.43	0.57	0.72	0.88	1.07	1.27	1.49
180	0.08	0.15	0.23	0.34	0.46	0.60	0.76	0.94	1.13	1.35	1.58
190	0.09	0.16	0.25	0.36	0.48	0.63	0.80	0.99	1.20	1.42	1.67
200	0.09	0.17	0.26	0.37	0.51	0.67	0.84	1.04	1.26	1.50	1.76
210	0.10	0.17	0.27	0.39	0.54	0.70	0.88	1.09	1.32	1.57	1.85
220	0.10	0.18	0.29	0.41	0.56	0.73	0.93	1.14	1.38	1.65	1.93
230	0.11	0.19	0.30	0.43	0.59	0.77	0.97	1.20	1.45	1.72	2.02
240	0.11	0.20	0.31	0.45	0.61	0.80	1.01	1.25	1.51	1.80	2.11
250	0.12	0.21	0.33	0.47	0.64	0.83	1.05	1.30	1.57	1.87	2.20
260	0.12	0.22	0.34	0.49	0.66	0.87	1.10	1.35	1.64	1.95	2.28
270	0.13	0.22	0.35	0.51	0.69	0.90	1.14	1.40	1.70	2.02	2.37
280	0.13	0.23	0.36	0.52	0.71	0.93	1.18	1.46	1.76	2.10	2.46
290	0.14	0.24	0.38	0.54	0.74	0.97	1.22	1.51	1.82	2.17	2.55
300	0.14	0.25	0.39	0.56	0.76	1.00	1.26	1.56	1.89	2.25	2.64
320	0.15	0.27	0.42	0.60	0.82	1.06	1.35	1.66	2.01	2.40	2.81
340	0.16	0.28	0.44	0.64	0.87	1.13	1.43	1.78	2.14	2.55	2.99
360	0.17	0.30	0.47	0.67	0.92	1.20	1.52	1.87	2.27	2.70	3.16
380	0.18	0.32	0.49	0.71	0.97	1.26	1.60	1.98	2.39	2.85	3.34
400	0.19	0.33	0.52	0.75	1.02	1.33	1.68	2.08	2.52	3.00	3.52

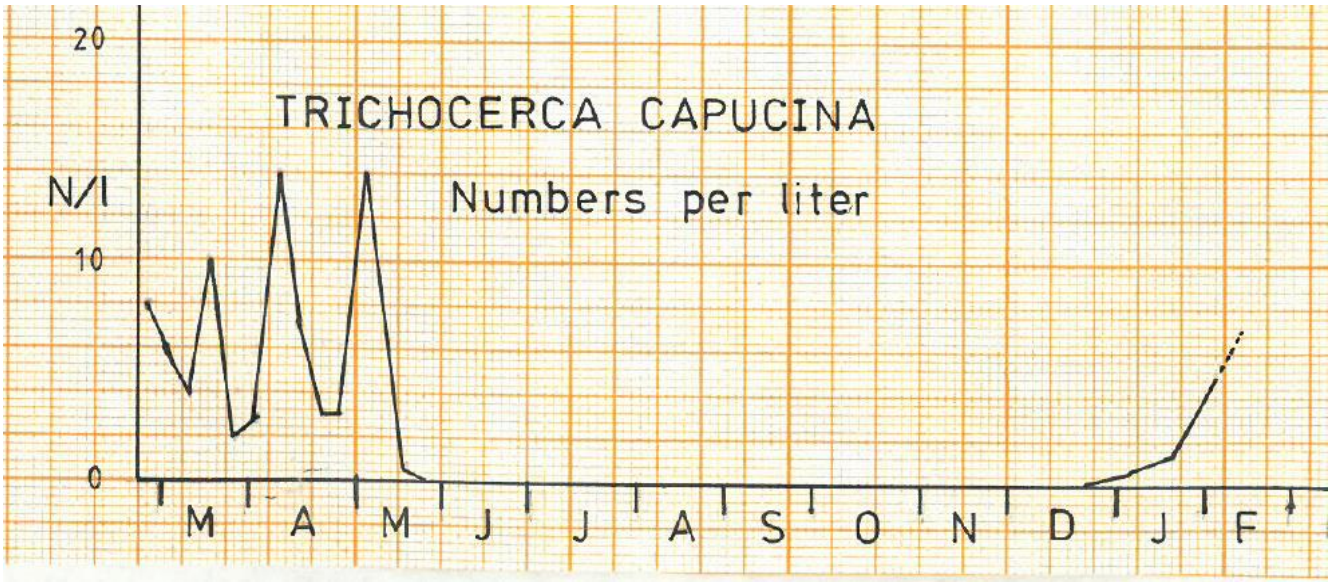


Diurella, Subgenus

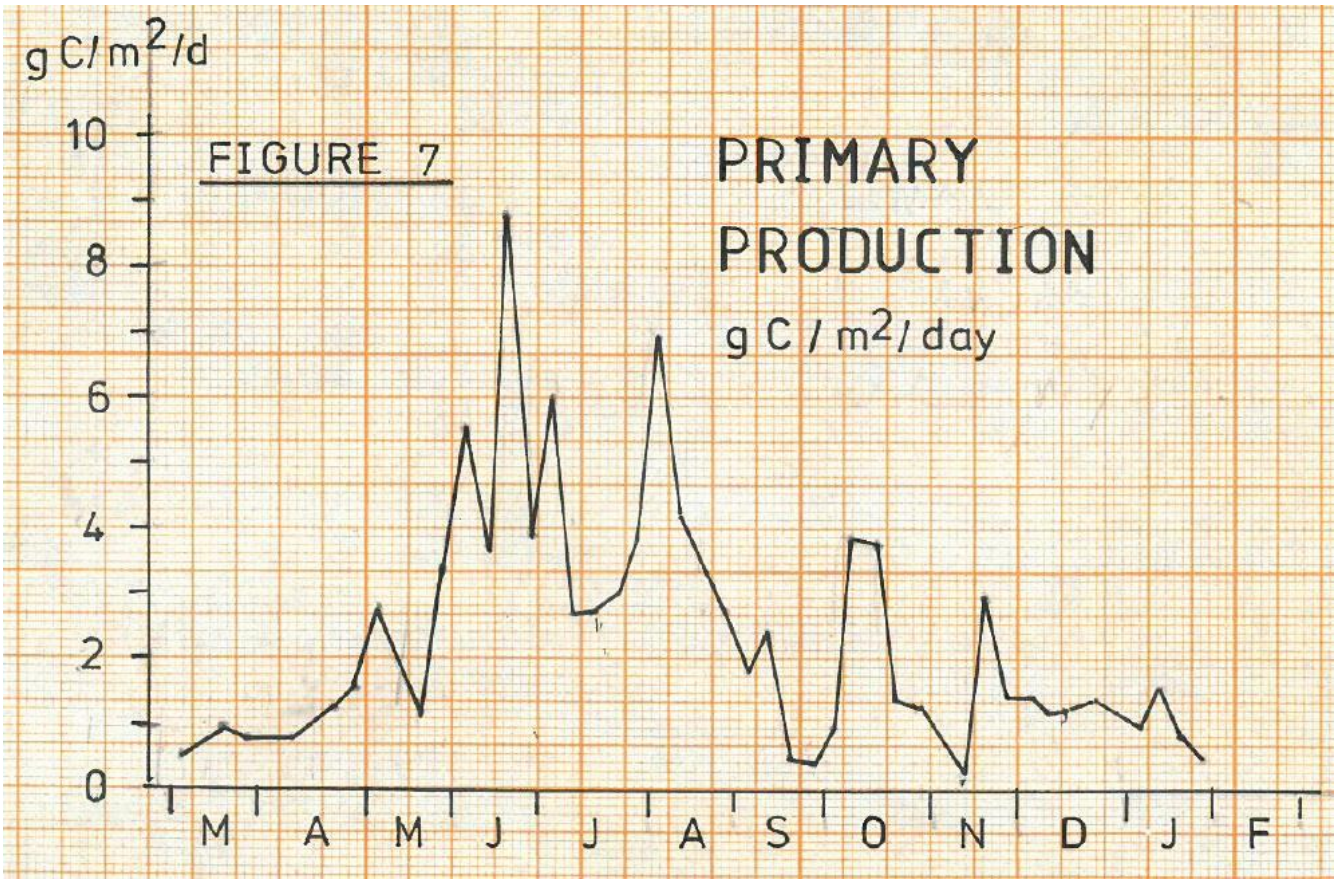
60 a. With hood or plate-like projection on anterior margin of

lorica. Two toes, right toe very short. Body long, slender, and cylindrical. Size < 300 µm, left toe 125 µm. Sucks out the yolk of other rotifers eggs, especially Keratella, and attaches its eggs to other rotifers. Planktonic. Rare. Usually sporadic, rarely numerous.

In Laguna de Bay in was common in period with low primary production and low temperature.



***T. capucina* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

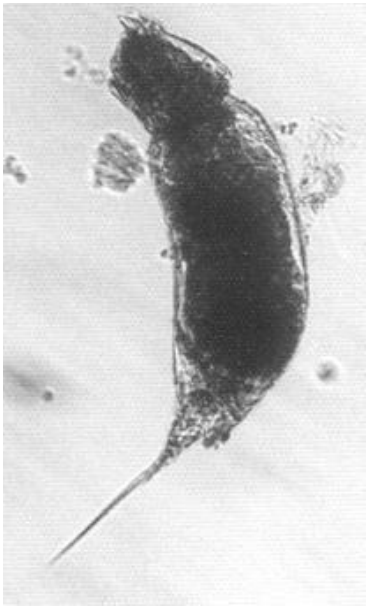


Fluctuation in primaryproduction in Laguna de Bay in 1980. (Petersen, 1981e).

- Laguna de Bay, La Mesa Dam, Paoay Lake, Taal Lake.

Trichocerca capucina, (WIERZEJSKI and ZACHARIAS, 1893), (syn. Diurella capucina).

[1941a, 1974, (T. longiseta), 1978a+b, 1980, 1984a, 1986a, 2008b, 2011b+c]



***T. capucina* from Laguna de Bay**

60 b. Without this. Body short compact.....61

Trichocerca (s. str.), (Subgenus)

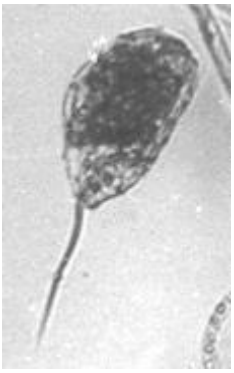
61 a. Single dorsal ridge or wide keel at the anterior end. Keel usually striated. One long toe. Size 170 µm. Rare.
- Lake Lanao, ponds in Lanao del sur.
Trichocerca rattus, (MULLER, 1776)
[1978a+b, 1986a]

61 b. Without dorsal ridge.....62

62 a. Right toe absent, or extremely small. Size 70-110 my, left toe 40-60 um. Eggs attached to other rotifers like Brachionus angularis. Planktonic in lakes and ponds, also in brackish water. Usually sporadic.
- Bunot Lake, Laguna de Bay (Laguna Lake)

Trichocerca pusilla, (LAUTERBORN, 1898)

[1941a, 1980, 1984a, 1999]



***T. pusilla* from Laguna d Bay**

62 b. Right toe present but much reduced. Left toe less than half the body length. Anterior border of lorica with undulations. Size of body 120 µm. Planktonic in tropical waters.

- Lake Danao (Leyte/Cebu?), Tadlac Lake, Taal Lake.

Trichocerca dixon-nuttalli (JENNINGS, 1903)

(syn. *Diurella dixon-nuttalli*)

(syn. *Trichocerca inermis*),

(syn. *Trichocerca ruttneri*)

[1941a, 1999, 2001a, 2011a]

62 c. Right toe present. Kidney-shaped lorica, body is short, thick, and strongly curved, so that the back forms an arc. The head sheath is marked off from the body and is composed of eight longitudinal folds. Lacks anterior spines and protuberances. The toes from almost equal length to left toe larger than the right. Body (excluding the toes) 100 µm. Width up to 40 µm. Length of longest toes 25-40 µm. The species were correlated with abundance of cyanobacteria (blue green algae) in occurrence (Lewis 1979b)

- Lake Lanao (in 1970-71)

Trichocerca brachyura (GOSSE, 1851)

(syn. Diurella brachyura)

[1979b]

GASTROPODIDAE, {REMANE, 1933) (family)

Jaws virgate. Mostly littoral and only a few planktonic species.

ASCOMORPHA, (PERTY 1850),

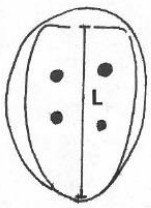
(syn. Sacculus, Chromogaster, Anapus).

Without foot. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation or stiff forming a distinct lorica. Body Small sack-shaped to oval, with 1-**4** dark masses. Green colored. Jaws virgate for sucking. A littoral and planktonic genus. (See Radwan & Bielanska-Grajner, 2002).

LENGTH-WEIGHT-RELATIONSHIP OF ASCOMORPHA. (wet weight)

FORMULA $W = 0.12 \times 10^{-6} \times L^3$ (W = weight in ug, L = length in um)

Length	Weight
70	0.04
80	0.06
90	0.09
100	0.12
110	0.16
120	0.21
130	0.26
140	0.32
150	0.41
160	0.49
170	0.59
180	0.70
190	0.82
200	0.96
210	1.11



63 a. With sickle-shaped palp on head, used for holding pray (e.g.

Ceratium). Body ovate, more or less flattened dorso-ventrally. Lorica slightly stiff, consisting of dorsal and ventral plates covered with thin membrane. Yellow-green colored by chromophores in stomach wall. Stomach with four blind sacs. With 4 small dark masses (accretion bodies). Size 100-200 µm, with 66-84 µm. Food *Ceratium*. Maxima coincide with dinoflagellates blooms. In Laguna de Bay it occurs during a bloom of flagellates in October 1980. *Ceratium* is common in Laguna de Bay (Nielsen, 1983, Petersen, 1981e). Eurytopic, tolerates pH 5-9, 1-14 mg O_2/L, abundant at 8-9 mg O_2/L, 40-1585 µS cm^{-1} abundant at 150 µS cm^{-1} (Radwan & Bielanska-Grajner, 2002). In littoral and plankton in lakes, ponds, and rivers, also in saline waters, although it cannot handle a wide fluctuation in the salt content of water.

- Laguna de Bay

Ascomorpha ovalis, (BERGENDAHL, 1892)
(syn. *Chromogaster ovalis* HARRING, 1913)
(syn. non *Ascomorpha ecaudis* PERTY, 1850).
[1980, 1984a]



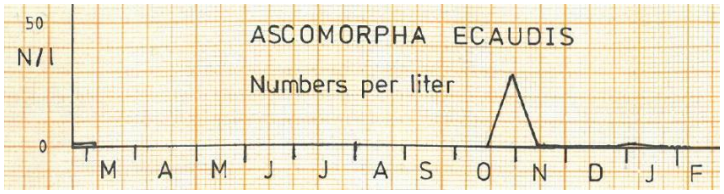
***A. ovalis* from Laguna de Bay. (Photo: Flemming Petersen, 1980)**

NOTE:

63 b. A similar species without palp on head. With 4 small dark masses (accretion bodies). Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. Body sack-shaped, green colored. Size 100 µm. Food unicellular green algae, which are digested intracellularly, or stay alive and multiply as zoochlorella in the body wall. Eurytopic, eurythermic, euryionic tolerates pH 4.0-9.2, maximum abundance reached at pH 6.2. 1-14 mg O_2/L, conductivity up to 551 µS cm^{-1} (Radwan & Bielanska-Grajner, 2002). However, Sládeček (1983) refer *A. ecaudis* as an indicator of oligotrophic waters.

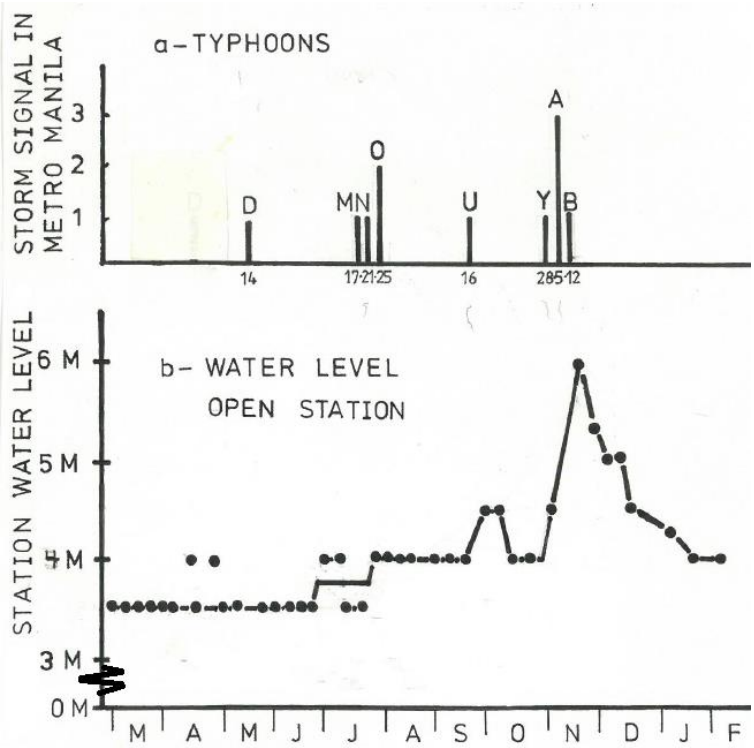
In littoral and plankton in lakes and ponds, also in saline waters.

In Laguna de Bay found only in free water mass efter increase in water level causes by heavy rainfall efter typhoons. Probably washed out from the littoral zone.



***ecaudis* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

A.



Typhoons and storm signals in Manila (a) and water level (b) in Central Bay in Laguna de Bay in 1980. (Petersen, 1981e).

- Record not verifiable.

Ascomorpha ecaudis, (PERTY, 1850)

(syn. Sacculus viridus).

[1980, 1984a cf.,

probably mis determination]

ASPLANCHNIDAE, HARRING and MYERS 1926 (family)

Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. Large sack-shaped, with corona (wheel organ) anteriorly. Rather big viviparous rotifers Planktonic family. Jaws incudate. Curved, sharp-pointed rami like pincers. Seizing type. Intestine and anus absent. *Asplanchna* releases a waterborne

signal that induces spine formation in several *Brachionus* and *Keratella* species and *Filinia longiseta* (Snell, 1998), while the presence of Asplanchna could be responsible for the development of spines in these genera if present together. Planktonic in oligotrophic and eutrophic fresh and brackish waters (Paggi, 2002).

ASPLANCHNOPUS, DE GUERNE 1888.

With foot. Prefer alkaline waters (Sládeček 1983).

64 a. With short, ventral foot with two toes. Ovary horseshoe-shaped. Size 700-1000 µm. Carnivorous. Semi planktonic, littoral in large and small alkaline waters, pH 6-8.1, warm stenotherm 10-28◦ C. Common.

- Paoay Lake, Lake Lanao, Pasig River and Quezon City: UP. Campus, Los Baños. Univ. of Santo Tomas: abandoned pond (Rey Donne S. Papa personal communication)

Asplanchnopus multiceps, (SCHRANK, 1793)

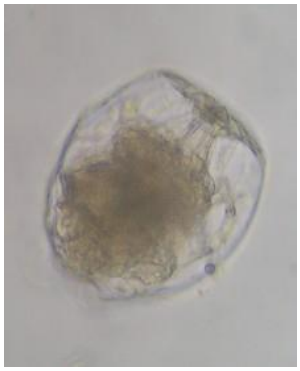
[1978a+b, 1986a, 2008b, 2009a]



A. multiceps (Photo by Rey Donne S. Papa, 2007)



A. multiceps (Photo by Rey Donne S. Papa, 2007)



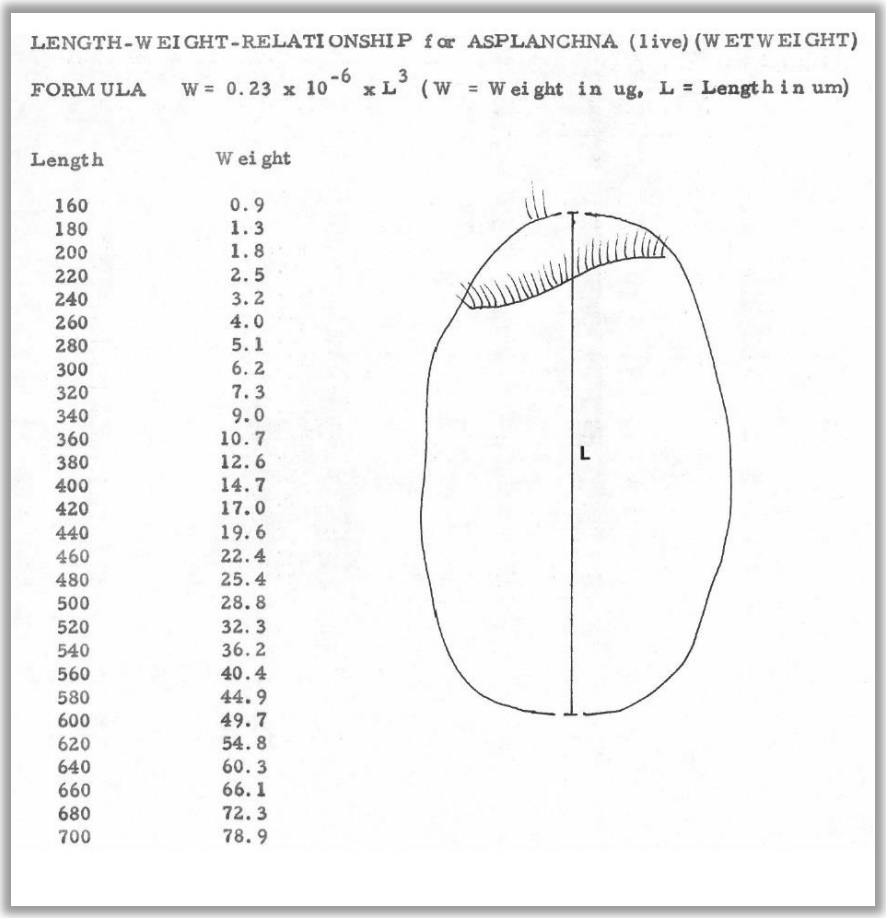
A. multiceps (Photo by Rey Donne S. Papa, 2007)

ASPLANCHNA, GOSSE 1850.

Without a foot. Feeds on particles larger than 10 µm like algae, protozoa, other rotifers (*Keratella*) and small Cladocera like Bosmina, catching them individually. Prefer alkaline waters (Sládeček 1983).

- Pasig River.

[2009a]



LENGTH-WEIGHT-RELATIONSHIP for ASPLANCHNA (live) (WET WEIGHT)

FORMULA $W = 0.23 \times 10^{-6} \times L^3$ (W = Weight in ug, L = Length in um)

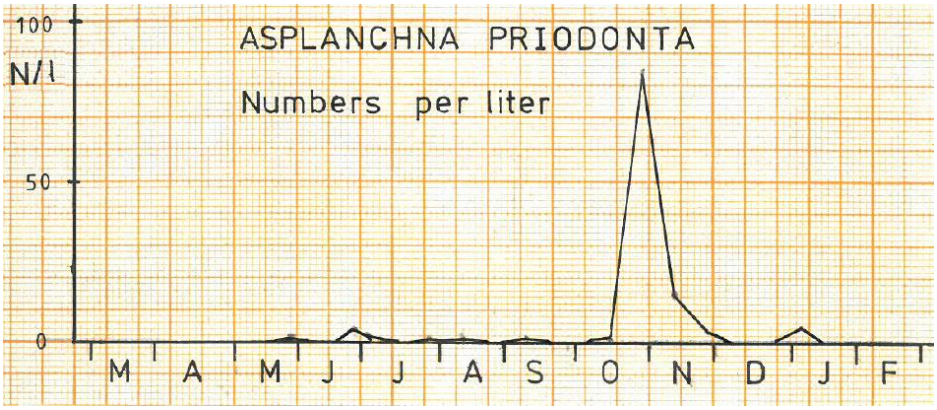
Length	Weight
160	0.9
180	1.3
200	1.8
220	2.5
240	3.2
260	4.0
280	5.1
300	6.2
320	7.3
340	9.0
360	10.7
380	12.6
400	14.7
420	17.0
440	19.6
460	22.4
480	25.4
500	28.8
520	32.3
540	36.2
560	40.4
580	44.9
600	49.7
620	54.8
640	60.3
660	66.1
680	72.3
700	78.9

65 a. Without foot. Yolk gland (vitellarium) round. Size 500-1500 µm. Feed on diatoms, dinoflagellates and Chrysophyseae, but predate also on rotifers as Keratella, Polyarthra and Anuraeopsis and cladocerans and copepods. Important

predator in control of micro-plankton populations (Paggi, 2002). Planktonic in lakes and ponds, often numerous, also found in brackish water.

ASPLANCHNA, SUDZUKI, 1964 **or PRIODONTA GROUP.**

Body length 250-1500 µm. Feeds on algae, ciliates and small rotifers. Indicator of mesotrophic waters (Sládeček, 1983)
In waters with pH 4.5-8, temperature up to 29°C.
Found abundant only in a short period I Laguna de Bay in October-November 1980 after a short boost in primary production followed by an increase in *Brachionus* biomass coincident with a decreasing number of cyclopoid copepodites – to suggest some possible explanations of coordinated events.



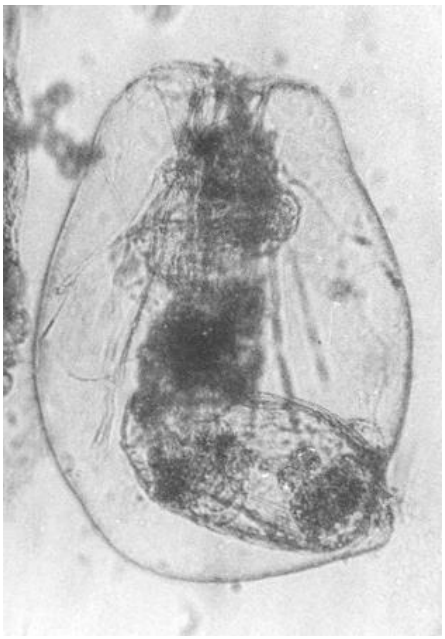
Asplanchna priodonta **population size fluctuation in Laguna de Bay in 1980.**

(Petersen, 1981e).

- Laguna de Bay.

Asplanchna priodonta, (GOSSE, 1850)

[1941a, 1980, 1984a]



***A. priodonta* from Laguna de Bay**

65 b. Without foot. Yolk gland horseshoe-shaped.

ASPLANCHNELLA, SUDZUKI, 1964 **or GIRODI-BRIGHTWELLI GROUP.**

Size 500-2500 µm. Feed on Volvocales, Chlorococcales and several genera of rotifers including their own and micro crustaceans. Diet can induce smaller morphoforms: form saccate and form cruciform (with lateral outgrowths to protect against cannibalism), while the normal form is campanulata (Wallace et al., 2006). Planktonic in fresh-water, also in brackish water.

- Calibato Lake, Tadlac Lake.

Asplanchna sieboldii (LEYDIG, 1854)

(syn. *Asplanchna sieboldi*)

[1941a, 1980, 1984a]

SYNCHAETIDAE, HUDSON & GOSSE, 1886 (family)

Jaws virgate, symmetrical. All four part present, fulcrum is long, asymmetric and the rami pointed. Piercing and sucking.

POLYARTHRA, EHRENBERG 1834.

Without foot. Cuticle thin, transparent, not usually retaining its shape well after preservation. Body with 12 blades or feathers in 4 groups of 3 blades, 2 groups dorsoventrally and 2 groups ventro-laterally. Planktonic and, some epiphytic on roots of *Eichornia*, Water hyacinth (Arora and Mehra, 2003c). See Hollowday (2002) for a key to the genus.

- Laguna de Bay.

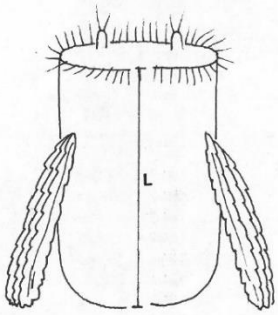
Polyarthra sp.

[2012a]

LENGTH-WEIGHT-RELATIONSHIP for POLYARTHRA (WETWEIGHT)

FORMULA $W = 0.308 \times 10^{-6} \times L^3$ (W = Weight in ug, L = Length in um)

Length	Weight
50	0.04
60	0.07
70	0.11
80	0.16
90	0.22
100	0.31
110	0.41
120	0.53
130	0.68
140	0.85
150	1.04
160	1.26
170	1.51
180	1.80
190	2.11
200	2.46
210	2.85
220	3.28
230	3.75
240	4.26
250	4.81
260	5.41
270	6.06
280	6.76
290	7.51
300	8.32



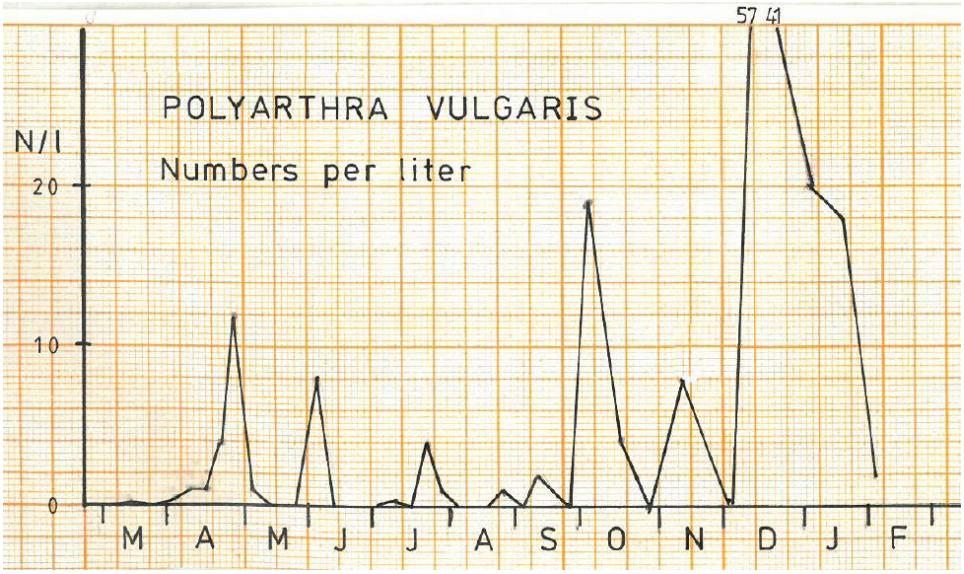
66 a. Blades feather-like, up to 30 µm broad. Length of blades equal to or less than body length.....67

66 b. Blades serrated sword-shaped, only up to 15 µm broad. Length of blades longer than length of body. Size 90-120 µm. Ventral finlets present (can only be seen for sure in lateral view). pH range 4.2-8.6. In eutrophic waters. (Hollowday, 2002)
- IRRI rice field.
Polyarthra cf. ***dolichoptera*** IDELSON, 1925
[1999]

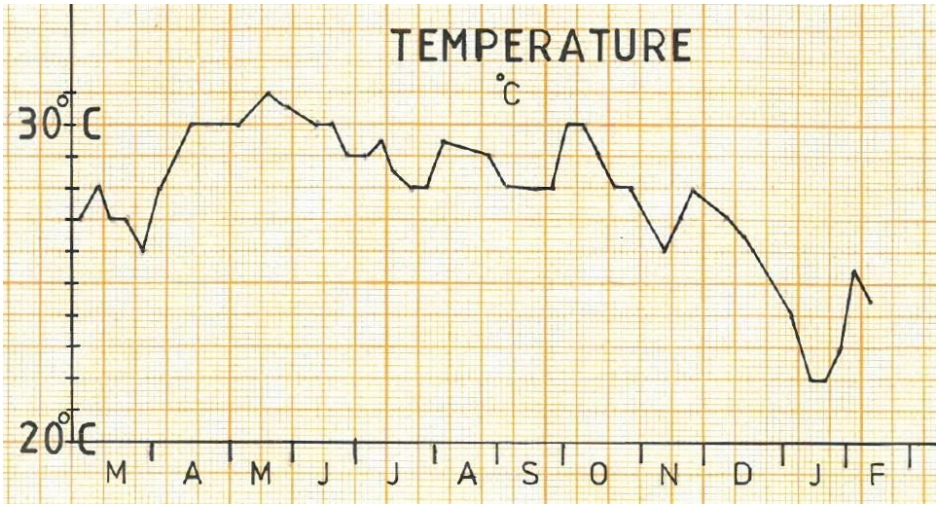
67 a. Blades 20-30 µm broad (should be measured by a micro meter on a flat blade). Length of blades less than length of body. No ventral finlets. Size 150-170 µm. Planktonic in lakes and occasionally in big ponds. Eurythermic and eutrophic. pH 3.5-9 (Hollowday, 2002).
- Lake Danao (Leyte/Cebu?).
Polyarthra major, BURCKHARDT, 1900
[1999]

67 b. Blades 8-20 µm broad, but variable, grading from father-shape to narrow sword-shape (narrowing the *P. dolichoptera* shape). Length of blades equal to or less than body length. Ventral finlets present. Size 100-150 µm. Feeds only on algae (Diatoms and cryptomonads, as in Lake Lanao (Lewis 1979)). Planktonic in lakes, ponds and reservoirs of eurytherm and oxygen rich types, pH 4.9-8.7. Indicator of mesotrophic waters (Sládeček 1983). Abundance was higher in the Northern basin of Taal Lake, than the Southern basin, probably caused by the eutrophication effect of the fish gages in the area (Papa et al. 2011b). Common.

In Laguna de Bay it was only abundant in the period of decreasing temperature in 1980. Otherwise it occurred only in few numbers. Se following graphs.



P. vulgaris **population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



Fluctuation surface temperature in Laguna de Bay in 1980. (Petersen, 1981e).

- Laguna de Bay, Pasig River, La Mesa Dam, Lake Mainit, Lake Lanao, Paoay Lake, Taal Lake.

Polyarthra vulgaris, (CARLIN, 1943)

Syn.: *Polyarthra trigla vulgaris* SUDZUKI 1964

[1973, 1977, 1978a+b, 1979b, 1980, 1984a, 1986a, 2008b, 2009a, 2011b+c, 2012a]



***P. vulgaris* from Laguna de Bay**

GNESIOTROCHA, KUTIKOVA, 1970 (superorder)

FLOSCULARIACEA, (REMANE, 1933) (order)

TESTUDINELLIDAE, (BARTOS, 1959) (family)

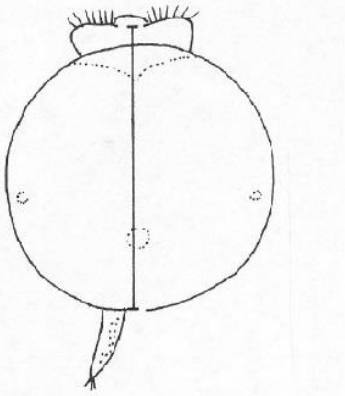
Jaws malleoramate. Fulcrum short, rami more or less triangular, flat; unci teeth numerous.

TESTUDINELLA, (BORY ST. VINCENT, 1826), (syn. Pterodina)

Lorica present, i.e. cuticle thickened to form a stiff shell (lorica), which retain its shape well after preservation. Lorica strongly flattened, circular in outline, foot opening ventral, and foot ends in circle of cilia.

LENGTH-WEIGHT-RELATIONSHIP for TESTUDINELLA (WETWEIGHT)

FORMULA $W = 0.088 \times 10^{-6} \times L^{3}$ (W = Weight in ug, L = Length in um)



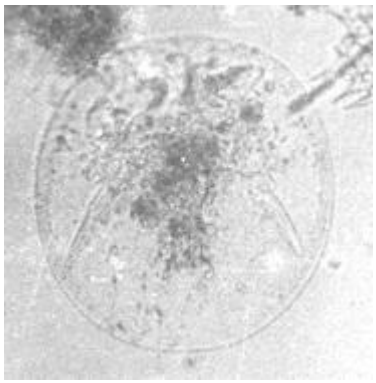
Length	Weight		
50	0.01		
60	0.02		
70	0.03		
80	0.05		
90	0.06		
100	0.09		
110	0.12		
120	0.15		
130	0.19		
140	0.24		
150	0.30		
160	0.36		
170	0.43		
180	0.51		
190	0.60		
200	0.70		
210	0.81	360	4.11
220	0.94	370	4.46
230	1.07	380	4.83
240	1.22	390	5.22
250	1.38	400	5.63
260	1.55	410	6.04
270	1.73	420	6.52
280	1.93	430	7.00
290	2.15	440	7.50
300	2.38	450	8.02
310	2.62	460	8.57
320	2.88	470	9.14
330	3.16	480	9.73
340	3.46	490	10.35
350	3.77	500	11.00

68 a. In fresh and brackish water. Only one species planktonic. Indicator of mesotrophic waters (Sládeček 1983).Very common.

- Laguna de Bay, Pasig River, Paoay Lake, La Mesa Dam, Taal Lake, Lake Lanao, Calamba River, IRRI rice field.

Testudinella patina (HERMAN, 1783)

[1978a+b, 1980, 1984a, 1986a, 1999, 2001a, 2008b, 2009a, 2011a]



***T. patina* from** Laguna de Bay



***T. patina* (?)** (Photo Rey Donne S. Papa, 2007)

see also: http://forum.mikroscopia.com/index.php?s=808ba833eba6f030026c5634e51ab47b&showtopic=1068

POMPHOLYX, GOSSE 1851.

Lorica present, i.e. cuticle thickened to form a stiff shell (lorica), which retain its shape well after preservation. Planktonic. Typical inhabitants of warm pond plankton (Wallace et al., 2006).

69 a. Lorica oval, 4 loped in cross section. Planktonic in eutrophic ponds and lakes, also in brackish water.

- Laguna de Bay.

Pompholyx sulcata, (HUDSON, 1885)

[1941a, 1974]

69 b. Lorica flattened, 3 loped in cross section. Planktonic in eutrophic ponds and lakes, not in brackish water.

- Taal Lake.

Pompholyx complanata, (GOSSE, 1851)

[2001a, 2011a]

TROCHOSPHAERA, SEMPER 1872.

Without foot. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. Large, spherical, with Wheel organ (corona) in equator of body. (Wallace et al., 2006)

70 a. Feed on nannoplankton (small *Staurasmus* species), detritus and bacteria. Warm stenotherm (20-32°C), pH 5.9-7.5, and conductivity 35-110 µS cm^{-1}. In shallow waters like pond but especially in rice fields.

- Rice field ditch.

Trochosphaera aequatorialis (SEMPER, 1872)

[1875 (in 1978c), 1895, 2002c]

FILINIIDAE, HARRING AND MEYERS, 1926 (family)

Without foot. Cuticle thin, transparent, not usually retaining its shape well after preservation. Body with long spines, 2 anterior and 1 (***Filinia***) or 2 (***Tetramastix***) posterior spines. Feeds on small algae, flagellates, bacteria and detritus less than 10 µm (Sládeček 1983).

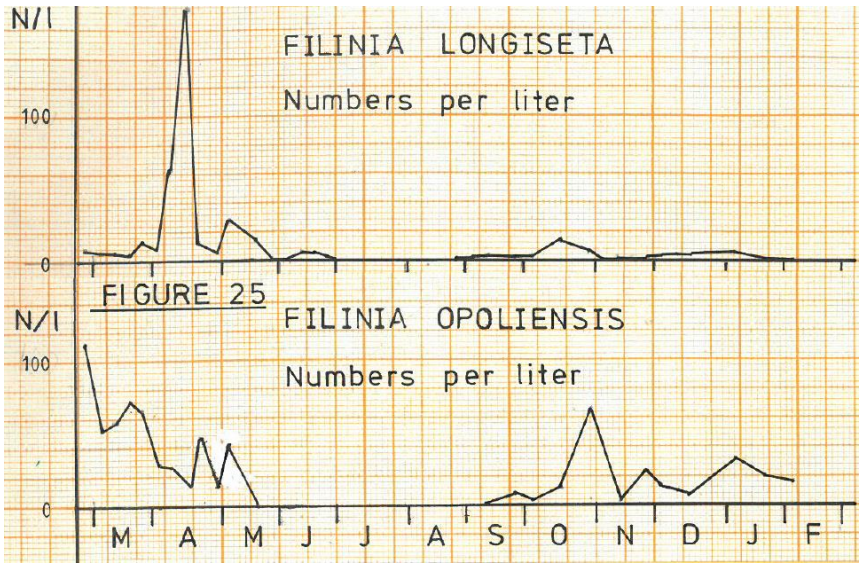
. Planktonic.

The separation in two genera (Filinia and Tetramastix) based on the number of posterior spines might not be valid since intermediates are found (Albertova, 1959 in: Sanoamuang, 2002, Ruttner-Kolisko 1972).

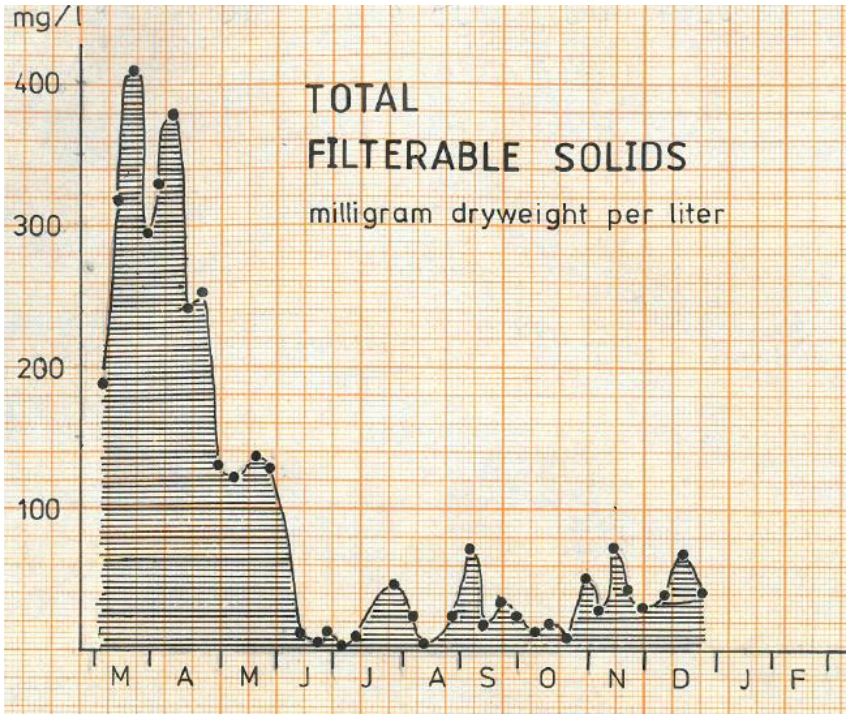
FILINIA, BORY ST. VINCENT 1824.

The genus is abundance among the plankton in polluted biotopes like Pasig River (2009a). Prefer alkaline waters (Sládeček 1983).

Rather common in periods with low primary production in Laguna de Bay in 1980. In the beginning of the year the number of filterable solids where the limiting factor for the primary production because of its absorption and exclusion of the light from the phytoplankton organism photosynthesis.



***F. longiseta and opoliensis* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

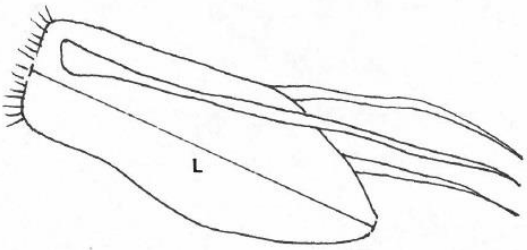


Fluctuation of filterable solids in Laguna de Bay in 1980. (Petersen, 1981e).

LENGTH-WEIGHT-RELATIONSHIP for FILINIA (WETWEIGHT)

FORMULA $W = 0.13 \times 10^{-6} \times L^3$ (W = WETWEIGHT in ug, L = Length in um)

Length	Weight
50	0.02
60	0.03
70	0.04
80	0.07
90	0.09
100	0.13
110	0.17
120	0.22
130	0.29
140	0.36
150	0.44
160	0.53
170	0.64
180	0.76
190	0.89
200	1.0
210	1.2
220	1.4
230	1.6
240	1.8
260	2.3
270	2.6
280	2.9
290	3.2
300	3.5

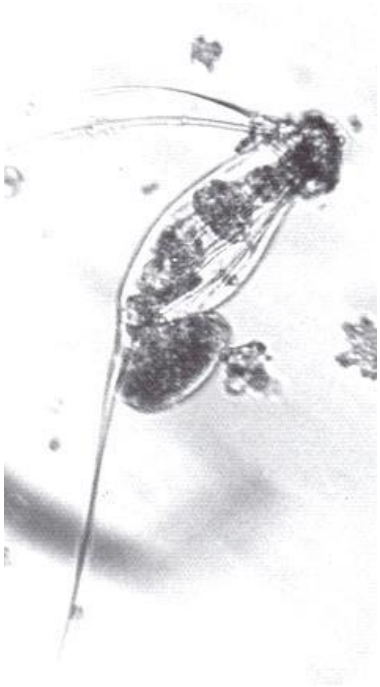


TETRAMASTIX GROUP

71 a. Two posterior spines developed. One well developed (200 µm) one more or less reduced (= spine). Lateral spines broad-based, club-like, and only slightly longer the body. Body spindle shaped. Size 150-200 µm. Shows affinity for cryptomonads, cyanobacteria (blue greens) and dinoflagellates in Lake Lanao (Lewis 1979).
Warm stenotherm (25-38°C), pH 7.3-8.2, conductivity 50-1,450 µS cm^{-1}. Planktonic in lakes and ponds. Indicator of oligotrophic waters (Sládeček 1983). Stenohaline, cannot handle a wide fluctuation in the salt content of water. Common.

- Laguna de Bay, La Mesa Dam, Calibato Lake, Lake Lanao, Paoay Lake, Taal Lake.

Filinia opoliensis, (ZACHARIAS, 1898)
(syn. ***Tetramastix opoliensis***, ZACHARIAS, 1898)
[1941a, 1974, 1977, 1978a+b, 1979b, 1980, 1984a, 1986a, 2008b, 2011b+c]



F. opoliensis from Laguna de Bay



F. opoliensis

(Photo Rey Donne S. Papa, 2007)

71 b Only one posterior spine.....72

FILINIA-TERMINALIS GROUP

72 a. Only one movable posterior spine, arising from the ventral surface. Spines not thickened at the base. Lateral spines much longer than body, but less than 4 times than the body length. Inserted more than 10 µm from terminal end of body. Size of body 150-250 µm, lateral spines 300-710 µm, terminal spine 125-315 µm. Lake forms usually with longer spines than pond form. Form *limnetica* (or species *Filinia limnetica* (ZACHARIAS 1893)) if spines 4 times longer than body or more. Feed on detritus and bacteria, with a particle size less than 10 µm. Warm stenotherm 23-31°C, pH 7.4-8.1, and conductivity 180-1,600 µS cm^{-1}, salinity 0-0.5 $^{0}/_{00}$ but stenohaline, so it cannot handle a wide fluctuation in the

salt content of water. In shallow, eutrophic lakes, fishponds, village ponds. May dominate the rotifer community. Indicator of eutrophic and polytrophic waters (Sládeček (1983).Abundance was higher in the Northern basin of Taal Lake, than the Southern basin, probably caused by the eutrophication effect of the fish gages in the area (Papa et al. 2011b).

- Laguna de Bay, Sampaloc Lake, Taal Lake.

Filinia longiseta (EHRENBERG, 1834)
(syn. *Triarthra longiseta*)
(syn. Filinia longiseta (form) *limnetica*
Filinia limnetica (ZACHARIAS 1893))
[1941a, 1974, 1980, 1984a, 1999, 2011b+c]



***F. longiseta* from Laguna de Bay**

72 b. Posterior immobile spine inserted non-terminally 4-10 µm (<15 µm) from terminal end of body, only slightly thickened at base. Body

cylindrical-oviform body, posteriorly rounded but may be fusiform in contracted individuals. Lateral setae 3-4 times as long as the body. Body length 85-205 µm. Lateral spines 265-350 µm. Terminal spine 180-350 µm. Trophi with 18-19/19-22 unci. Temperature 20-34°C, pH 6.9-8.1, conductivity 160-375 µS cm^{-1}. In eutrophic lakes and rice fields (Shiel and Sanoamuang, 1993, Tuyor and Segers, 1999, Sanoamuang, 2002).

- IRRI rice field.

Filinia novaezealandiae, SHIEL AND SANOAMUANG, 1993 [1999]

72 c. Caudal seta inserted terminally, Body narrow-elongate fusiform. Body relatively short, usually shorter than 200 µm. Trophi with 16-17/17-19 unci.

- Laguna de Bay.

Filinia pejleri HUTCHINSON, 1964 [2012a]

Other pantropic species of Filinia from the neighborhoods (se Sanoamuang, 2002):

Lateral setae inserted at the point near middle part of body.

- Not recorded from the Philippines.

Filinia camasecla MEYERS, 1938

Lateral setae short.

- Not recorded from the Philippines

Filinia brachiata (ROUSSELET, 1901)

HEXARTHRIDAE, (BARTOS, 1959) (family)

Without foot. Jaws mallepramate. Fulcrum short, rami more or less triangular, flat; unci teeth numerous. Cuticle thin, transparent, not usually retaining its shape well after

preservation. Body with 6 arms with setae. Nauplius-like. Planktonic.

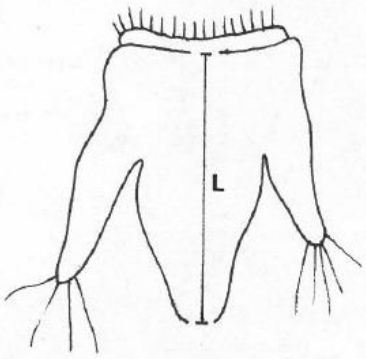
HEXARTHRA, (SCHMARDA 1854), (syn. Pedalia, Pedalion)

Feeds on particles less than 10 µm (Sládeček 1983).

LENGTH-WEIGHT-RELATIONSHIP for HEXARTHRA (WETWEIGHT)

FORMULA $W = 0.173 \times 10^{-6} \times L^{3}$ (W = Wetweight, L = Length in um) in ug

Length	Weight
100	0.2
120	0.3
140	0.5
160	0.7
180	1.0
200	1.4
220	1.8
240	2.4
260	3.0
280	3.8
300	4.7
320	5.7
340	6.8
360	8.1
380	9.5
400	11.1
420	12.8
440	14.7
460	16.8
480	19.1
500	21.6



73 a. In freshwater. Ventral arm with 3 spines on each side. Size 210 µm. Shows affinity for Cryptomonads and Dinoflagellates in Lake Lanao (Lewis 1979b). Feed mostly on particles < 6 µm (Pagano et al, 1999). Planktonic in freshwater and in weak brackish water. Abundance was higher in the Northern basin of Taal Lake, than the Southern basin, probably caused by the eutrophication effect of the fish gages in the area (Papa et al. 2011b). Common.

- Laguna de Bay, Pasig River, La Mesa Dam, Taal Lake.

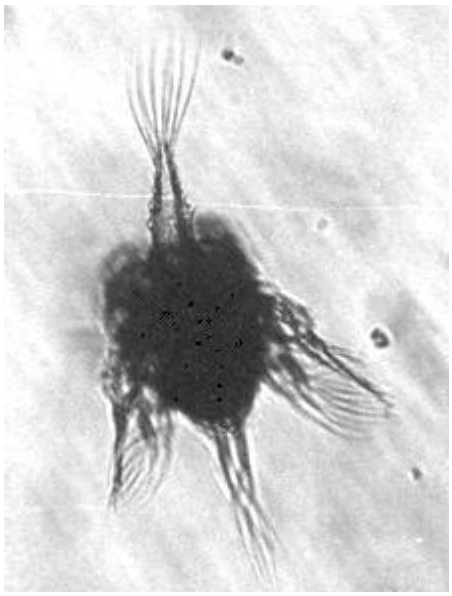
Hexarthra intermedia, (WISZNIEWSKI, 1929)
[1978a+b, 1979b, 1980, 1984a, 1986a, 1994b
2001a, 2009a, 2011a]



***H. intermedia* from Laguna de Bay**

73 b. In sea and salt water. Ventral arm with 4 spines on each side and 8 setae in 4 pairs terminally.
- Manila de Bay, Taal Lake

Hexarthra fennica (REMANE, 1933)
[1941a (Pedalia), 1941b, 1980,
1984a, 2001a, 2011a]



***H. fennica* from Manila Bay water culture**

CONOCHILIDAE, (REMANE, 1933) (family)

Jaws malleoramate. Fulcrum short, rami more or less triangular, flat; unci teeth numerous. Planktonic and epiphytic on roots of *Eichornia* (Water hyacinth), (Arora and Mehra, 2003c).

CONOCHILUS, EHRENBERG 1834

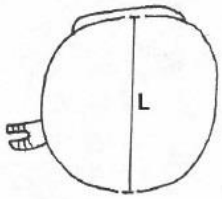
Foot fairly stout, without toes. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. A gelatinous, transparent case around foot and part of the body Head not funnel-like. Solitary (***Conochiloides***) or in colonies (***Conochilus***). *Conochilus* disappeared from Laguna de Bay in periods with relatively high salinity, thus showing sensitivity to the increased salinity. Formalin-preserved specimens separated from gelatinous case. Formalin-sugar-preserved specimens still in gelatinous case, usually strongly contracted. Antenna present, planktonic. The genus ***Conochilus***, EHRENBERG 1834, and ***Conochiloides***, HLAVA 1904, can be separated based on the

degree of fusion of the antennae. However, intermediates between total fused and unfused antennae are found and the two genera will be treated under ***Conochilus*** with two separate groups/genera (Ruttner-Kolisko 1972). Feeds on particles less than 10 µm (Sládeček 1983).

LENGTH-WEIGHT-RELATIONSHIP for CONOCHILUS (Preserved only)

FORMULA $W = 4.2 \times 10^{-6} \times L^3$ (W = WETWEIGHT in ug, L = Length in um)

Length	Weight
50	0.5
60	0.9
70	1.4
80	2.2
90	3.1
100	4.2
110	5.6
120	7.3
130	9.2
140	11.5
150	14.2
160	17.2
170	20.6
180	24.5
190	28.8
200	33.6
210	38.9
220	44.7
230	51.1
240	58.1
250	65.6
260	73.8
270	82.7
280	92.2
290	102.4
300	113.4



74 a. Antenna more or less separated, **CONOCHILOIDES GROUP**.....75

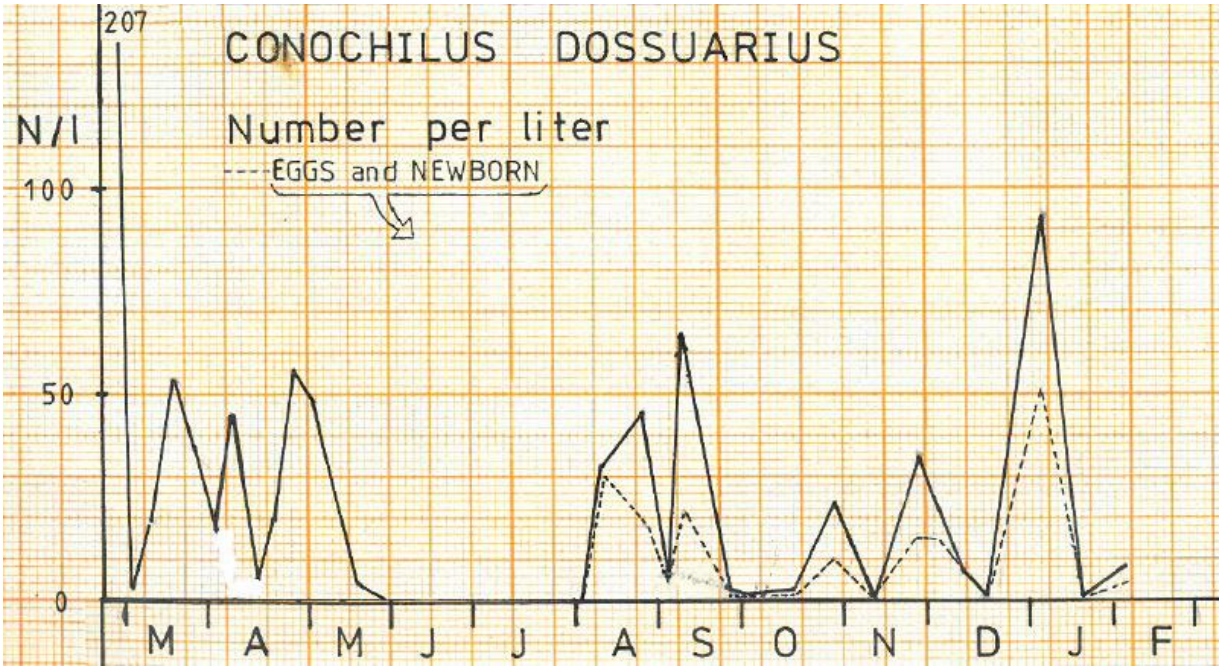
74 b. Antenna fused completely or nearly so, **CONOCHILUS GROUP**.....76

CONOCHILOIDES GROUP

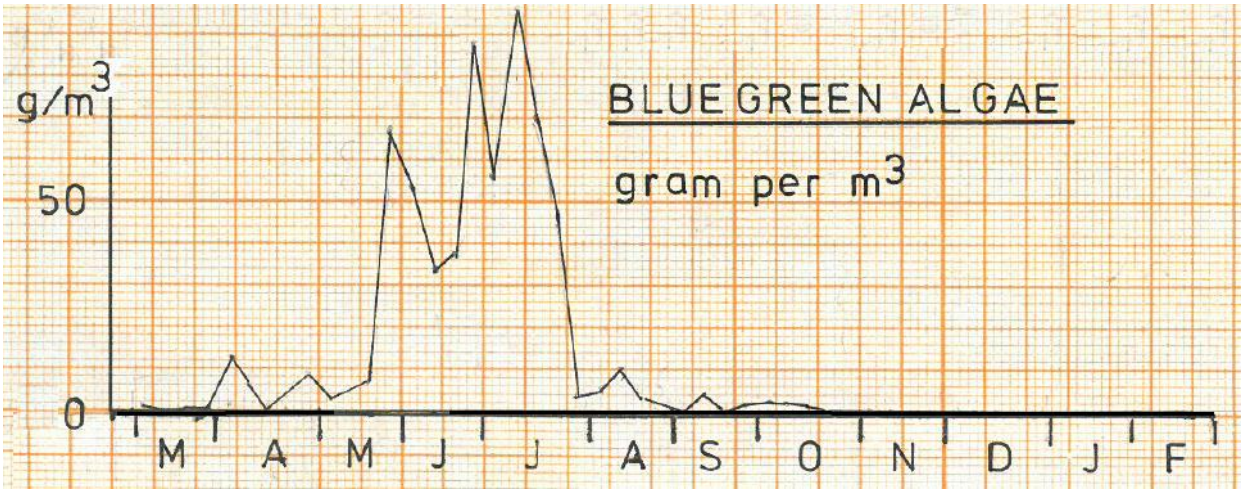
Antenna more or less separated

CONOCHILOIDES, HLAVA 1904

75 a. Antennae largely fused proximally to about one-third the length and free and the distal end, situated below corona. Basal mound is lacking. Mouth central. Right uncus has five large teeth, the left uncus three. Solitary in gelatinous case – not colonial. Body vase shaped. Size (without case, expanded) 250 µm. Feeds on unicellular algae up to 18 µm and shows affinity to cyanobacteria (blue green algae) in Lake Lanao (Lewis 1979b). Planktonic in lakes and ponds, thermophilic. Rare.
Found in Laguna de Bay most of the months in 1980. Eggs were only found in some of the months. In period with high biomass af cyanobacteria the species where absent. Se graph below.



***F. longiseta and opoliensis* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



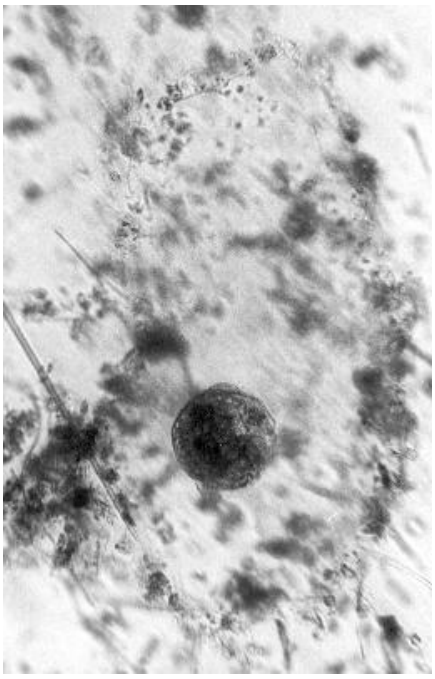
Fluctuation in biomass of *cyanobacteria* ("Bluegreen algae") in Laguna de Bay in 1980. (Petersen, 1981e).

- Laguna de Bay, Lake Mainit, Lake Lanao, Paoay Lake.

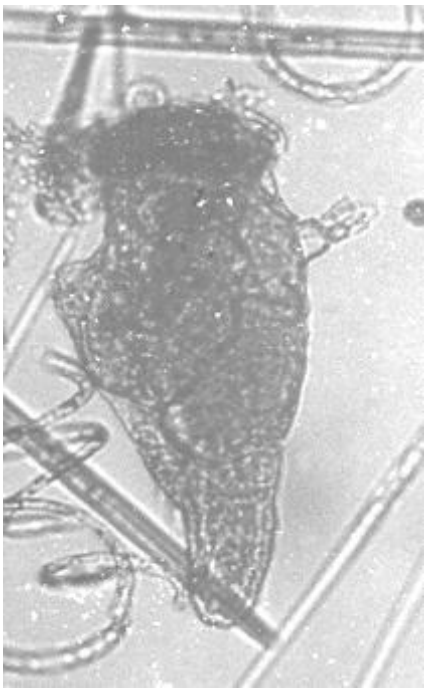
Conochiloides dossuarius, (HUDSON, 1885)

(syn. ***Conochilus dossuarius***)

[1941a, 1973, 1977, 1978a+b+d, 1979b, 1980, 1984a, 1986a, 2003b, 2008b]



***C. dossuarius* from Laguna de Bay**



***C. dossuarius* from Bunot Lake**

75 b. Ventral antennae arise from a mound-like expansion of equal length as the antennae, which are separated in their total length. Ventral antenna prominent. The foot is short and almost entirely contracted when fixed. Each uncus has three large teethes; one of the teeth of the left uncus is divided into three branches, however. Total length 160 µm. Body length 110-115 µm.

- IRRI Rice field, Lake Danao (Leyte/Cebu?).

Conochiloides coenobasis SKORIKOV, 1914.

(syn. ***Conochilus coenobasis***)

[1999]

CONOCHILUS GROUP

Antenna fused completely or nearly so.

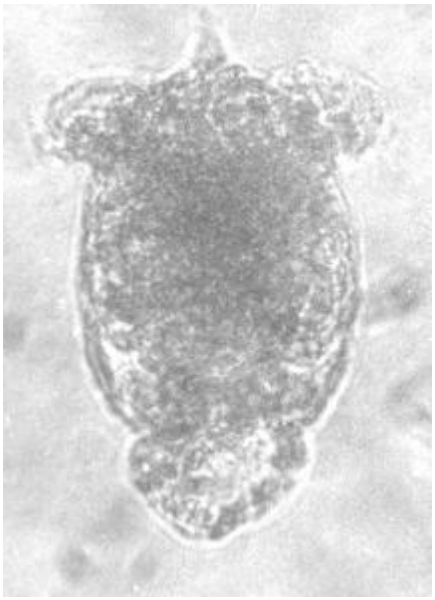
(**CONOCHILUS,** EHRENBERG 1834)

76 a. Antenna fused completely or nearly so, situated in the mouth field or the corona, mouth dorsal. In colonies of varying size (5-12 individuals), living together in a spherical gelatinous hull. The colony is less vulnerable to be attacked by Asplanchna and probably by copepods, too. Efficient consumer of bacteria-sized particles and thus an important consumer within the microbial loop (Wallace et al. 2006). Planktonic in oligotrophic lakes and ponds (Sládeček (1983).

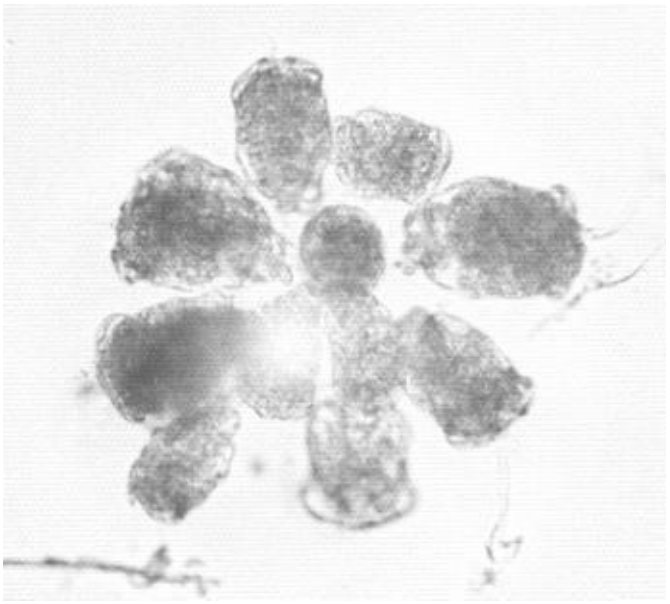
- Laguna de Bay, Sampaloc Lake.

Conochilus unicornis, (ROUSSELET, 1892)

[1980, 1984a]



***C. unicornis* from Laguna de Bay**



***C. unicornis* from Sampaloc Lake**

COLLOTHECACEA, REMANE 1933 (order)

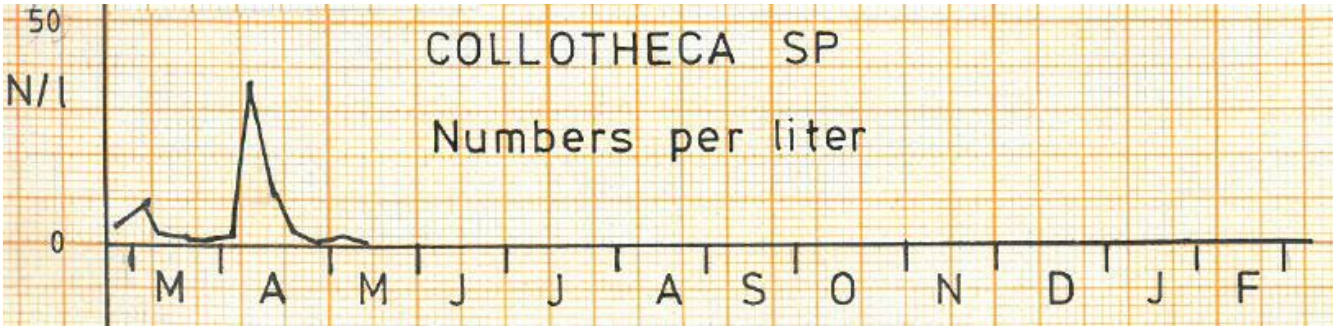
COLLOTHECIDAE, (BARTHOS, 1959) (family)

Jaws (trophi) uncinate. Only unci well developed. Not important since the food is already pre-digested.

COLLOTHECA, HARRING 1913, (syn. Floscularia)

Foot without toes, foot ends in a holdfast or in a circle of cilia or neither. Lorica absent, i.e. cuticle thin and flexible, not usually retaining its shape well after preservation. A gelatinous, transparent case around foot and part of the body. Head more or less funnel-like. Foot long and slender, stalk-like. Single animal in very transparent gelatinous case, usually contracted. Most species littoral, few planktonic species, some epiphytic on roots of *Eichornia* (Water hyacinth), (Arora and Mehra, 2003c).

77. In gelatinous case, most species benthic, only a few planktonic in lakes. The genus has been found planktonic in March to May in 1980 in Laguna de Bay, but the species not yet determined.



***Collotheca sp.* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

- Laguna de Bay, Sampaloc Lake

Collotheca* cf[12]. *pelagica (ROUSSELET, 1893)

[1980, 1984a]

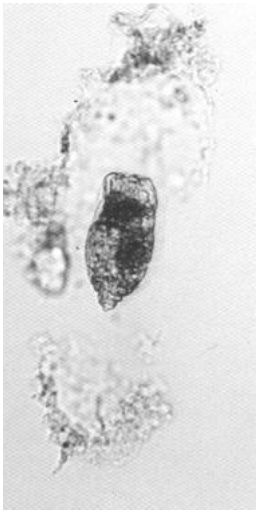
[12] **fc** = for compare = NOT SURE ABOUT THE SPECIES IDENTIFICATION

Key to planktonic, *cosmopolitan* ***Collotheca*** species

(None yet recorded from the Philippines.
Described species mostly resemble *C. pelagica*.)

77 a. Corona with 2 lobes. Size 200-500 µm.
Indicator of oligotrophic waters (Sládeček, 1983)
Collotheca mutabilis, (HUDSON, 1885)

77 b. Corona unlobed, cilia in 5 groups. Size 300-500 µm.
Indicator of oligotrophic waters (Sládeček, 1983)
Collotheca pelagica, (ROUSSELET, 1893)



C. pelagica **from Sampaloc Lake**

77 c. Corona with 1 lobe. Size 120-170 µm.
Collotheca libera, (ZACHARIAS, 1894)

ARTHROPODA, Arthropods (phylum)

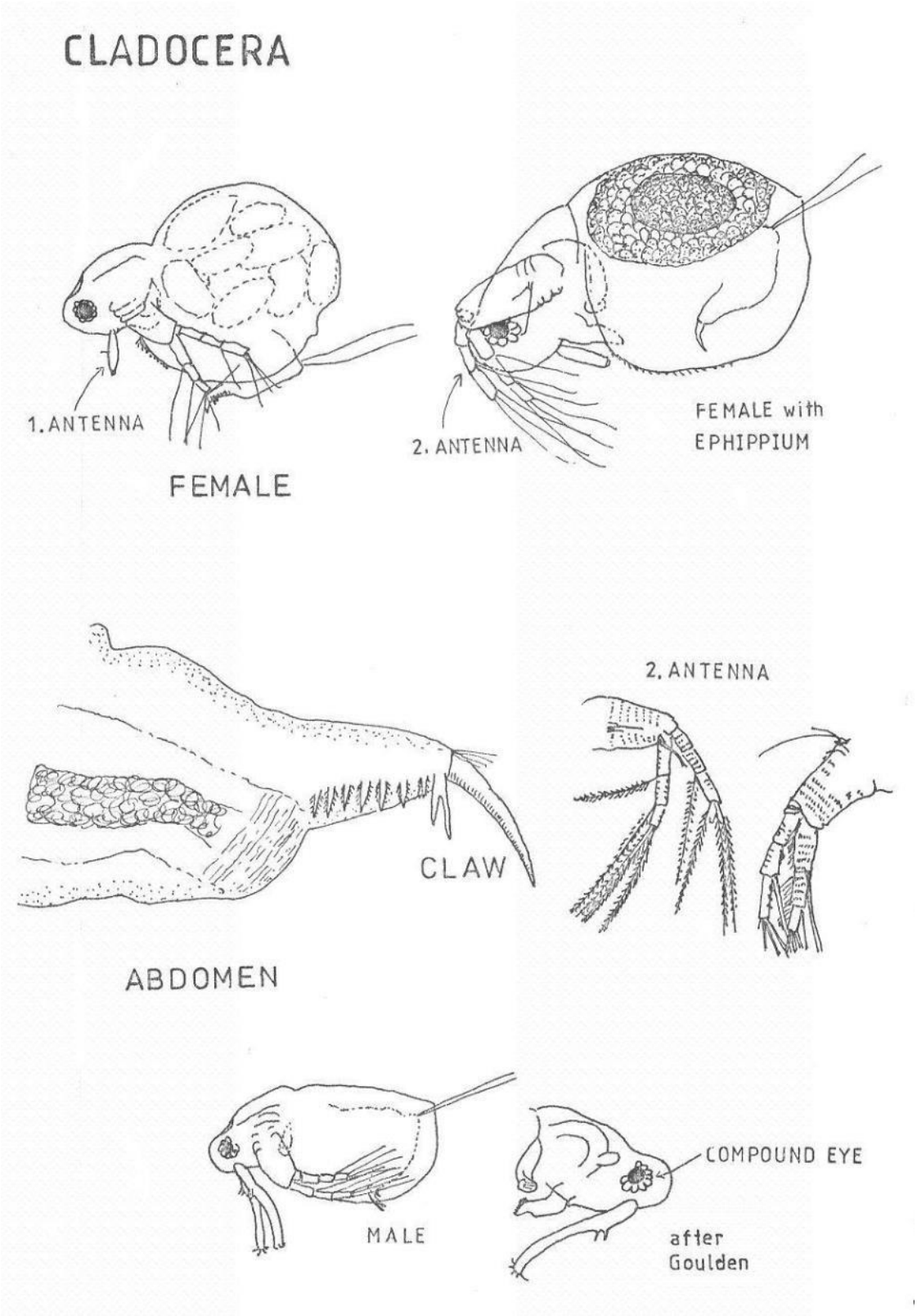
Back to content

CRUSTACEA, Brünnich, 1772 **Crustaceans** (subphylum)

BRANCHIOPODA, Latreille, 1829 **Branchiopods** (subclass).

(DIPLOSTRACA, GERSTEACKER 1866 (order))

CLADOCERA, Latreille, 1829, **Water fleas.** (order)
Bivalved shell (carapace) covers the body but leaves the head free. Second antenna with dorsal branch (exopodite) and ventral branch (endopodite). Six pairs of legs of similar structure. Legs leaf-like. Size 200-1500 µm. Filtrators, with filter setae on the legs. Food:
Algae, bacteria and detritus.

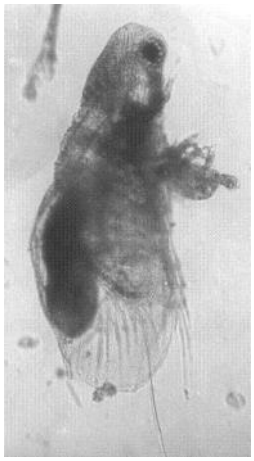

CLADOCERA
1. ANTENNA
FEMALE
2. ANTENNA
FEMALE with
EPHIPPIUM
CLAW
ABDOMEN
2. ANTENNA
MALE
COMPOUND EYE
after
Goulden

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Key to the families of Philippine water fleas.

(Key to genera and species → 83)

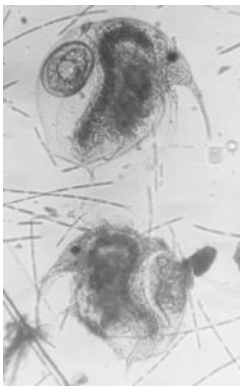
78 a. Head without a protective head shield. Second antenna (swimming antennae) with dorsal branch (exopodite) 2-segmented and ventral branch (endopodite) 3-segmented and totally with more than ten swimming setae. Six pairs of legs of similar structure.....SIDIDAE



Diaphanosoma sp.

78 b. Head with a protective head shield. Second antenna with dorsal branch 3-segmented and ventral branch 3- or 4-segmented and totally with less than ten swimming setae. Five or six pairs of legs of different structure.....79

79 a. First antenna fused with the rostrum of head, forming a snout like formation.....BOSMINIDAE

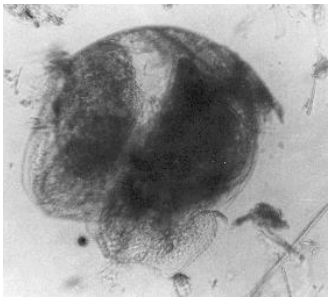


Bosmina sp.

79 b. First antenna not fused with rostrum of head.....80

80 a. One branch of second antenna 3-segmented, the other 4-segmented.....81

80 b. Both branches of second antenna 3-segmented.....CHYDORIDAE



Chydorus sp.

81 a. First antenna short, immobile.....DAPHNIIDAE



Ceriodaphnia sp.

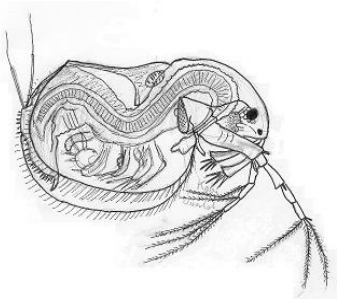
81 b. First antenna long, mobile.....81 c+d

81 c. First antenna situated on ventral side of the head.
Planktonic.....MOINIDAE



Moina sp.

81 d. First antenna situated on anterior margin of head
Not planktonic.....MACROTRICIDAE

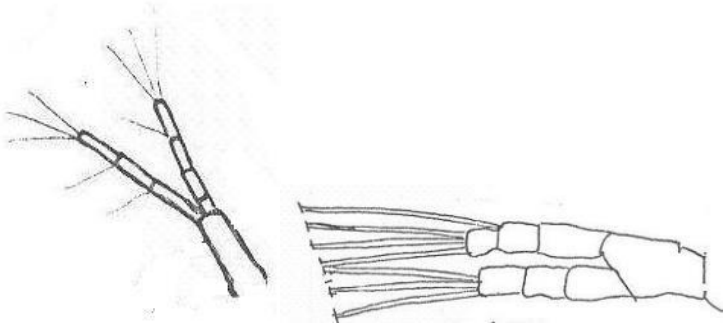


Macrothrix sp.

Key to the genera and species of Philippine water fleas.

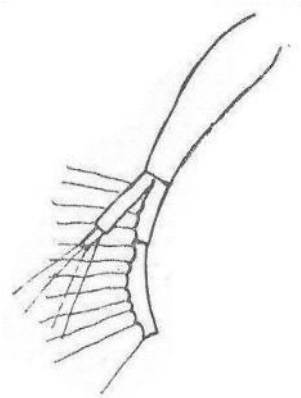
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82 a. Second antenna with dorsal branch 3-segmented and ventral branch 3- or 4-segmented.....83

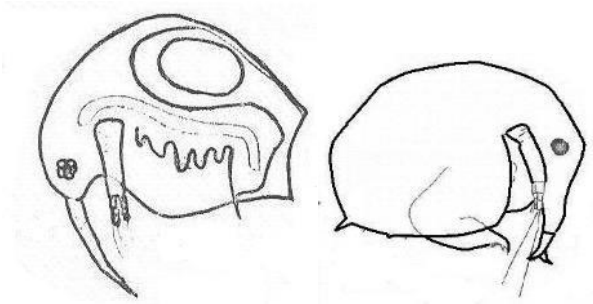


82 b. Second antenna with dorsal branch 2-segmented and ventral branch 3-segmented. Both branches together with more than 10 setae. 6 pairs of similar legs.

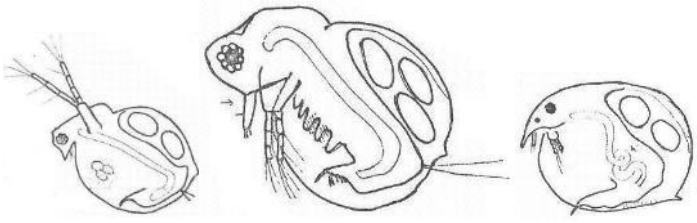
SIDIDA (family), ***Diaphanosoma***.....88



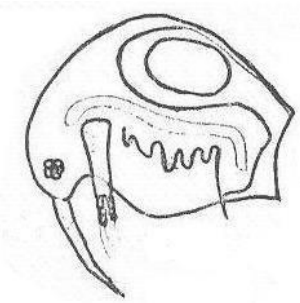
83 a. First antenna fused with head, forming a snout-like formation.
BOSMINIDAE (family).....84



83 b. First antenna not fused with head.....85



84 a. First antenna not united at base, distal part parallel to each other. Post abdomen rectangular in shape with oblique anal opening
Bosmina.....96



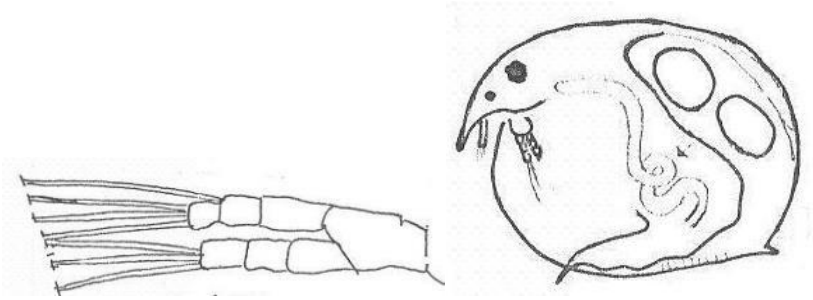
84 b. First antenna united at base and diverging from each other. Post abdomen cone-like with rounded tip

Bosminopsis.....97

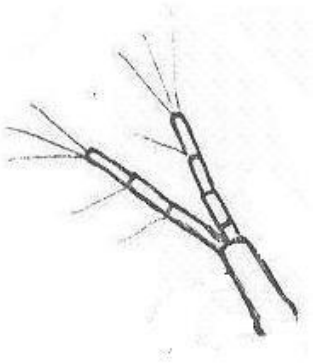


85 a. Both branches of second antenna 3-segmented.

CHYDORIDAE (family), ***Ephemeroporus (syn. Chydorus)***.....98

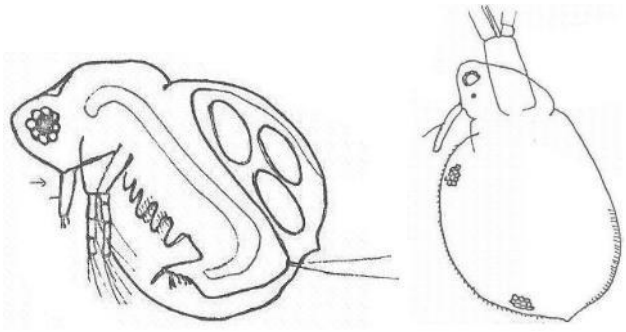


85 b. One branch of second antenna 3-segmented, the other 4-segmented.....86



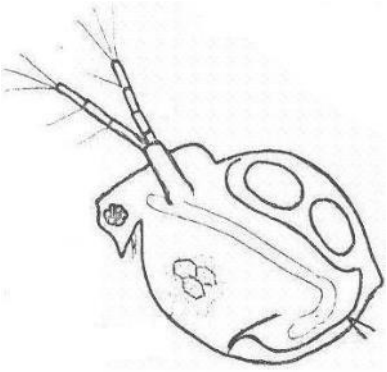
86 a. First antenna long, moveable, situated on the ventral side of the large head.

MOINIDAE (family).....87



86 b. First antenna short, not moveable, head small.

DAPHNIIDAE (family), ***Ceriodaphnia***.....91

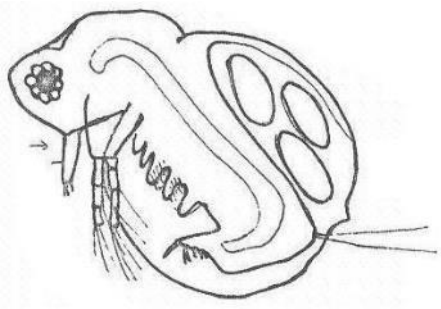


86 c. First antenna long, situated on anterior margin of head

MACROTRICIDAE.....99

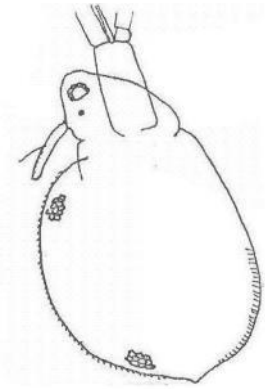
87 a. Ocellus eye absent, only compound eye present. .

Moina.....93



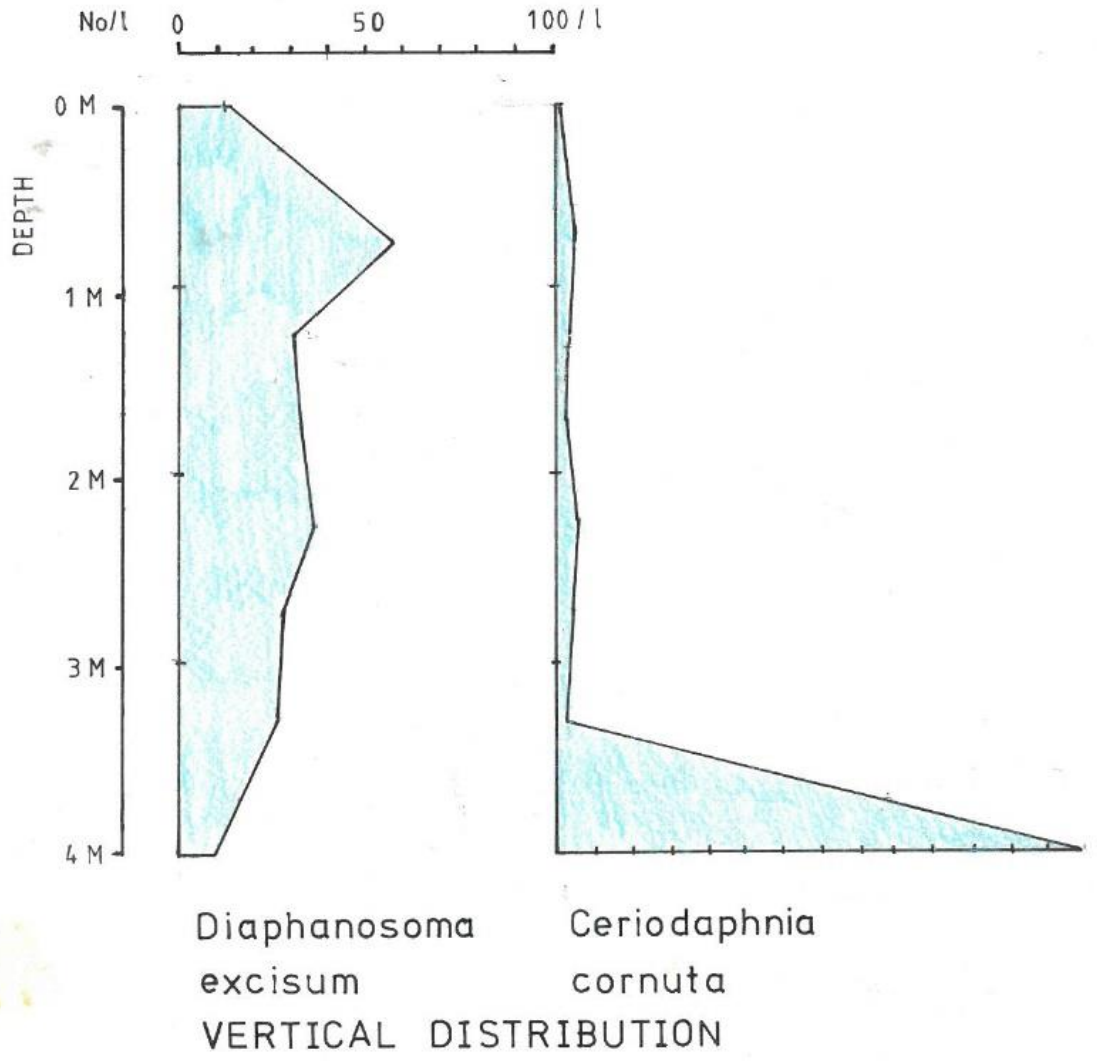
87 b. One ocellus eye and compound eye present.

Moinodaphnia.....95



CTENOPODA, SARS, 1865 (infraorder)

The vertical distribution cladocerans in Laguna de Bay in July 23th 1980 was found to be very different among the two species present at the time of sampling. *Diaphanosoma excisum* was almost equal distributed within the 4 m deep sampling station, with the highest number in the upper meter, while *Ceriodaphnia cornuta* was found almost entirely in the deepest meter, just above the bottom. Se the following graphs.



Vertical distribution of different species of Cladocera at Central bay sampling station in Laguna de Bay , July 23th in 1980.

SIDIDAE, BAIRD, 1850 (family)

Second antenna with dorsal branch 2-segmented and ventral branch 3-segmented. Both branches together with more than 10 setae. 6 pairs of similar legs.

DIAPHANOSOMA FISCHER 1850 [Spring-Waterfleas]

Planktonic in lakes. Food phytoplankton. Feed only on smaller sizes

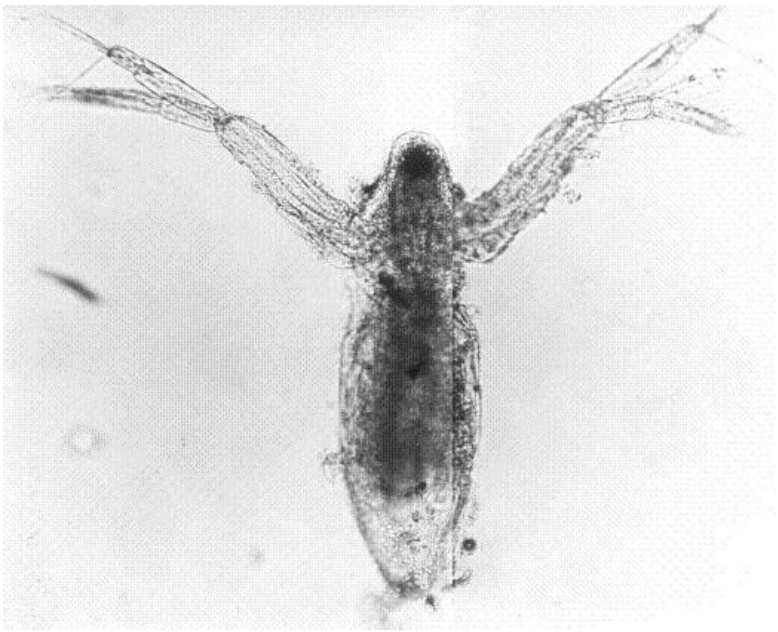
of phytoplankton (S-type[13] feeder) (Rizo et al., 2017b.)

The genus has been revised recently by Korovchinsky (1991, 1998a, 2000b).

See key to species in Korovchinsky (1992 + supplemented with 1998a) - Calibato Lake.

Diaphanosoma sp.

[Unpublished data (1979-80)]



Diaphanosoma sp. **from Calibato Lake**



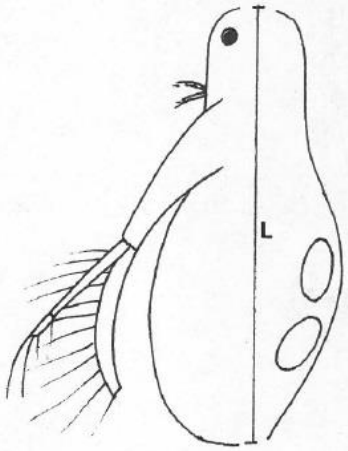
Diaphanosoma sp.**, Taal Lake**
(Photo: Rey Donne S. Papa, 2007)

[13] S=Sida type (of feeding)

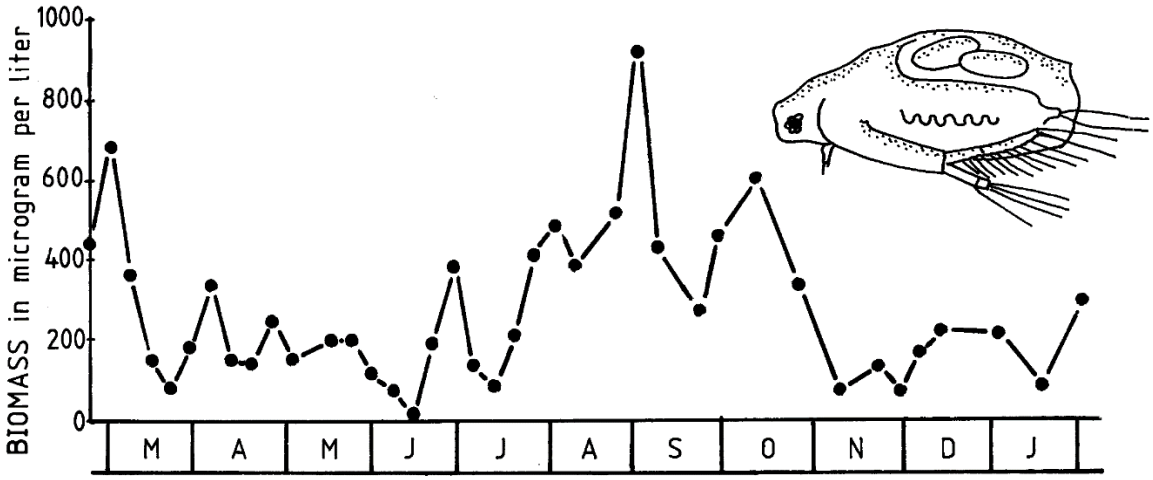
LENGTH-WEIGHT-RELATIONSHIP for DIAPHANOSOMA (WETWEIGHT)

FORMULA USED: $W = 1.76 \times 10^{-5} \times L^{2.11}$ (W = Wetweight in ug, L = Length in um)

Length	Weight	Length	Weight
200	1.26	700	17.7
220	1.54	720	18.8
240	1.85	740	19.9
260	2.19	760	21.1
280	2.56	780	22.3
300	2.97	800	23.4
320	3.40	820	24.8
340	3.86	840	26.1
360	4.36	860	27.4
380	4.88	880	28.7
400	5.44	900	30.1
420	6.03	920	31.6
440	6.66	940	33.0
460	7.31	960	34.5
480	7.99	980	36.1
500	8.72	1000 (=1mm)	37.6
520	9.47	1020	39.2
540	10.3	1040	40.9
560	11.1	1060	42.6
580	11.9	1080	44.3
600	12.8	1100	46.0
620	13.7	1120	47.8
640	14.7	1140	49.6
660	15.7	1160	51.5
680	16.7	1180	53.4
700	17.7	1200	55.3



The biomass of Diaphanosoma sp. in Laguna de Bay was highest in after the algae bloom in May 1980 (Petersen, 1981e).



Biomass of *Diaphanosoma spp*. in Laguna de Bay in 1980. (Petersen, 1981e).

88 a. Distinct wide, free flap-shaped inflexion (duplicature) on ventral margin of shell (carapace/valve) present.....90

88 b. No distinct free flap (duplicature) (See Fig. 90 a) on ventral margin of shell, only narrow inflection. Spines (denticles) of postero-ventral shell (valve) rather uniform, only dorsal-/ventral-most ones are smaller.....89

89 a. Head relatively small, its dorsal part not protruding, with even top, forming less than one-fourth of total length. Compound eye in frontal, vaulted part, close to top. With well-developed dorsal pert. 2nd antennae short, reaching to 2/3-3/4 of shell (carapace) length. Postero-ventral margin of shell (carapace) with 8-32 (often 10-18 in ssp. *orghidani* and 22-29 in ssp. *transamurensis*) mostly large and widely spaced spines and thin setules between them. Small ventral inflection of the shell, which is shifted much anteried, carrying up to 8 long, feathered setae. With short acute spine on the outer side on the end of upper antennal branch (Korovchinsky, 1991). Size 660-1200 µm, head/body length 0,38-0,43, 2nd antenna/body length 0,68-0,84 (Weiler, 1997, ssp. *orghidani*) (Figures 89a[1], 89a[2]). Polymorphic species. Production of *Diaphanosoma* "*modigliani*" (*D. o. transamurensis*) in Lake Lanao is associated with small to medium size algae (e.g. Cryptomonads) of round or oblong shape (Lewis, 1979, and Rizo et al., 2017b.). Predated by fish and *Chaoborus.*

Diaphanosoma orghidani, NEGREA, 1982.

Key to subspecies:

Postero-ventral edge of shell (carapace/valve) with not more than 18-20 denticles.

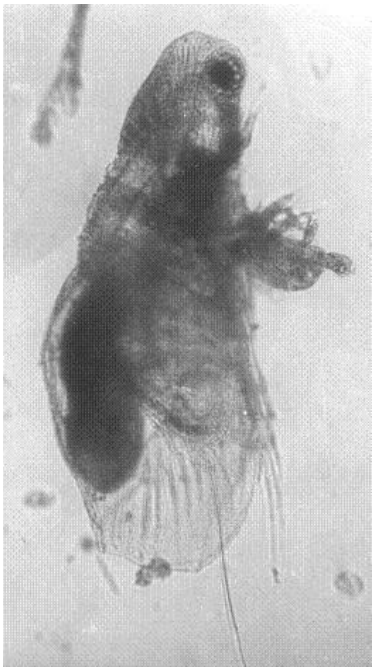
- Not recorded from the Philippines.
  Distributed in Western Eurasia

Diaphanosoma orghidani orghidani, NEGREA, 1982.

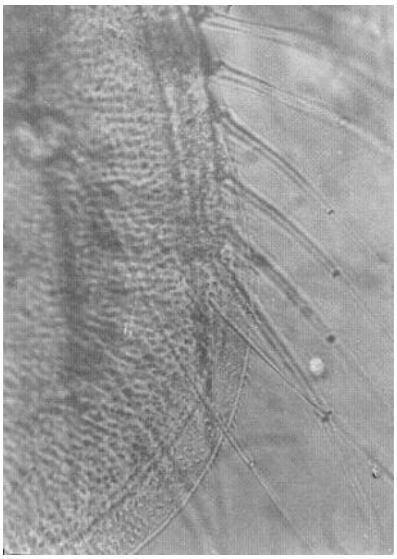
Postero-ventral edge of shell (carapace/valve) with more than 20 denticles (22, Laguna de Bay, 23, Sampaloc Lake). Showed a high degree of ephemeral patchiness in Lake Lanao (Lewis, 1978d). It co—occurs with *D. sarsi* (Lake Lanao) and *D. excisum* (Laguna de Bay and Sampaloc Lake). In oligotrophic lakes (Rizo et al. 2017b).

- Lake Lanao, Mindanao,
- Illaguen River, Ixabila, North-Eastern Luzon
- Laguna de Bay (female), Sampaloc Lake [Unpublished data from Oct. 1979]

Diaphanosoma orghidani transamurensis, KOROVCHINSKY, 1986
[1969, 1979b, 1980, 1984a, (D. modigliani)
1991, 1992, 1998a, 2000a+b, b (D. orghidani)]



D. orghidani from Laguna de Bay



D. orghidani . From Laguna de Bay D.



D. orghidani. **Live specimen from Laguna de Bay.** (Photo: Flemming Petersen, 1980)

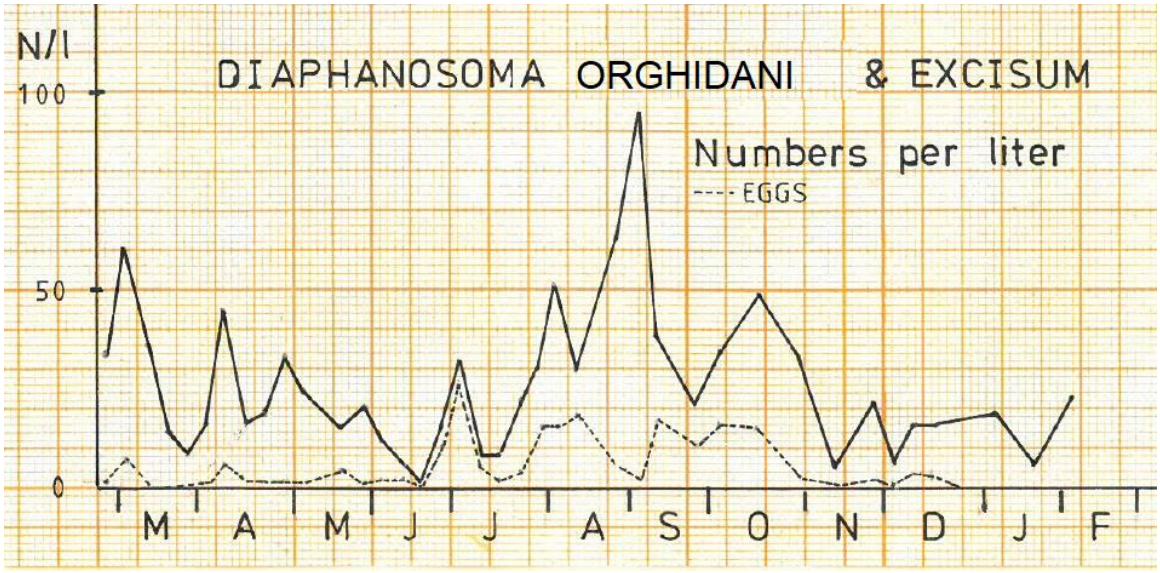
Note 1: Diaphanosoma species belonging to the *D. brachyurum* – group has been found e.g. in Sumatra. The dorsal part of the head is - like D. orghidani - relatively weakly developed, not or only weakly protruding. However the spines (denticles) of postero-ventral shell (valve) margin differ strongly in form and size; small intermediate spines are situated between large ones. The name "D. brachyurum" has been incorrectly used designation of other species of the genus e.g. *D. orghidani,* which probably is case with the following record for the Philippines. Found Indonesia, Africa and America with similar forms to *Diaphanosoma brachyurum s. str.* (LIEVEIN, 1848)) found in Europe and Asia. The systematic status of those forms is still unclear. (Negrea, 1982, Korovchinsky, 1992)

- Laguna de Bay (?).

Diaphanosoma brachyurum – group

(syn. *Diaphanosoma perarmatum* (BREHM, 1933))

[1954 non *D. brachyurum* (?)]



D. orghidani and excisum **population size fluctuation in Laguna de Bay in 1980.**

(Petersen, 1981e).

89 b. Head large but forming less than one half of the shell (carapace) – one third of the body size, with dorsal part strongly protruding. Marginal spines large, not very numerous (22-58), apical spine on the outer side on the end of upper antennal branch strongly curved. Dorsal side of post abdomen strongly convex, prominent. Ventral valve inflexion Comparatively long and not shifted proximal. Size 670 µm in average in Taal Lake (Papa et al., 2012b)
Lives in large and small reservoirs, mostly in limnetic but also in littoral zone, in ponds, fishponds, mining pools and stream backwaters. With only low abundance in Tall Lake compared to other cladocerans species (Papa et al., 2012b). Rare. Meso- to eutrophic lakes. Feed only on smaller sizes of phytoplankton (S-type feeder) (Rizo et al., 2017b.)

- Paoay Lake, Talasay Batangas, Taal Lake, Laguna de Bay. ***Diaphanosoma tropicum,*** KOROVCHINSKY, 1998

[1991, 1998a (type species!),
2000a, 2002a, 2011b+c, 2012b, 2014a]

Note 2: Head large, with dorsal part strongly protruding. Marginal spines small, very numerous (55-86), apical spine on the outer side of the end of upper antennal branch slightly curved or straight. Dorsal side of post abdomen flatly convex, not prominent. Ventral valve inflexion comparatively short and shifted proximal. *D. modigliani* inhabits Lake Tempe and Lake Toba in (Sumatra, Indonesia). Rare.
Probably synonymous with *D. tropicum* or *D. orghidani* (Lake Lanao, Korovchinsky, 2000a) and maybe *D. dubium*, in the Philippines, since D. modigliani is only found in Indonesia. (Korovchinsky, 1991+1998a).
- non-Laguna de Bay, non-Lake Lanao.

Diaphanosoma modigliani, RICHARD, 1894.
[1939c, 1941a, 1978a+b+d, (non D. modigliani),
1979c, 1980, 1984a (D. orghidani), 1986a]

89 c. Head very large, robust, cone shaped, with dorsal part protruding, length almost one half of shell (carapace). Without ventral fold on shell with only narrow inflection merging gradually with postero-ventral margin. Row of small spines along postero-ventral margin of shell are not numerous, mostly 12-29 (8-40). Representatives from tropical regions rather small: Body size: 760-940 µm, comparatively small head, large eye in specimens from Philippines and Thailand (Korovchinsky, 2000b). Planktonic in lakes, reservoirs, fishponds and rivers (Philippines).
- Sampaloc Lake, Laguna de Bay, Lake Baao, Illaguen River, Ixabila, North-Eastern Luzon

Diaphanosoma dubia, MANUILOVA, 1964
(syn. Diaphanosoma dubium, MANUILOVA, 1964)
[1998a, 2000b, 2014a]

TABLE: The morphological differences between *D. orghidani, D. modigliani, D. tropicum and D. dubia.* Se Korovchinsky (1998a+2002b) and Weiler (1998)

	Species: / Traits:	*D. orghidani transamurensis* (89a)	*D. modigliani* (89b-note)	*D. tropicum* (89b)	*D. dubium* (89c)
0	Status in the Philippines	Recorded	Philippine records now regarded as *D. tropicum*	Recorded	Recorded
1	Head	Head small, rectangular, with well-developed, high dorsal part not protruding.	Head large, protruding dorsally, less than half of shell length	Head large, protruding dorsally, less than half of shell length	Head very large, more massive, protruding dorsally, nearly half the length of shell
2	Spine on the end of upper antennal branch	Short acute	Slightly curved or straight	Strongly curved	Extremely variable. Straight to strongly curved
3	Ventral shell (valve) fold (inflexion)	Small ventral inflection of shell noticeable shifted proximal	Comparatively short and shifted proximal	Comparatively long and not shifted proximal	Large, narrow
4	Denticles of ventro-posterior valve margin	Few: 19-32 (more often 22-29) in ssp. *transamurensis,*	Small and very numerous: 55-86	Comparatively large and not very numerous: 25-43 (min.-max. range 22-58)	Small and very few: 12-29 (min.-max. range 8-40)
5	Post abdomen and terminal claws	Dorsal part not prominent.	Dorsal part not prominent, basal spines short	Dorsal part prominent, basal spines comparatively long	Dorsal part prominent.
6	Head length: Body length (%)	39,0	39,8	44,6	49,7 (min.-max. range 44,1-52,1)
7	Diameter of eye: Body length (%)	9,0 (moderate to large size)	6,6	7,8	7,4-11.1
8	Length of 2nd antenna: Body length (%)	76,5 ssp. *orghidani*	69,6	63,7	61,4 (Philippines: 65,2-78,3)

90 a. Distinct free flap (duplicature) narrow, not rounded on distal end, joining the ventral margin at right angle. Eye relatively small. Size 650-800 µm. Swimming antennae strong and long. Planktonic, inhabiting different water bodies, including acid, turbid (Laguna de Bay) and slightly brackish (up to 2 °/₀₀) waters. Meso- to eutrophic lakes (Rizo et al., 2017b.) Feed only on smaller sizes of phytoplankton (S-type feeder) (Rizo et al., 2017b.)
Rare to common in waters with aquaculture. (Figures 90a[1], 90a[2], 90a[3], 90a[4])

- Laguna de Bay (juvenile, adult), Sampaloc Lake [Unpublished data from Oct. 1979], Taal Lake

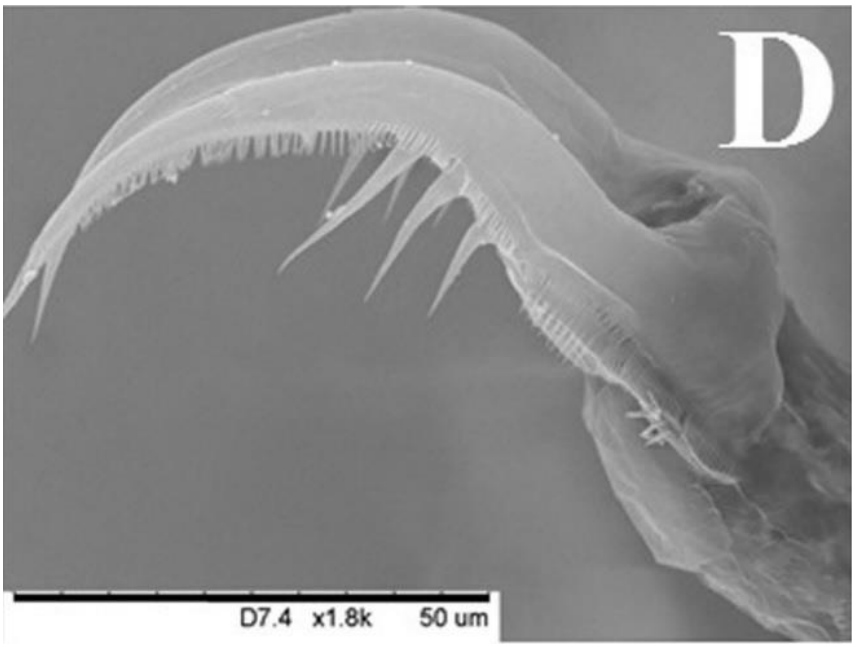
Diaphanosoma excisum, SARS, 1886

(syn. Diaphanosoma paucispinosum)

[1978a+b, 1980, 1984a, 1986a, 2011b+c 2012b, 2014a]



***D. excisum* from Laguna de Bay**



***D. excisum*.** Claw Scanning Electron Micrograph. (Pascual et al. 2014a)

90 b. Distinct free flap (duplicature) broad, rounded on distal end, with feathered and naked setae on edge. Head small. Eye big. With 8 setae on distal upper segment of antennal branch (see note). Adapted to life near shore shallow waters: The swimming function of the 2. antenna is adapted to contact with the substratum (lower branch is more developed) and 1. antenna relatively large. Weak and short. Large, broad free ventral flap (duplicature)) on the shell (carapace) protect the filtering limps from clogging (Korovchinsky, 1986). Size 650 µm in average In Taal Lake. (Papa et al., 2012b) Inhabiting different water bodies: lakes, reservoirs, ponds, swamps, rivers, rice fields and pools. Probably mainly in the littoral zone and shallow vegetated waters, but also in pelagic zone of some large lakes. pH range 5.8-8.4. Very common.

- La Mesa Dam, Tadlac Lake, Taal Lake, Lake Sampaloc, Lake Lanao, Illaguen River, Ixabila, North-Eastern Luzon, Paoay Lake.

***Diaphanosoma sarsi*, RICHARD, 1895**

[1939c, 1941a, 1973, 1966, 1978a+b+d 1979b, 1986a, 2000, 2001a+c, 2005a (D. sp.), 2008b, 2011a+b+c 2012a+b, 2014a]

90 c. With distinct free flap (duplicature) rounded on distal end like *D. sarsi*, but with naked setae **and** setules and without ornamentation. With only 7 setae on distal upper segment of antennal branch. Long confused with *D. sarsi* Richard, this species is widely distributed in the tropics and subtropics of the Eastern hemisphere. Mostly in shallow, vegetated habitats. Rare, not planktonic.

- Found In ponds in the Philippines.

Diaphanosoma volzi STINGELIN 1905

[1995]



D. sarsi From Taal Lake. (Photo: Rey Donne S. Papa, 2007)



D. sarsi. From Taal Lake. (Photo: Rey Donne S. Papa, 2007)

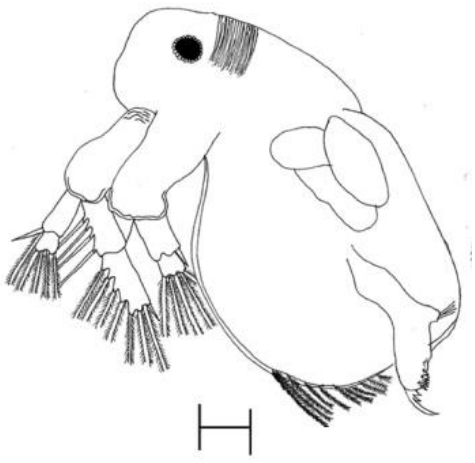
Note: ***Diaphanosoma celebensis***, STINGELIN, 1900, with distinct free flap (duplicature) rounded on distal end like *D. sarsi*, but with naked setae **and** setules. With only 7 setae on distal

upper segment of antennal branch is found in the region just outside the Philippines.

Some littoral species of the family can be found sporadically in pelagic plankton samples like:
Head not clearly delimited from the body. Antennule with a longer sensory setae than its basipodite, eye situated more dorsally:

Latonopsis australis SARS (Taal Lake [1939c, 1966, 2001a, 2011a, 2014a]),

which was found adapted to planktonic life in a lake on Sumatra (Woltereck, 1941a), and ***Pseudosida bidentata***, see Mamaril (1986a) and Korovchinsky (1992).



Latonopsis australis. Pascual et al. 2014a

ANOMOPODA (infraorder)

DAPHNIIDAE, STRAUS 1820 (family)

Second antenna with dorsal branch 3-segmented and ventral branch 4-segmented. First antenna short, not moveable,

head small.

CERIODAPHNIA, DANA 1853 [Dotted Waterfleas]

Food algae, bacteria and detritus.

Big individuals preyed upon by fish; small individuals preyed upon by invertebrate predators.

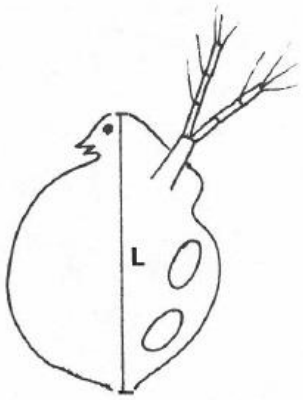


Sampaloc Lake

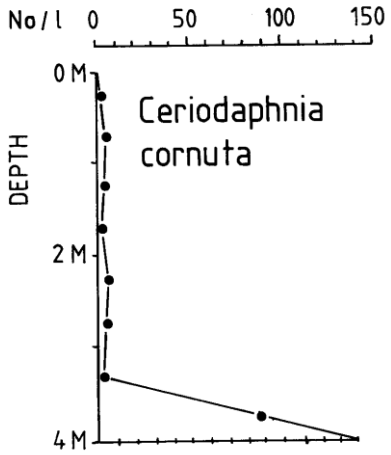
LENGTH-WEIGHT-RELATIONSHIP for CERIODAPHNIA (WETWEIGHT)

FORMULA USED: $W = 5.91 \times 10^{-5} \times L^{2.02}$ (W = Wetweight in ug, L = Length in um)

Length	Weight
200	2.63
220	3.19
240	3.80
260	4.47
280	5.19
300	5.96
320	6.79
340	7.68
360	8.62
380	9.61
400	10.7
420	11.8
440	12.9
460	14.1
480	15.4
500	16.7
520	18.1
540	19.5
560	21.0
580	22.6
600	24.2
620	25.8
640	27.6
660	29.3
680	31.1
700	33.0

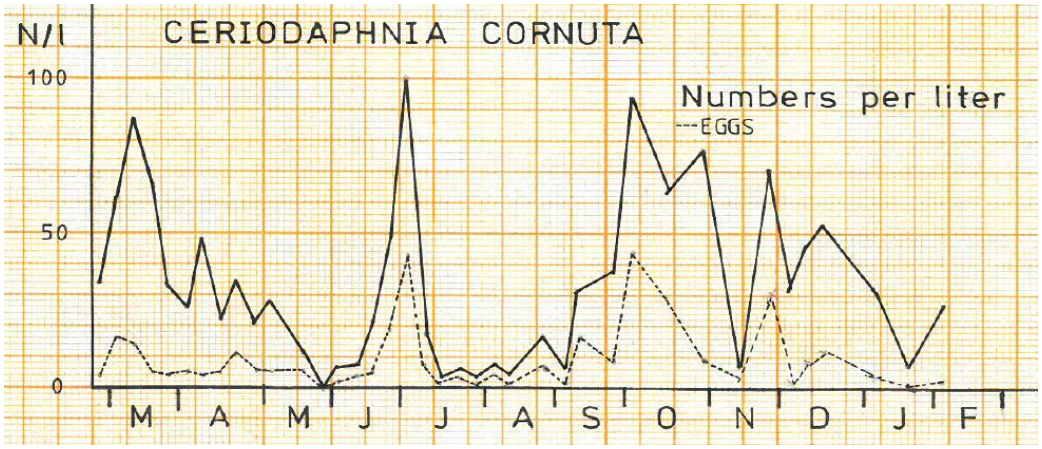


91 a. Head with well-developed rostrum, ventrally pointed. Polymorphic, with or without horn on the top of the head. Shell on fornix ("shoulders") with one or two minute small spines (spinules). The presence of fish predators favors the horned form, while the unhorned form is favored by a high primary production caused by its higher reproduction rate than the horned form (Zaret 1972). The unhorned form dominated in Tall Lake correlated with a high productivity (Papa et al., 2012b). Size 380-600 µm. Planktonic and littoral in lakes and ponds. Relatively abundant near bottom in shallow lakes (Laguna de Bay).

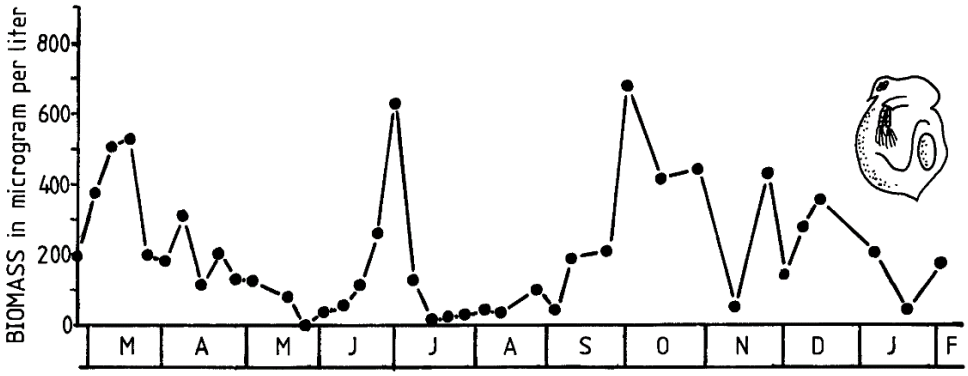


Vertical distribution of *Ceriodaphnia cornuta* at Central bay sampling station in Laguna de Bay , July 23th in 1980. (Petersen, 1981e).

Very common. Found in Laguna de Bay all year in 1980. See following figures.



***B. cornute* population size and eggnumber fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**



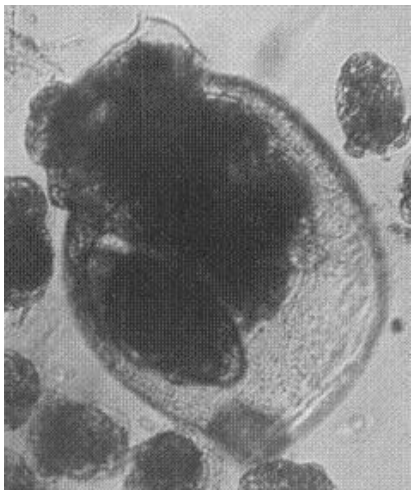
***Biomass of B. cornute* in Laguna de Bay in 1980. (Petersen, 1981e).**

- Laguna de Bay, Paoay Lake, La Mesa Dam, Sampaloc Lake, Bunot Lake, Tadlac Lake, Taal Lake, Lake Lanao.

Ceriodaphnia cornuta, SARS, 1885

(syn. Ceriodaphnia rigaudi)

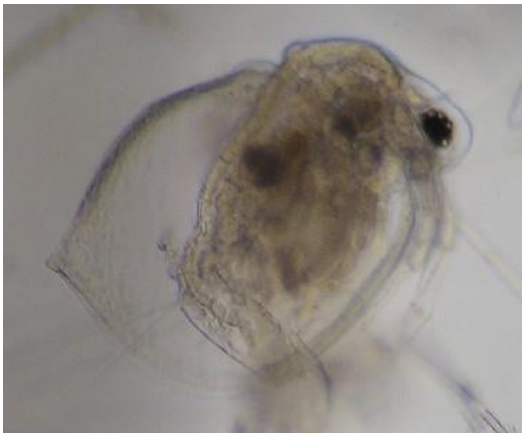
[1928a, 1939c, 1941a, 1954, 1966, 1978a+b, 1980, 1984a, 1986a, 2001a, 2008b+e, 2011a+b+c 2012a, 2012b]



***C. cornuta* from Sampaloc Lake**



***C. cornuta* from Laguna de Bay**



C. cornuta

(Photo: Rey Donne S. Papa, 2007)



C. cornuta

(Photo: Rey Donne S. Papa, 2007)

91 b. Head without protruding rostrum, rounded ventrally pointed. Head without a horn in front.....92

92 a. Claw on post abdomen with long spines in middle pecten (comb). Head rounded. Anal spines in a single row. Size up to 1500 µm. In littoral zone of lakes, fishponds and rice fields, also in brackish water, up to 5 ppt salinity.
- In the vicinity of Manila. Record not verified! Might be imported from Japan together with *Volvox* like *Daphnia pulex*

Ceriodaphnia reticulata (?) (JURINE, 1820)

[1928a]



Lowland rice field near Laguna de Bay, Binangonan. (Photo: Flemming Petersen, 1979)

Note: A similar species (***Ceriodaphnia dubia*** RICHARD, 1894) with long thin small spines (spinules) in middle pecten (comb) on claw on post abdomen occurs in tropics of all continents, but not yet recorded from the Philippines (Kořínek, 2002a).

92 b. Claw on post abdomen without big spines in middle of not well-separated group of fine thin spines. Head inflated and somewhat angular in front of the first antenna. Post abdomen with a row of 3 to 4 slender spines inner to the other row of spines. Size up to 860 µm. Planktonic in eutrophic lakes and ponds and in littoral zone. Also in brackish water, up to 8 ppt. salinity. Rare.
- Lake Lanao (Jetty near a mosque in Bacolod Chico near Lake Lanao)

Ceriodaphnia pulchella, SARS, 1862

[1978a+b, 1986a]

Note: Other Philippine genera of Daphniidae, which accidentally can be sampled near the shore.

With rostrum present:

Simocephalus SCHOEDLER, 1858. [Small headed Waterfleas]

In littoral zone on submerged macrophytes

Ponds and Rice fields. Common.

S. latirostris, (STINGELIN, 1906)

Roadside ditches. Rare.

- Taal Lake.

S. vetulus, O. F. MÜLLER, 1776,
[1939c, 1941a(*vetula*), 2001a, 2011a].

In the Philippines.

-

S. heilogjiangesis SHI et SHE 1994
[2001f].

Rice fields. Rare.

- Laguna de Bay

S. acutirostris, KING, 1853,
[1939c, 1978a+b, 1986a].



***Simocephalus acutirostris* from Laguna de Bay**

Scapholeberis SCHOEDLER, 1858. [Meniscus Waterfleas]
Littoral zone in ponds and lakes, inhabit the surface layer. Swimming with ventral part of shell upwards against the water surface.

S. kingi SARS, 1903

[1978a+b, 1986a]

Daphnia, O. F. Müller, 1785, [Common waterfleas] which almost invariably influence food-web interactions and structures of plankton communities in temperature lakes, still has to be recorded for the Philippines (the record by Wright (1928a), turned out to have come from Japan, along with imported *Volvox* (Mamaril, personal communication)). A high, year-round predation by fish-larvae and planktivorous fish pressure might cause the absence from many tropical lakes of these relative big zooplanktons (Fernando, 2002).

[1928a, 1939c, 1978a+b, 1986a, 2001a]

see, however, Aypa et al. (1983)

- Table 12 in Baluyut (1985).

MOINIDAE, GOULDEN 1968 (family) [Noble waterfleas]

Second antenna with dorsal branch 3-segmented and ventral branch 4-segmented. First antenna long, moveable, situated on the ventral side of the large head. For further information, see Goulden (1968).

MOINA, (BAIRD 1850)

Ocellus eye absent, only compound eye present.

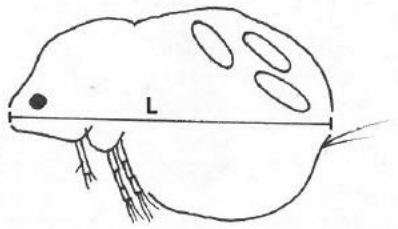
Food: algae, bacteria and detritus. Preyed upon by fish and phantom midge-larvae.

LENGTH-WEIGHT-RELATIONSHIP for MOINA (WETWEIGHT)

FORMULA USED: $W = 1.29 \times 10^{-6} \times L^{2.57}$

(W = Wetweight in ug, L = Length in um)

Length	Weight	Length	Weight	Length	Weight
		600	17.8	1000	66.1
		620	19.4	1020	69.6
		640	21.0	1040	73.1
		660	22.7	1060	76.8
		680	24.5	1080	80.6
300	3.0	700	26.4	1100	84.5
320	3.5	720	28.4	1120	88.5
340	4.1	740	30.5	1140	92.6
360	4.8	760	32.7	1160	96.8
380	5.5	780	34.9	1180	101.1
400	6.3	800	37.3	1200	105.6
420	7.1	820	39.7	1300	124.7
440	8.0	840	42.2	1400	156.9
460	9.0	860	44.9	1500	187.4
480	10.0	880	47.6	1600	221.2
500	11.1	900	50.4	1700	258.5
520	12.3	920	53.4	1800	299.4
540	13.6	940	56.4	1900	344.0
560	14.9	960	59.5	2000	392.5
580	16.3	980	62.8		
600	17.8	1000(=1mm)	66.1		



93 a. Distal claw on post abdomen without big spines. Spine on the second last segment of 1st thoracic limp with row of strong spines. The dorsal margin of the post abdomen has rows of thin setae. Head rounded, without depression over the eye, except on very large specimens. Ephippium with 2 eggs. Size up to 1800 µm. Often used in zooplankton cultures fertilized with cow dung and soil to produce bacteria as food. Reproduce up to 35°C. Lethal temperature is 48°C. Xu (1993) has studied the effect of infection of *Moina macrocopa* by a colonial peritrich, *Epistylis daphniae* as a phoretic epibiont.
In eutrophic ponds and fertilized fishponds, also in brackish water, up to 22 ppt salinity. Common. (Figures 93a[1], 93a[2])
- Ponds in Manila (Muntinglupa), Paoay Lake

Moina macrocopa, (STRAUS, 1820).
(syn. *Moina macrocopus*, (STRAUS, 1820).
[1937a, 1954, 1968, 1978a+b, 1980, 1984a, 1986a, 2008b]

93 b. Distal claws on post abdomen with big spines. Spine on the second last segment of 1st thoracic limp with row of fine setules. Head with depression over the eye.
Ephippium with one egg.....94

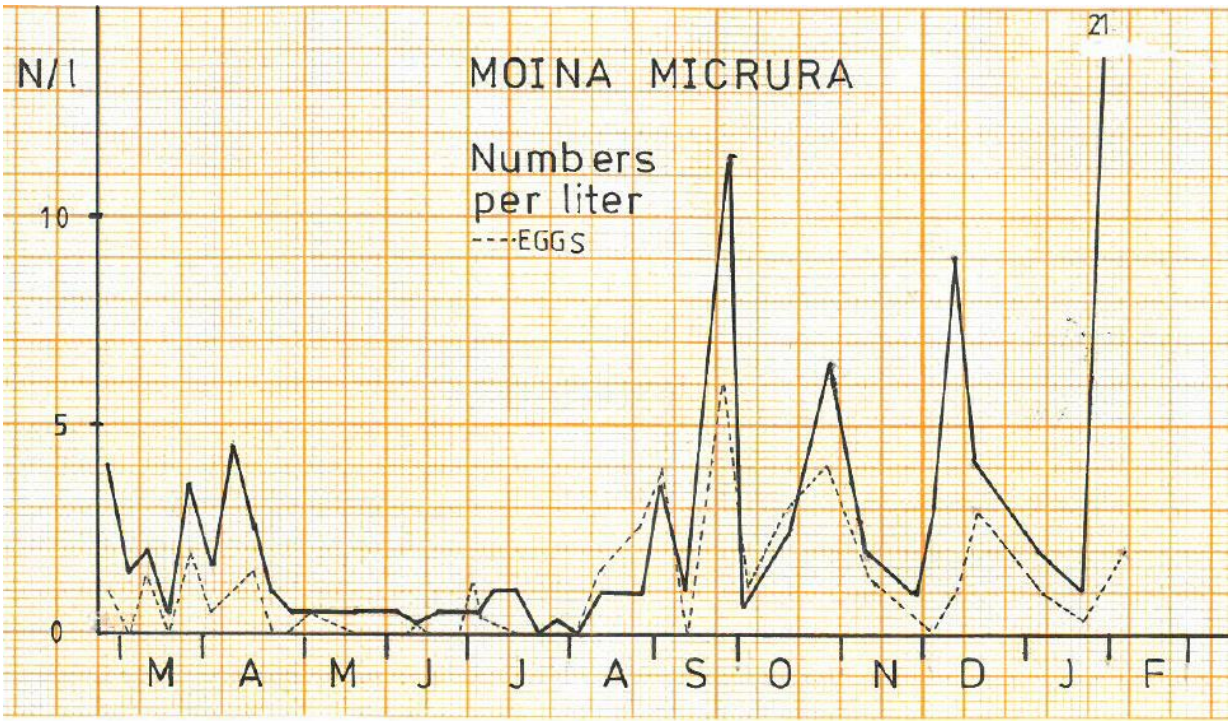


***Moina micrura*, Taal Lake**

(Photo: Rey Donne S. Papa,

2007)

94 a. Distal claws on post abdomen with a row of small spines decreasing in size distally. Hairs on ventral surface of head, behind the 1st antenna, absent. Adult small, measure less than 1000 µm (1 mm) with an average of 560 µm in Taal Lake. Ephippium reticulated all over its surface. Shows remarkable affinity for the cryptomonad algae, which evidently are very good food sources (Lewis 1979b). Showed a high degree of ephemeral patchiness in Lake Lanao (Lewis, 1978d). Undergo dial vertical migrations within the water column (Hare, 2006). Feed on different sizes of phytoplankton (D-type feeder) (Rizo et al., 2017b). According to Pagano (2008) M. micrura is better control algal blooms than Diaphanosoma (S-type feeder). Pelagic lakes, but more common in the littoral among plants in ponds, reservoirs. Meso- to eutrophic lakes (Rizo et al., 2017b.) Common.
(Figures 94a1, 94a2, 94a3, 94a4, 94a5, 94a6, 94a7)
Found in low numbers all year in Laguna de Bay in 1980. Se graph below.



***M. micrura* population size fluctuation in Laguna de Bay in 1980. (Petersen, 1981e).**

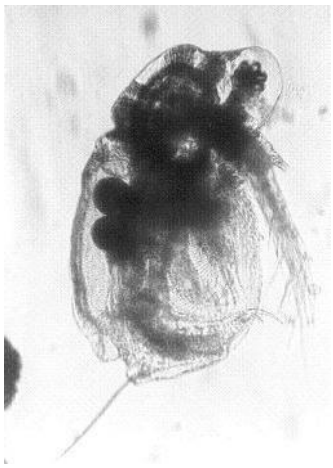
- Laguna de Bay (juvenile, female, male), Sampaloc Lake, Tadlac Lake, Taal Lake, Lake Lanao, Paoay Lake.

Moina micrura, KURZ, 1874.

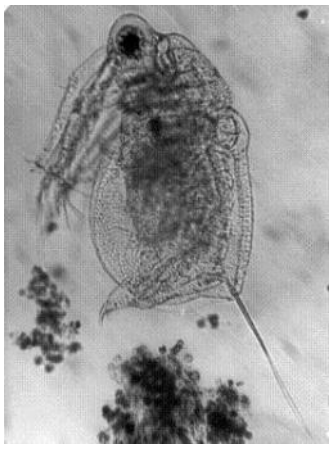
(syn. *Moina dubia, macrophtalma*

– *M. micrura* is probably a sibling group of species, rather than a cosmopolitan species).

[1939c, 1941a, 1954 (M. weismanni), 1966 (M. dubia f. parva), 1968, 1969, 1974, 1978a+b+d, 1979b, 1980, 1984a, 1986a, 2000, 2008b+e, 2011b+c, 2012a, 2012b, 2014a]



M. micrura from Laguna de Bay



***M. micrura*, male** from Laguna de Bay

94 b. Distal claws on post abdomen with 11-14 large spines. With hairs on ventral surface of head, behind the 1st antenna. Large form, adult measures 1000-1600 µm. Ephippium reticulated only around the edges. Planktonic in mesotrophic lakes, ponds, marshes and rice fields, also in salt lakes up to 36 ppt salinity. Rare. Probably not present in the Philippines (Pascual et al. 2014a)

- San Nicolas, Marikina

Moina brachiata, (JURINE, 1820).

[1978a+b, 1986a]



M. brachiata (?)
(Photo: Rey Donne S. Papa, 2007)

MOINODAPHNIA, (HERRICK 1887)

One ocellus eye and compound eye present.

95 a. One species. Bottom dwelling, filtering the water surrounding the weeds. Littoral, occurring in temporary ponds, small lakes, pools, swamps, and rice fields. Frequently occurring in limnetic zooplankton samples (Kořínek, 2002a) and feed on different sizes of phytoplankton (D-type feeder[14]) (Rizo et al., 2017b.) Common.

- La Mesa Dam, Taal Lake, Lake Calig.

Moinodaphnia McLeay, (KING, 1853)

[1968, 1978a+b, 1986a, 2001a, 2011a, 2014a]

BOSMINIDAE, BAIRD 1846 (family) [Long-nosed Waterfleas]

Second antenna with dorsal branch 3-segmented and ventral branch 4-segmented. First antenna fused with the rostrum of head, forming a snout like formation. Feeds on small phytoplankton algae and/or bacteria depending on availability. Preyed upon by invertebrate predators.

BOSMINA, BAIRD 1846.

First antenna not united at base, distal part parallel to each other. Post abdomen rectangular in shape with oblique anal opening. Asplanchna feed on particles larger than 10 µm like *Bosmina*, catching the individually (Sládeček 1983), B-type[15] feeder (Rizo et al., 2017b).

The genus was represented in Taal Lake in a number of 30 individuals/L in December.

- Taal Lake

***Bosmina* sp.**

[2005a]

[14] Daphnia-type
[15] Bosmina-type



***Bosmina sp.*, Taal Lake (Photo: Rey Donne S. Papa, 2007)**

LENGTH-WEIGHT-RELATIONSHIP for BOSMINA (WETWEIGHT)

FORMULA USED: $W = 1.084 \times 10^{-7} \times L^{3.13}$



Length	Weight		
160	0.86		
180	1.24		
200	1.73		
220	2.33		
240	3.05		
260	3.92		
280	4.95		
300	6.14	600	53.8
320	7.52	620	53.8
340	9.09	640	65.8
360	10.9	660	72.5
380	12.9	680	79.6
400	15.1	700	87.1
420	17.6	720	95.2
440	20.4	740	103.7
460	23.4	760	112.7
480	26.7	780	122.3
500	30.4	800	132.3
520	34.4	820	143.0
540	38.7	840	154.2
560	43.3	860	166.0
580	48.4	880	178.3
600	53.8	900	191.3

BOSMINA BOSMINA Baird, 1845 (subgenus)

96 a. Claw on post abdomen proximally with 3-4 long spines

increasing in length distally. After these follows 2-6 small spines and 15 very fine spines. Frontal sense hair midway between the junction of first antenna and eye. Lateral head pore close to ventral rim of triangular extension of head shield, close to insertion of 2nd antenna. Size up to 620 µm. Planktonic in lakes.
Kořínek found only *B. fatalis* in the 1970-71 Lake Lanao-samples, and this is almost certainly identical with Woltereck's (1941a) *B. longirostris*, se Lewis (1979b). Negatively affected by bloom of green algae *Botryococcus braunii* blooms in Paoay Lake (Papa et al., 2007a, 2008d).
The populations of *B. longirostris* in the tropics are most probably sibling species of that described by O. F. Müller from Danish rivers (Kořínek, 2002a), or *B. fatalis*, with a morphological variation like *D. longirostris* (Pascual et al. 2014a). The use of head pore morphology would exclude confusion among the two species.
Common - if a good species for the Philippines.
- Danao Lake (Leyte/Cebu?), Ponds around Lake Lanao, Paoay Lake, Taal Lake.

Bosmina longirostris (MÜLLER, 1785).
[1928a, 1934a, 1939c, 1941a, 1969, 1978a+b, 1986a, 2000(?), 2001a, 2003b, 2008b+d+e, 2011a+b+c]

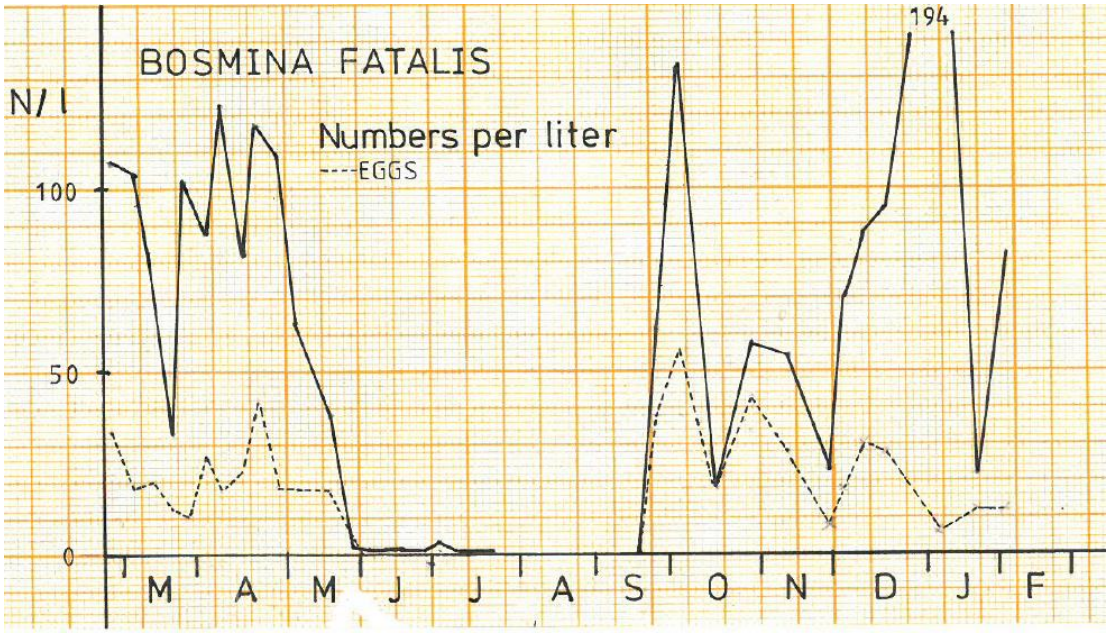
Note: *B. longirostris* has in India been a misidentification of the superficially similar *Bosmina tripurae* KOŘÍNEK, SAHA & BHATTACHARYA, 1999. With lateral head pores pattern as in *B. fatalis*. The post abdomen claw with basal pecten of 7-9 spines, growing in size distally and, like *B. longirostris*, with a dorsal row of small, sturdy spines (spinules). Distributed in India (lowland), China, Japan and Indonesia and probably New Zealand (Kořínek, 2002; Kořínek et al.,

1999, Taylor et al., 2002)

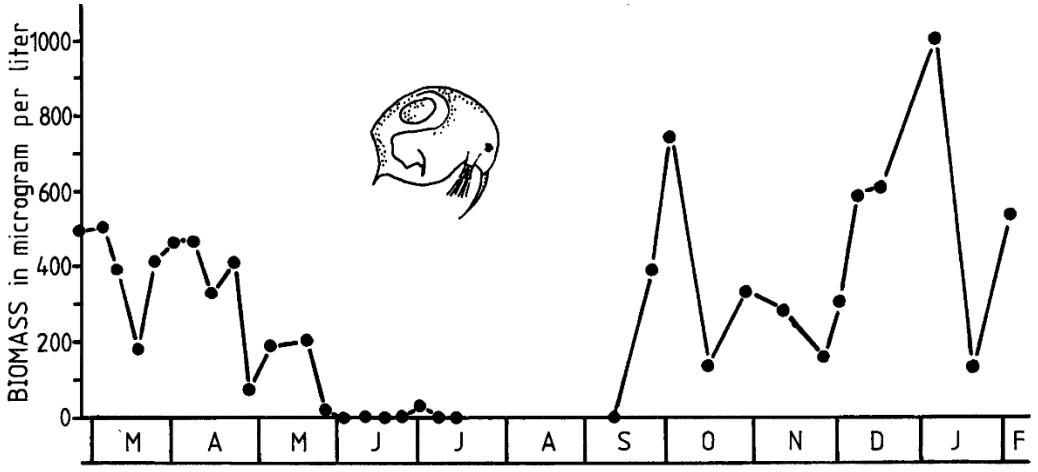
BOSMINA SINOBOSMINA Lieder, 1957 (subgenus)

Only one species.

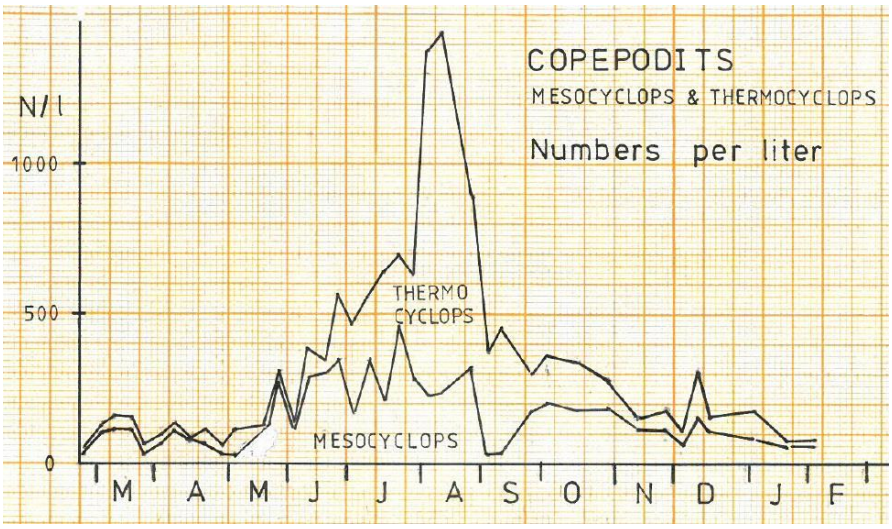
96 b. Claw on post abdomen proximally with 6-8 spines increasing in length distally, continuing in very fine spines to the tip of the claw. Frontal sense hair near the junction of the first antenna with the head. Lateral head pore shifted dorsally, over mandibular articulation. Size of adult female 370-600 µm, with an average of 390 µm in Tall Lake (Papa et al., 2012b and Pascual et al., 2014a). Shows a remarkable affinity for cryptomonads in Lake Lanao (Lewis 1979b). In lakes and reservoirs, abundance in January in Tall Lake (Papa et al., 2012b). Planktonic in Lakes. Predated upon by *Sardinella tawallis* (Clupeidae) in Taal Lake during the northeast monsoon season coinciding with a drop in the copepod abundance (Papa et al., 2008, 2012b). Common. (Figures 96b[1], 96b[2]). Found in Laguna de Bay in periods with a low number of cycloid copepodites. See graphs below.



***B. fatalis* population size and egg number fluctuation in Laguna de Bay in 1980 (Petersen, 1981e).**



Biomass of *C. Fatalis* in Laguna de Bay in 1980 (After Petersen, 1981e)



The number of cyclopoid copepodites (*Mesocyclops thermocyclopoides* and *Thermocyclops crassus*) in Laguna de Bay in 1980. (Petersen, 1981e).

- Laguna de Bay, La Mesa Dam, Sampaloc Lake, Lake Buhi, Tadlac Lake, Naujan Lake, Lake Lanao, Taal Lake.

Bosmina fatalis, BURCKHARDT, 1924.

(syn. *Sinobosmina fatalis* (BURCKHARDT, 1924))

[1934a (form philippinensis), 1939c, 1941a, 1954,1978a+b+d, 1979b, 1980, 1984a, 1986a, 2000a, 2001a, 2002a, 2008e, 2011a+b+c, 2012a, 2012b, 2014a]



***B. fatalis* from Laguna de Bay (Photo: Flemming Petersen, 1980)**



***B. sp.* (Photo: Rey Donne S. Papa, 2007)**

BOSMINOPSIS, (RICHARD 1895)
First antenna united at base and diverging
from each other. No apparent lateral head pore.
Post abdomen cone-like with rounded tip.

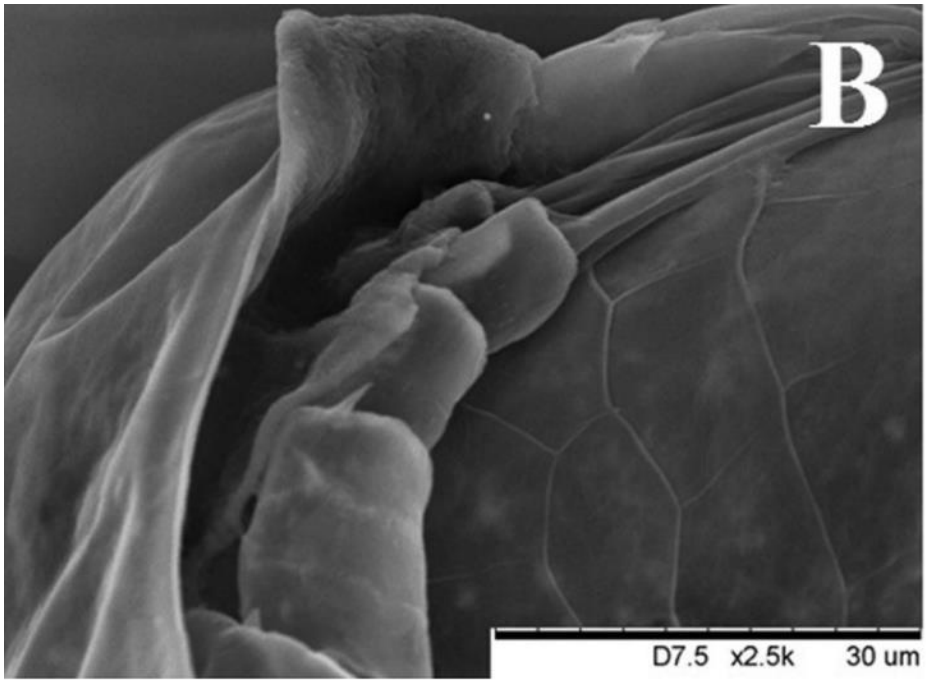
97 a. Only one species. Size 100-500 µm.
In lakes and reservoirs. Rare.
- Laguna de Bay (?), Lake Lanao (?), Davao Lake, Lake Bangalau, Lake Bato, Lake Baao, Lake Naujan

Bosminopsis deitersi, RICHARD, 1895
[1934, 1939c, 1941a, 1969, 1974, 1978a+b 1986a, 2000(?), 2014a]

CHYDORIDAE, STEBBING 1902 (family). [Ball Waterfleas]
Second antenna with dorsal branch 3-segmented and ventral ranch 3-segmented. Mostly littoral species. Feeding on epiphytic algae, detritus and bacteria, scraped off the surface of macrophytes and stones (*Alona*, *Kurtzia*, *Alonella* etc.)

98 a. Anal teeth on post abdomen gradually diminishing proximally ..... ***Ephemeroporus***

EPHEMEROPORUS FREY, 1982 (syn. Chydorus [partial] (LEACH 1816). Systematically status discussed by Smirnov (1996).



***B. barroisi*:** Scanning Electron Micrographs of antennae.
(Pascual et al. 2014a)

Rostrum blunt. Labrum with serrated teeth. One truly planktonic species, also littoral. With spine on lower corner of the valves. Systematically status discussed by Smirnov (1996) – a species complex. Common in littoral zones, sometimes found in low number in limnetic zone (Pascual et al. 2014a).
- Laguna de Bay, Paoay Lake, Lake Baao, Lake Mainit, Taal Lake.

Ephemeroporus barroisi, (RICHARD, 1894.)
(syn. Chydorus barroisi)
[1939c, 1971, 1973, 1978a+b, 1980, 1984a, 1986a,(1982), 2001a(Chydorus barroisi),2008b, 2011a, 2014a].



***E. barroisi* from Laguna de Bay**

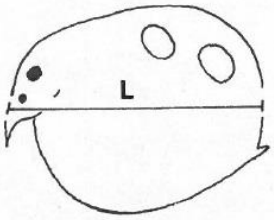
98 b. Anal teeth on post abdomen gradually diminishing proximally, but several much longer teeth before anal aperture.....***Chydorus***

CHYDORUS (LEACH 1816).

LENGTH-WEIGHT-RELATIONSHIP for CHYDORUS (WETWEIGHT)

FORMULA USED: $W = 1.45 \times 10^{-9} \times L^{3.93}$ (W = Wetweight in ug, L = Length in um)

Length	Weight
100	0.11
120	0.22
140	0.39
160	0.66
180	1.06
200	1.60
220	2.33
240	3.28
260	4.49
280	6.01
300	7.88
320	10.2
340	12.9
360	16.1
380	20.0
400	24.4
420	29.6
440	35.5
460	42.3
480	50.0
500	58.7
520	85.3



98 b Without spine on lower corner of the valves. Philippine species littoral, see Mamaril and Fernando (1978a,b, 1986a).
One species is, however, found in plankton.
- Paoay Lake, Taal Lake.

Chydorus ventricosus DADY, 1894
[2001a, 2008b, 2011a].

98 c Anal denticles almost equal in sizes, valves with polygons. Found mostly in eutrophic freshwater bodies with dense macrophytes cover in the littoral zones. A species complex which might be separated into several genera and species. Littoral and limnetic (Pascual et al. 2014a).
- Lake Malbato (Palawan),Lake Danao

Chydorus cf. sphaericus (MÜLLER 1785)

[2014a].

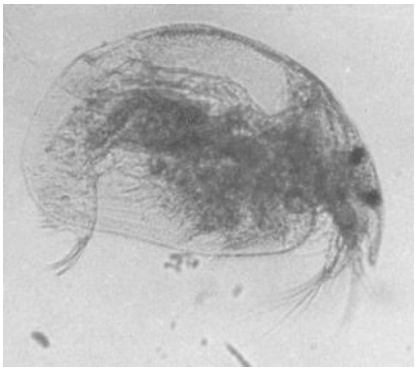
Note:

98 d. Other genera from Chydoridae recorded from the Philippines: ***Pleuroxus, Alonella, Anthalona, Dadaya, Dunhevedia[16], Leydigia[17], Alona[18], Kurzia[19], Camptocercus, Euryalona, Indialona, Biapertura[20] and Oxyurella.***

All benthic genera, but underlined genera might be taken in plankton samples in shallow lakes in very low numbers

See Smirnov (1971) and Mamaril and Fernando [1978a,b + 1986a] and Pascual et al. [2014a] for further information.

Biapertura pseudoverrucosa



Alona sp. (?)

MACROTHRICIDAE, NORMAN and BRADY 1867 (family).

A benthic family, but might be taken in plankton samples in shallow lakes in very low numbers

[16] E.g. D. crassa KING, Taal Lake: Mamaril 2001a, Papa & Mamaril 2011a
[17] E.g. L. acanthocercoides FISHER, Smirnov 1971
[18] E.g. A. archeri SARS, Brehm 1933d, A. pseudoanodonta BREHM, Brehm 1933d
[19] E.g. K. longirostris DADAY, Smirnov 1971, Mamaril and Fernando 1978b
[20] E.g. B. pseudoverrucosa, Paoay Lake: Aquino et al. 2008b, Taal Lake:, Mamaril 2001a, Papa & Mamaril 2011a; B. intermedia SARS, Smirnov 1971

99 a. ***Echinisca, Macrothrix, Grimaldia, Guernella* and *Ilyocryptus*[21].**
See Mamaril and Fernando [1978a,b + 1986a] for further information.

Back to content

MAXILLOPODA (class)

COPEPODA, Copepods (subclass)

Without a shell-like covering of the body, with up to five pairs of 2-branched swimming legs (might have a 6th rudimentary pair of leg). Abdomen without appendages. Size 100-2000 µm. Food: Algae, detritus and zooplankton. Many copepods are important food for planktivorous fishes and young stages of almost all fishes (Alekseev, 2002a).

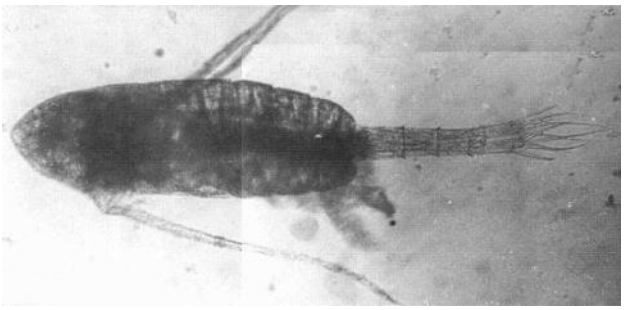
Key to the families of the Philippine copepods.

(Key to genera and species → **104**)

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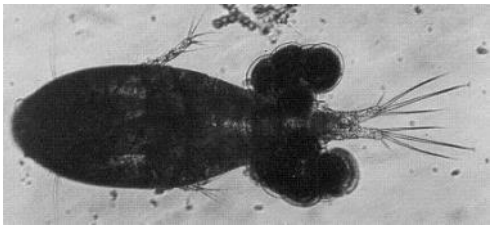
100 a. Anterior part of the body much bigger than more than twice length of the abdomen. First antenna long, about as long as body, with more than 17 segments. Fifth leg asymmetrical. Mostly with only one brood sack.
CALONOIDA (order).....101

[21] E.g. I. spinifer HERRICH , Mamaril 2001a, Papa & Mamaril 2011a,



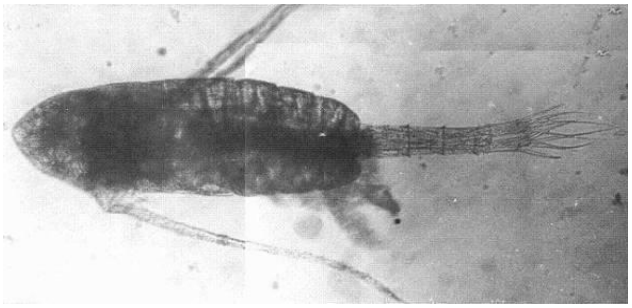
100 b. Anterior part of the body only a little bigger than and less than twice the length of the abdomen. First antenna short, with 6-17 segments, never reaching the abdomen. Fifth leg not asymmetrical. With two brood sacks.

CYCLOPOIDA (and HARPACTICOIDA) (orders).....102



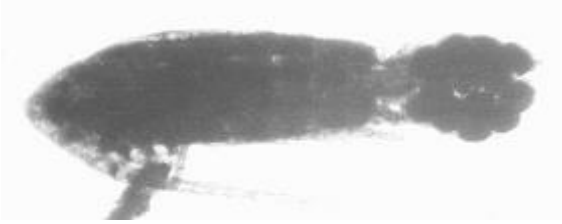
101 a. Inner branch (endopodite) of first, second, third and fourth leg with 3 segments. Caudal branches more than two times longer than wide.

PSEUDODIAPTOMIDAE (family).....116



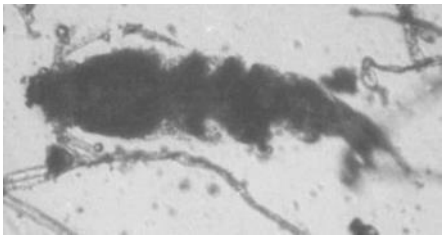
101 b. Inner branch of first leg with 2 segments, inner branch of second, third and fourth leg with 3 segments. Caudal branches less than two times longer than wide.

DIAPTOMIDAE (family).....106



102 a. Abdomen not clearly separated from the anterior part of the body.

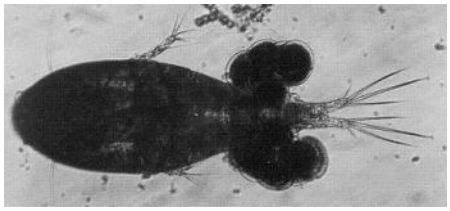
LERNAIDAE (and HARPACTICIDAE)(families)..... 145



102 b. Abdomen distinct from the anterior part of the body.....103

103 a. Second antenna small without a large claw. First antenna long, up to 17 segments (6-21 worldwide).

CYCLOPIDAE (family).....108



103 b. Second antenna large, with a large claw for grasping. First antenna short with 6 segments.

ERGASILIDAE (family).....134



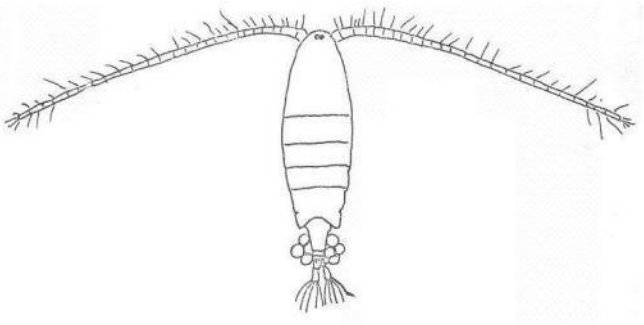
To Key to genera and species → **104**

Key to genera and species of the Philippine copepods.

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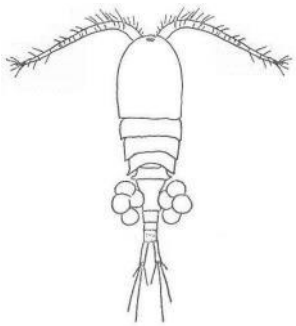
104 a. First antenna long, about as long as body, with more than 17 segments. With one brood sack (brood sack bilobed in Pseudodiaptomus!).

CALONOIDA (order).....105



104 b. First antenna short, with 6-17 segments, never reaching the abdomen. With two brood sacks.

CYCLOPOIDA (order).....108



105 a. Inner branch (endopodite) of first, second, third and fourth leg with 3 segments. Caudal branches more than two times longer than wide.

PSEUDODIAPTOMIDAE (family)

Pseudodiaptomus.....116



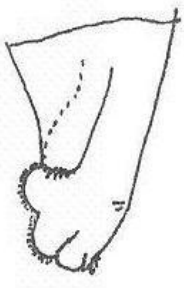
105 b. Inner branch of first leg with 2 segments, inner branch of second, third and fourth leg with 3 segments. Caudal branches less than two times longer than wide.

DIAPTOMIDAE (family).....106

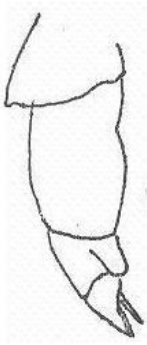


106 a. Left outer branch of male fifth leg bilobed, distal lobe circular saw-like.

Tropodiaptomus.....121

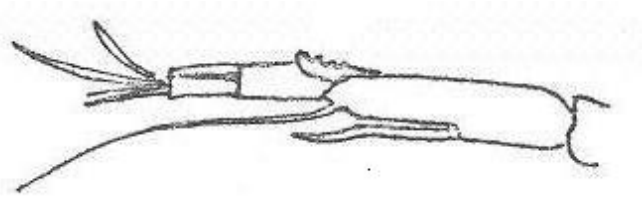


106 b. Left outer branch of male fifth leg without circular saw-like lobe.....107



107 a. Hyaline process of the 3rd last segments of the right first antenna of male short and serrated. Basis of male fifth leg with 3 sigmoid protrusions. Outer distal corner without particular extension of the exopodite of the 5th right male leg. Front part of female abdomen with peg-like spines on genital segment.

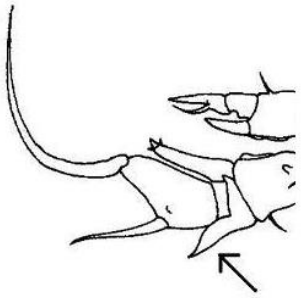
***Filipinodiaptomus*.....119**



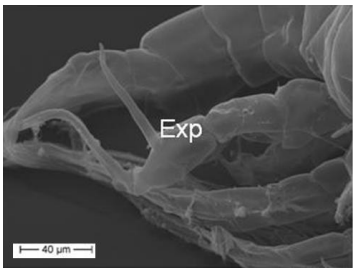
1. Antenna.

107 b. Differ from Filipinodiaptomus by outer distal corner being produced sharply of the exopodite of the 5th right male leg (large wings).

***Arctodiaptomus*.....119c**



Exopod 5th right leg, male



Exopod 5th leg, male

SEM-photo, with permission from Papa et al. 2012b

107 c. Hyaline process of the 3rd last segment of right first antenna of the male membranous without serration. None sigmoid protrusions on basis of male right leg. No peg-like processes on the female abdomen.

Mongolodiaptomus.....120

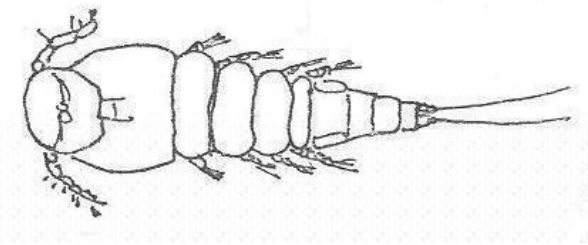


108 a. Abdomen not clearly separated from the anterior part of the body.

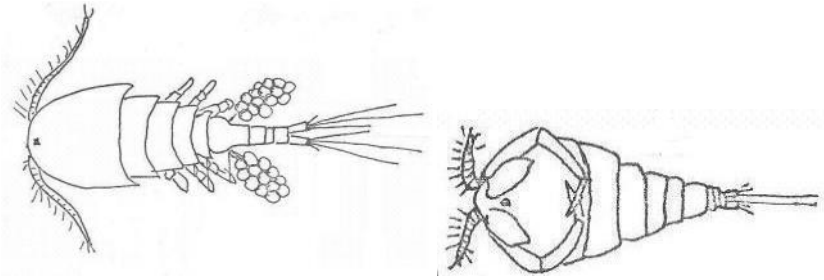
LERNAIDAE (family)

Antenna terminating in a minute hook..... ***Lernaea*** 145

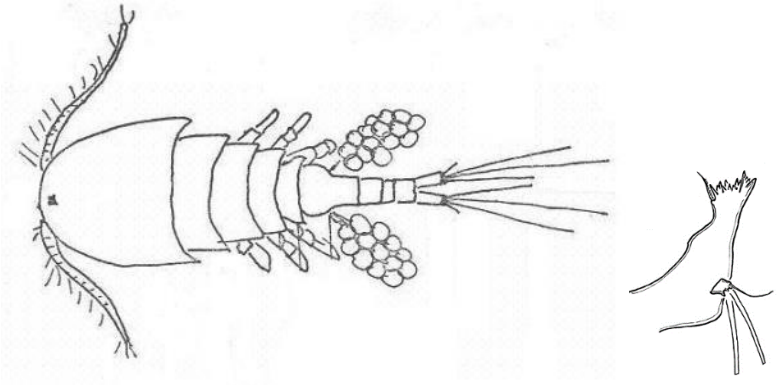
Antenna without terminal hook.....***Lamproglena*** 146



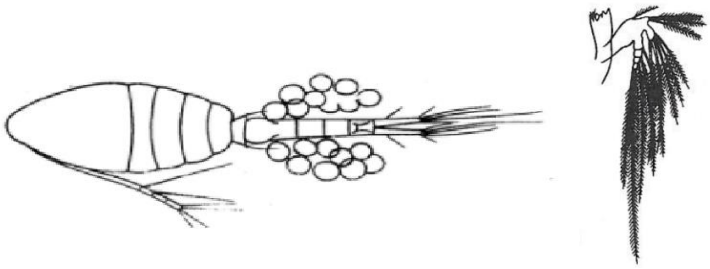
108 b. Abdomen distinct from the anterior part of the body.....109



109 a. Second antenna small, without a large claw.
First antenna long, up to 21 segments (6-21 worldwide).
CYCLOPOIDA (order)
The palp of the mandible is poorly developed and represented by
one process with 3 setae. Most freshwater "cyclops":
CYCLOPIDAE (family).....110



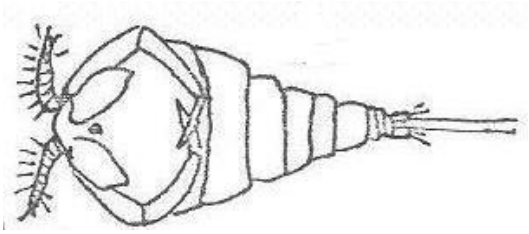
The palp of the mandible is well developed and represented by a segment with 5-6 setae. Very few species in freshwater, most marine copepods:
OITHONIDAE (family) 144d



109 b. Second antenna large, with a large claw for grasping.
First antenna short with 6 segments.

ERGASILIDAE (family)

Ergasilus.....147



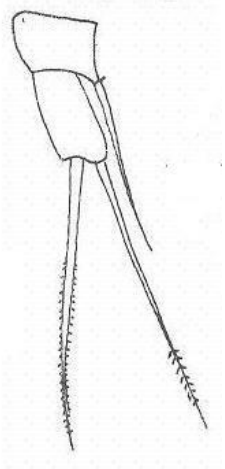
110 a. Last segment of fifth leg of female with 3 appendages.
Caudal branches often with bristles.

EUCYCLOPINAE.....111



110 b. Last segment of fifth leg of female with 1 or 2 appendages.
Sides of caudal branch without groups of bristles.

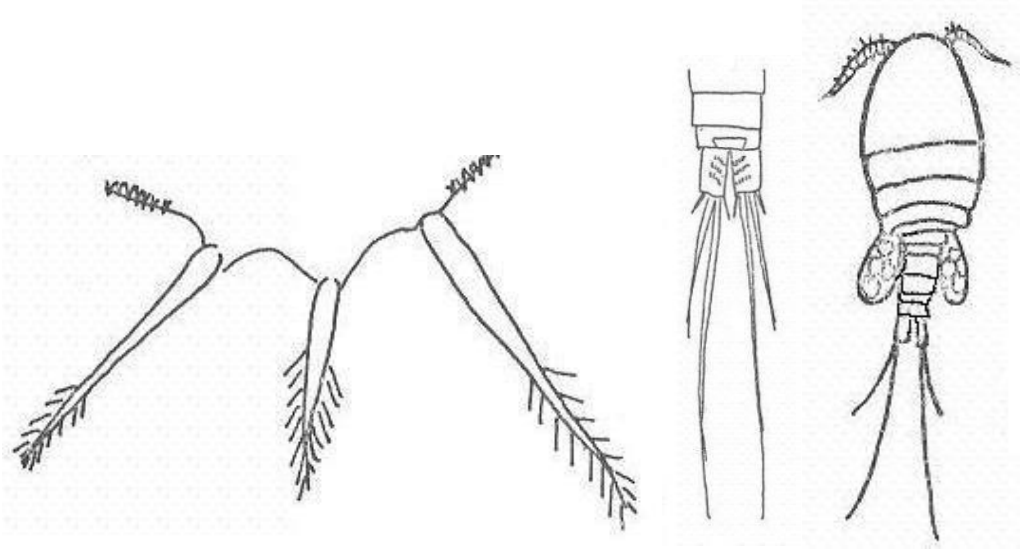
CYCLOPINAE.....114



111 a. Fifth leg "unisegmented" and fused to fifth thoracic

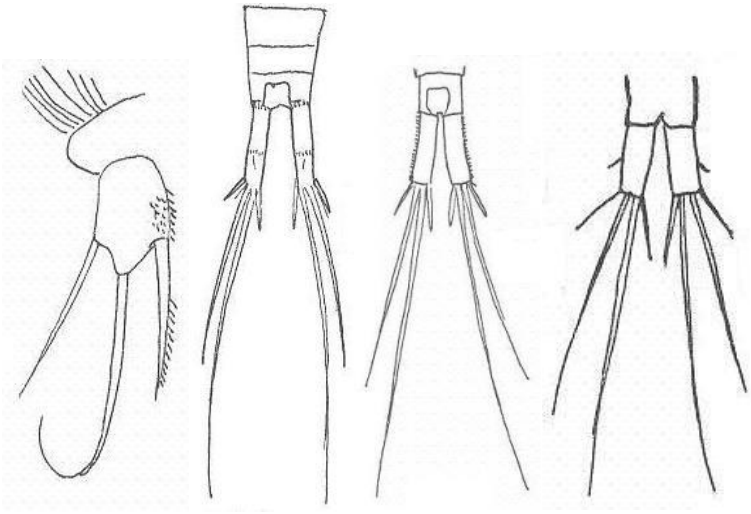
segment and forms a very short and wide plate without articulation with the fifth (posterior) thoracic segment. First antenna with 9-10 segments. Caudal branches short and thick with several transverse rows of small spines.

Ectocyclops.....127



111 b. Fifth leg unisegmented and articulated with the fifth thoracic segment, angular in outline. First antenna with 6-12 segments

.....112

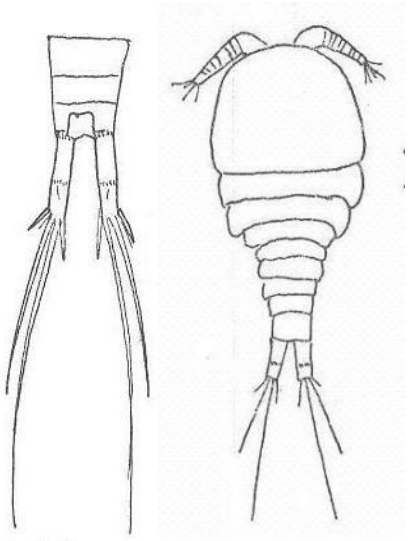


111 c. Fifth leg two-segmented

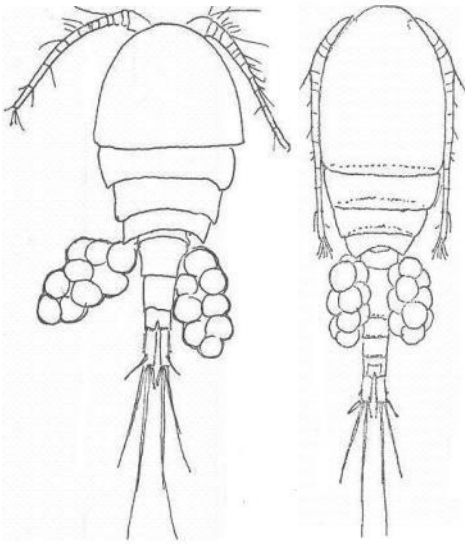
Macrocyclops.....127c

112 a. Anterior part of body clearly flattened dorsoventrally. First antenna very short with 8 segments (6-11 worldwide), reaching only to the middle of the cephalothorax. Caudal branch long and thin, 5-6 times as long as wide, dorsally with transverse row of small spines. Littoral.

Paracyclops.....126

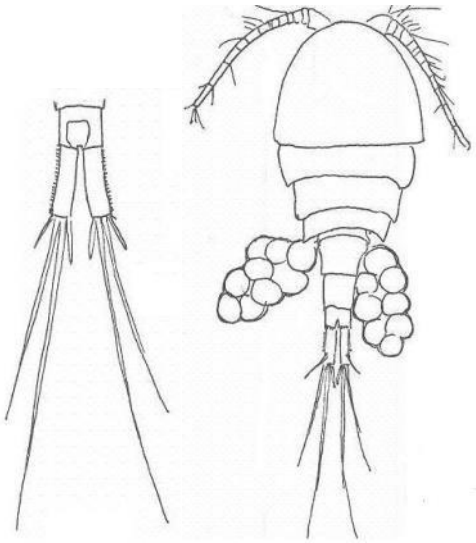


112 b. Anterior part of the body usually thick, only slightly flattened. First antenna with 12 segments.....113



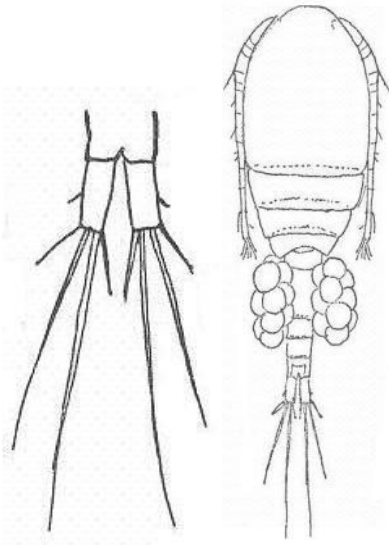
113 a. Outer margin of caudal branches with small distinct saw-like spines. Caudal branches usually very divergent and 4-5 times as long as wide. Lateral spine near the end of the caudal branch. The internal angle of the basipod of 4th leg sharply produced. Littoral.

Eucyclops.....124



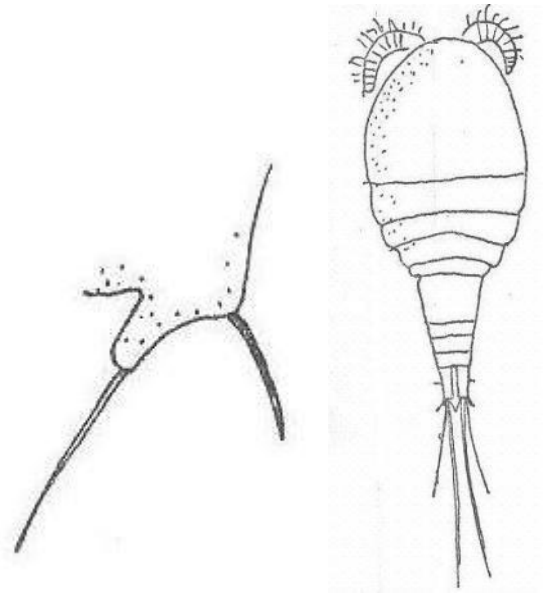
113 b. Outer margin of caudal branches without such spines, and only diverging slightly, 2 1/2 times as long as wide. The internal angle of the basipod of 4th leg rounded produced. Littoral.

Tropocyclops.....125



114 a. First antenna with 9-11 segments, not reaching beyond the cephalothorax. Last, distal segment of fifth leg of female with one long seta and one very small spine. Inner setae on caudal branch less than two times as long as outer setae.

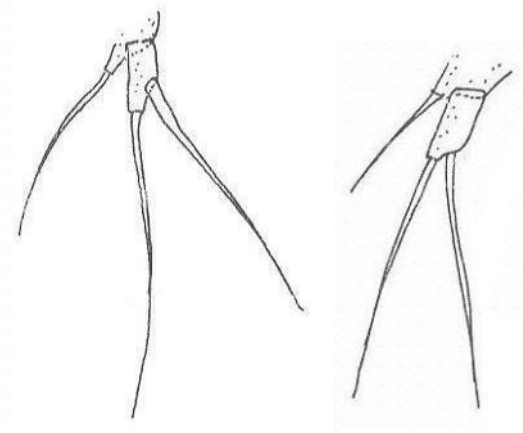
Microcyclops.....128



114 b. First antenna with 17 segments reaching beyond the cephalothorax. Last segment of fifth leg of female with 2 long setae. Inner setae on caudal branch more than twice

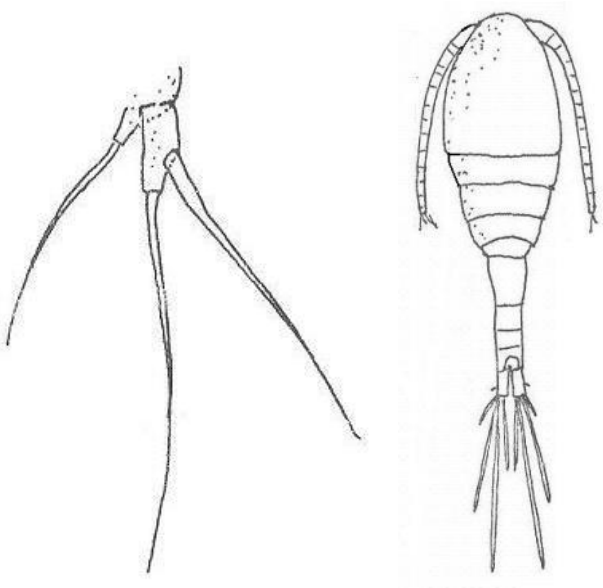
as long as outer setae.

Planktonic.....115



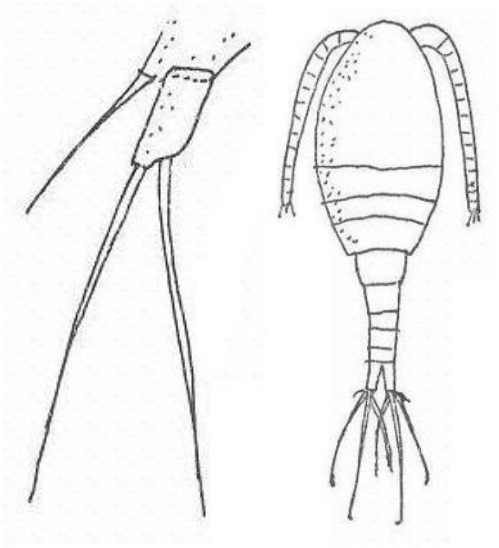
115 a. Last segment of fifth leg of female with one terminal seta and one seta on the inner margin. First antenna with hyaline plate on last segment.

Mesocyclops.....129



115 b. Last segment of fifth leg of female with two terminal setae. First antenna without hyaline plate on the last segment.

Thermocyclops.....142



COPEPODA, Copepods (subclass)

CALANOIDA, G.O.SARS 1903 (order)

Anterior part of the body much bigger than more than twice length of the abdomen. First antenna long, about as long as body, with more than 17 segments. Fifth leg asymmetrical. Mostly with only one brood sack.

Three (Two) species of calanoid copepods are endemic, a somewhat remarkable occurrence considering that calanoids are represented by only six (five) known species in the Philippines and absent in many large tropical lakes. (Mamaril, 2001a.

"Copepods, specifically calanoid copepods, play an important role in the productivity of aquatic ecosystems since they serve as a crucial link between primary producers and carnivores. In tropical reservoirs and lakes, they are not only a major source of food for many invertebrates and zooplanktivorous fish, but also good biological indicators. Calanoid/cyclopoid-cladoceran ratio is used in limnological studies as an indicator of water quality". (Quotation: Palomar & Mamaril, 2001.), an abundance of Calanoids indicating a good water quality and a low trophic state (Papa et al. 2012c)

PSEUDODIAPTOMIDAE, SARS 1902(family)

Inner branch (endopodite) of first, second, third and fourth leg with 3 segments. Caudal branches more than two times longer than wide.

PSEUDODIAPTOMUS, HERRICK 1884.

The genus primary coastal demersal species living near or on the bottom of lake, sea or estuaries. (Walter, 1986b, 2006) Brood sack bilobed in freshwater species. A key to the 14 Philippine species of *Pseudodiaptomus* is given by Walter (2006). In big brackish waters like Laguna de Bay Pseudodiaptomus can be of ecological importance in "Inland

waters". This is the reason for including the family in the key. See Walter (2009) – World of Copepods.

116 a. Second segment of left fifth leg of male gives off two long spines of nearly equal length and a third small one near the inner junction of the succeeding segment. Apex of male left endopodite hook-like and bifid. Urosome with lateral spines anteriorly. Planktonic in fresh-, brackish- and seawater. LOBUS-GROUP, POPPEI-SUBGROUP
- Luzon, Around Manila (no locality data, assumed collected from freshwater (Wright, 1928)), Taal Lake.

Pseudodiaptomus smithi, (WRIGHT, 1928)
[1928c, 1939b, 1986b, 2006]



P. smithi (Photo: Rey Donne S. Papa, 2007)

116 b. Second segment of fifth left leg of male gives off one spine. Endopodite simple.....117

117 a. This spine *shorter* than the second segment. Male right endopodite large. Left endopodite absent. Pediger (segment) five posterior corners distally pointed. Marine species. HYALINUS-GROUP
- Luzon

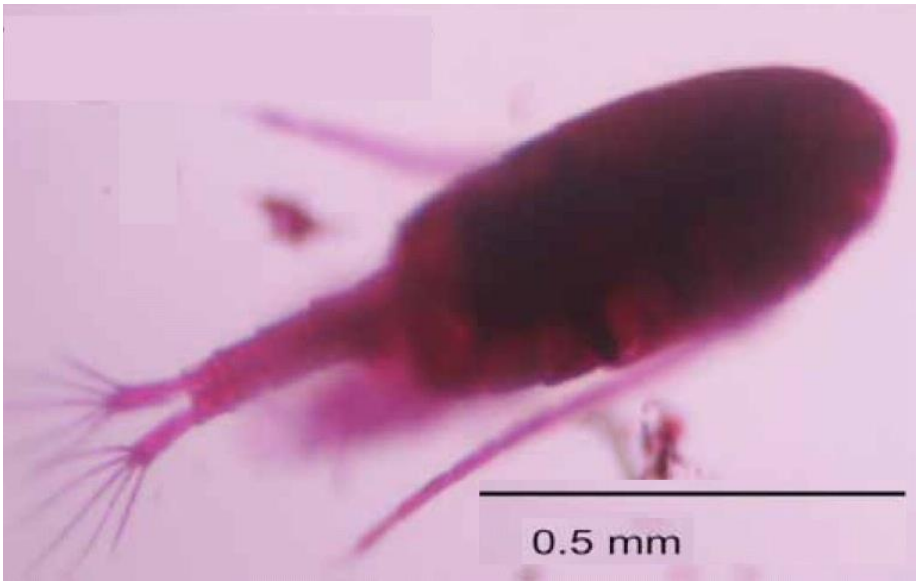
Pseudodiaptomus trihamatus, WRIGHT, 1937
[1937c, 2006]

117 b. This spine *longer* than the second segment.
Apex of male left endopodite hook-like and simple.
Pediger (segment) five with corners rounded.
LOBUS-GROUP, FORBESI-SUBGROUP.....118

118 a. Second segment of left fifth leg of male gives
of one very slim spine longer than the second
segment. Exopodite lacking medial pointed
processes. Urosome without lateral spines.
Female total length 600-800 µm and male total length 500-800 µm. The number of eggs per egg sac varied between 4-9 and the egg diameter 8-14 µm. All data from Taal Lake(Papa et al., 2017a).
Up to 3 individuals per L in the deeper water af Taal Lake thus separated from the population of *Arctodiaptomus dorsalis*, which decrease the food competition (Papa et al., 2017a).
In fresh-, brackish- and **seawater**.
- Naujan (Mindoro – not found in 2012a), Taal (Luzon) (Endemic)

Pseudodiaptomus brehmi, (KIEFER, 1939)

[1938d, 1941a, 1986b, 2006, Taal: 2011c, -2012a, 2017]



Pseudodiaptomus brehmi from Taal Lake 2011. Photo R. D. S. Papa.
UST, 2013



Rey D. S. Papa Lecture at UST 10th January 2015.
Source

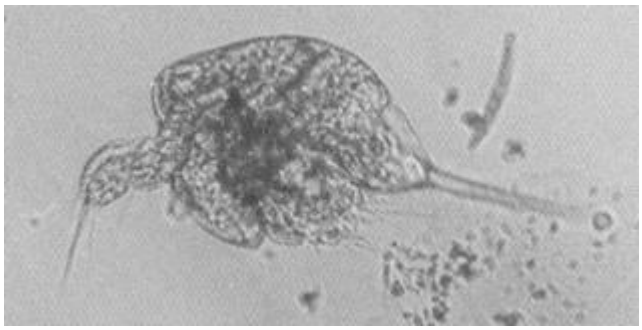
118 b. Second segment of left fifth leg of male gives
of one very broad spine *longer* than the second

segment, third segment gives off a smaller spine.
Exopodite medial with two pointed processes.
Urosome with one pair of lateral spines anteriorly.
Size female 1300 µm. In fresh, brackish and sea-water
(up to 3 ppt in Laguna de Bay in 1980).
(Figures 118b[1], 118b[2], 118b[3], 118b[4], 118b[5], 118b[6], 118b[7], 118b[8],)
- Laguna de Bay (Nauplii, copepodite, female A+B, egg,
male, 5th leg) Luzon Island, Calatagan, Batangas (marine in
eelgrass), Province, Panay Island.

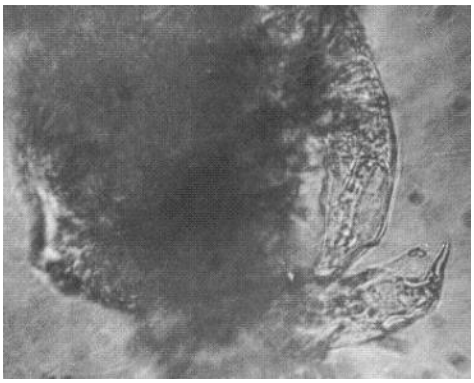
Pseudodiaptomus annandalei SEWELL, 1919

(syn. *Pseudodiaptomus nostradamus* BREHM, 1933b)
(syn. *Schmackeria annandalei, S. dubia*)

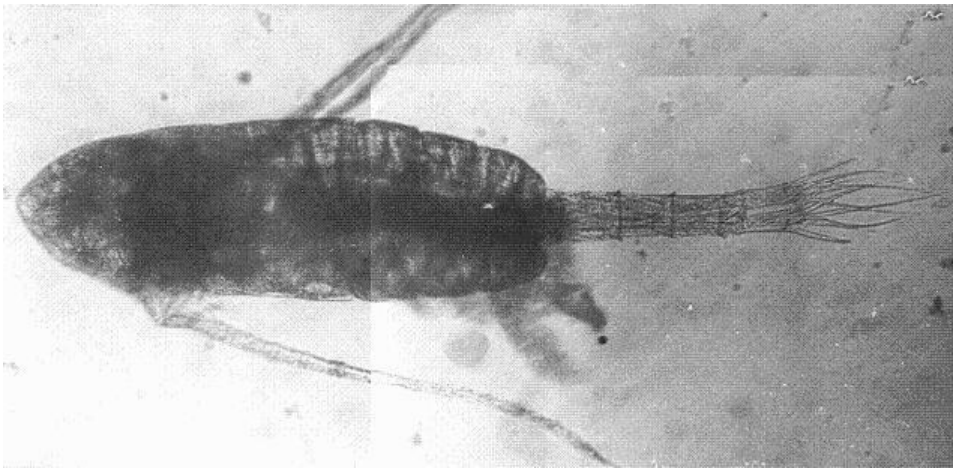
[1933b, 1937e, 1939b (from Java),
1980, 1984a (*nostradamus*),
1986b, 2006 (*annandalei*)]



***P. annandalei*. Metanauplius from Laguna de Bay**



***P. annandalei* Male 5th legs from Laguna de Bay**



***P. annandalei* Male from Laguna de Bay**

NOTE: Some marine species of *Pseudodiaptomus*, whereof one can collect up to 10 congenic species at the same marine locality (coral reef) in the Philippine coastline. Se Walter (2006, 1986b) for further descriptions and a key of the Philippine marine species:

Pseudodiaptomus philippinensis WALTER, 1986 (Endemic).
Pseudodiaptomus bispinosus WALTER, 1984. (Endemic).
Pseudodiaptomus trispinosus WALTER, 1986 (Endemic).
Pseudodiaptomus terazakii WALTER, 2006.
Pseudodiaptomus caritus WALTER, 1986 (Endemic).
Pseudodiaptomus diadelus WALTER, 1986.

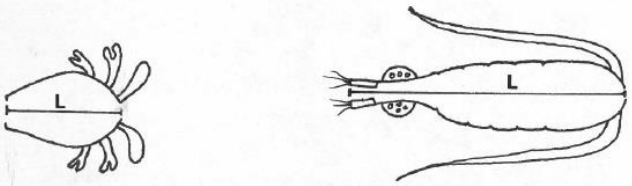
DIAPTOMIDAE, G. O. SARS 1903 (family)

Inner branch of first leg with 2 segments, inner branch of second, third and fourth leg with 3 segments. Caudal branches less than two times longer than wide. Feeds by selective filtration of algae, detritus and bacteria. They are able to separate organic particles of detritus, single cells of algae and bacteria from mineral components of seston (Alekseev, 2002a). This is why they are able to live in very turbulent river waters where most Cladocera are suppressed, or dominate the zooplankton biomass, as in Laguna de Bay, a big shallow, and therefore turbid lake. Their ability to escape predations by fish larvae sustains their dominance in plankton of tropical lakes. They show vertical diurnal migration (Carlos 1982, Lewis 1979). (Figure: Nauplii)

LENGTH-WEIGHT-RELATIONSHIP for COPEPODA - CALANOIDA (DIAPTOMUS-GROUP) (WETWEIGHT)

FORMULA USED: $W = 7.9 \times 10^{-6} \times L^{2.33}$ (W = Wetweight in ug, L = Length in um)

Length	Weight	Length	Weight	Length	Weight
100	0.36	300	4.6	860	54.3
110	0.45	320	5.4	880	57.3
120	0.55	340	6.2	900	60.4
130	0.67	360	7.1	920	63.6
140	0.79	380	8.1	940	66.8
150	0.93	400	9.1	960	70.2
160	1.08	420	10.2	980	73.7
170	1.24	440	11.4	1000 (=1.0mm)	77.2
180	1.42	460	12.6	1020	80.9
190	1.61	480	13.9	1040	84.6
200	1.82	500	15.3	1060	88.4
210	2.03	520	16.8	1080	92.4
220	2.27	540	18.3	1100	96.4
230	2.51	560	19.9	1120	100.5
240	2.78	580	21.7	1140	104.8
250	3.05	600	23.4	1160	109.1
260	3.35	620	25.3	1180	113.5
270	3.65	640	27.2	1200	118.1
280	3.98	660	29.3	1220	122.7
290	4.32	680	31.4	1240	127.4
300	4.67	700	33.6	1260	132.3
		720	35.9	1280	137.2
		740	38.2	1300	142.3
		760	40.7	1320	147.4
		780	43.2	1340	152.7
		800	45.9	1360	158.0
		820	48.6	1380	163.5
		840	51.4	1400	169.1
				1420	174.8
				1440	180.6
				1460	186.5
				1480	192.5
				1500	198.6

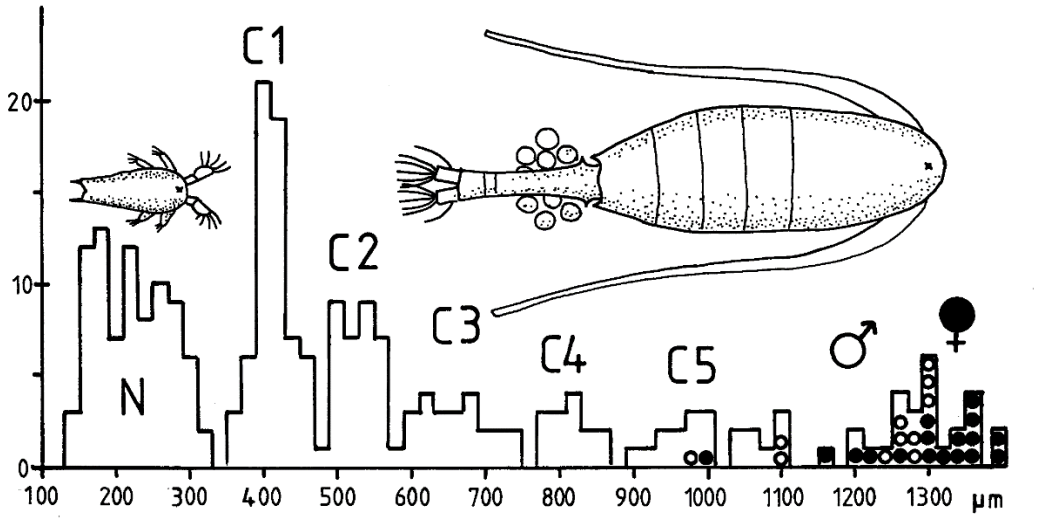


FILIPINODIAPTOMUS, LAI, MAMARIL and FERNANDO 1979,

(syn. Diaptomus)

Left outer branch of male fifth leg without circular saw-like lobe. Hyaline process of the 3rd last segment of the right first antenna of male short and serrated. Basis of male fifth leg with 3 sigmoid protrusions. Outer distal corner being of the exopodite of the 5th right male leg without processes (see NOTE). Front part of female abdomen with peg-like spines on genital segment.

119 a. Last segment of right fifth leg of male with short and broad spine besides the terminal hook. Size of female 1400 µm. Postembryonic development, feeding habits, and density fluctuations of its life history stage in La Mesa Dam reservoir, has been reviewed by Palomar & Mamaril (2001). Endemic in Bulacan-Rizal-Laguna area. Mamaril (1978a) reported it as far north as Nueva Ecija and Tarlac. Recently Aquino et al. (2008b) found it together with *Tropodiaptomus australis in* Paoay Lake. Found in lakes, reservoirs, and rice fields. Endemic. Thus, the record from Karela, South India, by Jose & Sanalkumar (2012) has to be confirmed. (Figures 119a[1], 119a[2], 119a[3], 119a[4], 119a[5], 119a[6], 119a[7], 119a[8],) The sizes of the different development stages can be found for a given population by setting up a length frequency diagram as shown below for the 1980 population in Laguna de Bay (Petersen, 1981e).



Length frequency diagram for Filipinodiaptomus in Laguna de Bay. . After Petersen, 1981e.

- Laguna de Bay[22] (Nauplii, overview, copepodite, female,

[22] Until 2008+ (2008b) may have been displased by the invasive *Arctodiaptomus dorsalis* (2012a)

egg, male, 5th leg), La Mesa Dam, Bustos Dam, Lake Paoay.

Filipinodiaptomus insulanus, (WRIGHT, 1928)

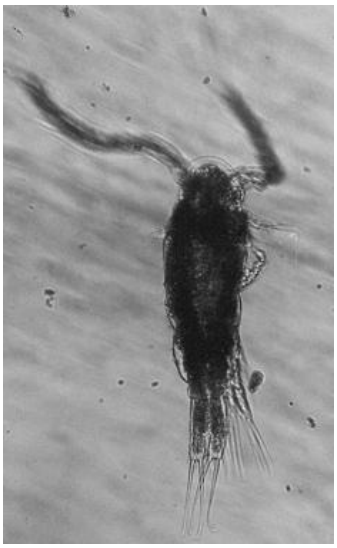
(syn. *Diaptomus insulanus*, WRIGHT, 1928)

(syn. *Diaptomus sensibilis*, KIEFER, 1928)

[1928a+b, 1930a, 1933a, 1937b (with map), 1937e, 1941a, 1978a+b, 1979a, 1980, 1984a, 1986a, 2001, 2002a, 2008b, -2012a]



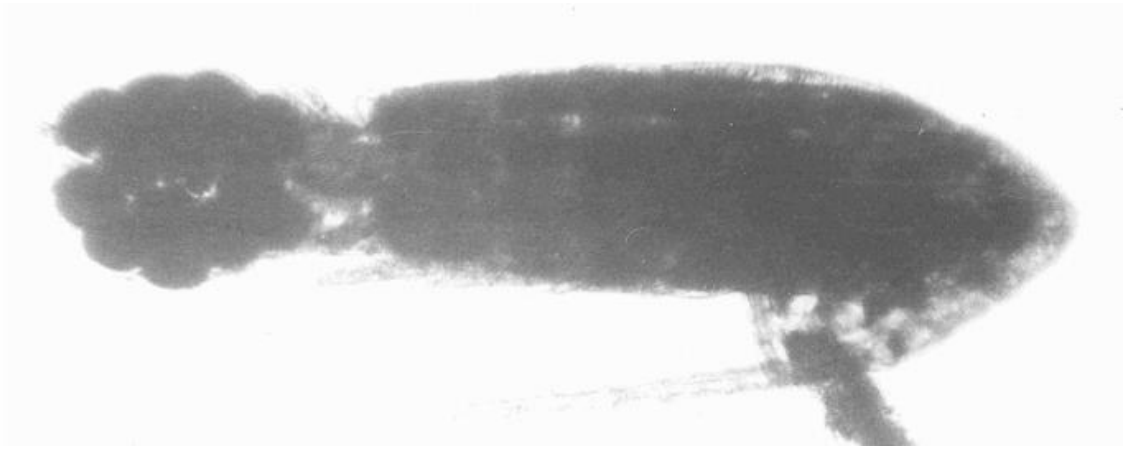
***F. insulanus* nauplii from Laguna de Bay**



***F. insulanus* C1 from Laguna de Bay**



***F. insulanus* Adult from Laguna de Bay**



***F. insulanus* Female from Laguna de Bay**

119 b. Last segment of right 5th leg of male with long and sharply pointed spine besides the terminal hook. Brehm (1933) has described this species from Danao Lake (Leyte), while Lai et al. (1979) looked for it, in vain, in Lanao Lake, Mindoro. Brehm (1933d) writes (translated from German): "In the plankton of Lake Danao Leyte (No.

142 in the collection) was found a specimen which seems to be closely related to *Diaptomus insulanus* recently reported from Laguna de Bay." Since its morphology is similar to *Filipinodiaptomus insulanus*, he only added a single drawing to his description of this new species of the males 5th leg, showing the long spine. However ***F. vexillifer*** has not yet been established as a valid name for ***Diaptomus vexillifer***, BREHM 1933, and the existence of the species has not been confirmed (Augustus C. Mamaril, personal communication). Endemic.

- Danao Lake (Leyte).

Filipinodiaptomus vexillifer, (BREHM, 1933)
(syn. Diaptomus vexillifer)
[1933d, 1937b (with map), 1937e (Misspelled: "Lanao-See"), 1941a]

ARCTODIAPTOMUS KIEFER, 1932

119 c Differ from Filipinodiaptomus by the outer distal corner being produced sharply of the exopodite of the 5th right male leg (large wings). ***Size female 970 µm and 820 µm for males in Tall Lake (2012b).*** Worldwide 780-1060 µm and female 770-1130 µm (2015a). Nearctic genus.
Eutrophic. A general eutrophication of Philippine lakes might have boosted its dispersal, influences by intensive aquaculture, together with transfer of fingerlings from lake to lake. Invasive species, first recorded in 1991. Occurred in 18 out of 27 lakes in the archipelago (2012a). An increase in body size has been found after a reduction in aquaculture in Lake Taal. A relation to a decrease in fish predation is suggested (Leon et al., 2016c). The average clutch size in culture are 9 eggs (Tordesillas et al., 2016a). The presents in a lake suggest that the lake being in an enhanced productive state (Papa et al., 2012c and Legaspi et al., 2015b)
Ponds and lakes. Invasive.

The population and the individual sizes has been investigated by Leon et. al (2016c).

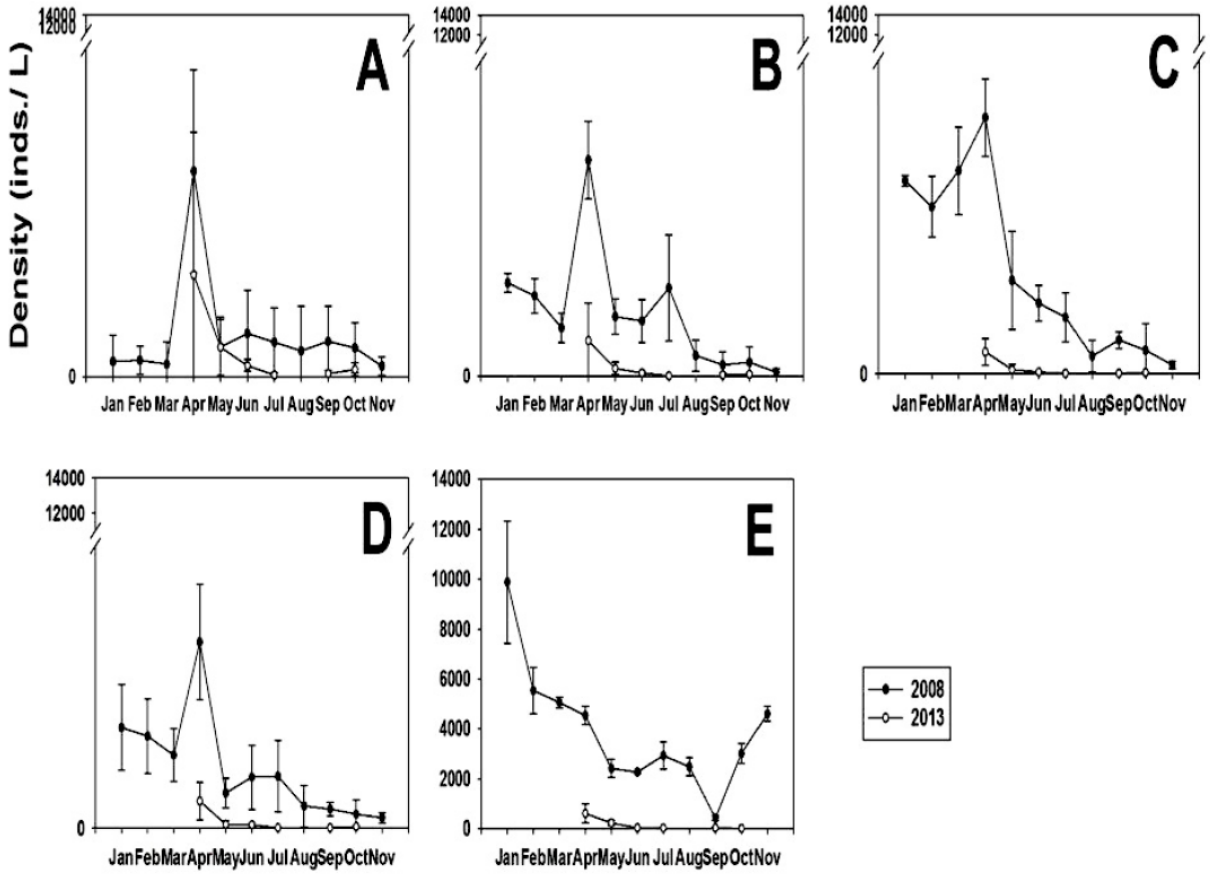


Figure 4. Abundance of 2008 VS 2013 *Arctodiaptomus dorsalis* (A) Adult Male (B) Adult Female (C) C1-C3 Early Copepodite (D) C4-C5 Late Copepodite (E) Nauplii.

The fluctuation in number (No./L) of *Arctodiaptomus dorsalis* in Lake Taal in 2008 and 2013 (Leon et al., 2016c).

Tordesillas et al. (2016a) have determined the development time (D) of different stages in cultures for different temperatures for naupliar stage development time (25◦C: 4,41 days, 30◦C: 2,84 days 35◦C: 2,25 days) described by following function $D = 1017{,}9 \cdot (T - 4{,}4)^{-1{,}80}$, copepodite stage development time (25◦C: 25,85 days, 30◦C: 21,38 days 35◦C: 15,00 days) described by following function $D =$

$12826{,}6 \cdot (T + 6{,}2)^{-1{,}80}$, and post-embryonic development time from hatching to adult (25◦C: 31,50 days, 30◦C: 26,00 days 35◦C: 18,29 days) described by following function $D = 15527{,}2 \cdot (T + 6{,}1)^{-1{,}80}$.
- Lake Paoay, Laguna de Bay, Pasig River, Lake Taal, Naujan, Lake Buhi, Bicol River, Lake Danao(Leyte), Lake Danao(Cebu), Lake Mainit, Lake Lanao (2016c). ~~Invasive.~~

Arctodiaptomus dorsalis, (Marsh, 1907)

[2001d, 2003c(*A. sp.*), 2012b, 2012c, 2014b, 2015a, 2015b, 2016c]



***Calanoid copepod*, Taal Lake**
(Photo: Rey Donne S. Papa, 2007)

MONGOLODIAPTOMUS, KIEFER 1932.

Left outer branch of male fifth leg without circular saw-like lobe. Hyaline process of the 3rd last segment of right first antenna of the male membranous without

serration. None sigmoid protrusions on basis of male right leg. No peg-like processes on the female abdomen.

120 a. Only one species in the Philippines, which seems to be closely related to *Mongolodiaptomus formosanus*, KIEFER 1937. Rather small and slender.
Planktonic in lakes and ponds. Distribution restricted. Rare.
- Lake Paoay, Baguio City.

Mongolodiaptomus birulai, (RYLOV, 1923[23])
(syn. *Diaptomus birulai*, *Eudiaptomus birulai*)
[1978a+b, 1979a, 1986a, 2012a]

TROPODIAPTOMUS, KIEFER 1932
Left outer branch of male fifth leg bilobed, distal lobe circular saw-like.

121 a. Spine on segment 15 of the right first antenna of the male absent. See Table 2. Last outer segment of fifth leg of male usually bilobed (rarely trilobed) with distal lobe having discernible spines. First antenna of female reaches the end of caudal branches. Size of female 1100 µm only. Preferred food sources in Lake Lanao are diatoms. Predated upon by Chaoborus. Planktonic and endemic in Mindanao. Rare. Under extinction I Lake Lanao by the intrusion by the invasive *Arctodiaptomus dorsalis* (Metillo, 2014b)
- Lake Lanao.

Tropodiaptomus gigantoviger, (BREHM, 1933)
[1933a, 1937b (with map), 1937e, 1941a, 1969, 1978a+b+d, 1979a+b, 1986a, 2001a[24]]

121 b. Spine on segment 15 present. Both lobes on last

[23] Dussart and Defaye, 2001
[24] Tabel 3 in Mamaril (2001a) mark it present in Laguna de Bay instead of Lake Lanao, which is probably a mistake?

outer segment of the fifth leg of male with discernible spines. First antenna of female short, seldom reaching caudal branches. Size of female more than 1100 µm (AUSTRALIS GROUP).....122

122 a. Spines on segment 13, 15, 11, 10 and 12 (in descending order of spine length) on right male first antenna. Size of female 1900 µm. Planktonic and littoral, often with epibionts. ***T. prasinus*** is considered to be the same as ***T. vicinus***, see 123b, which were found instead by Lai et al. (1979). Distribution limited to Mindanao and vicinity (Mamaril 1986a) and is the main species of *Tropodiaptomus* in Southern parts of the Philippines (Lai et al., 1979a). Has been extended from Lake Buhi efter the invasion by Arctodiaptomus dorsalis Rizo, 2015a). Rare.

- Lake Lanao, Lake Buhi

Tropodiaptomus vicinus, (KIEFER, 1933)

(syn. Tropodiaptomus prasinus, KIEFER, 1933)

[1933a, 1934b, 1937b, 1937e, 1941a: (prasinus), 1978a+b, 1979a+b]

122 b. Spine on 12th segment of right male first antenna absent.....123

123 a. Spines on the proximal lobe of left outer segment of the male fifth leg several times larger than the spines on distal 1obe. Cephalothorax 1080-1220 µm. Abundant in Northern Philippines (Lai et al., 1979a). In ponds, lakes and rice fields. Can co-occur with *Filipinodiaptomus insulanus* (Mamaril and Fernando,1978b). Common.

- La Mesa Dam (Figures 123a1, 123a2), Paoay Lake

Tropodiaptomus australis, (KIEFER, 1936)

[1978a+b, 1979a, 1986a, 2008b]



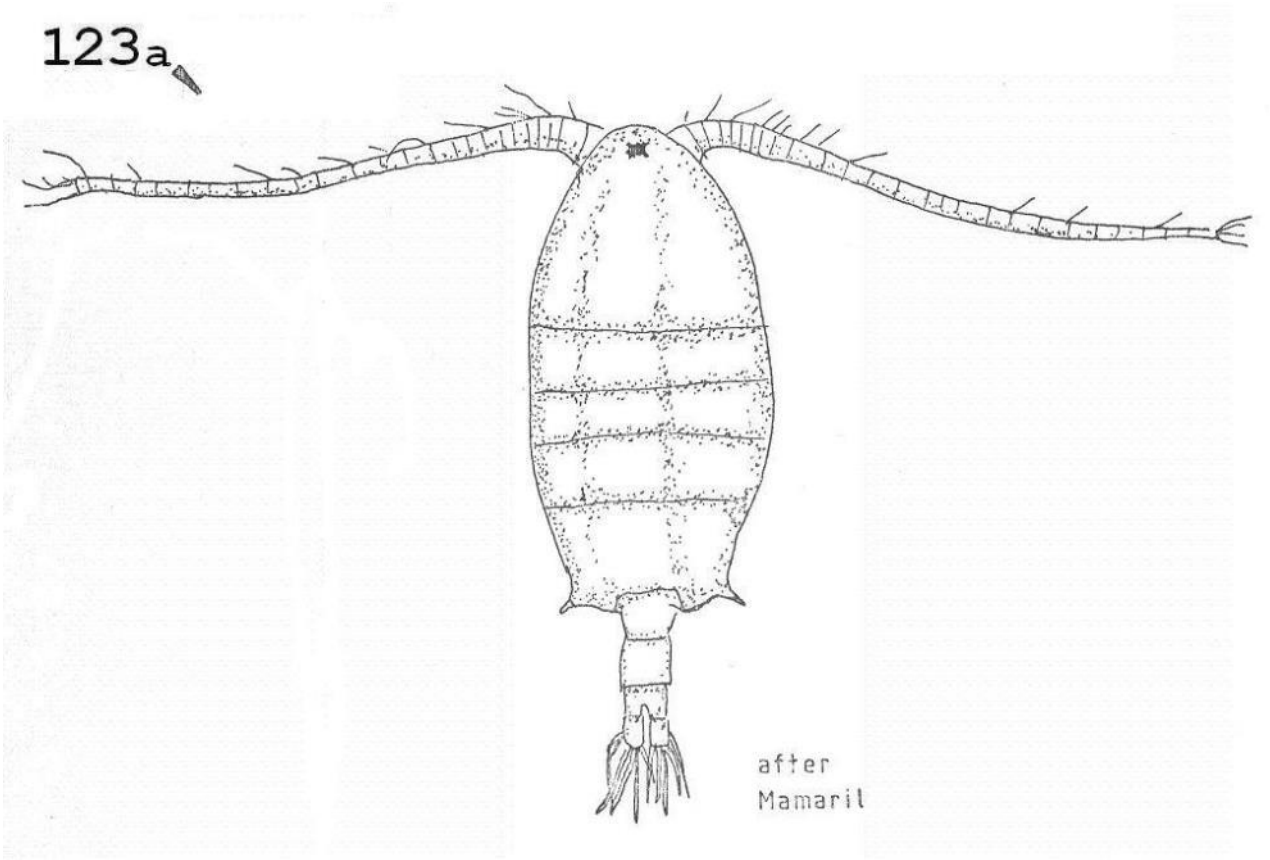
T. australis (Photo: Rey Donne S. Papa, 2007)

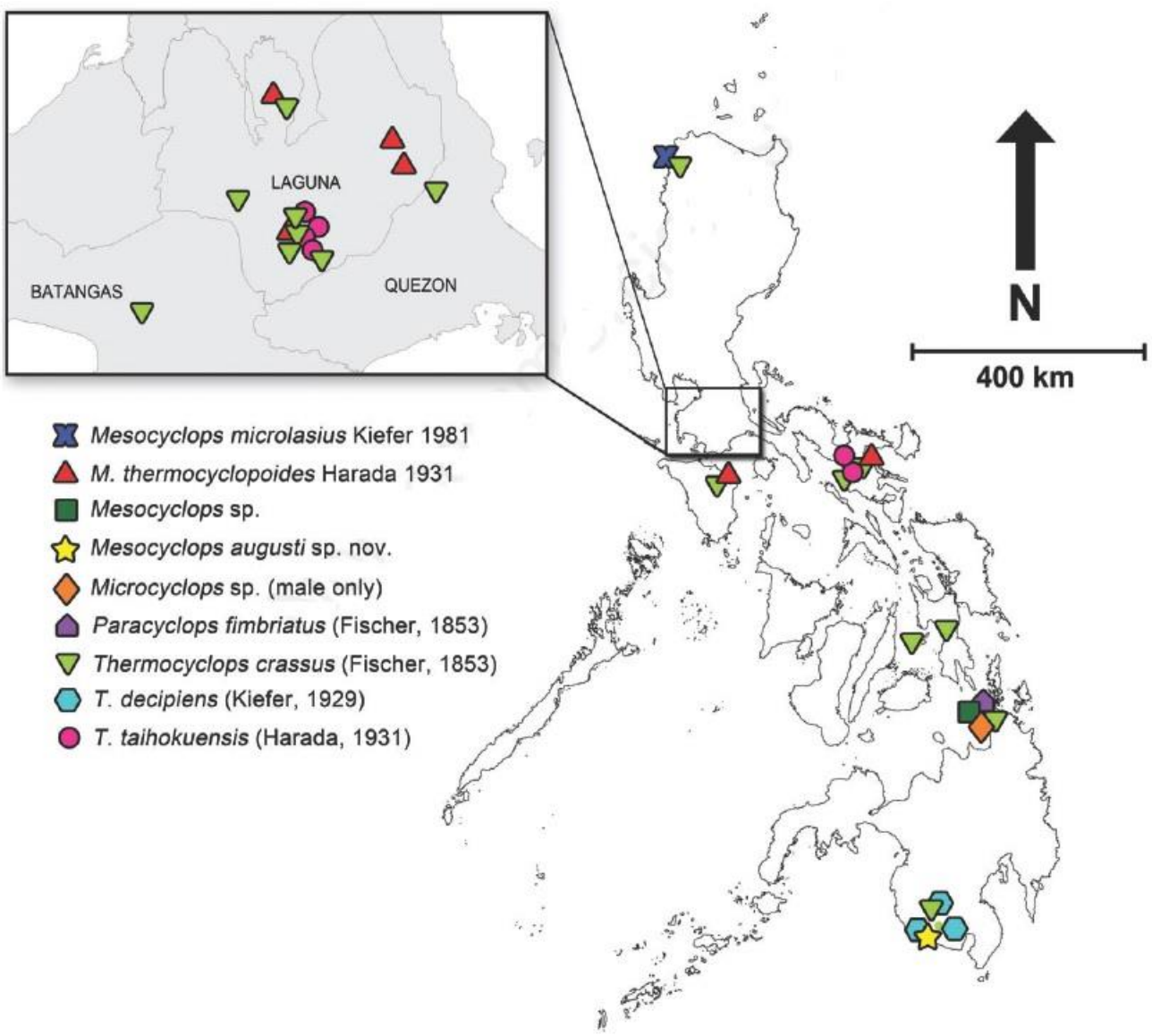
123 b. Spines on both lobes of about the same size.
Cephalothorax 880-900 µm. Southern distribution.
T. prasinus is considered to be the same as *T. vicinus* (Lai et al, 1979a, Augustus C. Mamaril, personal communication). Rare.
- Lake Lanao, Taal Lake

Tropodiaptomus vicinus, (KIEFER, 1930)
(syn. Diaptomus vicinus, KIEFER, 1930)
[1978a+b, 1979a, 1986a, 2001a, 2008e, 2011c]

Table: Spines on 1st antenna of male *Tropodiaptomus*.

Species	Spines on 1st antenna	10	11	12	13	15
T. gigantoviger	*121a*	small	small	absent	big	absent
T. prasinus	*122a*	small	small	small	big	big
T. vicinus	*123b*	small or absent	small	absent	big	big
T. australis	*123a*	small	small	absent	big	Big





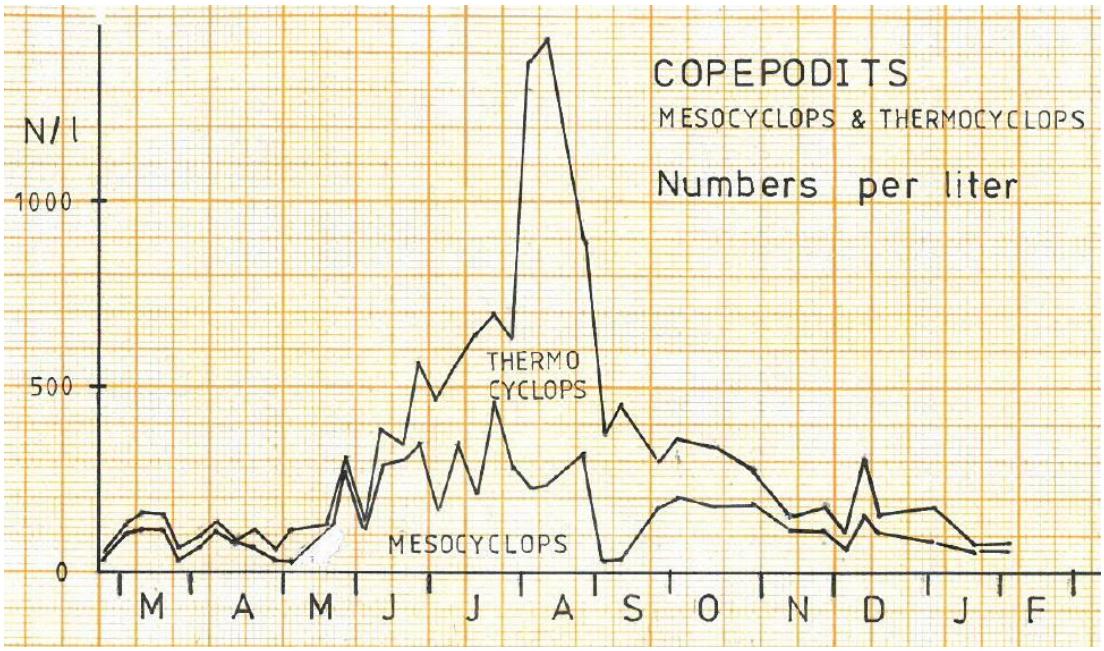
Records of some copepods. (Papa and Hołyńska, 2013).

CYCLOPOIDA, BILLBERG, 1820 (order)

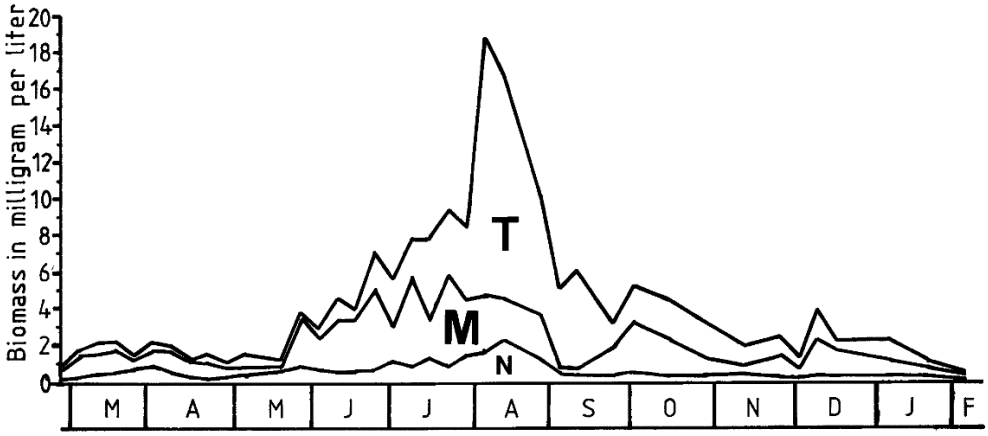
CYCLOPIDAE, RAFINESQUE, 1815 [BILLBERG, 1820] (family)

An important group with at least 18 species recorded - 11 of these found in limnetic zone (Papa, R. D. S., M. K. Hołyńska, 2013). Anterior part of the body only a little bigger than and less than twice the length of the abdomen. First antenna short, with 6-17 segments, never reaching the abdomen. Fifth leg not asymmetrical.

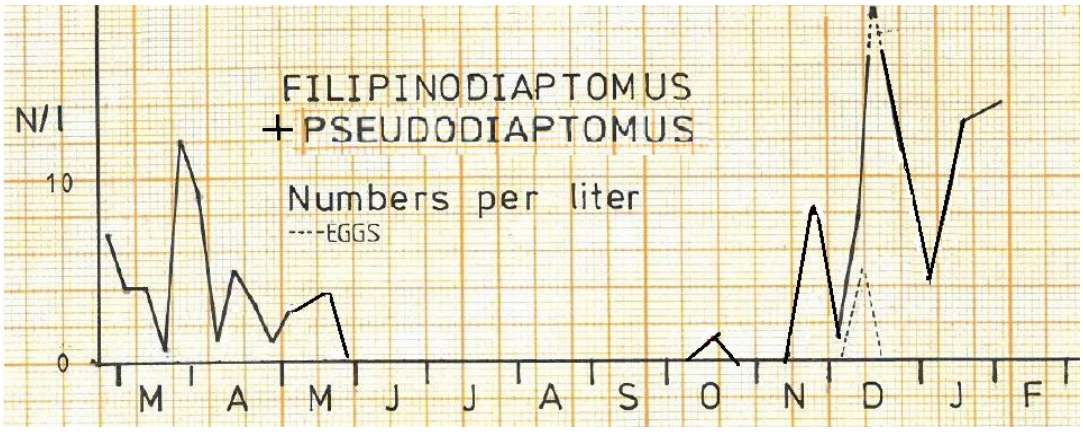
The palp of the mandible is poorly developed and represented by one process with 3 setae. Most freshwater “cyclops”. With two brood sacks.
Micro-predators, which feeds on protists, small invertebrates and even small fish-larvae. Most copepods have mixed diets though some tend to be carnivorous while others predominantly are herbivorous.
General small-sized animals, able to avoid being predated upon by fish (*Tropocyclops* and *Thermocyclops*). (Alekseev, 2002a)
The use of cyclopoid copepods (*Mesocyclops* and at least one *Thermocyclops* species, as potential biological control agents of Dengue-carrying mosquitoes (*Aedes* spp.) has been investigated by Ueda and Reid (2003a). Calanoid/cyclopoid-cladoceran ratio is used in limnological studies as an indicator of water quality”. (Quotation: Palomar & Mamaril, 2001.), an abundance of Copepoids indicating a high nutrient level, emphasizing a high trophic state and doubtful water quality (Papa et al. 2012c).
In Laguna de Bay a high number of copepodites during period with high primary production indicated the high nutrient level. During periods with lower primary production the number of calanoid copepodites were increasingly higher, dominated by *Filipinodiaptomus insulanus*. Se following graphs.



The number of cyclopoid copepodites (*Mesocyclops thermocyclopoides* and *Thermocyclops crassus*) in Laguna de Bay in 1980. (Petersen, 1981e).



Biomass of nauplius (N) and cyclopoid copepodites (M = *Mesocyclops thermocyclopoides* and T =*Thermocyclops crassus*) in Laguna de Bay in 1980. (Petersen, 1981e).

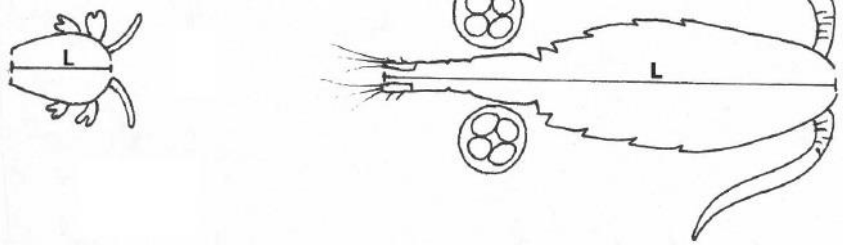


The number of calanoid copepodites (*Filipinodiaptomus insulanus and Pseudodiaptomus annandalei*) in Laguna de Bay in 1980. (Petersen, 1981e).

LENGTH-WEIGHT-RELATIONSHIP for COPEPODA - CYCLOPOIDA (CYCLOPS-GROUP) (WETWEIGHT)

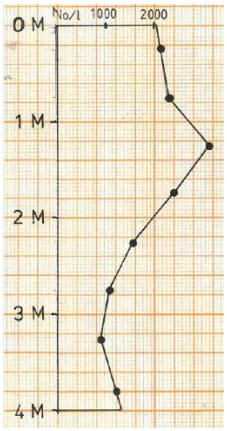
FORMULA USED: $W = 1.1 \times 10^{-4} \times L^{1.89}$ (W - Wetweight in ug, L = Length in um)

Length	Weight	Length	Weight	Length	Weight
80	0.43				
100	0.66	300	5.29	600	19.6
110	0.79	310	5.62	610	20.2
120	0.94	320	5.97	620	20.9
130	1.09	330	6.33	630	21.5
140	1.25	340	6.70	640	22.1
150	1.43	350	7.07	650	22.8
160	1.61	360	7.46	660	23.5
170	1.81	370	7.86	670	24.1
180	2.01	380	8.26	680	24.8
190	2.23	390	8.68	690	25.5
200	2.46	400	9.11	700	26.2
210	2.69	410	9.54	710	26.9
220	2.94	420	9.98	720	27.7
230	3.20	430	10.44	730	28.4
240	3.47	440	10.90	740	29.1
250	3.75	450	11.38	750	29.9
260	4.03	460	11.86	760	30.6
270	4.33	470	12.35	770	31.4
280	4.64	480	12.85	780	32.2
290	4.96	490	13.36	790	33.0
300	5.29	500	13.88	800	33.8
		510	14.41	810	34.5
		520	14.95	820	35.4
		530	15.50	830	36.2
		540	16.06	840	37.0
		550	16.62	850	37.8
		560	17.20	860	38.7
		570	17.78	870	39.5
		580	18.38	880	40.4
		590	18.93	980	41.3
		600	19.59	900	42.2

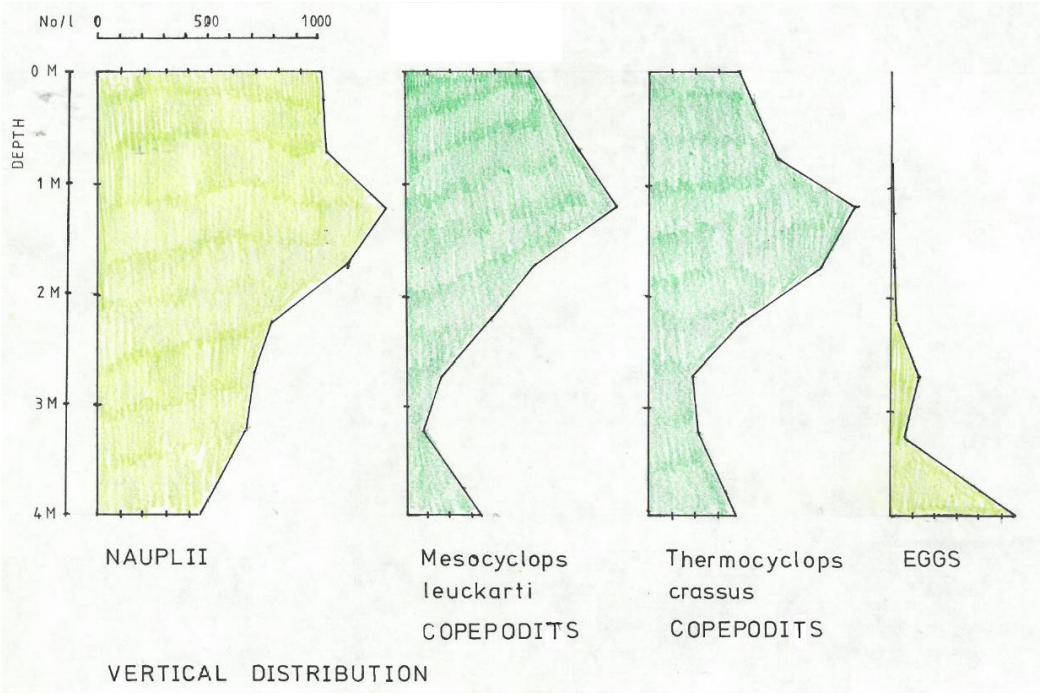


The vertical distribution copepods in Laguna de Bay in July 23th 1980 was found to be with a concentration a little below the surface layers, however it seemed that females with eggs

preferred to swim just above the bottom layer within the 4 m deep sampling station. Se the following graphs.



Vertical distribution of all copepods at Central bay sampling station in Laguna de Bay , July 23th in 1980. **(Petersen, 1981e).**



Vertical distribution of different species and stages of copepods at Central bay sampling station in Laguna de Bay , July 23th in 1980. **(Petersen, 1981e).**

EUCYCLOPINAE, KIEFER, 1927

Last segment of fifth leg of female with 3 appendages. Caudal branches often with bristles.
Feed by seizing food when colliding with it. Feed on bacteria, algae and zooplankton.

EUCYCLOPS, CLAUS 1893.

Fifth leg articulated with the fifth thoracic segment, angular in outline. First antenna with 6-12 segments. Outer margin of caudal branches with small distinct saw-like spines. Caudal branches usually very divergent and 4-9 times as long as wide. Lateral spine near the end of the caudal branch. The internal angle of the basipod of 4th leg sharply produced. Both nauplii and copepodite feed on algae (diatoms and filamentous green algae and cyanobacteria (blue-green algae)). Littoral. The geographical range of *E. serrulatus* extends from North Africa, the Mediterranean basin, continental Europe and Russia to most of Siberia and perhaps Central Asia. In South-east Asia we know of *serrulatus*-like specimens close to genotype A of the type population (Northern Thailand and Southern China, Guangdong Province)(ALEKSEEV et al. 2005).

124 a. Rami 4-5 times longer than wide. Outer margin with dense row of small, clearly discernible saw-like small spines. 5th leg with knife-like inner spine and two setae; outer seta equal in length to spine, middle seta about 1.3–1.5 times as long as spine. Egg sacs rather divergent, compact and pointed at the end. Size female 800-1450 µm. Littoral and tychoplanktonic, e.g. rare in plankton samples. Found abundant in the floodwater irrigating rice-fields (Schoenly

1998b). Also in brackish water. Common. (Figures 124a[1], 124a[2])

- Laguna de Bay (nauplii and female), Paoay Lake, La Mesa Dam, Taal Lake, Naujan, Lake Lanao, Taal Lake.

Eucyclops serrulatus "type A", (FISCHER, 1851)

[1978a+b, 1980, 1984a, 1986a, 1998b, 2001a+c, 2002a, 2008a, 2011a]

Note: Some "candidate records" from the region:

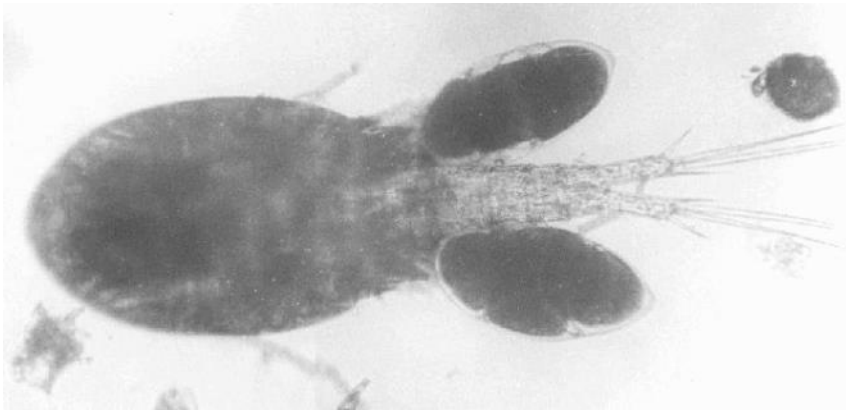
Rami 4-5 times longer than wide.
- Not recorded from the Philippines. Distributed in Africa and Asia. Freshwater.
Eucyclops agiloides (SARS, 1909) **(?)**

Rami 5 times longer than wide
- Not recorded from the Philippines. Distributed in Africa and Asia. Fresh waters.
Eucyclops euacanthus (G. O. SARS, 1909)

Rami rather long. 7 times longer than wide.
- Not recorded from the Philippines. Distribution: cosmopolitan, except Australia; fresh waters.
Eucyclops macruroides denticulatus (GRAETER, 1903)

Rami very long. 9 times longer than wide.
- Not recorded from the Philippines. Distribution: Cosmopolitan, except Australia; fresh waters.
Eucyclops macrurus (G. O. SARS. 1863).

- Not recorded from the Philippines. Distributed in Asia: India and Java. Fresh waters.
Eucyclops permixtus KIEFER, 1928



***E. serrulatus* Female from Laguna de Bay**



(Photo Rey Donne S. Papa, 2007)

TROPOCYCLOPS, KIEFER, 1927

Fifth leg articulated with the fifth thoracic segment, angular in outline. First antenna with 6-12 segments. Outer margin of caudal branches without such spines, and only diverging slightly, 2 1/2 times as long as wide. The internal angle of the basipod of 4th leg rounded produced. Littoral.

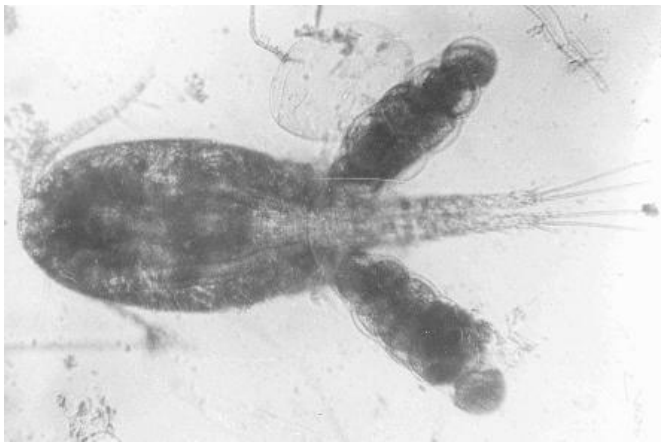
125 a. One species. Egg sacs closely opposed to abdomen. Lateral spine in the middle of caudal branch. Swimming rather than creeping form, swims on its back. An especially small

cyclopoid copepod. Usually size of females 680-750 µm. Herbivorous and carnivorous. Under *in situ* food conditions, *T. p. mexicanus* depended to a larger extent on algae than invertebrate prey. Daily mass-specific uptake rates for algae ranged between 10 and 24% of its body mass versus 0.7-7% for invertebrate prey. However, under enriched food availability, *T. p. mexicanus* is able to ingest a biomass equivalent to its body mass, with algae (54%) and prey (40%).Body size appears to be an important factor for the relative importance of algal versus invertebrate prey for cyclopoid copepods. (Adrian and Frost, M. 1992). In ponds and littoral zone in lakes, tychoplanktonic and planktonic (form pelagica). Rare. More than 10 subspecies described in the tropics. One subspecies pantropic.
Genus needs revision. Records need confirmation (Papa and Hołyńska 2013).
(Figures 125a[1], 125a[2])
- Laguna de Bay, La Mesa Dam, Lake Lanao, Paoay Lake.

Tropocyclops prasinus (FISCHER, 1860).

(syn. *Eucyclops prasinus*)

[1978a+b, 1980, 1984a, 1986a, 2008b]



T. prasinus. **Female from Laguna de Bay**

PARACYCLOPS, CLAUS, 1893

Fifth leg articulated with the fifth thoracic segment, angular in outline. First antenna very short with. First antenna with 8 segments (6-12 worldwide), reaching only to the middle of the cephalothorax. Anterior part of body clearly flattened dorsoventrally. Caudal branch long and thin, 5-6 times as long as wide, dorsally with transverse row of small spines. Littoral.

126 a. Egg sacs closely opposed to abdomen, with few large eggs. Adaptive species, eurytherm 13.5-39° Celsius in alkaline water. First antenna 8 segmented. Outer branch (exopodite) of 3rd leg with 4 spines. Size female 860-900 µm. Benthic in lakes and rivers. Also found in rice fields. Rare. Older records need confirmation (Papa and Hołyńska 2013).

- Laguna de Bay (littoral), Los Baños, Paoay Lake.

Paracyclops fimbriatus, (FISCHER, 1853)

[1978a+b, 1980, 1986a, 2008b, 2013]

126 b. First antenna 11 segmented. Outer branch (exopodite) of 3rd leg with 3 spines. A predator of plant parasitic nematodes. Cosmopolite. See "Krepsdyr I ferskvann" (Crustacean In Freshwater): http://www.nina.no/nb-no/milj%C3%B8overv%C3%A5king/krepsdyr.aspx *and* (http://www.bar.gov.ph/database/barlib/items.asp?id=6231)

- Philippines

Paracyclops affinis (SARS, 1863)

[2001d]

126 c. Unknown species.

- Philippines

Paracyclops sp.

[2001d]

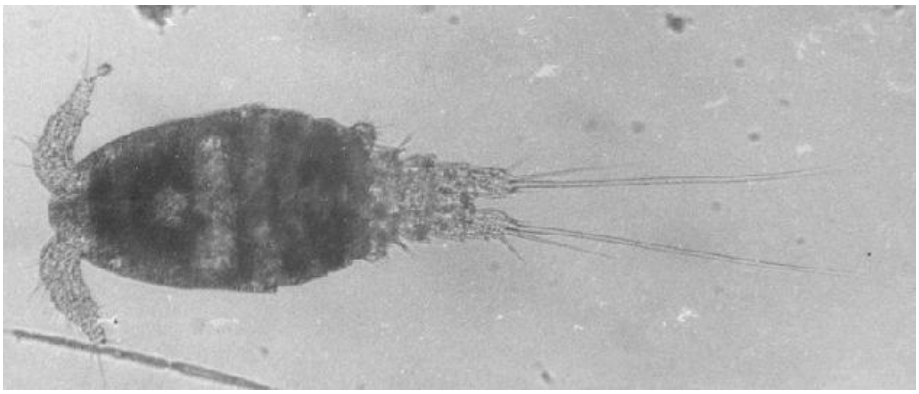
ECTOCYCLOPS, BRADY, 1904

5th leg form a very short and wide plate without articulation with the thoracic segment. First antenna with

only 9-10 segments. Caudal branches short and thick with several transverse rows of small spines. More or less littoral. One species recorded from the Philippines.

127 a. All dorsal spines of 5th leg more or less of equal length. Egg sacs closely pressed to abdomen. Size of female 900-1000 µm. In all type of freshwater except running water. Common.
Genus needs revision. Record need confirmation (Papa and Hołyńska 2013).

- Laguna de Bay, Taal Lake, Naujan, Lake Lanao, Paoay Lake.
  Ectocyclops phaleratus, (KOCH, 1838)
  [1978a+b, 1980, 1984a, 1986a, 2001a, 2008a, 2011a]



***E. phaleratus* from Laguna de Bay**

127 b. Inner dorsal spine of setae of 5th leg much longer than the other two spines. Mainly benthic in lakes, marshes, and ephemeral waters. Often considered as a subspecies of *E. phaleratus*

- **Not recorded** in the Philippines. Distributed in South-East Asia (Alekseev, 2002a)
  Ectocyclops rubescens, (BRADY, 1904)

Note:

127 c.

MACROCYCLOPS CLAUSE, 1893.

Is not recorded from the Philippines, but Mamaril & Fernando (1978b) suggested that further sampling can reveal the presence of ***M. distinctus*** (RICHARD, 1887) from Indonesia, Sri Lanka, India or (Alekseev, 2002) the cosmopolitan species ***M. albidus*** (JURINE, 1820), ***M. fuscus*** (JURINE. 1820) or the South-East Asian species ***M. neuter*** (G. O. SARS, 1909)

CYCLOPINAE, KIEFER, 1927 (subfamily)

Last segment of fifth leg of female with 1 or 2 appendages. Sides of caudal branch without groups of bristles

MICROCYCLOPS, CLAUS, 1893

First antenna with 9-11 segments, not reaching beyond the cephalothorax. Last, distal segment of fifth leg of female with one long seta and one very small spine. Inner setae on caudal branch less than two times as long as outer setae. Nauplii as well as copepodites feed mainly on small algae, also protozoan and rotifers. Benthic, crawling along the Substratum.

Species from Indonesia are belonging to a sub-genus called *Nediocyclops* (Dussart & Sarnita, 1986), se Dussart and Defaye (2001).

- Visayans

Microcyclops (Sp.)

[2016b]

128 a. Besides fourth leg a long seta. Egg sacs large, slightly diverging. Size female 600-900 µm. Eurytherm; 20-39° Celsius. Feeds on algae. Benthic in littoral. Very common.

The records likely refer to other species (Papa and Hołyńska 2013).

- Laguna de Bay, Paoay Lake, La Mesa Dam, Sampaloc Lake, Tadlac Lake, Taal Lake, Lake Mainit, Lake Lanao.

Microcyclops "varicans", (SARS, 1863)

[1941a, 1978a+b, 1986a, 2001a, 2008e, 2011a, 2013]

128 b. Besides fourth leg a small spine. Eurytherm in alkaline freshwater. Genus needs revision. Record need confirmation (Papa and Hołyńska 2013).

Microcyclops linjanticus, (KIEFER, 1928)

(syn. Cryptocyclops)

[1941a]



Fishing bangas in Laguna de Bay during 1980 sampling.

MESOCYCLOPS, G. O. SARS, 1914

First antenna with 17 segments reaching beyond the cephalothorax. Last segment of fifth leg of female with 2 long setae. Inner setae on caudal branch more than twice as long as outer setae. Last segment of fifth leg of female with one terminal seta and one seta on the inner margin. First antenna with hyaline plate on last segment. Planktonic. Copepodites feeds mainly on zooplankton (calanoids, cladocerans and rotifers) and phytoplankton, when the phytoplankton is abundant. Some species are known as predators on smaller freshwater animals, such as mosquito larvae, cladocerans, rotifers and other copepods.

See Ueda & Reid (2003a) for a comprehensive key of the genus.

The following key is a combination of records from the Philippines and records from South-East Asia outside Philippines. Of the 4 Philippine records of Mesocyclops species (*M. leuckarti, M. aspericornis, M. microlasius,* and *M. ogunnus*) the records of M. leuckarti has to be revised. The species is now confined to the

Palearctic area and records from the tropics are no longer valid. It is the hope that the expanded key, with some selected candidate species, can help in identification of "M. leuckarti" [1928a, 1930a, 1941a,1978a+b, 2013]. See Ueda and Reid's (2003a) key for *Mesocyclops* of the world or better Paz et al. (2016b) for a key to the Philippine species of *Mesocyclops*.

129 a. Inner portion of basipodite of 1st leg with seta. Distributed in Africa and India. No records from Philippines.....141.

129 b. Inner portion of basipodite of 1st leg without seta.....130.

130 a. No patterns of hairs on body surface (Without patterns of hair on 5th segment and caudal rami without hairs).....131.

130 b. Body with patterns of hair.....134.

Leuckarti group. Hairless forms.

- Without patterns of hair on 5th segment.
- Caudal rami without hairs (Alekseev, 2002a).

131 a. Copulatory duct sinuously curved.....132.

131 b. Copulatory duct not sinuously curved.....133.

132 a. Copulatory duct sinuously curved. Without patterns of hair on 5th segment. Caudal rami without hairs Copulatory duct sinuously curved. Planktonic species. Egg sacs large, divergent. Food infusorians, young stages of cladocerans, rotifers. Size 600-1000 µm. Size of longest setae 270-390 µm. Eurytherm: 19-39° Celsius and occur in pH 4.5-8.5. Dominating

the zooplankton biomass and production in Laguna de Bay together with *Thermocyclops crassus* in 1980 (Petersen, 1981e). Planktonic in ponds and lakes. The **genus is** very common. The species, previously considered as a cosmopolitan, is confined to the **Palearctic area** (Europe and the western part of northern Asia). Thus, *M. leuckarti* is only a **collect name**, and all records have to be revised.

Kiefer (1930a) notes that the material from Laguna de Bay, Luzon, not is the form found in Europe, but a full different variety, which is distributed widely in the tropics, and maybe should be accepted as a subspecies. Kiefer (1981c) concluded this opinion, while Papa and Hołyńska (2013) claimed that all records belong to other species, probably ***Mesocyclops thermocyclopoides*** (see 138b), e.g. in Laguna de Bay[25], Lake Naujan, La Mesa Dam, Lake Lanao, Paoay Lake, Taal lake. See also Paz et al. (2016b).

Mesocyclops leuckarti, (CLAUS, 1857)

[**non** *M. Leuckarti* s. str. 1928a, 1930a, 1941a, 1978a+b, 1980, 1984a, 1986a, 2008b, 2011a]

133 a. Lateral arms of seminal receptacle relatively narrow. Connecting plate on fourth pair of legs with large (length/width >> 1) spines (prominences). Copulatory duct not sinuously curved. Anterior margin of proximal part of seminal receptacle sinuate in middle. Body size 1100-1700 µm. Prefer eutrophic ponds and lakes, but also in marshes, ditches, creeks, artificial water containers, and wells (Ueda & Reid, 2003a).

- **Not recorded** from the Philippines. Distributed in Central Asia, India, Sri Lanka, (Malaysia?), Indochina, China, Japan and United States

[25] My own illustrations from Laguna de Bay is yet assigned to *M. thermocyclopoides*.

Mesocyclops pehpiensis HU, 1943
(syn. *Mesocyclops Leuckarti pehpiensis* HU, 1943)
(syn. *Mesocyclops ruttneri* KIEFER, 1981)
(1981c, 2002a, 2003a).



Mesocyclops sp. **From Laguna de Bay**

133 b. Lateral arms of seminal receptacle conspicuously wide. Connecting plate on fourth pair of legs with large (length/width >> 1) spines (prominences). Copulatory duct not sinuously curved. Anterior margin of proximal part of seminal receptacle arcuate in middle. Body size 1300-1700 µm. In ponds, swamps, pools, shallow ditches, slow-current streams, and littoral zone of lakes.
- **Not recorded** from the Philippines.
Distributed in Australia, New Guinea, Java and Borneo
Mesocyclops papuensis VAN DE VALDE, 1987
(2003a).

134 a. Both 5th segment and caudal rami with hairs on medial margin.....
.....135.

134 b. Body only with one pattern of hairs. Caudal rami naked on medial margian.....137.

Aspericornis group.

- Inner portion of basipodite of 1st leg without seta
- With patterns of hair on 5th segment.
- Caudal rami with hairs (Alekseev, 2002a).

135 a. Caudal branch (ramus) with media hairs on entire medial surface. See further morphological details in Zehra, A. and K. Altaff (2002).Body size 1110-1600 µm. Urosome length (Cebu specimens) ca. 490 µm (Paz et al., 2016b). The size difference may be due to the difference in water chemistry, physical parameters as temperature or the food available i.e. plankton concentration (Zehra, A. and K. Altaff, 2002) Can suppress mosquito larvae under experimental conditions and are supposed to be an important weapon against malaria. Research shows that *M. aspericornis* females are good biological control agents by consuming about two-thirds of the wild dengue mosquito larvae population. (Alekseev, 2002a, Panogadia-Reyes et al., 2004a). Found in freshwater from small containers of only a few liters to large lakes. But general the species is an epibenthic form dwelling in the littoral zones of fresh waters, (Gutiérrez-Aguirre, 2002b). Further found in rice fields (Kiefer, 1981c; Paz et al., 2016b), marshes, karst holes, and wells. Pantropical species.

- Philippines, Luzon and Cebu Islands

Mesocyclops aspericornis (DADAY, 1906)

[1981c (with map), 1984b, 1986a, 2001d, 2002b, 2013, 2016b].

135 b. Caudal branch (ramus) with medial hairs only on proximal half. Body length 1000 µm. With patterns of hair on 5th segment. For more anatomical details see Papa and Hołyńska's redescription(2013) and Paz et al. (2016b)

Found in limnetic habitats and seems to be anatomically closely

related to ***M. geminus*** from East Borneo (Papa and Hołyńska 2013). Endemic.

- Manila, Lake Paoay, Laguna de Bay, Lake Sebu(Mindanao). (sample by R. Woltereck from Wallacea-expedition, without further record)

Mesocyclops microlasius KIEFER, 1981
[1981c, 2002a, 2003a, 2013, 2016b].

Thermocyclopides group.

- Inner portion of basipodite of 1st leg without seta
- With patterns of hair on 5th segment.
- Caudal rami without hairs (Alekseev, 2002a).

137 a. Maxillulary palp with group of spines. Can be used as a biological control agent of *Aedes aegypti* (Linnaeus) (Panogadia-Reyes et al., 2004a). Found in all types of water bodies: fishponds, rice fields, lakes and reservoirs, eutrophic ponds with heavy micro algae, marshes, and brackish and saline waters. Not found in limnetic habitats (Papa and Hołyńska 2013). Common.

- Luzon, Philippines.

Mesocyclops ogunnus, ONABAMIRO, 1957
[1986a, 2001d, 2004a, 2013]

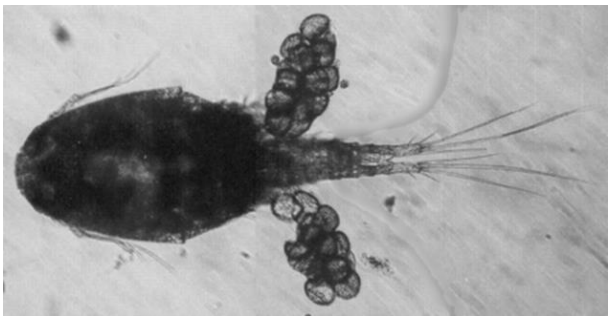
137 b. Maxillulary palp without group of spines.....138.

138 a. Genital double segment bare on dorsal surface, without small hairs.....139.

138 b. Genital double segment with small hairs on anterior part of dorsal surface (pilose). Maxillulary palp without group of spines. Body length 800-1200 µm. Caudal rami without hairs. 5th segment with hairs. It feeds on brachionids and other rotifers and prefers

Brachionus calyciflorus for *B. angularis* (Kumar and Rao, 2001.)
In ponds, rainwater tanks, and pelagic zone and among plants of large lakes. Probably very common. Papa and Hołyńska (2013) claimed that this species formerly might have been determined as *M. leuckarti* (see 133a), e.g. in Laguna de Bay and Lake Naujan. Pantropic.
(Figures nauplii, C1, C2, C3, C4, C5, female, egg sac, male C5, male C6, setae)
- Northern Philippines: Luzon (Laguna de Bay, Calamba River), Mindoro (Lake Naujan).

Mesocyclops thermocyclopoides, HARADA, 1931
[1981c, 2002a, 2003a, 2012a, 2013].



M. thermocyclopoides **Female from Laguna de Bay**

139 a. Transverse ducts of genital double segment directed towards each other at straight angle before connecting with copulatory duct. Small spines present at implantation of lateral most terminal caudal seta. Maxillulary palp without group of spines. Genital double segment bare on dorsal surface. Body length 900-1600 µm. Found in shallow ditches, rainwater tanks, jars, swamps, lakeshores, ponds, rice fields and in plankton in deep lakes.
- **Not recorded** from the Philippines.
Distributed in New Guinea through Indonesia and Malaysia as far as Indochina.

Mesocyclops affinis VAN DE VALDE, 1987

[2003a].

Following species is placed in the Pseudospinolosus group by Fernando (2002a). Since it, according to Ueda & Reid (2003a), doesn't possess these, it is here placed in the Thermocyclopides group (wourtersi-superspecies-complex, Hołyńska) .

139 b. Transverse ducts of genital double segment directed towards each other at acute angle before connecting with copulatory duct. Small spines absent at implantation of lateral most terminal caudal seta. Maxillulary palp without group of spines. Genital double segment bare on dorsal surface. Body length 1000-1300 µm. Littoral zone of lakes, ponds, rice fields, streams, ditches, water containers, wells, and also found in coral gravel pits. Distributed in Australia, New Guinea, Indochina, South China, and Japan.
- Lake Lamak (Cebu Is.), Lake Balinsasayaw (Negros Is.)
Mesocyclops woutersi VAN DE VELDE, 1987
(syn. *M. guangxiensis* Reid & Kay, 1992)
[2016b][26].

139 c. Transverse ducts of genital double segment directed towards each other at obtuse angle before connecting with copulatory duct, after a short joint channel. Small spines present at implantation of lateral most terminal caudal seta. 1080 µm. Closely related to *M. dissimilis* (Papa and Hołyńska 2013).
- Vietnam: Lake Vac, Vĩnh Púc and Philippines: Lake Siloton, Mindanao.
Mesocyclops augusti PAPA AND HOŁYŃSKA 2013.

[26] The new record of this species, has in some way been foreseen by this key, since it was included in the key before this record ☺

[2013].

140-141 – DELITED FROM KEY

THERMOCYCLOPS, KIEFER, 1927, (syn. Mesocyclops Thermocyclops) (subgenus)

First antenna with 17 segments reaching beyond the cephalothorax. Last segment of fifth leg of female with 2 long setae. Inner setae on caudal branch more than twice as long as outer setae. Last segment of fifth leg of female with two terminal setae. First antenna without hyaline plate. Planktonic.

Copepodites feed on zooplankton and phytoplankton when it is abundant. Mainly tropical species. Often found together with Mesocyclops in the plankton, e.g. Laguna de Bay (Petersen, 1981e). It is presumed that the smaller and larger species use different food sources. See Ueda & Reid (2003a) for a comprehensive key of the genus. However genus needs revision (Papa and Hołyńska 2013). Paz et al. (2016b) has included a key to the Philippine species of *Thermocyclops*.

142 a. Connecting plate on fourth pair of legs without spines on outgrowth. Caudal branch 2 times as long as wide. Longest terminal setae not curved in Lanao material, but slightly curved in Papua New Guinea material. Receptaculum seminis with thin head, curved slightly posteriorly. Size 560-600 µm. Differ morphologically from *T. crassus* in Lake Lanao only with regard to length and length ratio. *Thermocyclops wolterecki* thus appears to be a sibling species of *T. crassus* or possible even just a morphotype (Lewis 1979b). Herbst 1986 (se Herbst 1986c) however, accept the status as species in his key of *Thermocyclop*. In small waterbodies and planktonic in lakes. Limnetic and littoral ecoforms with

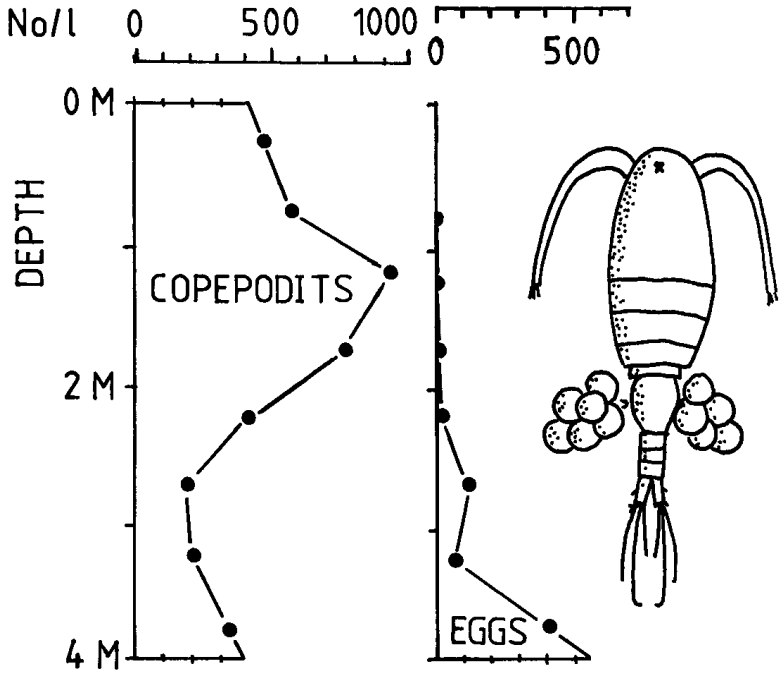
distinct morphometric characters of smaller and slender form in limnetic zone (Papa and Hołyńska 2013).
Endemic for Mindoro and Papua New Guinea.
- Lake Lanao, Mindanao.

Thermocyclops wolterecki, (KIEFER, 1938)
[1939a, 1941a, 1969, 1986c, 2002a, 2003a]

142 b. Connecting plate on fourth pair of legs with spines on outgrowth.....143

143 a. Longest terminal seta curved at the tip and is 120-230 µm. The wings of receptaculum seminis with broad head, only slightly bended backwards. Caudal branch 2-2.6 times as long as wide. Inner caudal setae (S1) 2.7-3.6 times as long as the caudal ramus. Connecting plate on fourth pair of legs with spines on outgrowth, by witch it might be distinguished from *T. decipiens* together with its straight spine in the inner distal segment of the endopodite.
Size 560-800 µm, with at mean length of 490 µm for males and 580 µm for females in Tall Lake (Papa et al., 2012b).
Feeds on diatoms (e.g. *Nitzchia*), cyanobacteria (blue green algae, e.g. Anabaena) and cryptomonads.
A preference for elongate filaments or unicells has been found in Lake Lanao (Lewis 1979b, se also Fernando 1980).
The abundance per unit area increased towards deeper water in Lake Lanao. The ephemeral patchiness increased with progressive stages in life history (Lewis, 1978d).
Dominating the zooplankton biomass and production in Laguna de Bay together with *Mesocyclops leuckarti* in 1980 (Petersen, 1981e) and the copepod species in Taal Lake (Papa et al. 2012b). In one occasion the female were

found to concentrate just above the bottom in the shallow water Laguna de Bay.

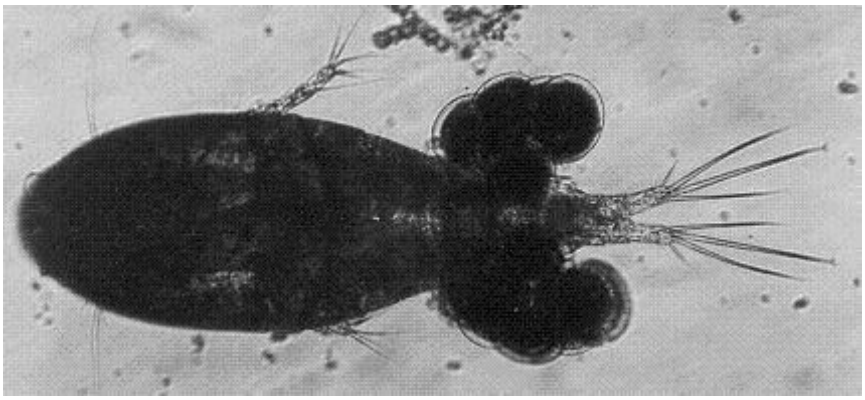


Vertical distribution of *T. crassus* copepodites and female with eggs at Central bay sampling station in Laguna de Bay , July 23th in 1980. (Petersen, 1981e).

Eurytherm. Planktonic in ponds and lakes. Very common all over the Philippines.
(Figures: nauplii, copepodites C2+C3, C4, female C5, female adult, male C6).
Records need confirmation (Papa and Hołyńska 2013).

- Laguna de Bay Paoay Lake, La Mesa Dam,
  Bunot Lake, Calibato Lake, Taal Lake, Naujan,
  Lake Lanao

Thermocyclops crassus, (FISCHER, 1853)
(syn. Mesocyclops (Thermocyclops) hyalinus)
[1939a, 1941a, 1978a+b, 1978d (T. hyalinus), 1979b, 1980, 1984a, 1986a, 1986c, 2001a, 2008e, 2001a+c, 2012a, 2012b, 2016b]



***T. crassus* Female from Laguna de Bay**

143 b. Longest terminal seta curved at the tip. Caudal branch 2-2.5 times as long as wide. Inner caudal setae (S1) 1.9-2.3 times as long as the caudal ramus. Lateral arms of seminal receptacle strongly curved posteriorly. Size 600-700 µm. Distributed in East and Central Asia (Paz et al., 2016b).
- Cluster of lakes around San Pablo: e.g. Pandin and Bunot Lakes and Camarin Sur: Buhi and Baao Lakes.

Thermocyclops taihokuensis (HARADA, 1931)
[2013, 2016b]

143 c. Longest terminal setae not curved at the tip.
The wings of receptaculum seminis with thin head, bended slightly backwards.....144

144 a. The membrane connecting the bases of the fourth pair of legs (swimming feet) has two rounded processes, with a number of small spines on. Caudal branch 3 times as long as wide. Longest terminal setae not curved. Longest setae not curved. Receptaculum seminis with thin head. Abdomen covered with small dots in rows. Size of female 900-1000 µm. In freshwater, not limnetic (Papa and Hołyńska 2013).

- Manila area

Thermocyclops philippinensis (MARSH, 1932)

(syn. Mesocyclops/Thermocyclops philippinensis)

[1932, 1986c, 2002a, 2003a]

144 b. The membrane connecting the base of the fourth pair of legs (swimming feet) has two high and slime outgrowths with bigger spines on. Caudal branch 2½ times as long as wide. Longest setae not curved. Receptaculum seminis with thin head, lateral arms of strongly curved posteriorly. Size of female 760-790 µm. Planktonic in alkaline lakes and reservoirs. Common.

- Naujan Lake

Thermocyclops decipiens, (KIEFER, 1938)

[1939a, 1941a, 2013, 2016b]

144 c. In Lake Mainit is found a fourth species, different from the species mentioned above.

- Lake Mainit

[1973]

Note: Thermocyclops species in the "vicinity" of the Philippine Islands are:
T. operculifer (KIEFER, 1930) [Indonesia: Lesser Sunda Islands, Cambodia, and Vietnam],
T. trichophorus, KIEFER 1930 [Java],
T. ianthinus (HARADA, 1931) [Taiwan],
T. orientalis DUSSART & FERNANDO, 1985 [Sri Lanka, Malaysia, and India (?)].
(See 2003a, Herbst 1986c)

OITHONIDAE, DANA, 1853 (family)

The palp of the mandible is well developed and represented by a segment with 5-6 setae. Very few species in freshwater, most marine copepods:

LIMNOITHONA, BURCHARDT 1912 (genus)
(syn. Oithona)

144 d. Only two truly freshwater species. Female: Length 0.42 – 0.54 mm Male: Length 0.45 mm (Dang, 2015). *L. sinensis* is described from China but also recorded from North America. In the Philippines only found in one sample by Paz et al. (2016b)
- Visayans
Limnoithona sinensis, (BURCHARDT 1912)
[2016b]

OITHONIDAE (family) 144d

LERNAIDAE WILSON, 1917, Anchor worms (family)
Abdomen not clearly separated from the anterior part of the body.

LERNAEA, LINNAEUS, 1758 (genus)

145 a. All nauplii stages are not feeding, and planktonic. Copepodite stages are parasites on fish gills. The unmetamorphosed adults are planktonic. Metamorphosed adults parasitic, e.g. in the skin tissue, in head embedded in eye, nostril, musculature, with body protruding externally. Hosts: *Anabas testudineus, Carassius auratus, Channa striata, Chanos chanos* FORSKÅL, *Glossogobius biocellatus, G. giuris, Terapon plumbeus, Tilapia* and *Cyprinus carpio (Common carp)*. Believed to have been introduced along with importation of an unknown host (see Velasquez 1979). Has caused great economic loss to freshwater milkfish in Laguna de Bay fish cultures. (Figures 145a[1], 145a[2], 145a[3])

- Laguna de Bay, Luzon.

Lernaea cyprinacea (LINNAEUS, 1758)

(Syn. Lernaea sp.)

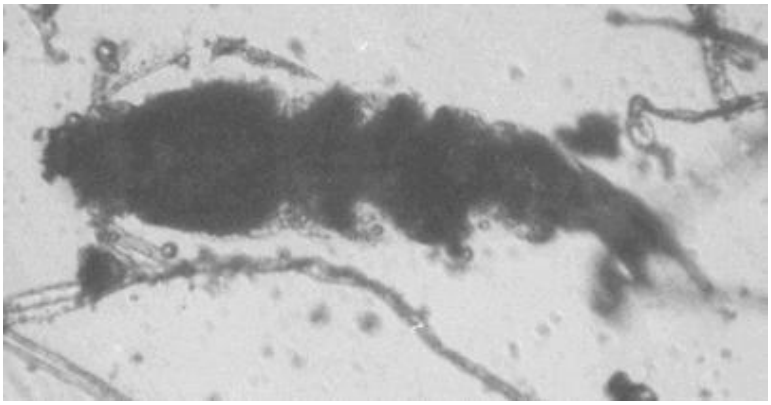
[1974, 1980, 1984a (sp.), 1997]

145 b. Location: head embedded in musculature with body protruding externally. Hosts: *Anabas testudineus, Glossogobius giuris.* The report of this copepod from *Anabas testudineus* involved an experimental infection.

- Luzon

Lernaea lophiara HARDING, 1950

[1997]



Lernaea sp. from Laguna de Bay

LAMPROGLENA NORDMANN, 1832 (genus).

Larval development similar to Lernaea

146 a. Location: gills. Host: *Oreochromis niloticus niloticus.* This parasite appears to have entered the Philippines with the recent importation of Nile tilapia from Africa for brood stock improvement.

- Luzon.

Lamproglena monodi CAPART, 1944.

[1997]



Fish pen in Laguna da Bay. (Photo: Flemming Petersen, 1980)

POECILOSTOMATOIDA (**DOJIRI** & **CRESSEY,** 1987) (order)

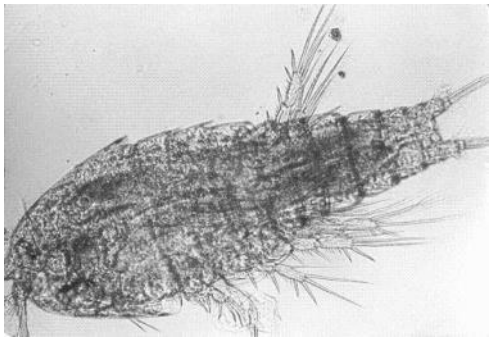
[**POECILOSTOMATOIDA THORELL, 1859**]

Eyes absent. Second antennae uniramous, exopodite vestigial or absent. Carapace absent. Thorax and abdomen differentiated, 4-6 pairs of legs. Larval development metamorphic. Larvae are truly planktonic but are mostly found in inshore waters in larger lakes (Fryer, 1978.)

Harpacticoid copepods generally have an exopodite on the antennae. (Lowry, 1999) [1930b]



Harpacticoid copepod



Harpacticoid copepod

ERGASILIDAE, THOREL, 1859 (family)

Second antenna large, with a large claw for grasping.
First antenna short with 6 segments.
Parasitic, in sea- and freshwater.

ERGASILUS, NORDMANN, 1832

147 a. Body violin-shaped. Antennae 4-segmented, claw-shaped, as long as the body. Female with violet-blue streaks. Only the adult female is parasitic, the immature females and all stages of males being free living. Velasquez (1951) reported the species to be parasitic on the gills of the flathead goby *Glossogobius giurus*, BUCHANAN-HAMILTON, locally known as biyang puti, from Laguna de Bay. Average parasitic burden was found to be 15 parasites per fish. Endemic.
- Laguna de Bay, La Mesa Dam

Ergasilus philippinensis VELASQUEZ, 1951
[1951, 1978a+b, 1986a, 1997]

Other species: ***Ergasilus coleus***, CRESSEY & COLLETTE, 1970, from *Strongylura strongylara* and *S. urvillii*. Found at Culion Island and Mindanao. Seawater species: ***Ergasilus rotundicorpus*** JONES & HINE, 1983, From Orange-spotted spinefoot *Siganus guttatus* (Bloch), Panay.

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(Photo: Flemming Petersen, 1980)

An Illustrated Key To the Philippine Freshwater Zooplankton.

Including some brackish water species from Laguna de Bay.

With ecological notes.

By
Flemming Petersen.

In cooperation with

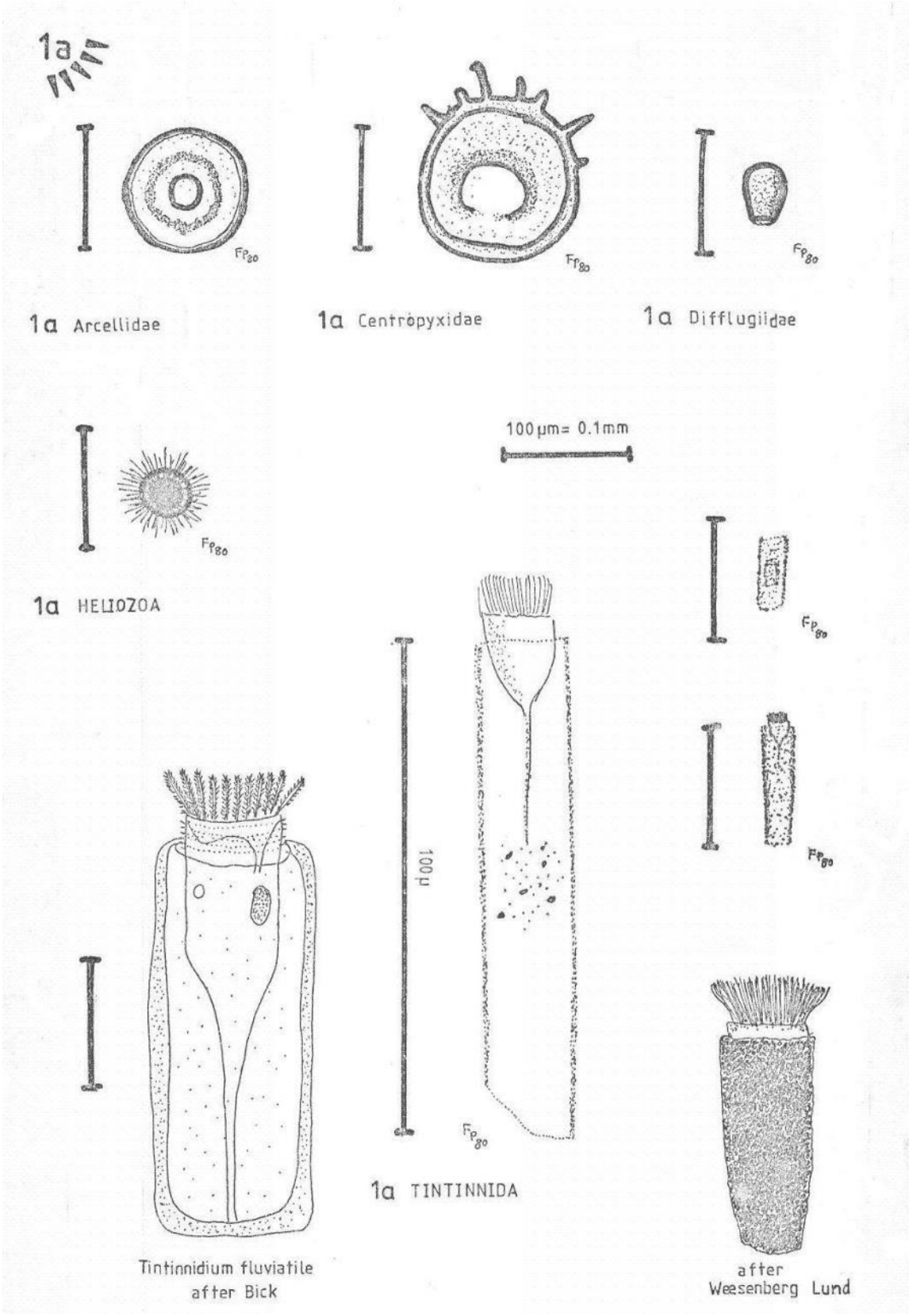
Rey Donne S. Papa
and
Augustus C. Mamaril Sr
2014

PART 2.

Illustrations, Literature and Index

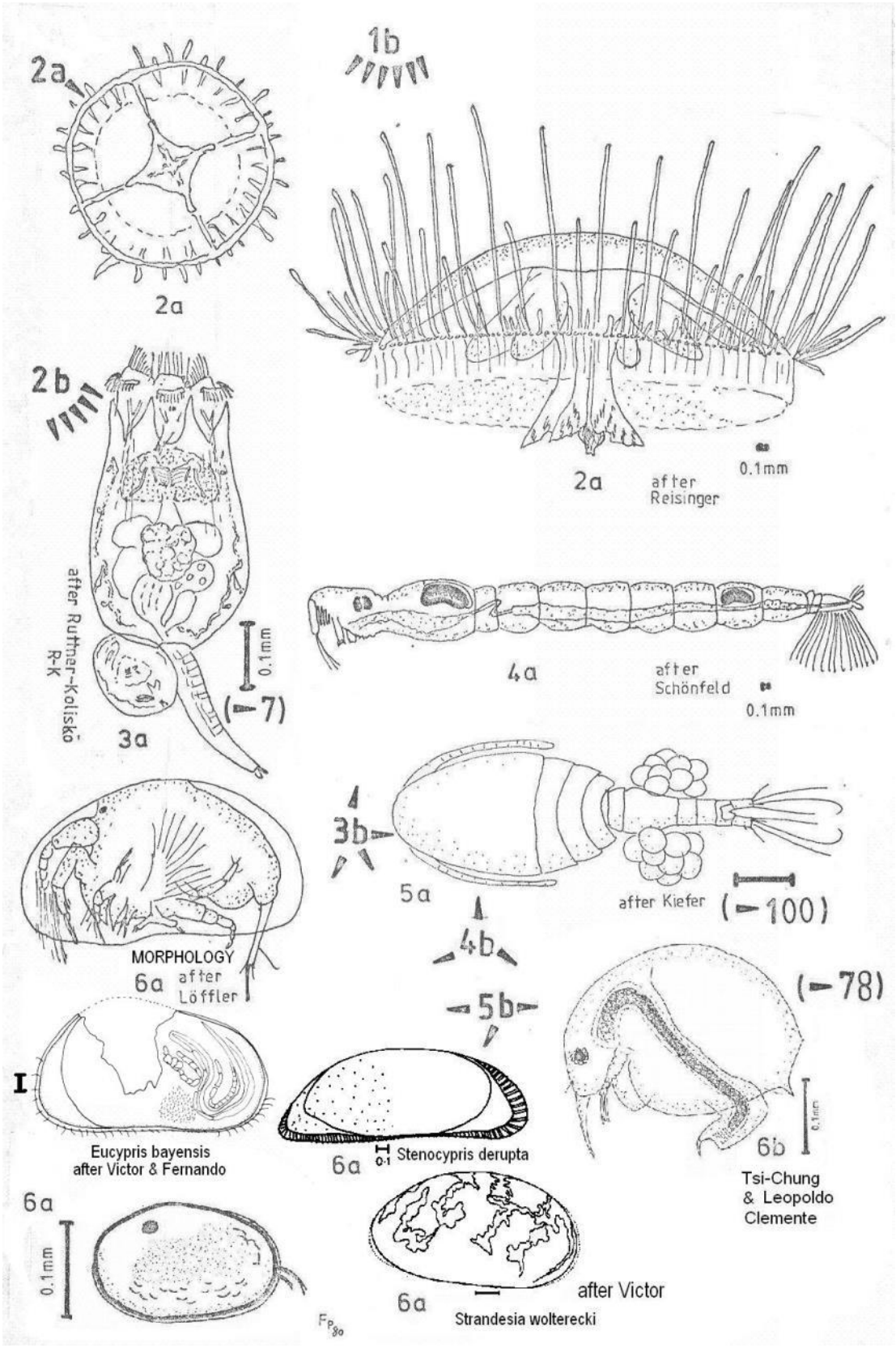
6. Illustrations
7. References
   - Chronological – special references
   - Alphabetical
8. Index

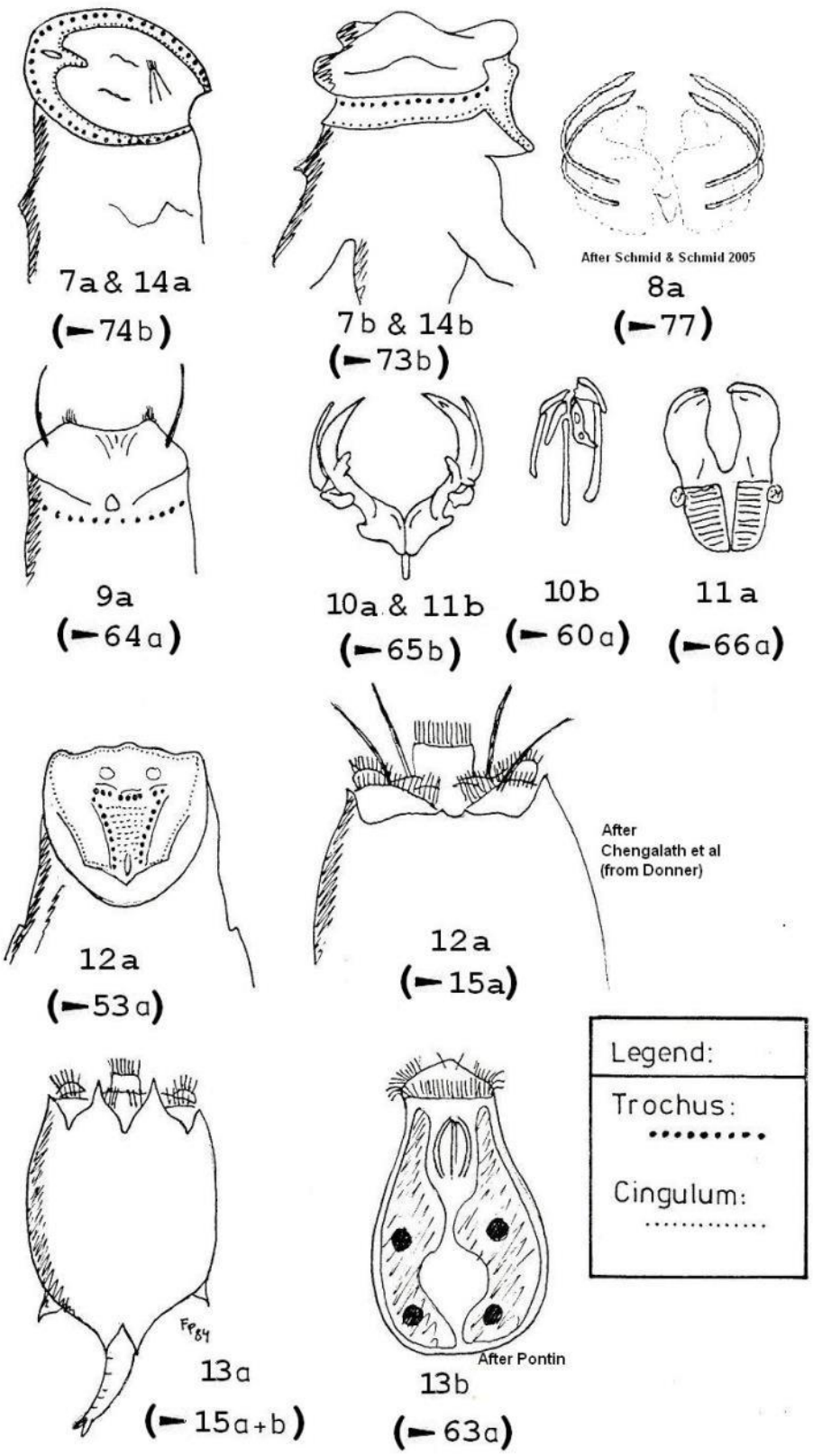
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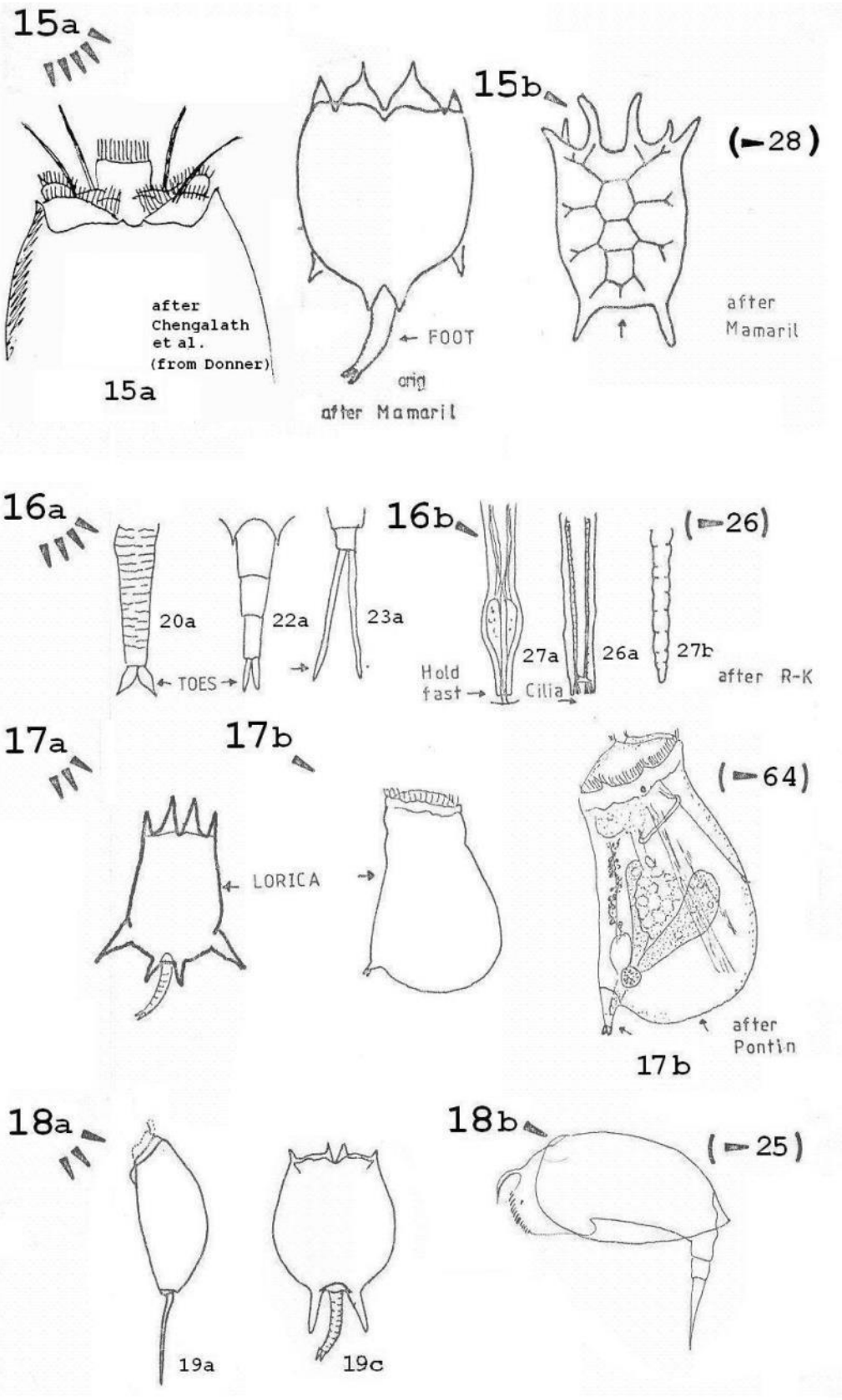

1a
1a Arcellidae
1a Centropyxidae
1a Difflugiidae
100 µm= 0.1mm
1a HELIOZOA
100µ
1a TINTINNIDA
Tintinnidium fluviatile
after Bick
after
Weesenberg Lund

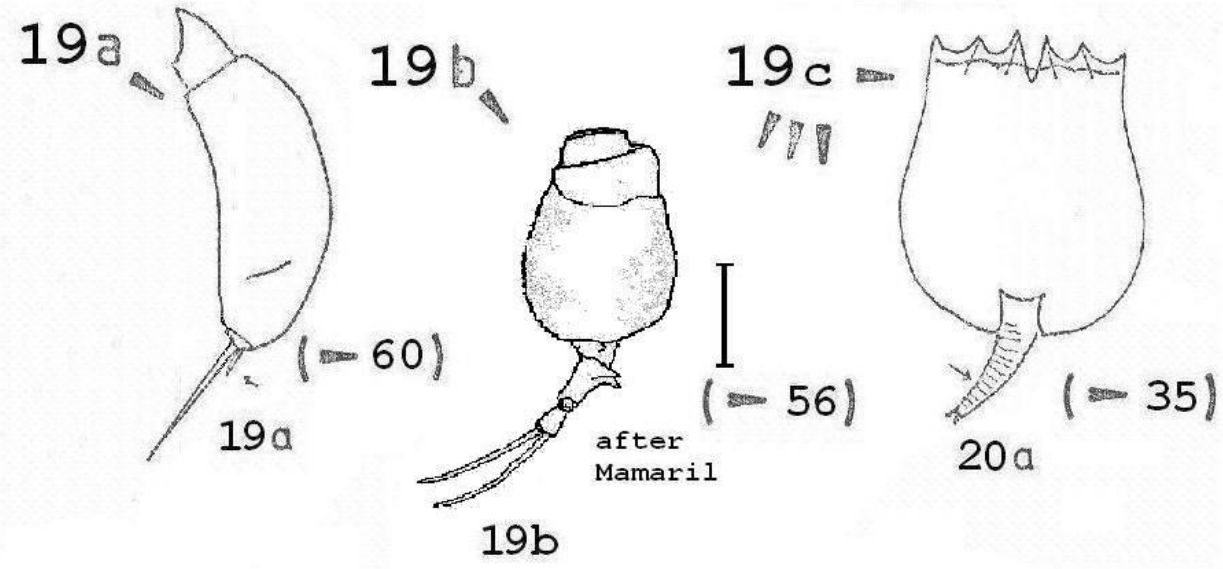
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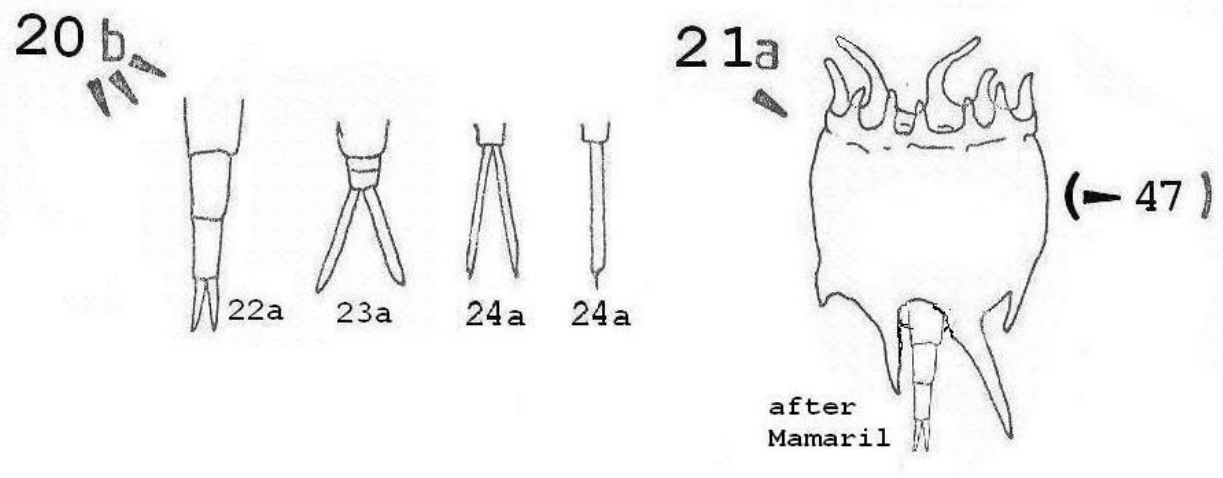
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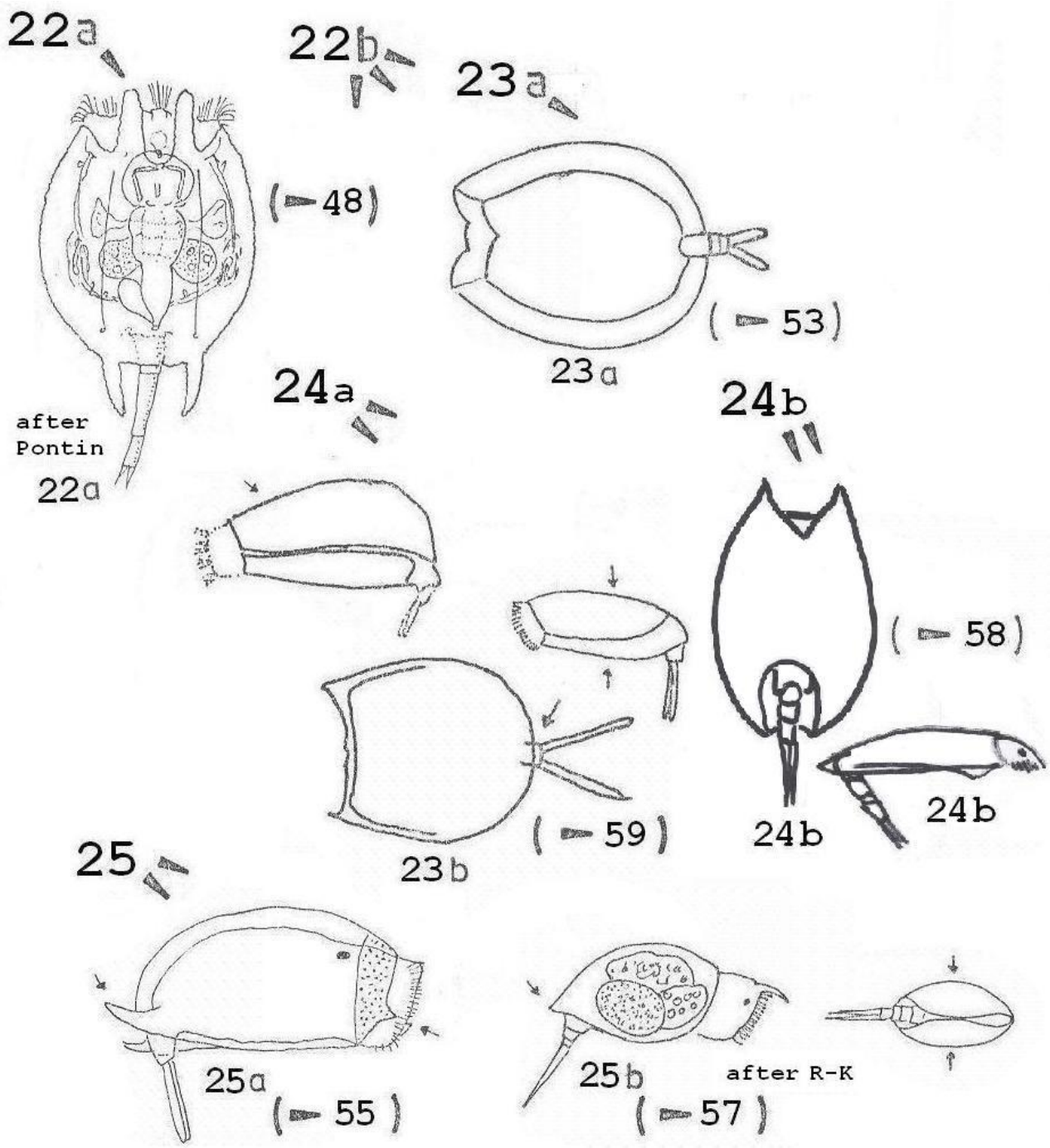

2a
2a
1b
2a
after Reisinger
0.1mm
2b
after Ruttner-Kolisko R-K
0.1mm
(-7)
3a
4a
after Schönfeld
0.1mm
3b
5a
after Kiefer
(-100)
MORPHOLOGY
6a after Löffler
4b
5b
(-78)
I
Eucypris bayensis
after Victor & Fernando
6a
Stenocypris derupta
6b
Tsi-Chung
& Leopoldo
Clemente
6a
0.1mm
6a
after Victor
Strandesia wolterecki

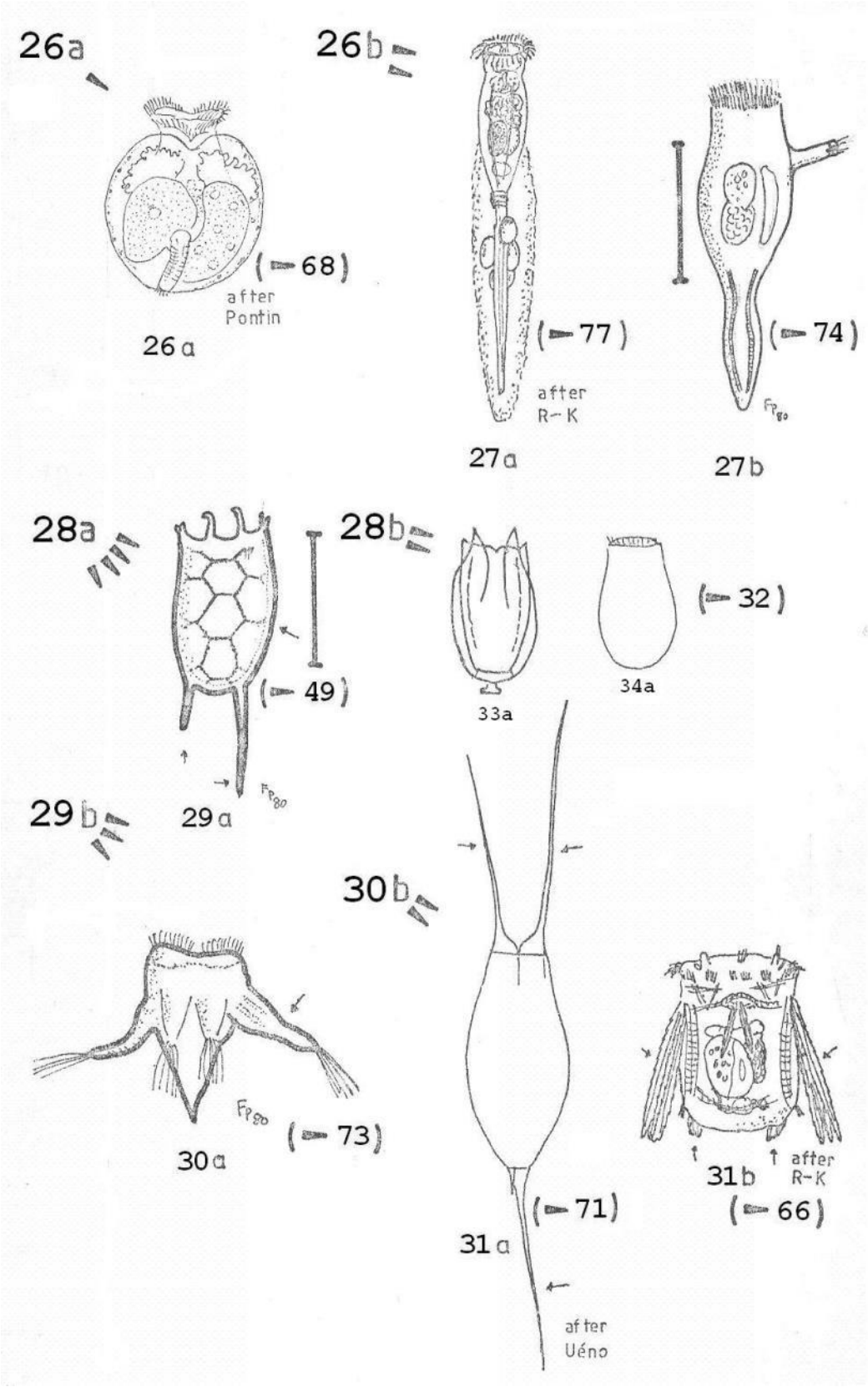

7a & 14a
(→74b)
7b & 14b
(→73b)
After Schmid & Schmid 2005
8a
(→77)
9a
(→64a)
10a & 11b
(→65b)
10b
(→60a)
11a
(→66a)
12a
(→53a)
After
Chengalath et al
(from Donner)
12a
(→15a)
Legend:
Trochus:
Cingulum:
13a
(→15a+b)
After Pontin
13b
(→63a)

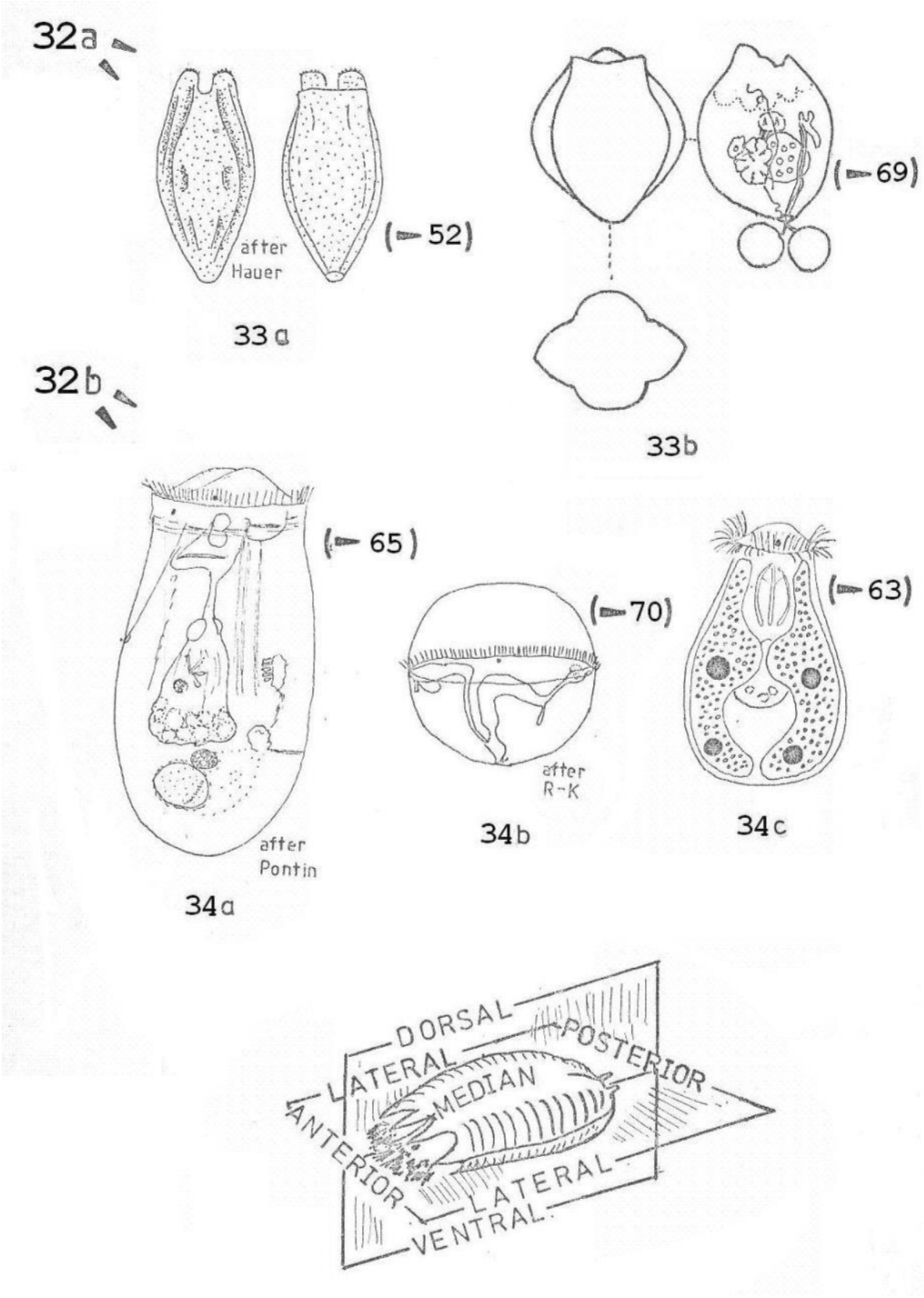

15a
after Chengalath et al. (from Donner)
15a
15b
(-28)
FOOT
orig
after Mamaril
after Mamaril
16a
20a
22a
23a
TOES
16b
(-26)
27a
26a
27b
Hold fast
Cilia
after R-K
17a
17b
LORICA
(-64)
after Pontin
17b
18a
19a
19c
18b
(-25)

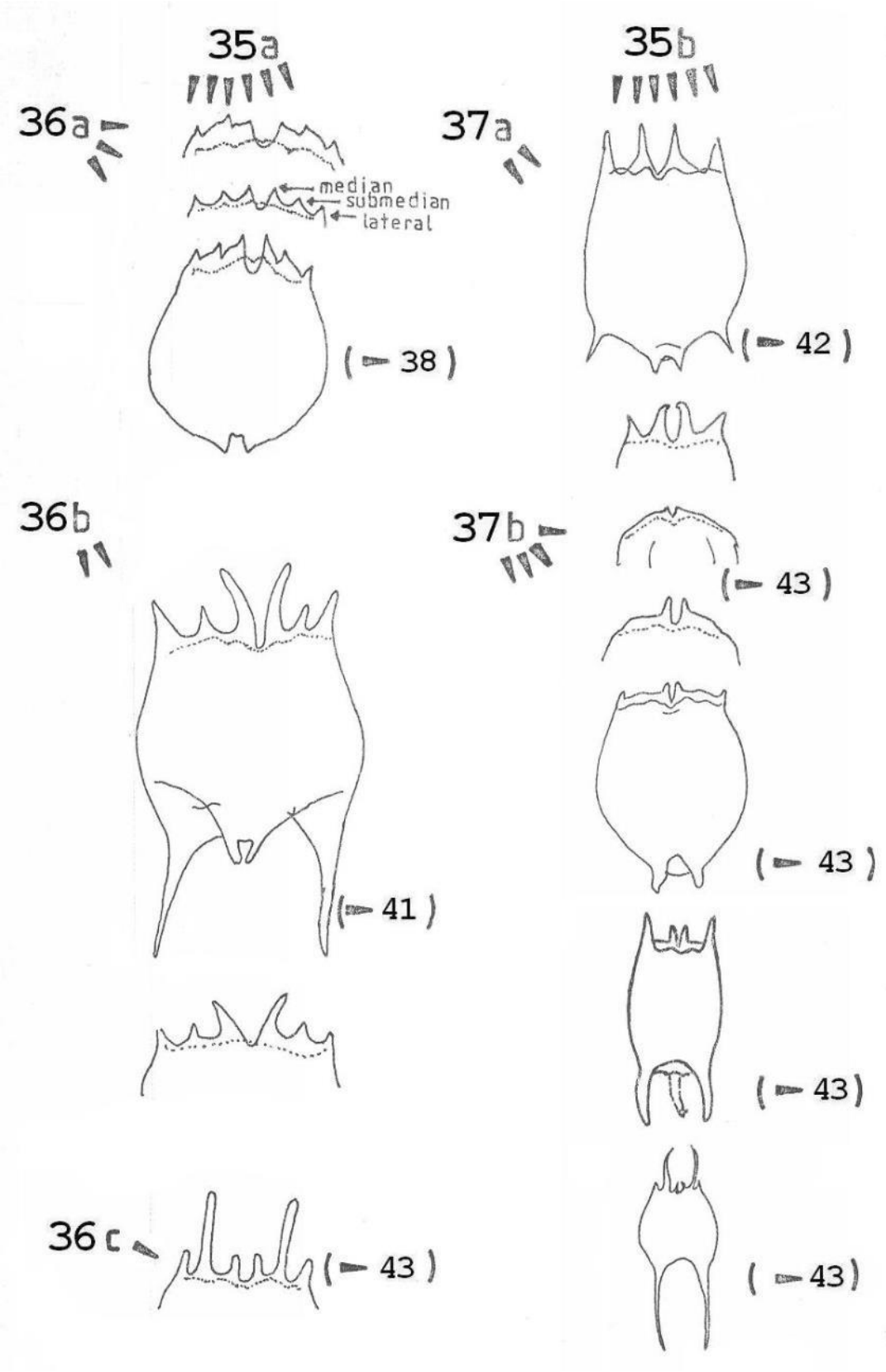

19a
(– 60)
19a
19b
after
Mamaril
19b
19c
(– 56)
(– 35)
20a

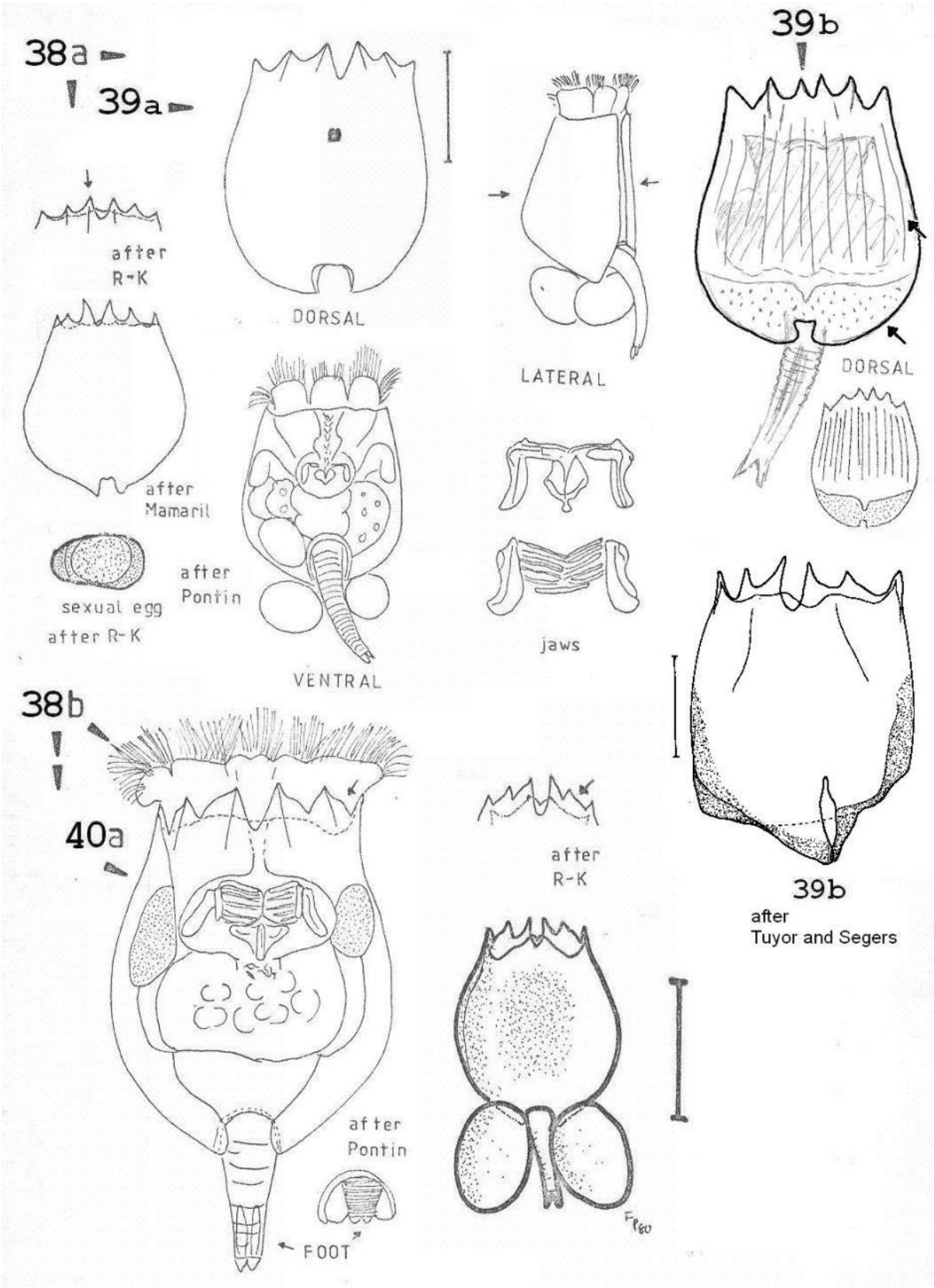

20b
22a
23a
24a
24a
21a
(– 47)
after
Mamaril

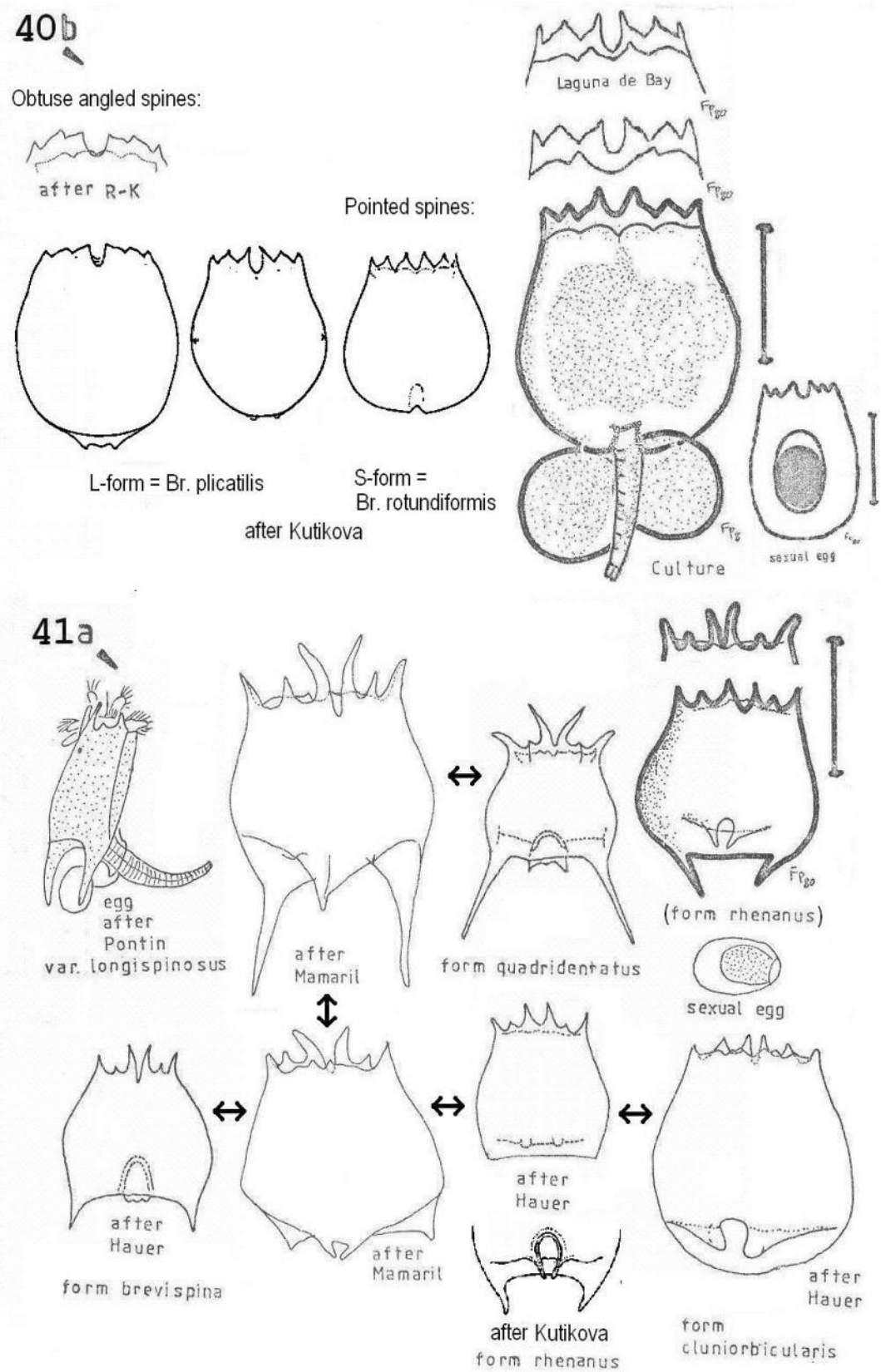

22a
22b
23a
(- 48)
after
Pontin
22a
(- 53)
23a
24a
24b
(- 58)
24b
24b
(- 59)
23b
25
25a
(- 55)
25b
after R-K
(- 57)


26a
(— 68)
after Pontin
26a
26b
(— 77)
after R-K
27a
(— 74)
27b
28a
(— 49)
29a
28b
33a
34a
(— 32)
29b
30b
30a
(— 73)
31a
(— 71)
after Uéno
31b
after R-K
(— 66)

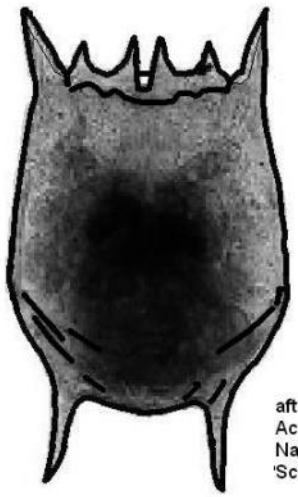

32a
after Hauer
(← 52)
33a
32b
(← 69)
33b
(← 65)
after Pontin
34a
(← 70)
after R-K
34b
(← 63)
34c
DORSAL
LATERAL
POSTERIOR
MEDIAN
ANTERIOR
LATERAL
VENTRAL


35a
36a
median
submedian
lateral
(– 38)
35b
37a
(– 42)
36b
(– 41)
37b
(– 43)
(– 43)
(– 43)
36c
(– 43)
(– 43)


38a
39a
after
R-K
DORSAL
LATERAL
39b
DORSAL
after
Mamaril
after
Pontin
sexual egg
after R-K
VENTRAL
jaws
38b
40a
after
R-K
39b
after
Tuyor and Segers
after
Pontin
FOOT

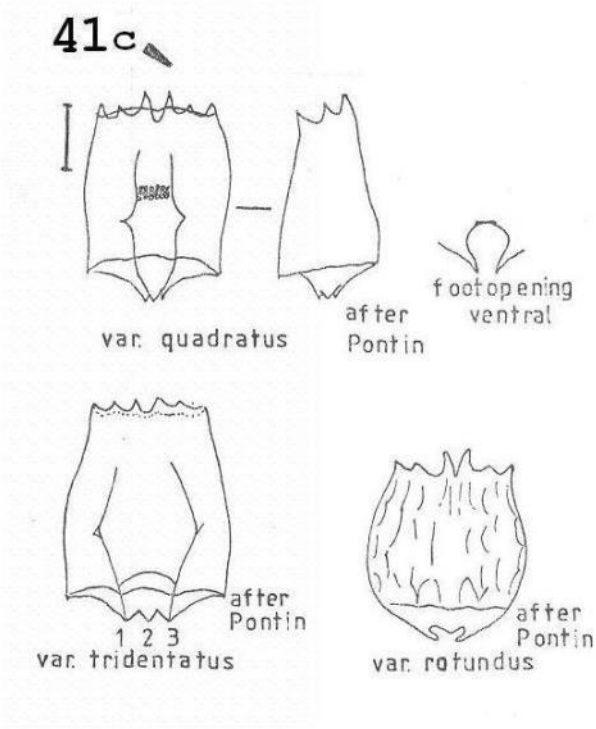

40b
Obtuse angled spines:
after R-K
Pointed spines:
L-form = Br. plicatilis
S-form =
Br. rotundiformis
after Kutikova
Laguna de Bay
Culture
sexual egg
41a
egg
after
Pontin
var. longispinosus
after
Mamaril
form quadridentatus
(form rhenanus)
sexual egg
after
Hauer
form brevispina
after
Mamaril
after
Hauer
after Kutikova
form rhenanus
after
Hauer
form
cluniorbicularis

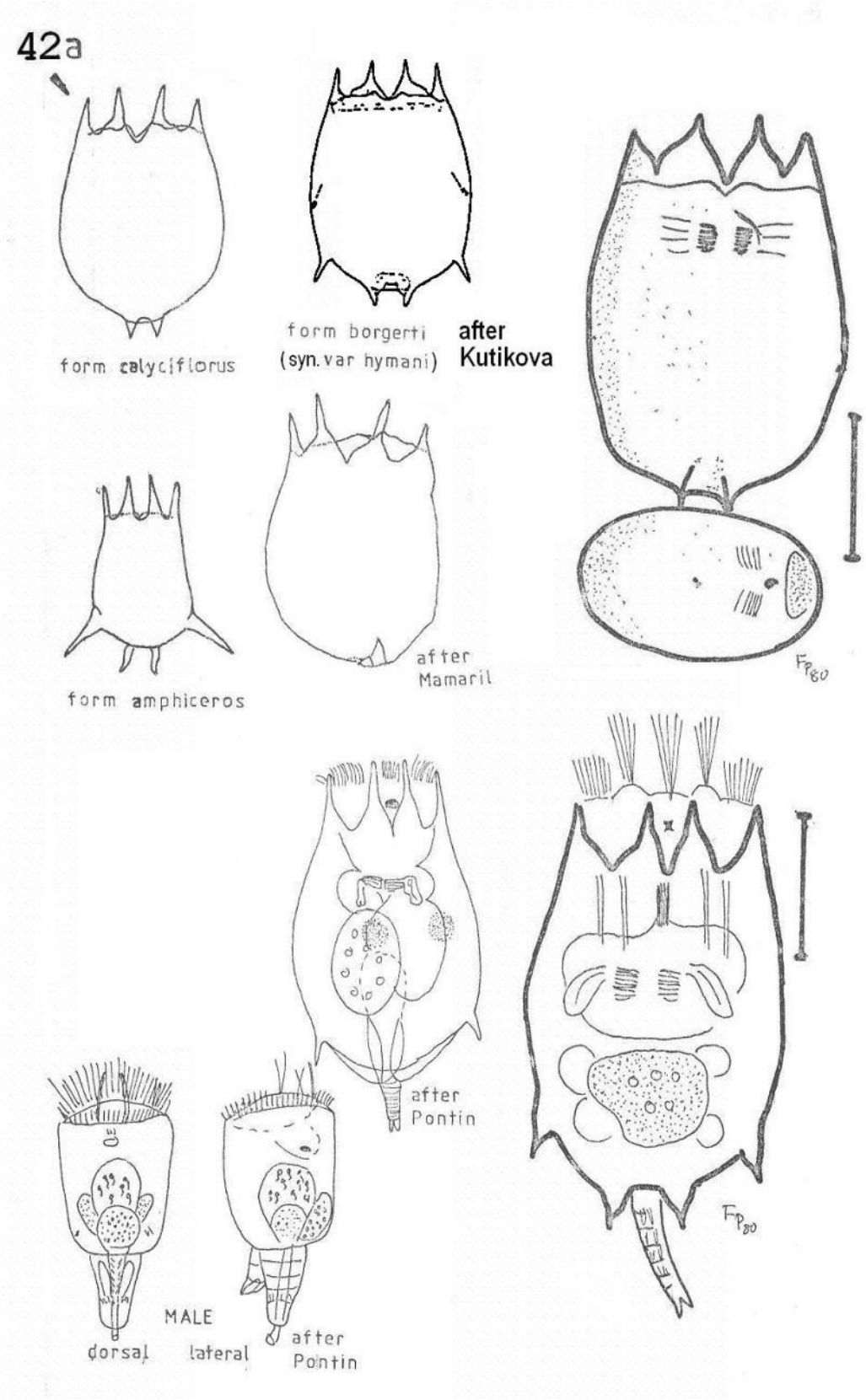
41b

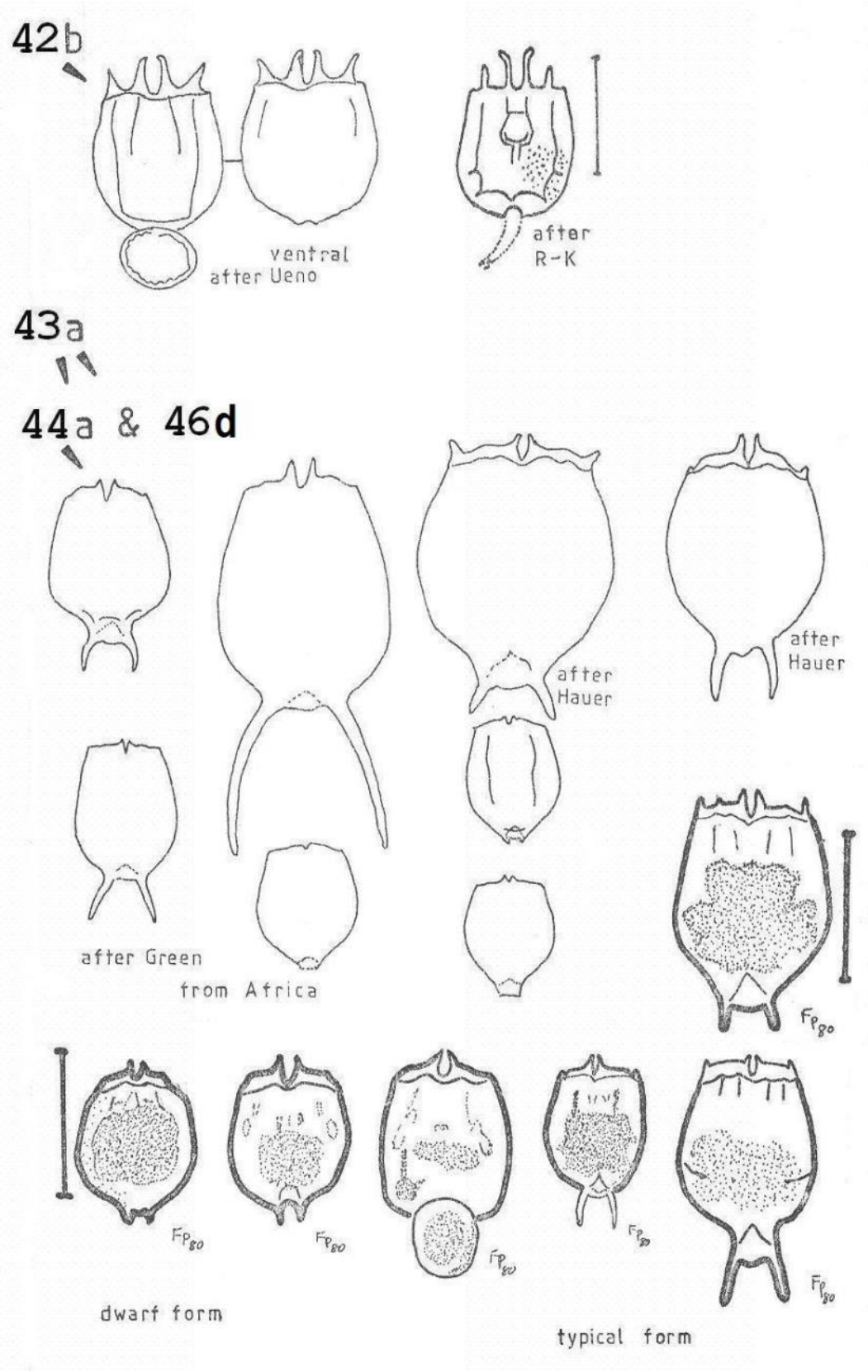


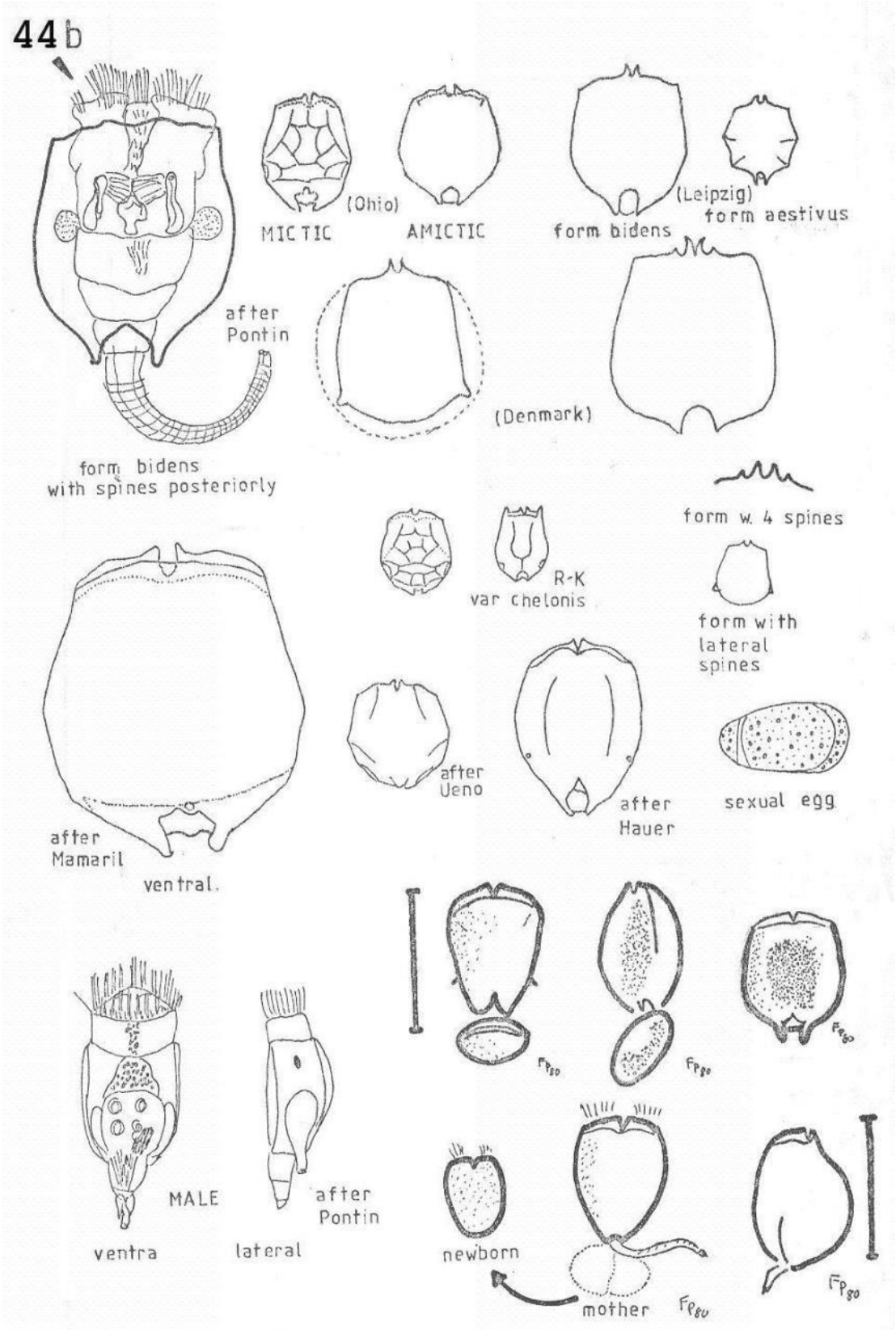
after The Academy of Natural Sciences

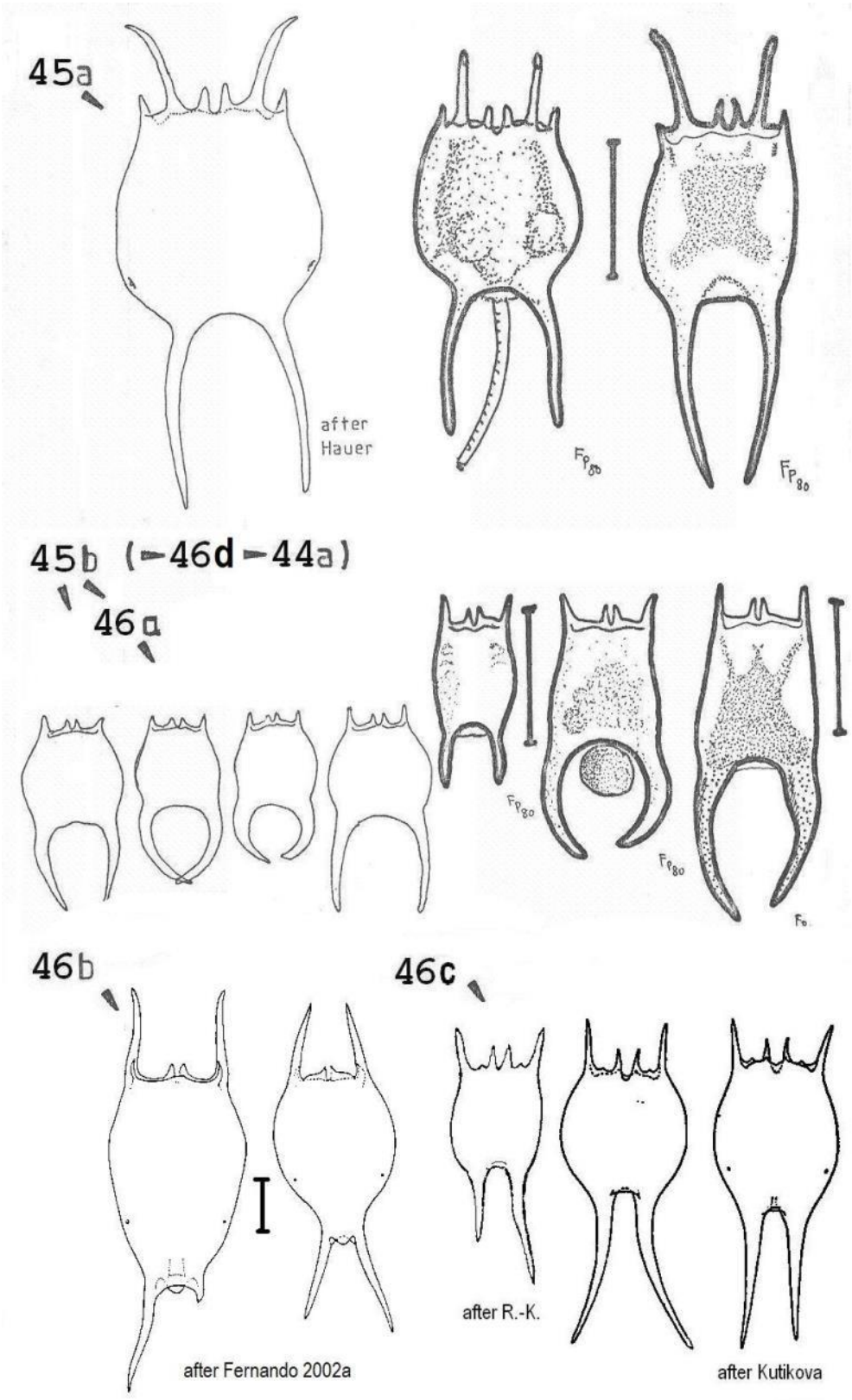
41c

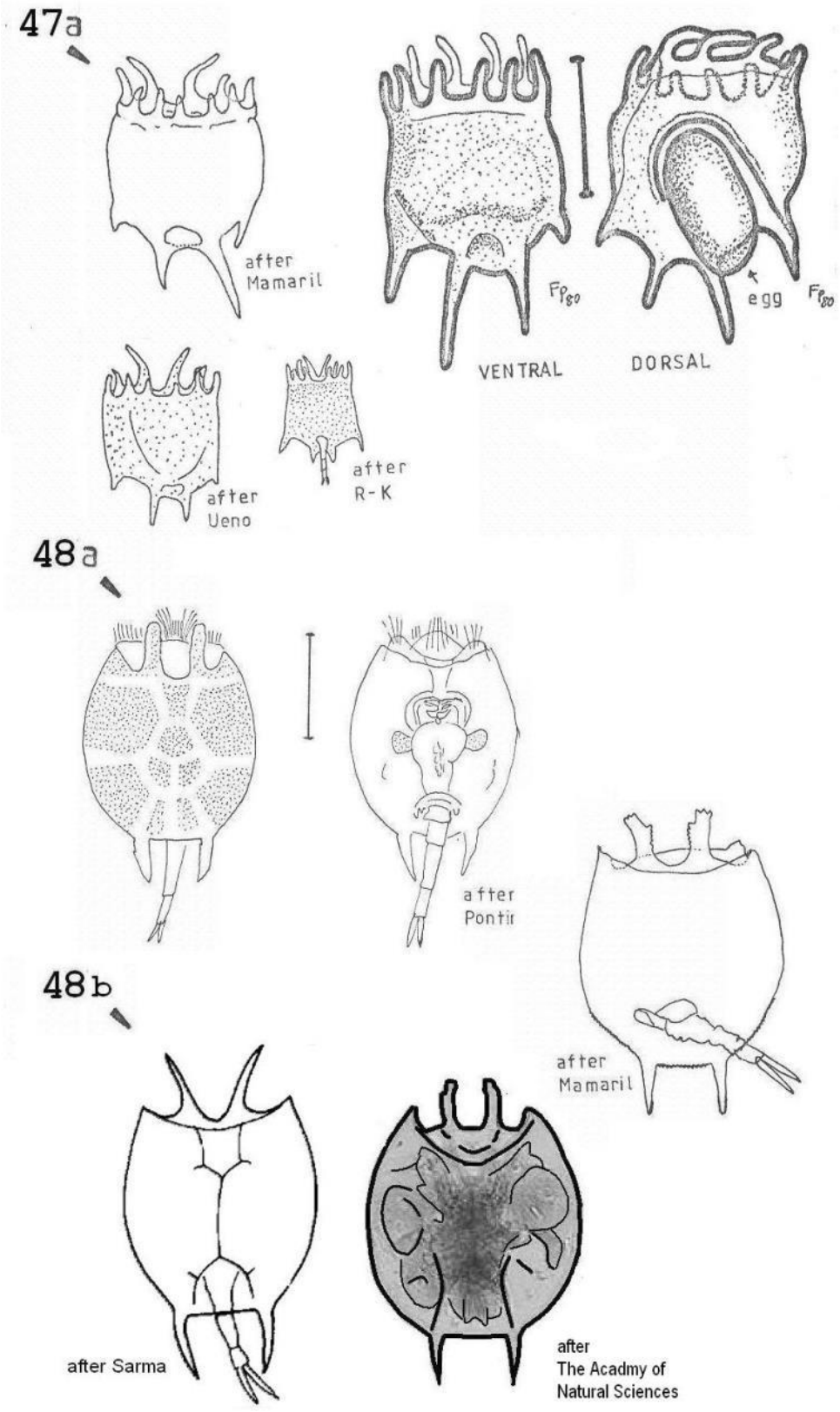


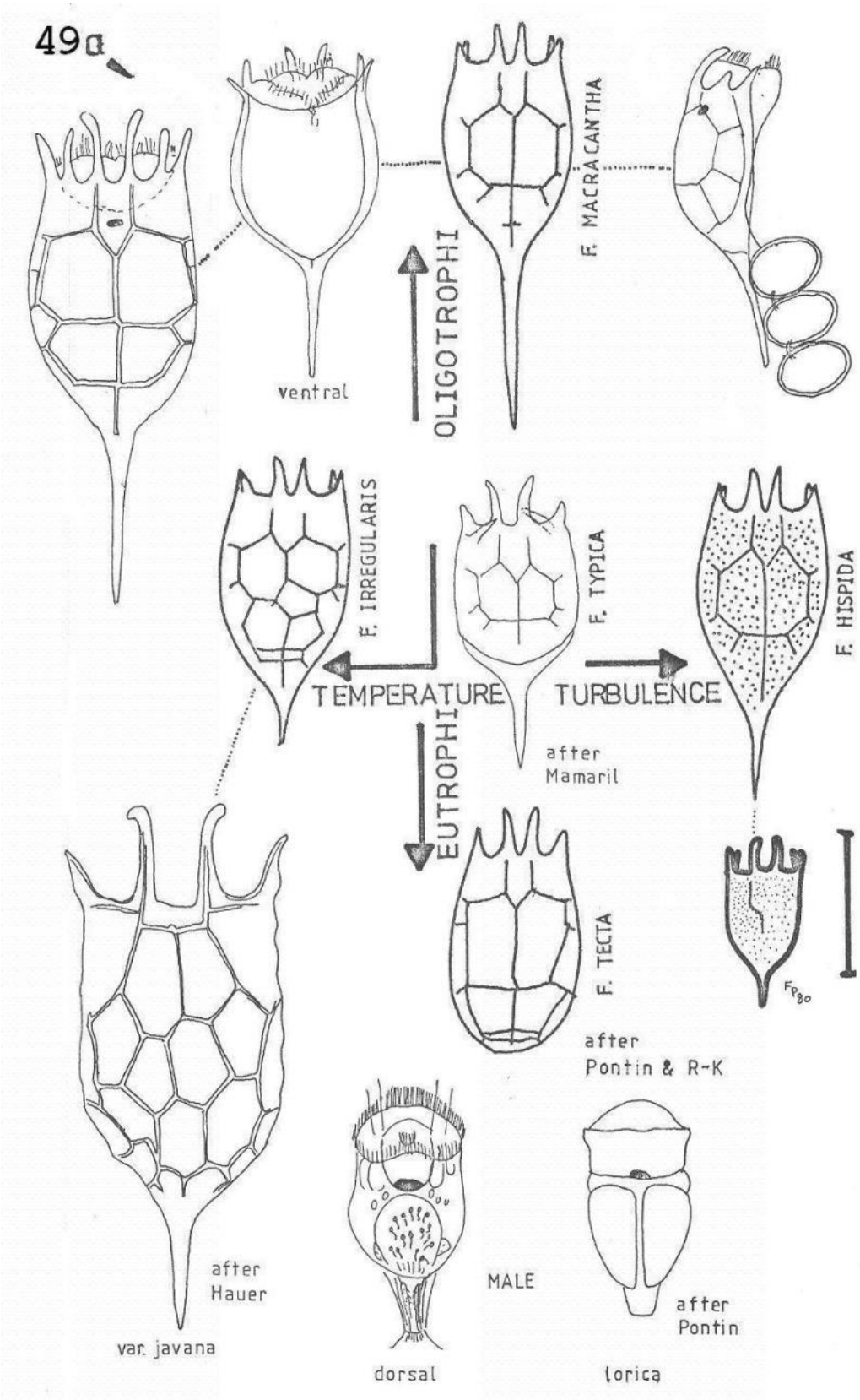

42a
form calyciflorus
form borgerti
(syn. var hymani)
after
Kutikova
form amphiceros
after
Mamaril
FP80
after
Pontin
FP80
TESTES
MALE
dorsal
lateral
after
Pontin

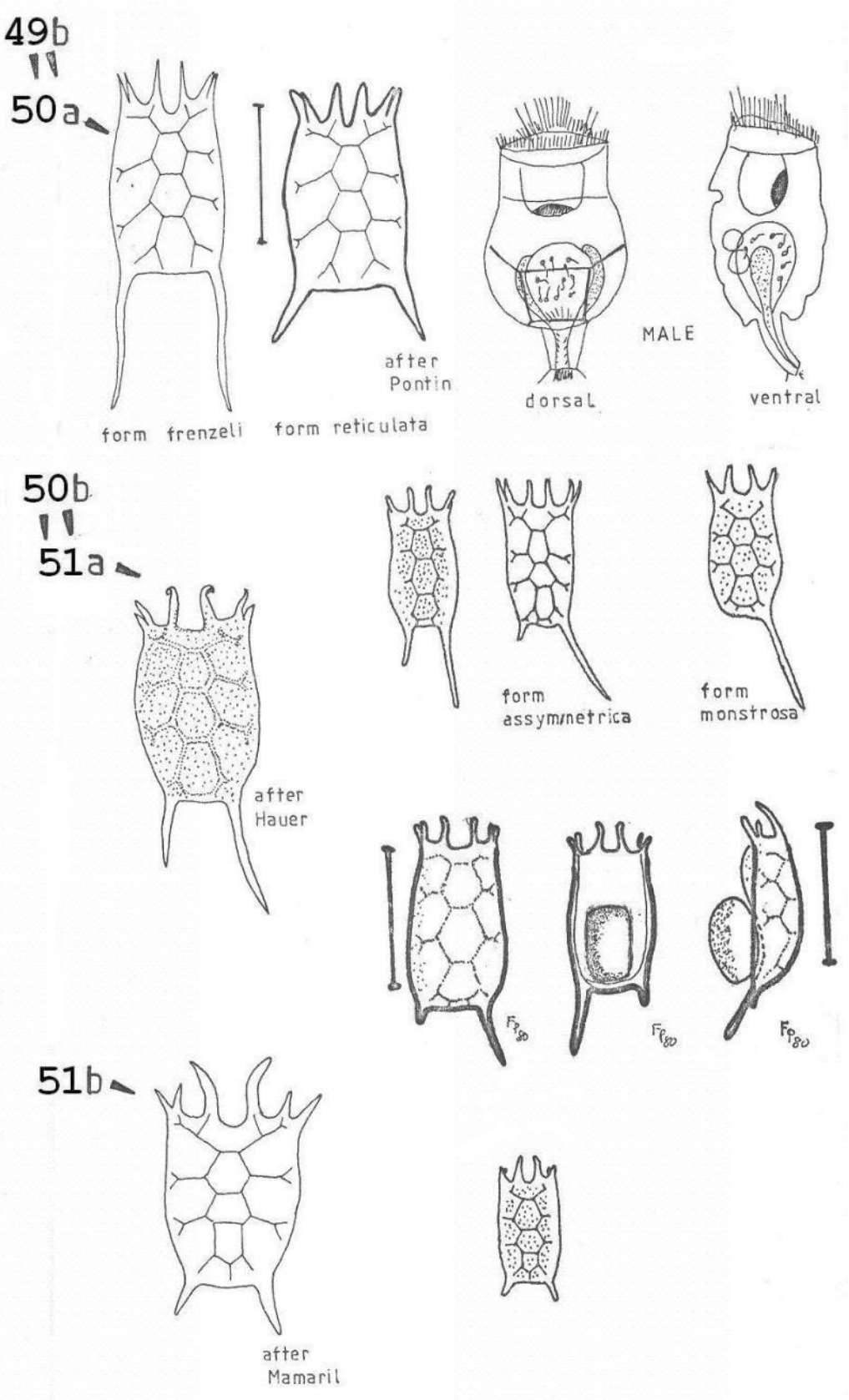

42b
ventral
after Ueno
after
R-K
43a
44a & 46d
after Hauer
after Hauer
after Green
from Africa
dwarf form
typical form

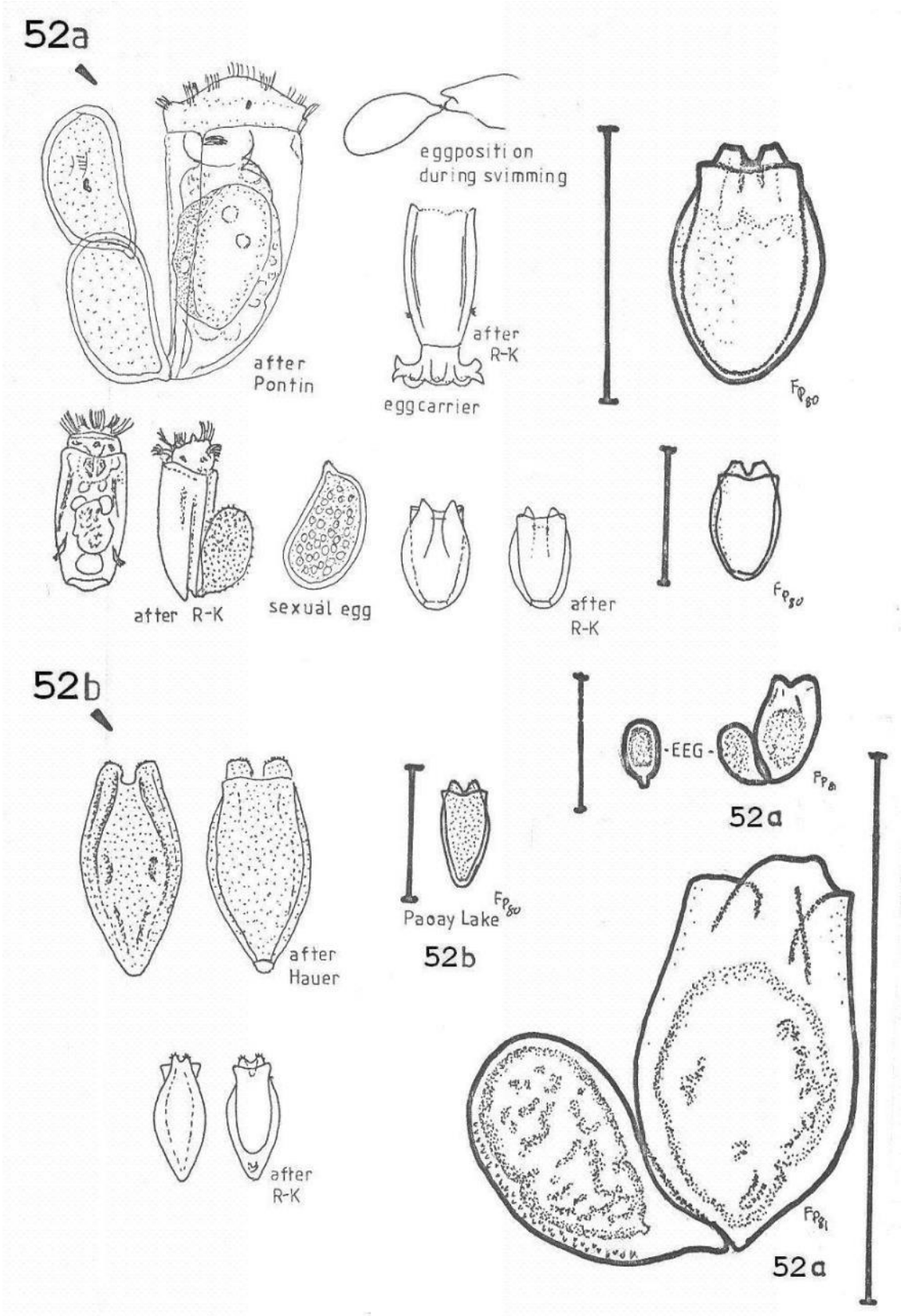

44b
after Pontin
form bidens with spines posteriorly
MICTIC
(Ohio)
AMICTIC
form bidens
(Leipzig)
form aestivus
(Denmark)
form w. 4 spines
R-K
var chelonis
form with lateral spines
after Ueno
after Hauer
sexual egg
after Mamaril
ventral.
MALE
ventra
lateral
after Pontin
newborn
mother

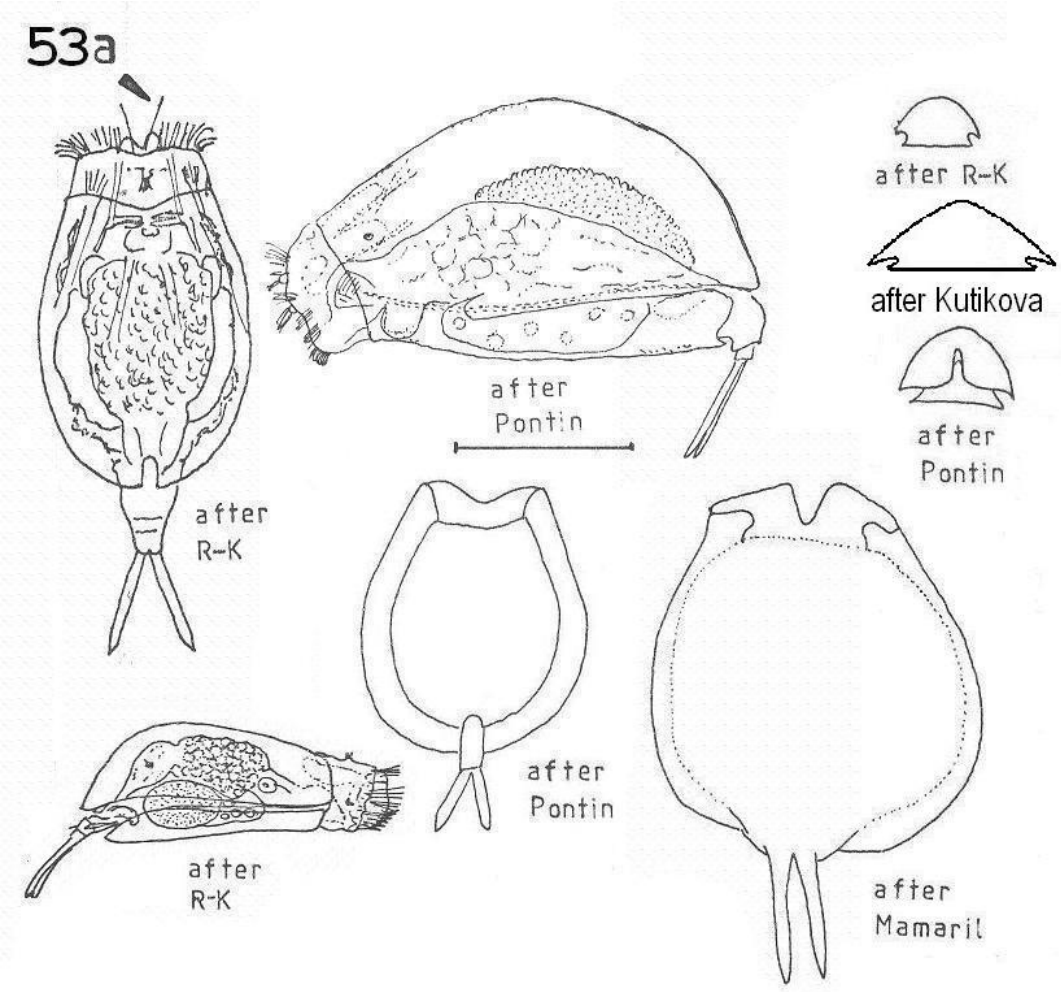

45a
after Hauer
45b (–46d–44a)
46a
46b
after Fernando 2002a
46c
after R.-K.
after Kutikova

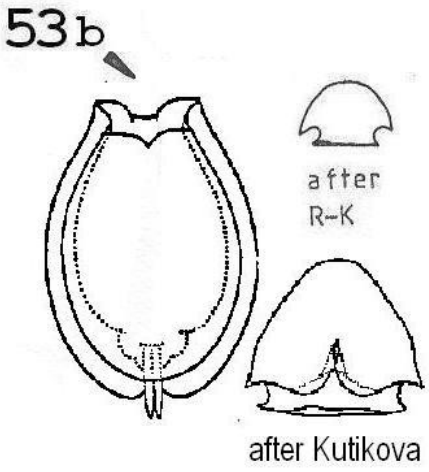

47a
after
Mamaril
VENTRAL
DORSAL
egg
after
Ueno
after
R-K
48a
after
Pontir
48b
after
Mamaril
after Sarma
after
The Acadmy of
Natural Sciences

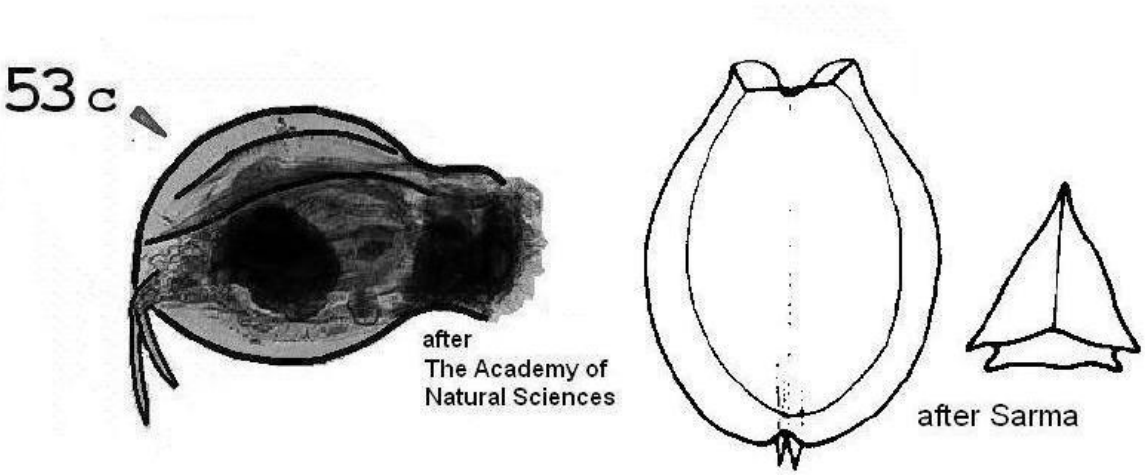

49a
ventral
OLIGOTROPHI
F. MACRACANTHA
F. IRREGULARIS
F. TYPICA
F. HISPIDA
TEMPERATURE
TURBULENCE
after
Mamaril
EUTROPHI
F. TECTA
after
Pontin & R-K
after
Hauer
var. javana
dorsal
MALE
after
Pontin
lorica

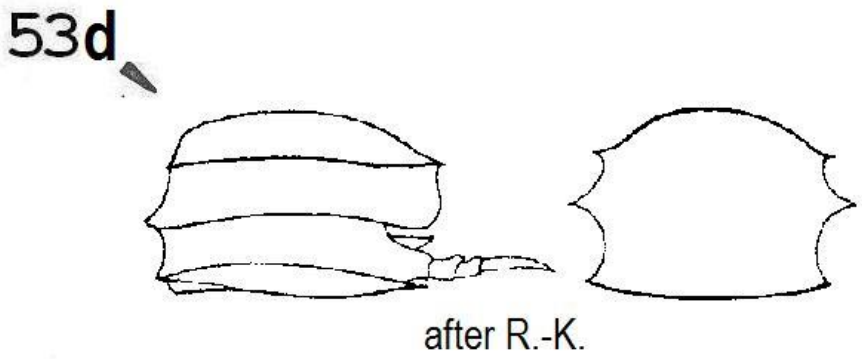

49b
50a
after
Pontin
MALE
dorsal
ventral
form frenzeli
form reticulata
50b
51a
form
assymmetrica
form
monstrosa
after
Hauer
51b
after
Mamaril

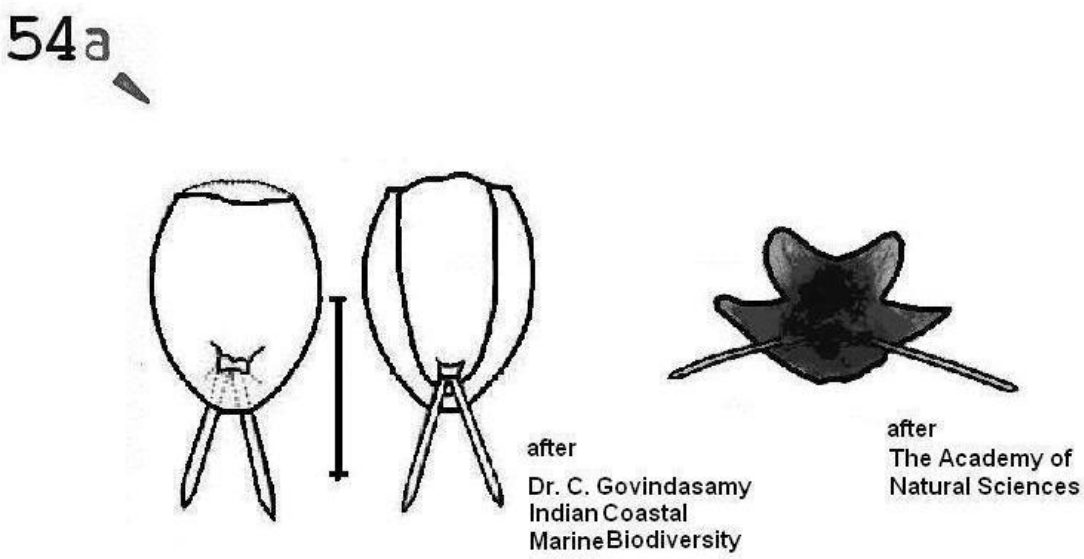

52a
after Pontin
eggposition during svimming
after R-K
eggcarrier
after R-K
sexual egg
after R-K
52b
after Hauer
after R-K
Paoay Lake
52b
-EEG-
52a
52a

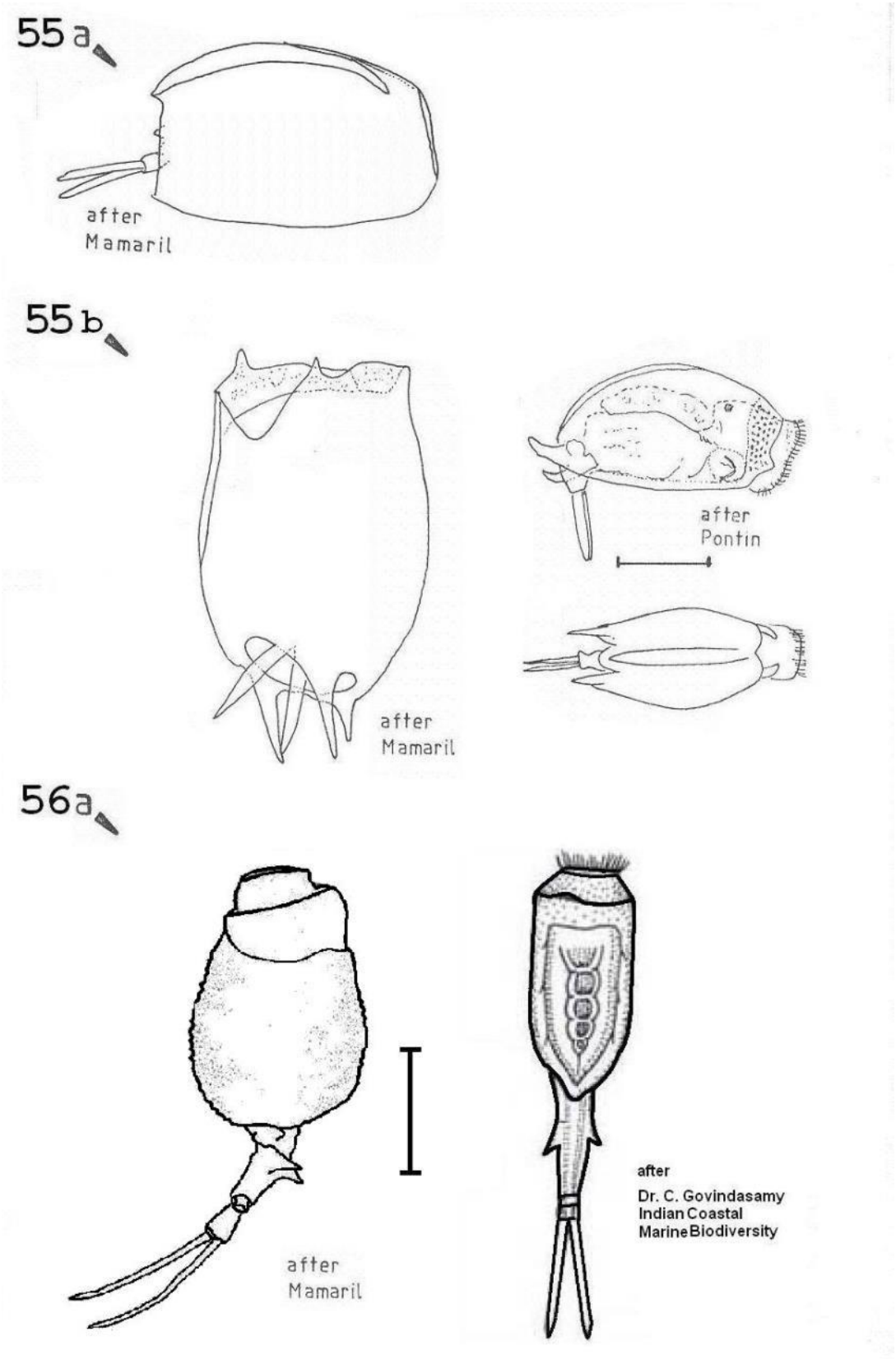

53a
after R-K
after Kutikova
after Pontin
after R-K
after Pontin
after Pontin
after R-K
after Mamaril

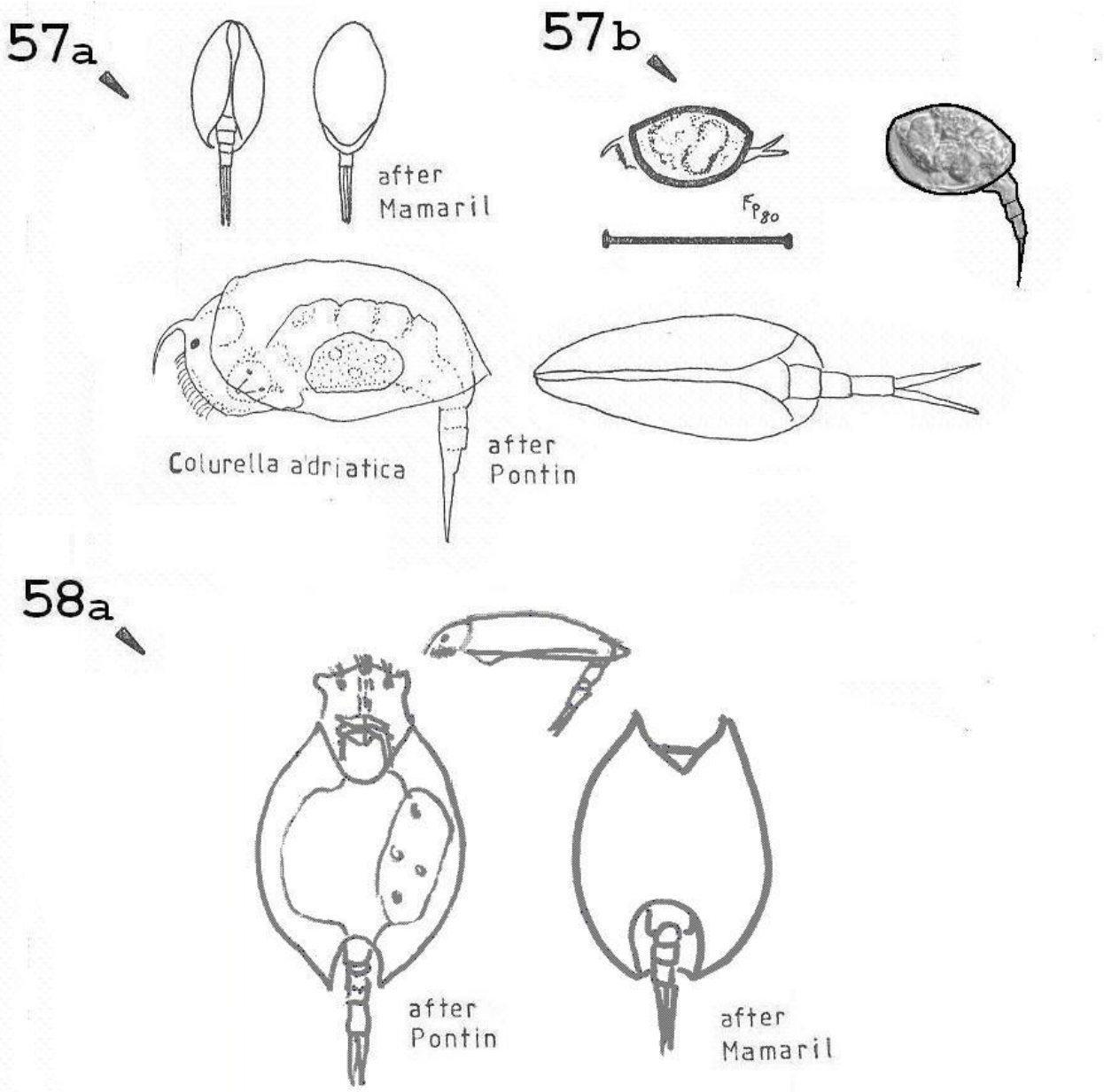

53b
after R-K
after Kutikova

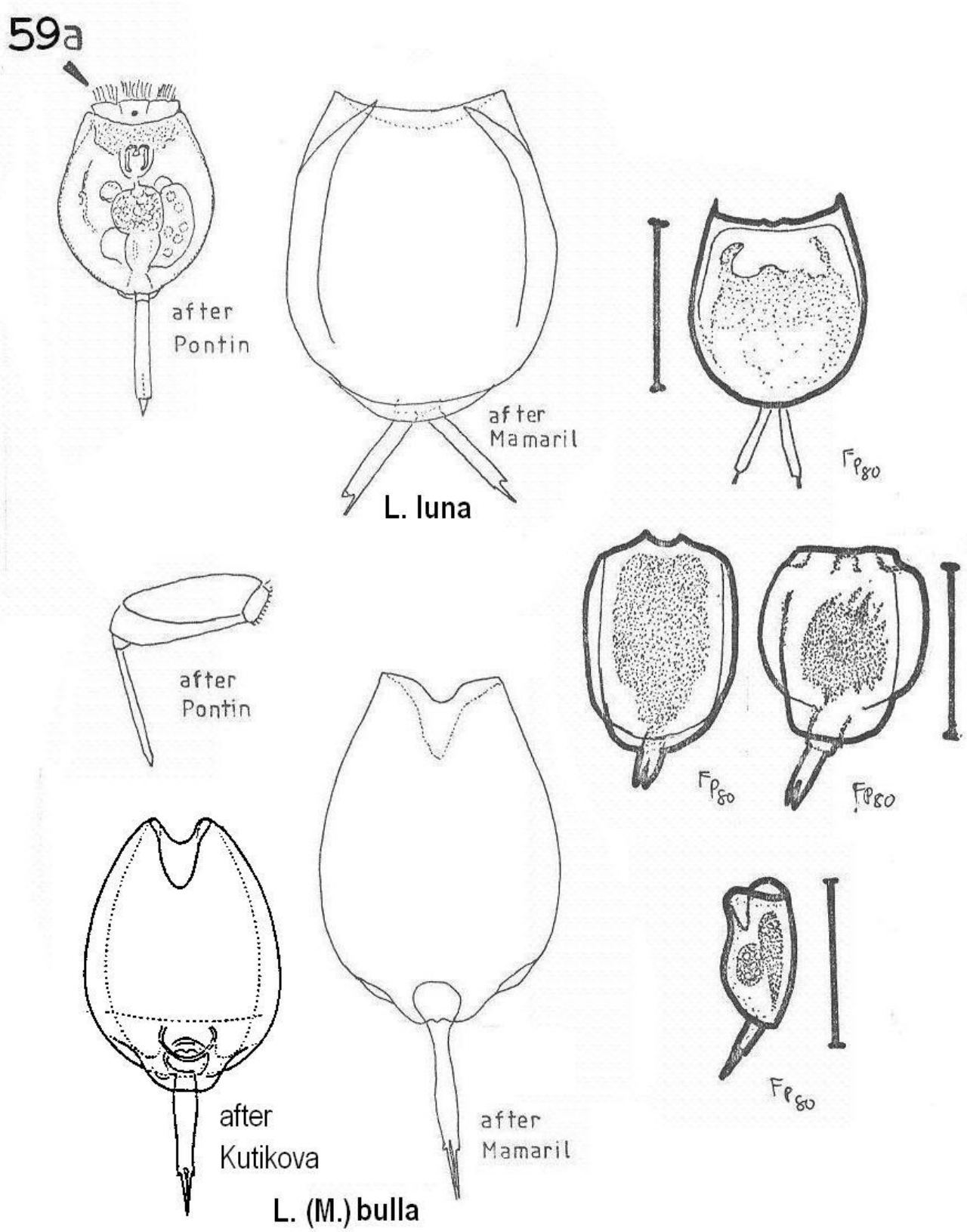

53c
after
The Academy of
Natural Sciences
after Sarma

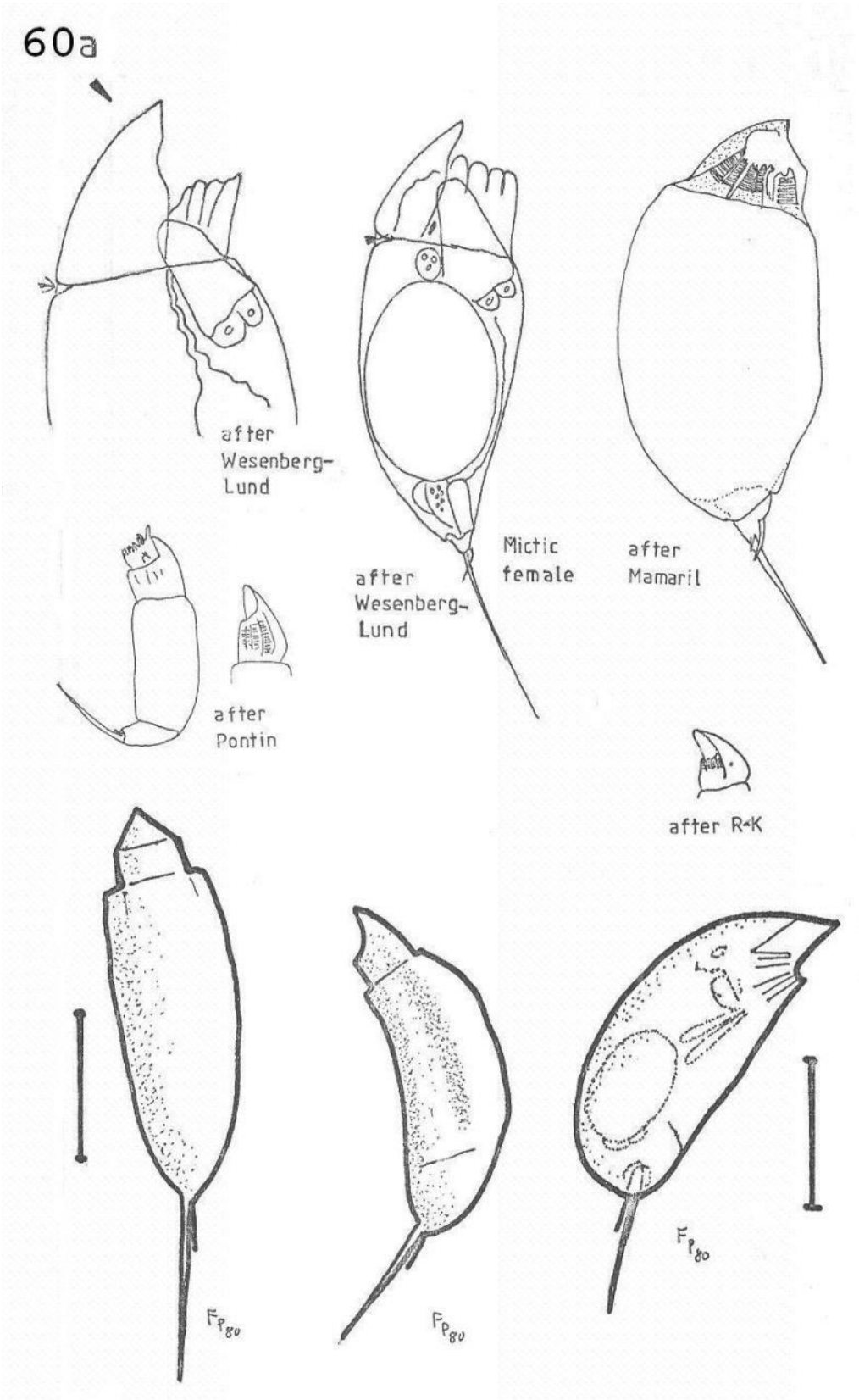

53d
after R.-K.

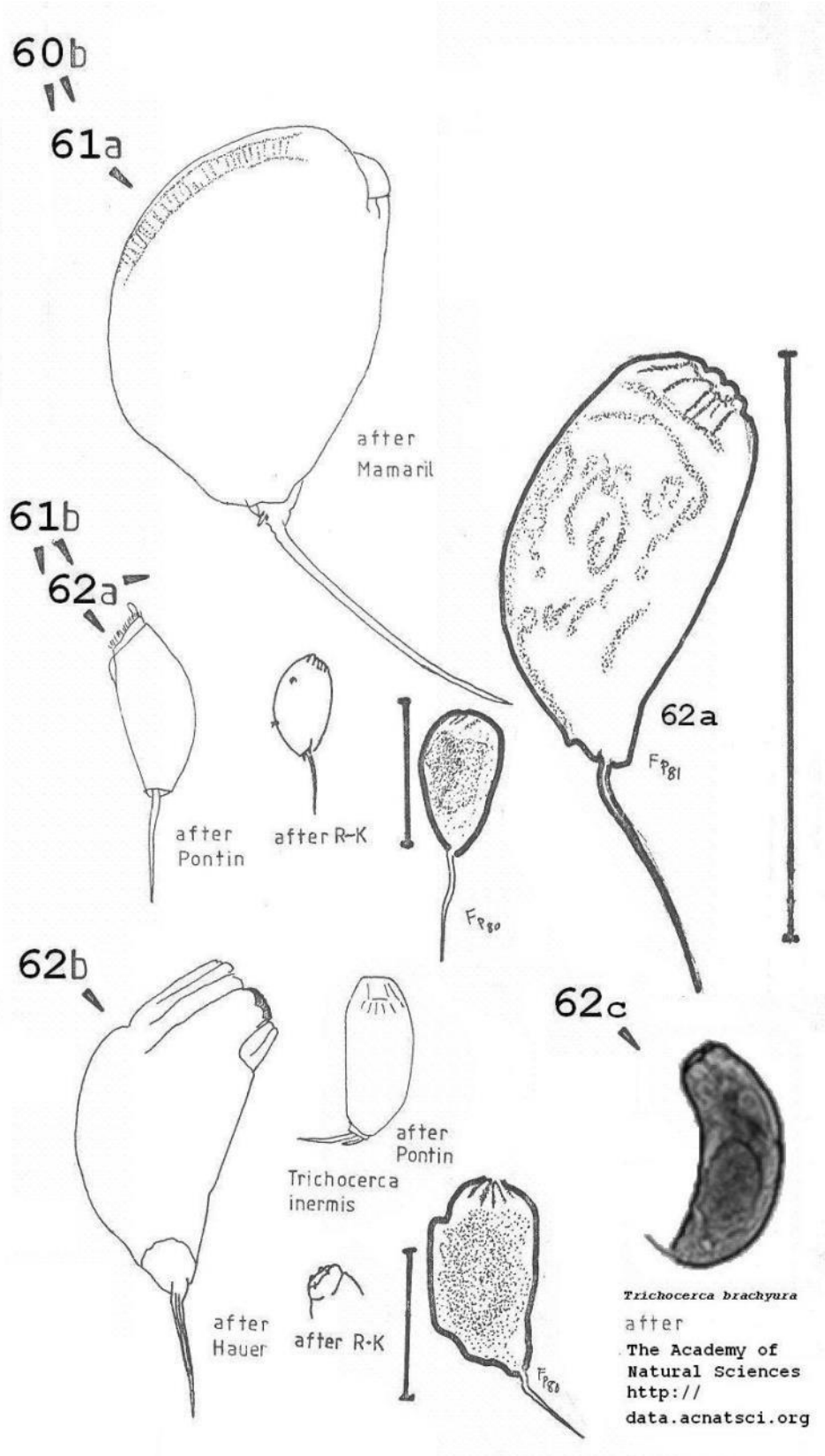

54a
after
Dr. C. Govindasamy
Indian Coastal
Marine Biodiversity
after
The Academy of
Natural Sciences

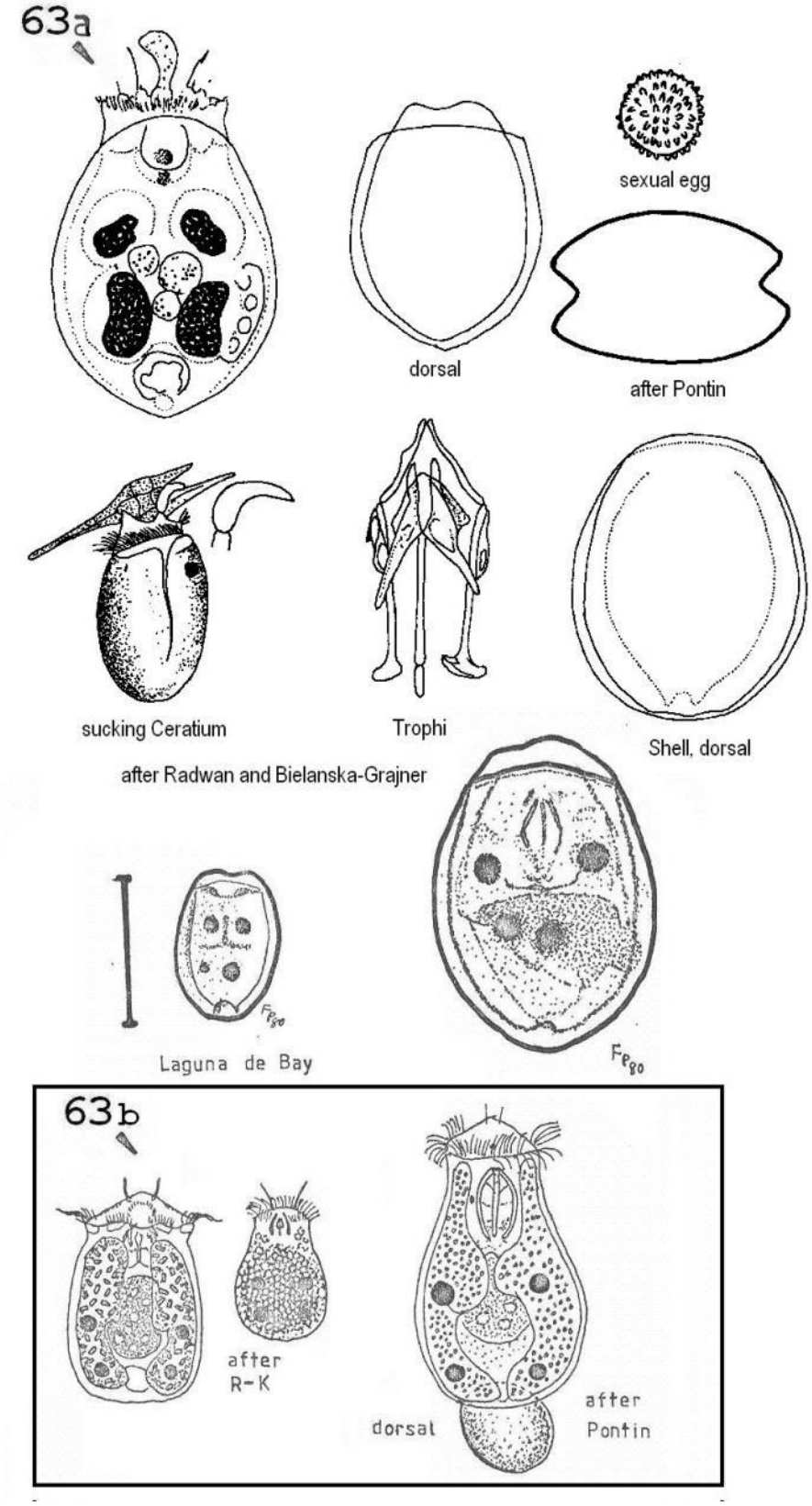

55 a
after
Mamaril
55 b
after
Mamaril
after
Pontin
56a
after
Mamaril
after
Dr. C. Govindasamy
Indian Coastal
Marine Biodiversity

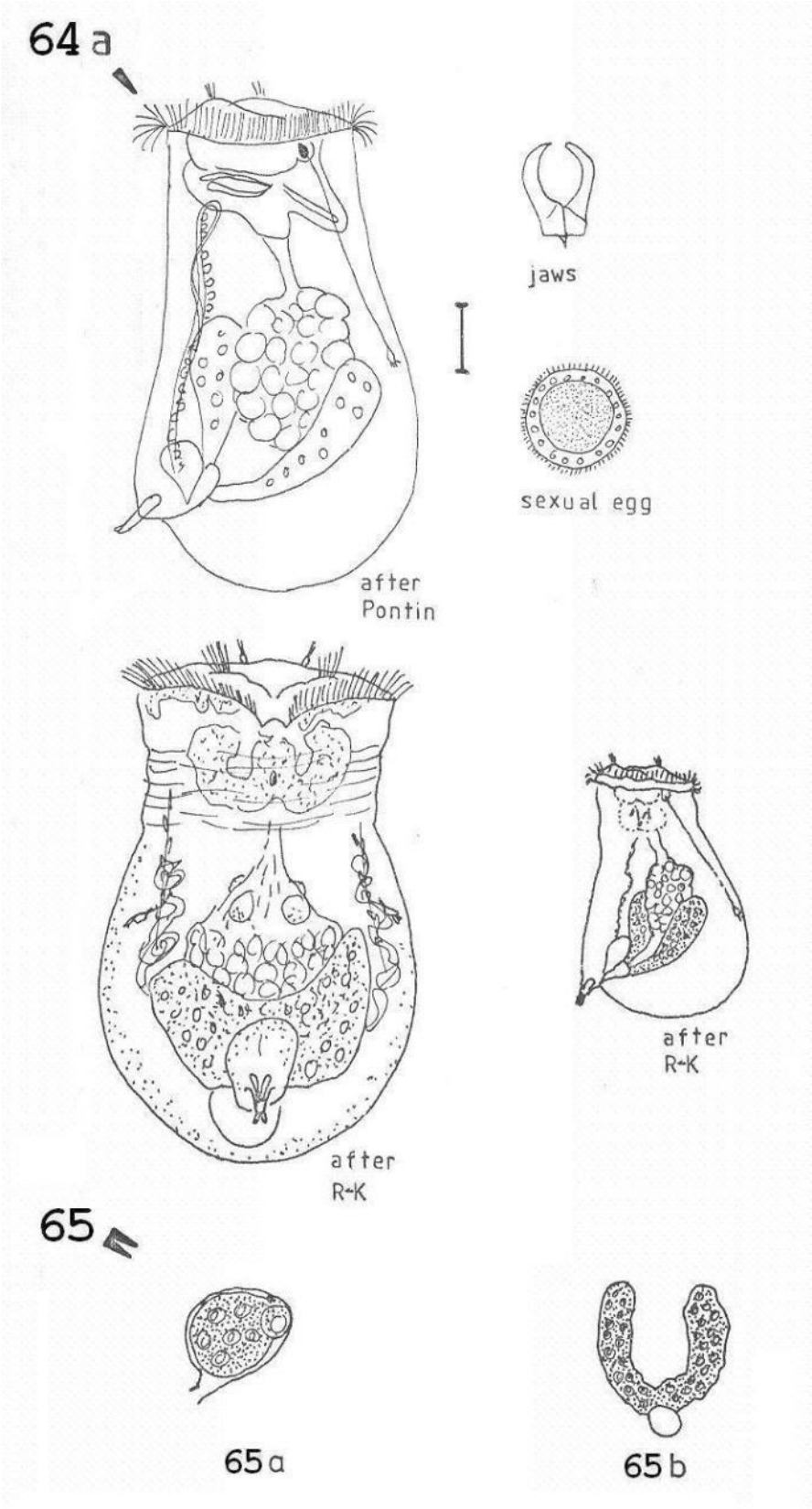

57a
after
Mamaril
57b
Fig 80
Colurella adriatica
after
Pontin
58a
after
Pontin
after
Mamaril

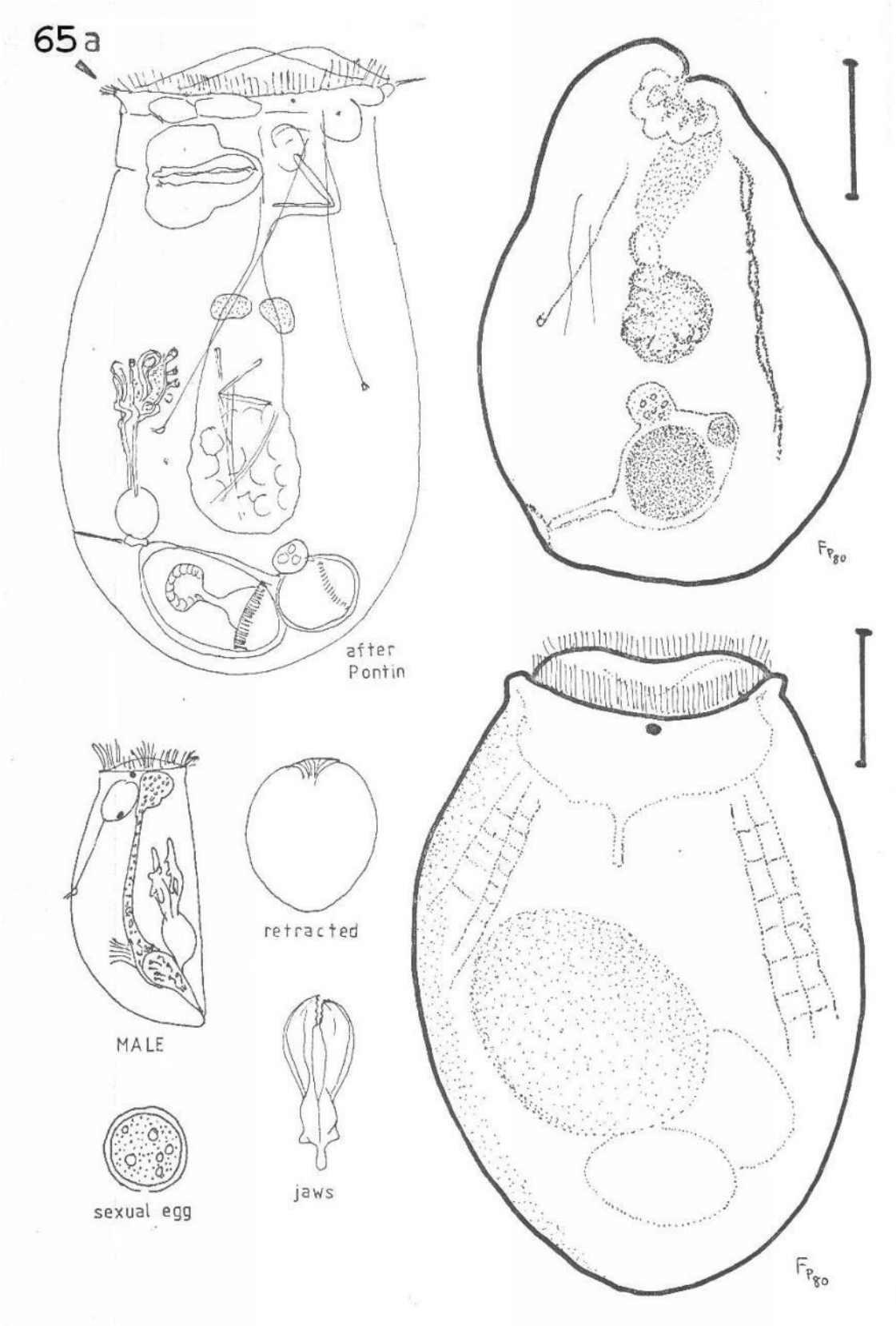

59a
after
Pontin
after
Mamaril
L. luna
Fp80
after
Pontin
Fp80
Fp80
after
Kutikova
after
Mamaril
Fp80
L. (M.) bulla

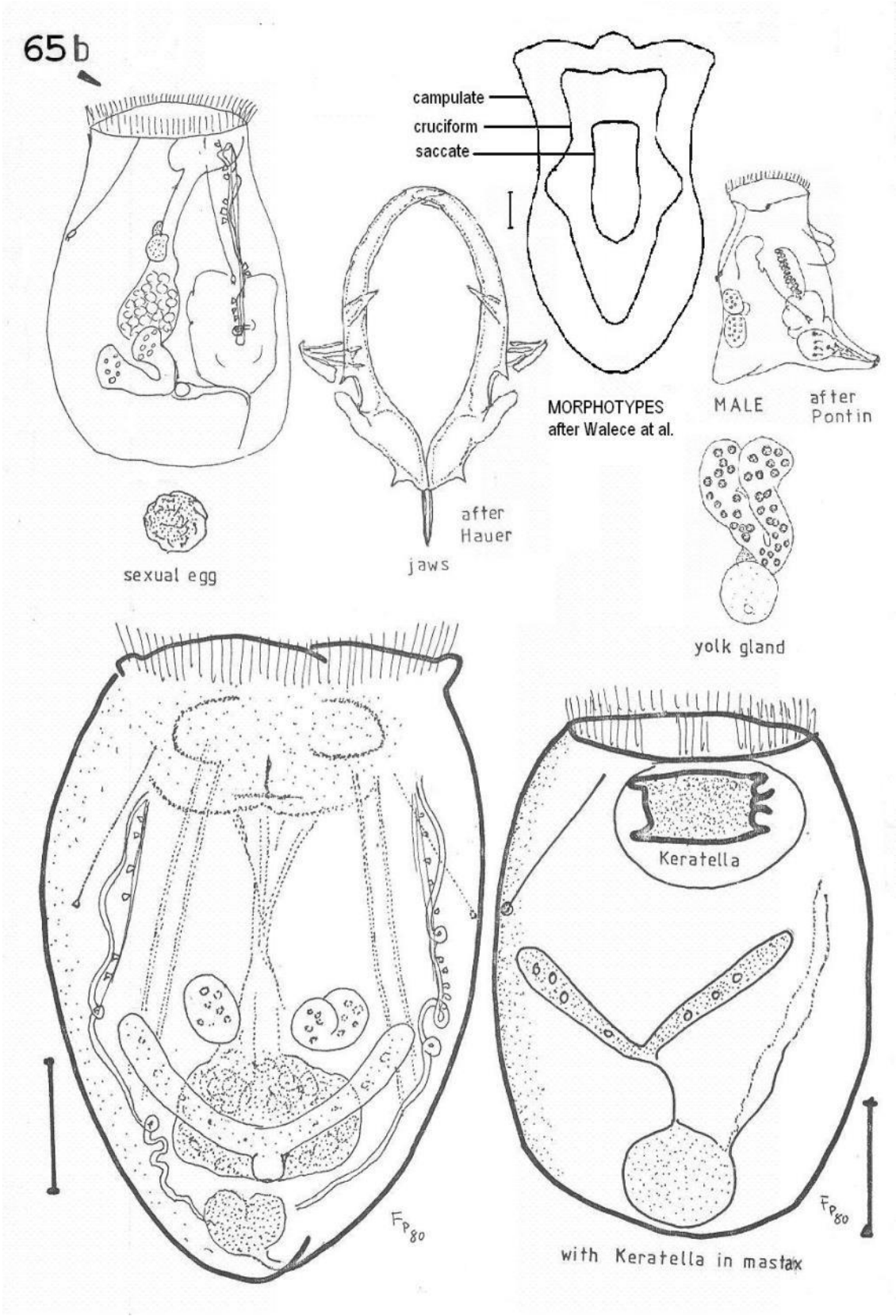

60a
after Wesenberg-Lund
after Pontin
Mictic female
after Wesenberg-Lund
after Mamaril
after R-K
Fp80
Fp80
Fp80

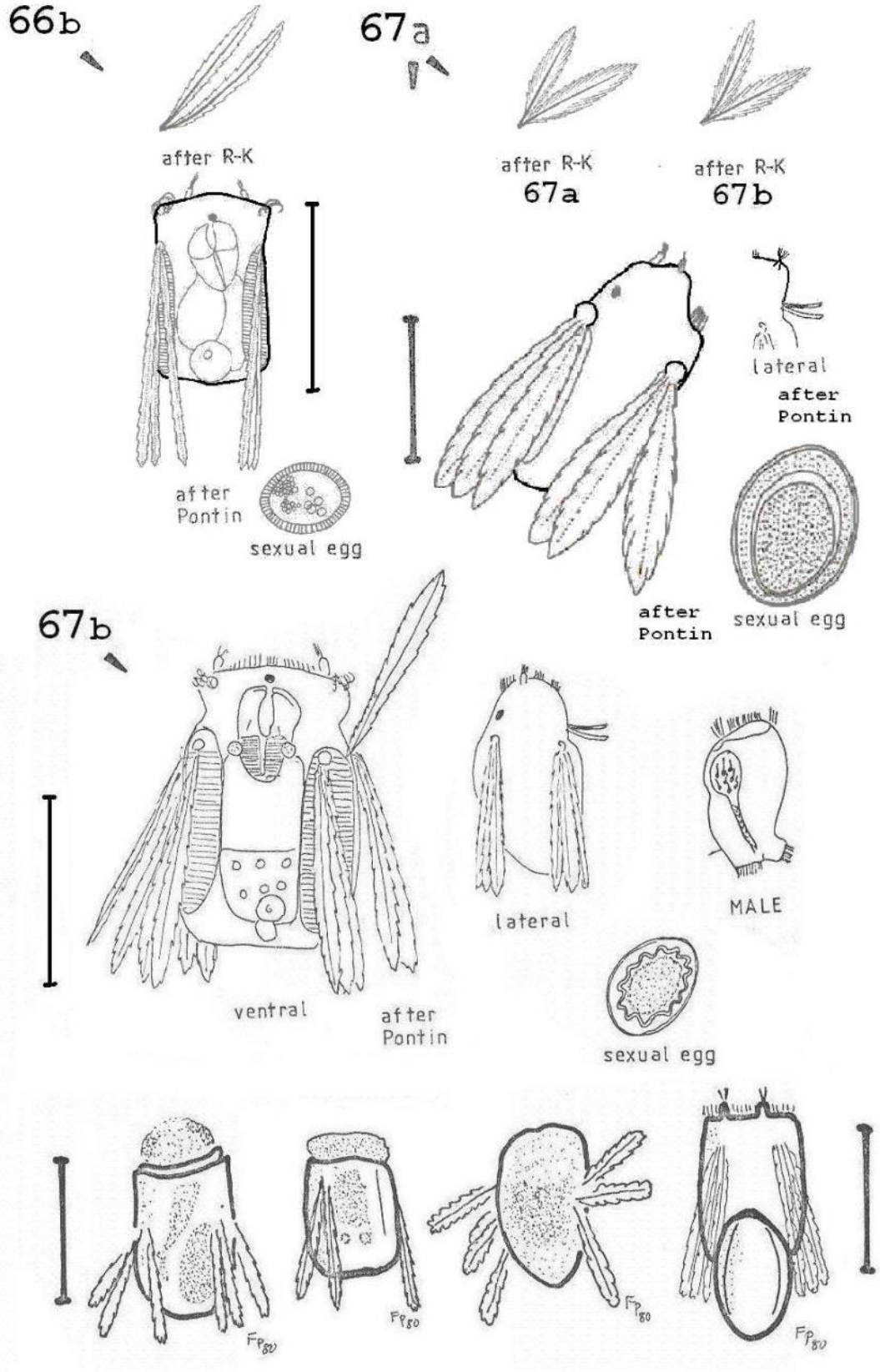

60b
61a
after
Mamaril
61b
62a
after
Pontin
after R-K
62a
62b
after
Pontin
Trichocerca
inermis
62c
after
Hauer
after R-K
Trichocerca brachyura
after
The Academy of
Natural Sciences
http://
data.acnatsci.org

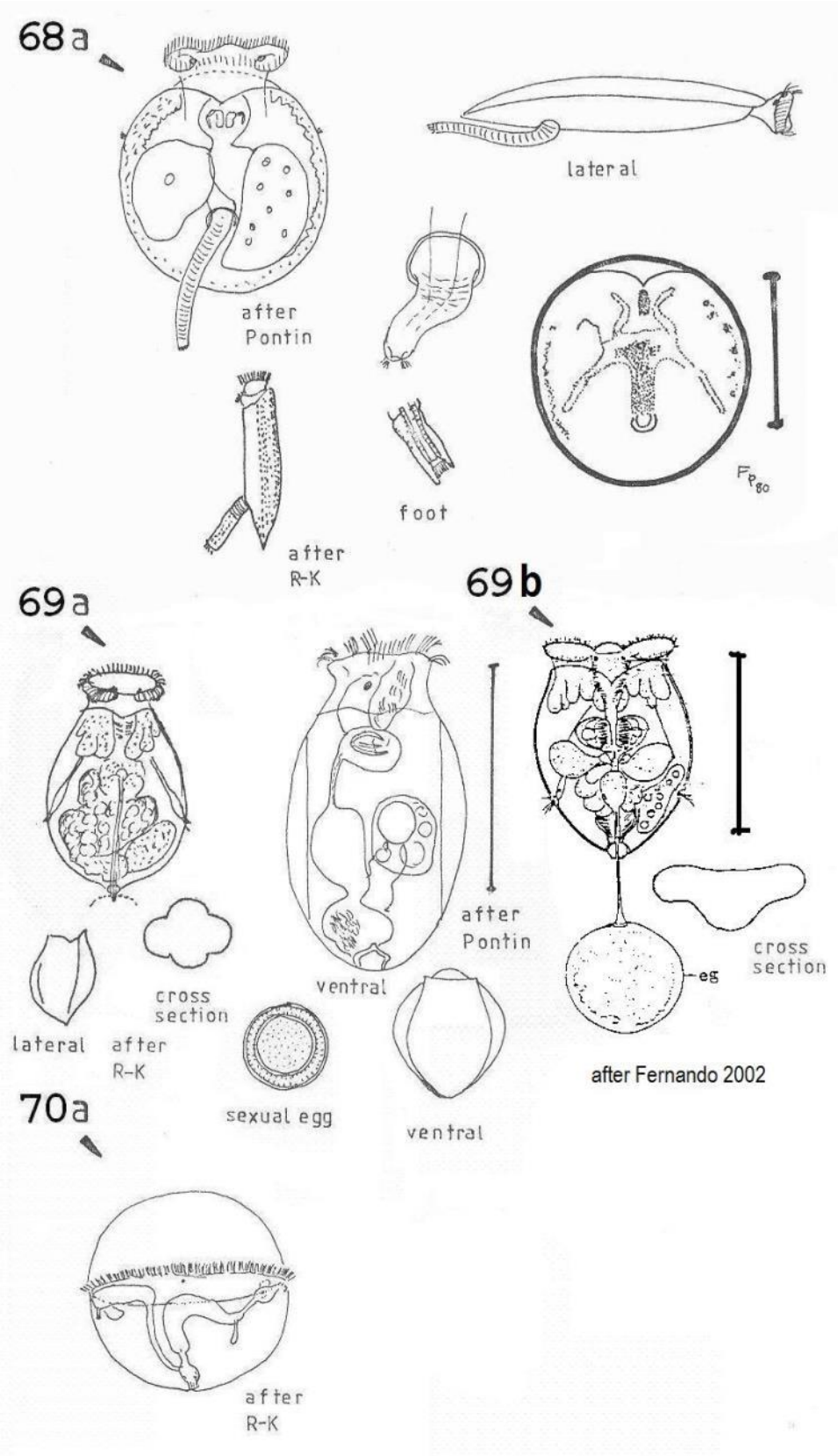

63a
sexual egg
dorsal
after Pontin
sucking Ceratium
Trophi
Shell, dorsal
after Radwan and Bielanska-Grajner
Laguna de Bay
63b
after
R-K
dorsal
after
Pontin

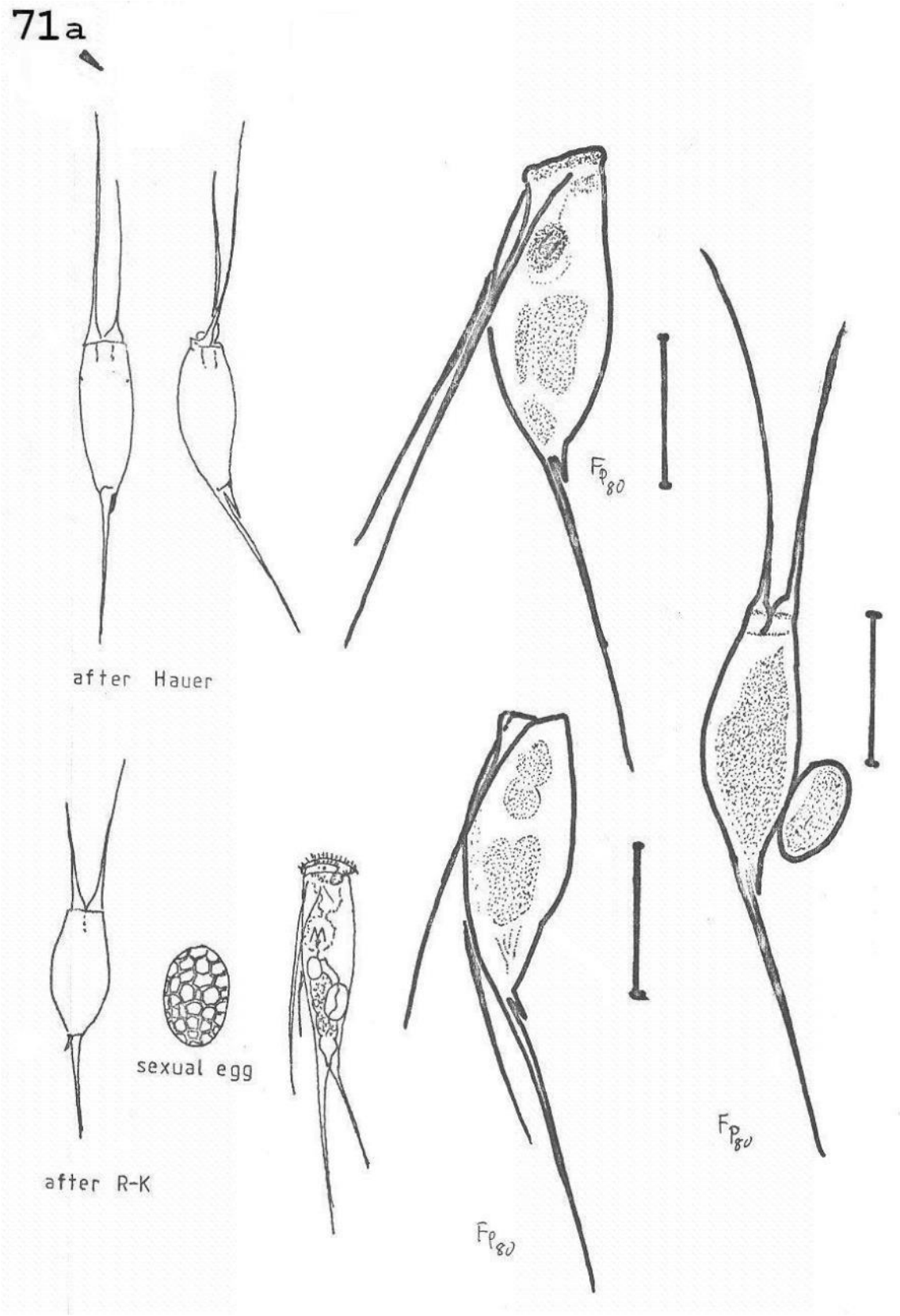

64 a
jaws
sexual egg
after
Pontin
after
R+K
after
R+K
65
65 a
65 b

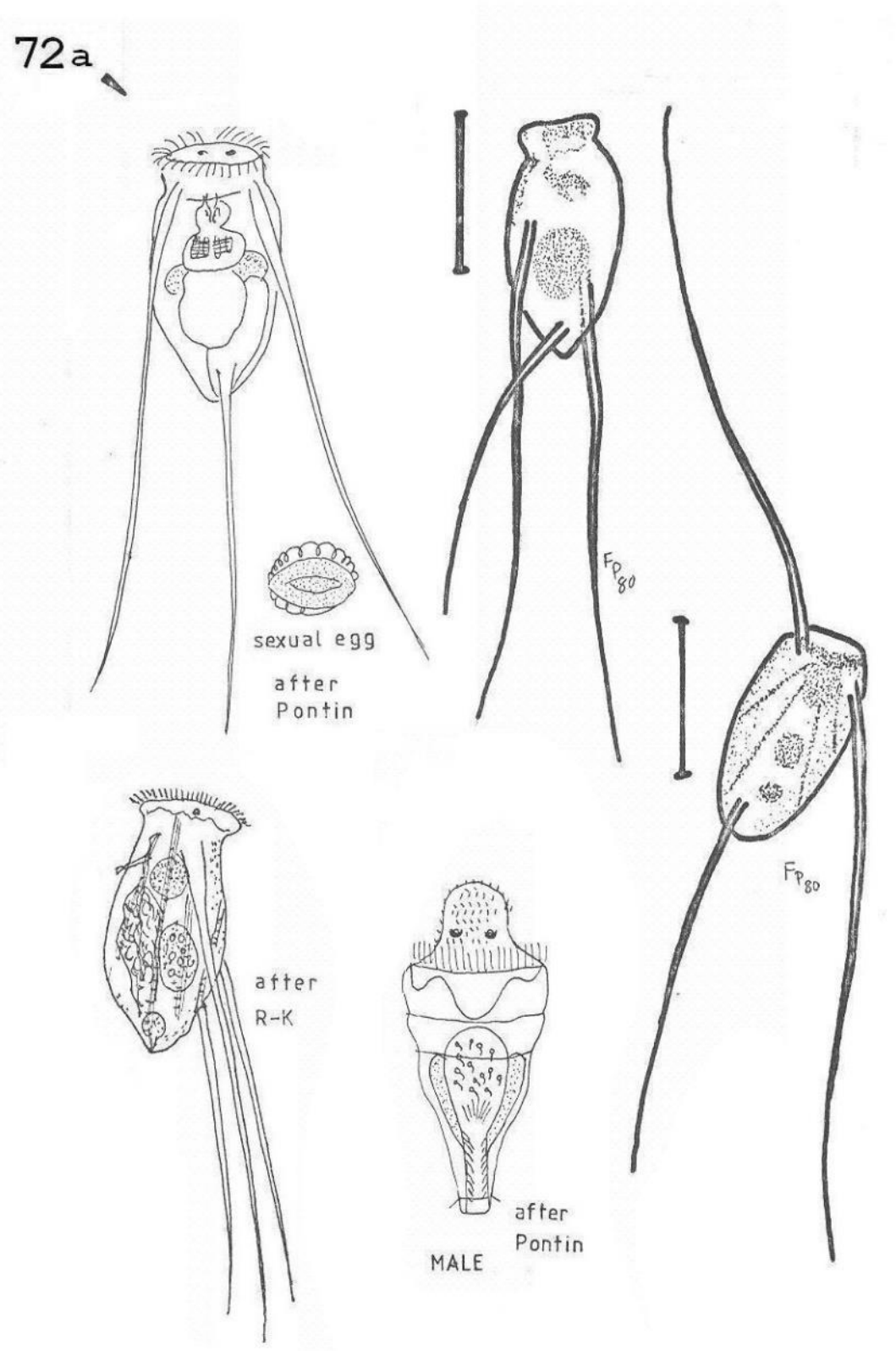

65 a
after Pontin
retracted
MALE
jaws
sexual egg
F. P. 80
F. P. 80

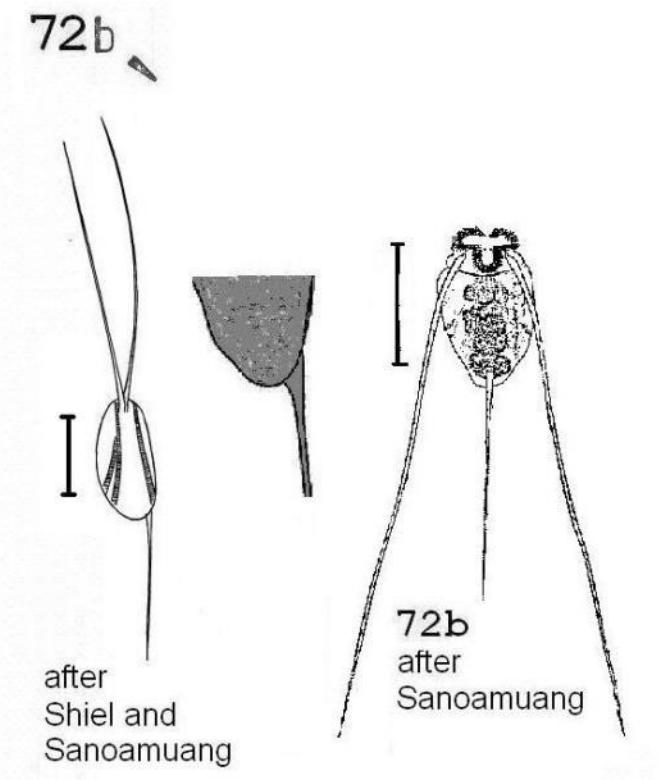

65 b
campulate
cruciform
saccate
MORPHOTYPES
after Walece at al.
MALE
after
Pontin
sexual egg
after
Hauer
jaws
yolk gland
Keratella
with Keratella in mastax

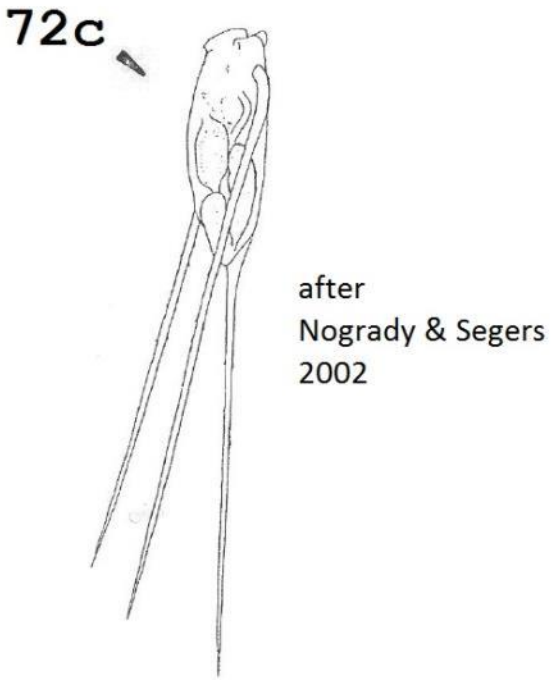

66b
after R-K
after Pontin
sexual egg
67a
after R-K
67a
after R-K
67b
lateral
after Pontin
after Pontin
sexual egg
67b
ventral
after Pontin
lateral
MALE
sexual egg

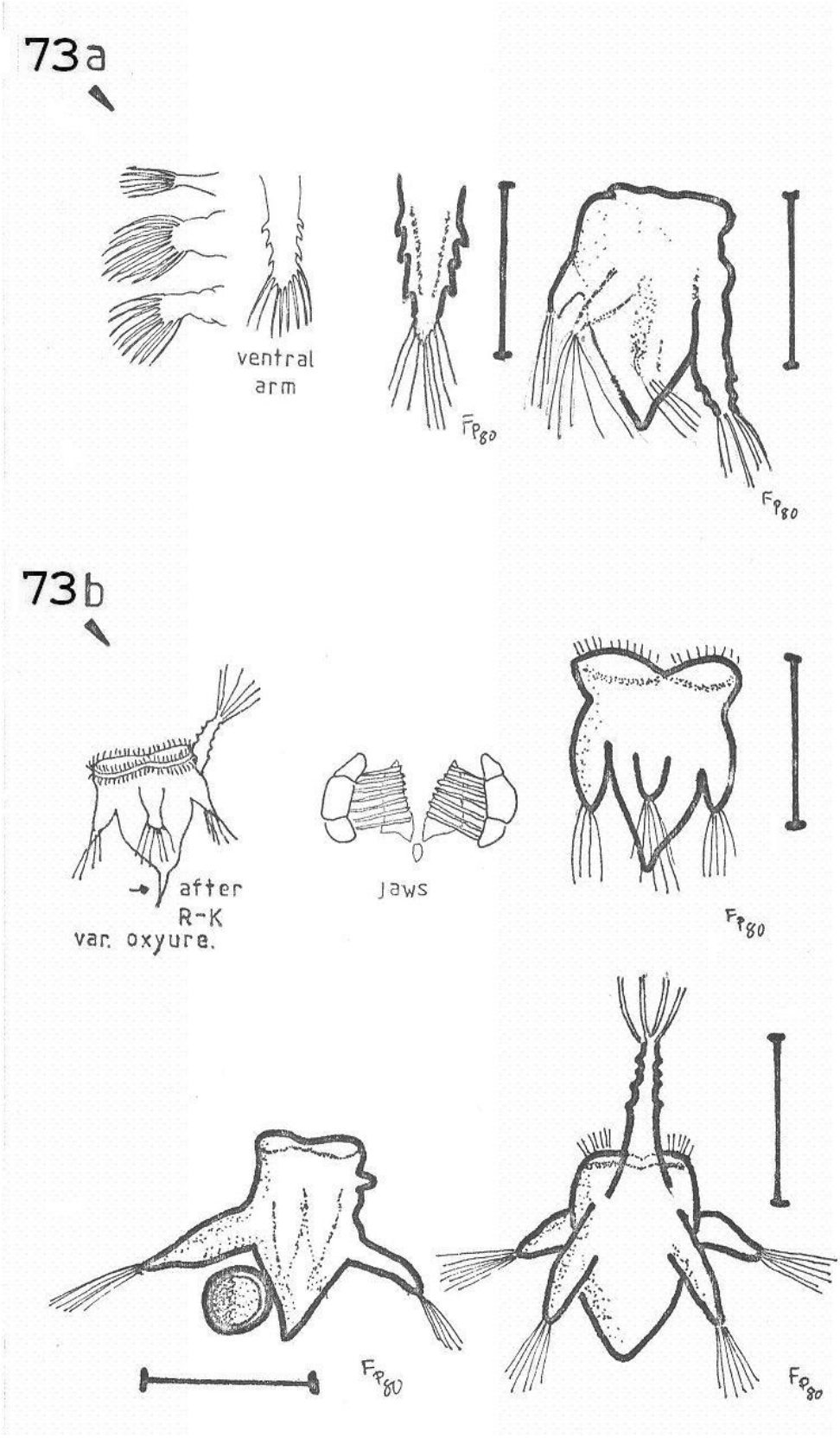

68 a
after Pontin
lateral
foot
after R-K
69 a
lateral
after R-K
cross section
ventral
after Pontin
sexual egg
69 b
eg
cross section
after Fernando 2002
70 a
ventral
after R-K

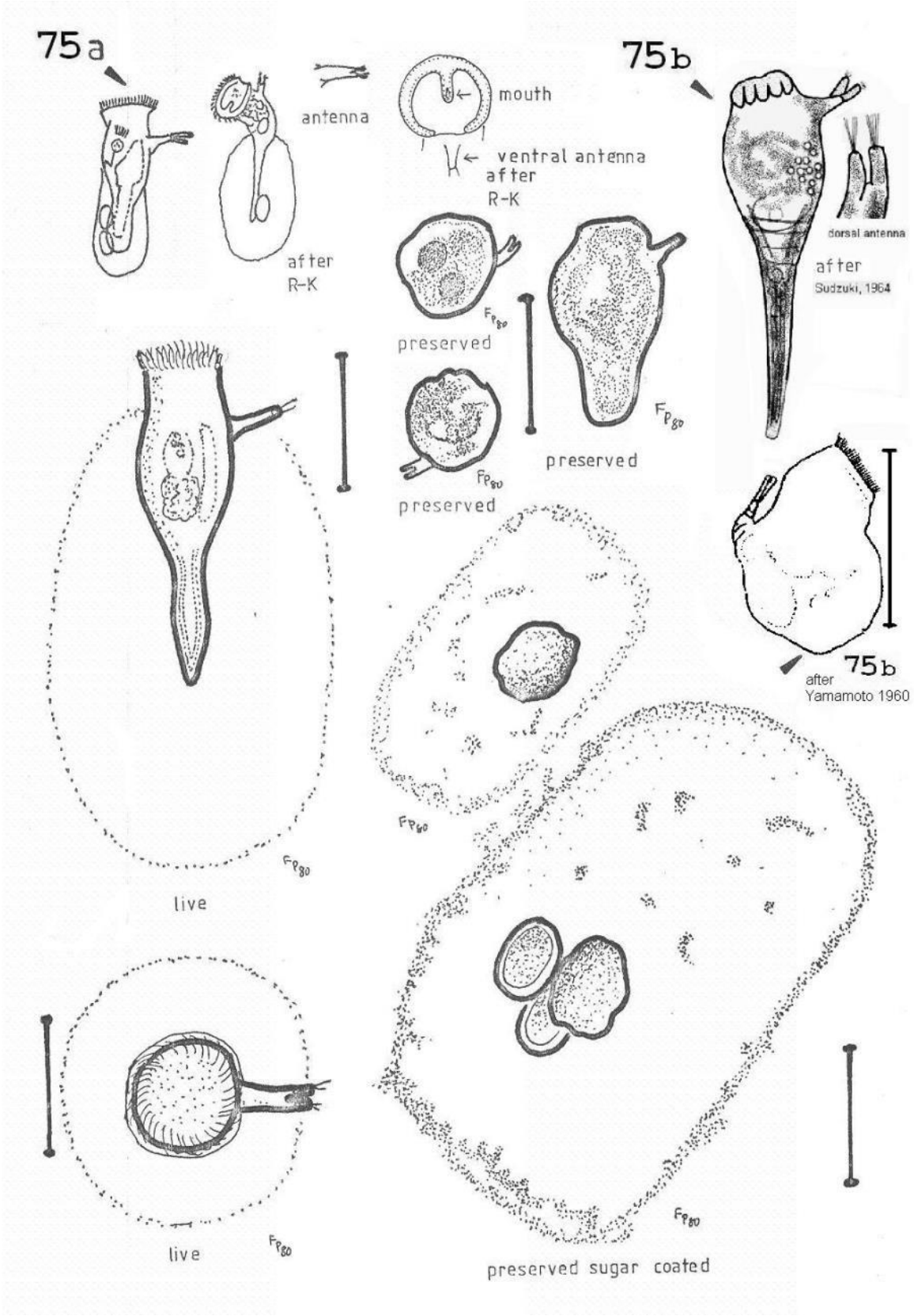

71a
after Hauer
after R-K
sexual egg
Fp80
Fp80
Fp80

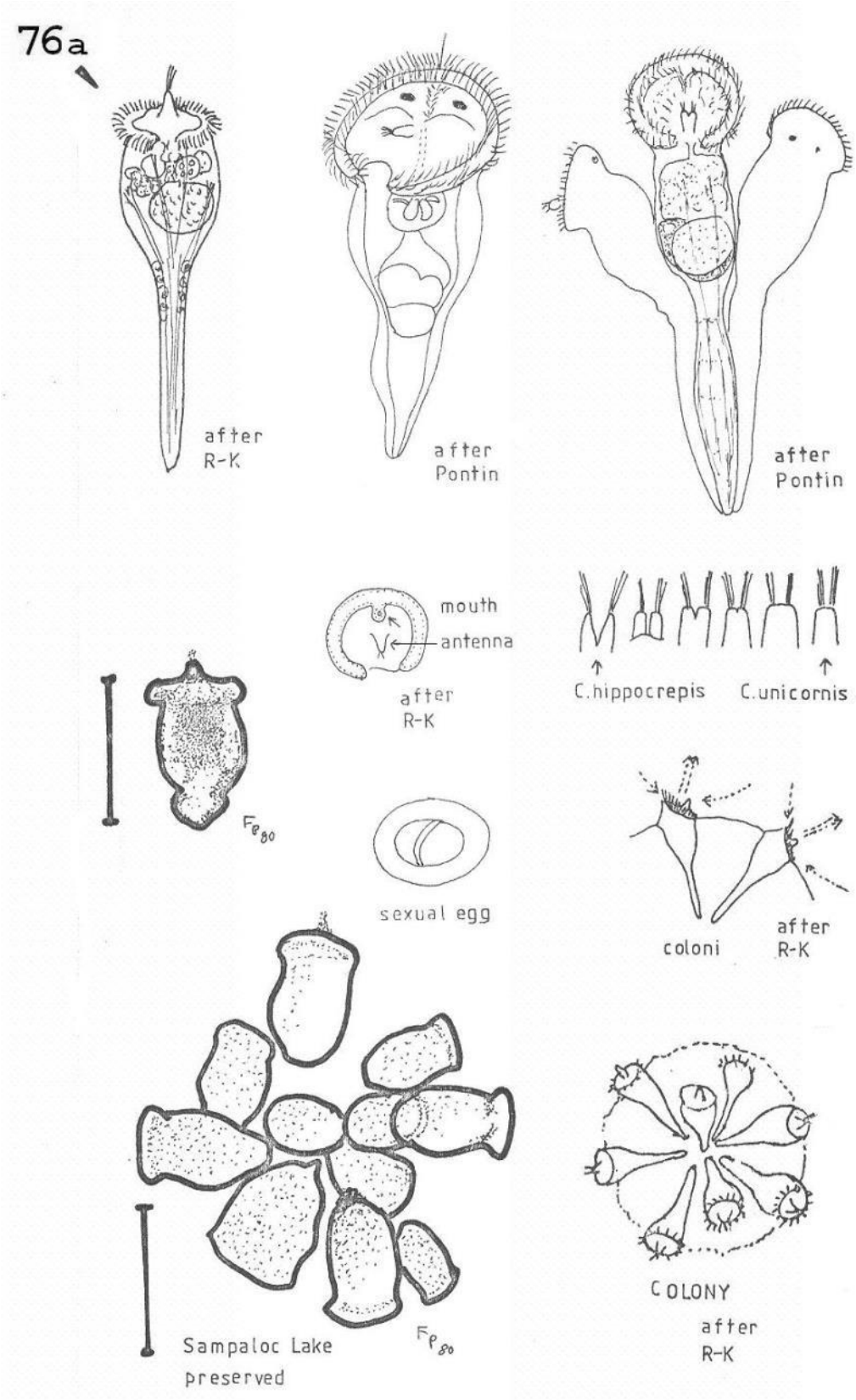

72a
sexual egg
after
Pontin
after
R-K
after
Pontin
MALE

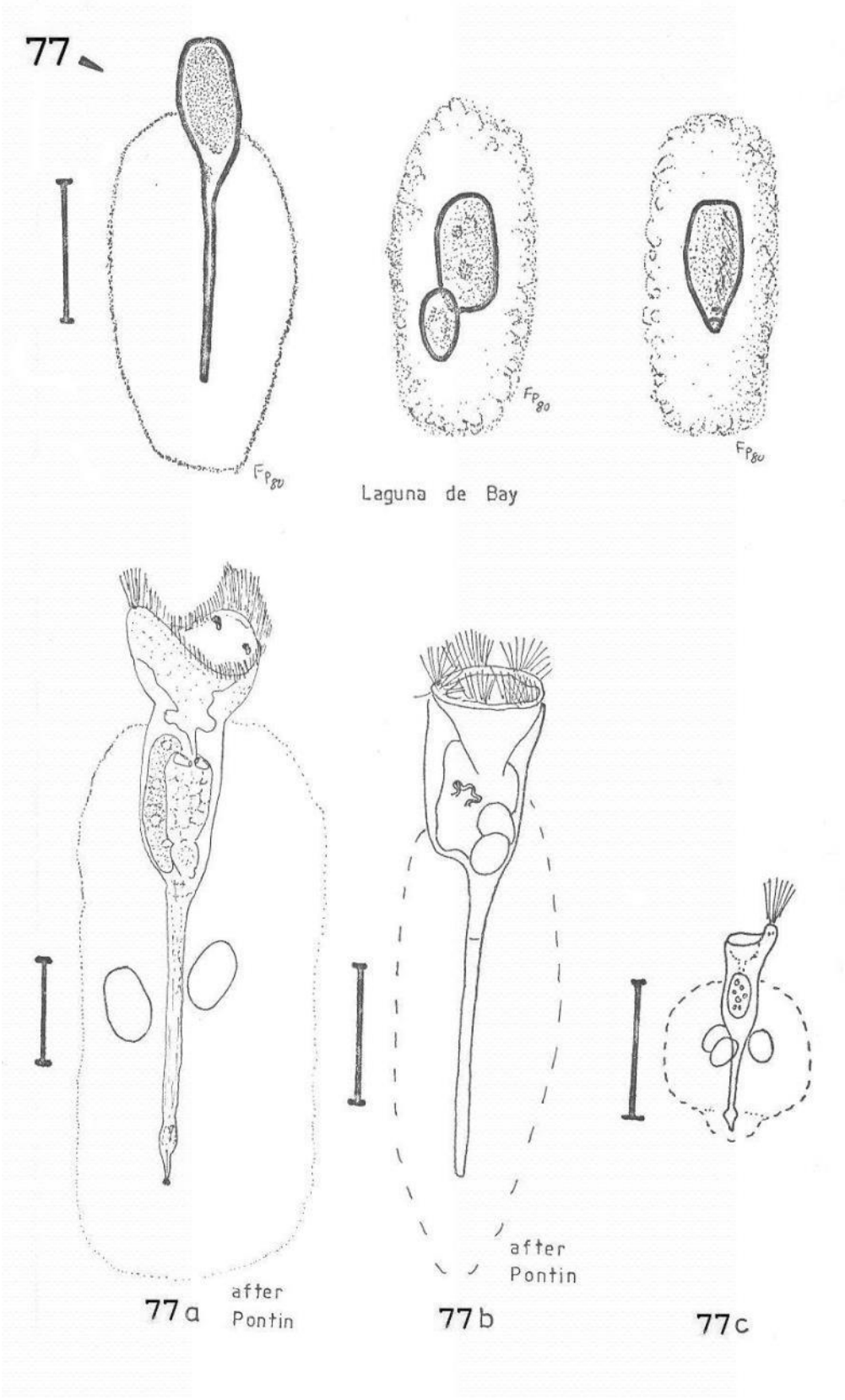

72b
after
Shiel and
Sanoamuang
72b
after
Sanoamuang

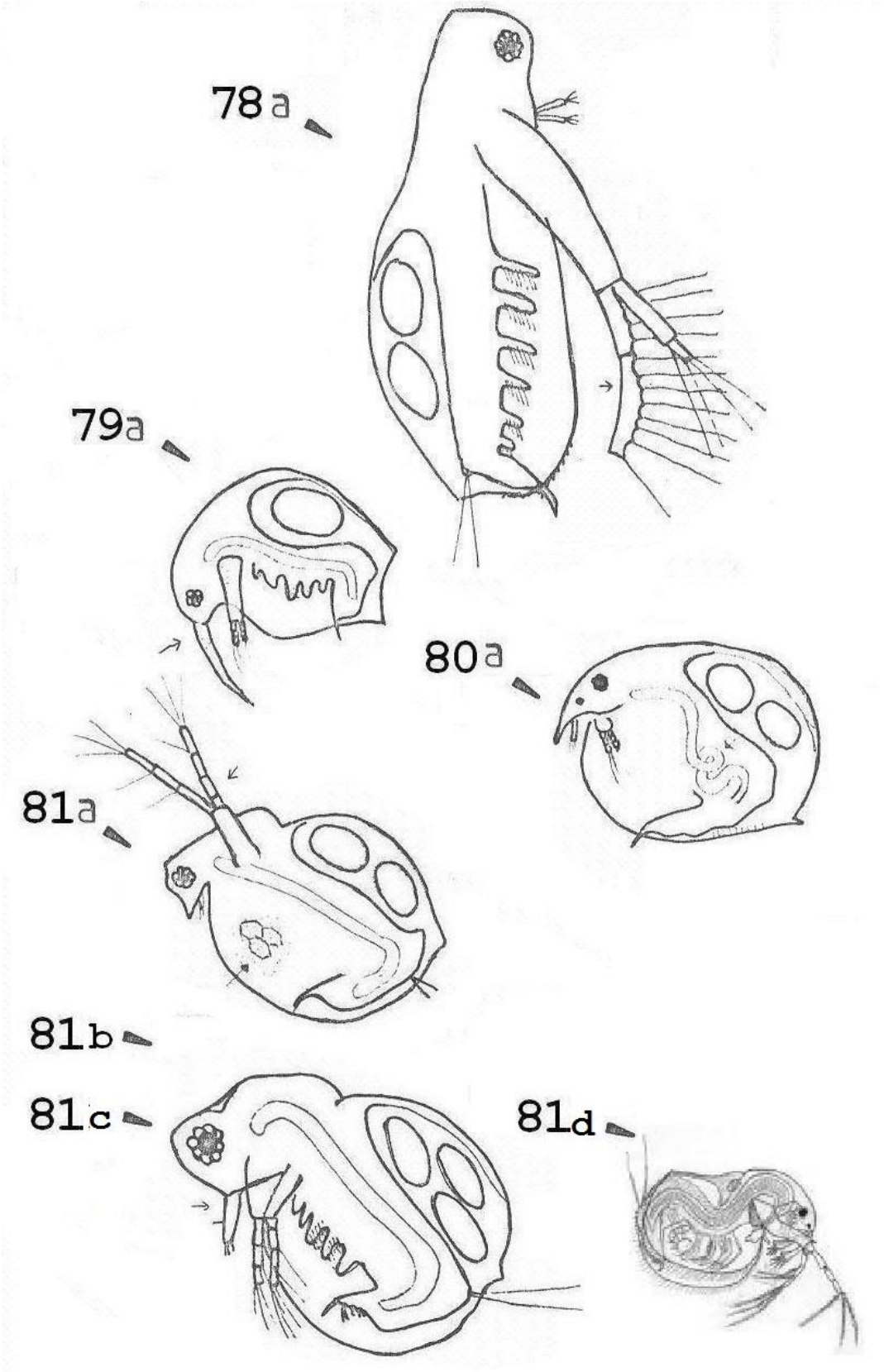

72c
after
Nogrady & Segers
2002

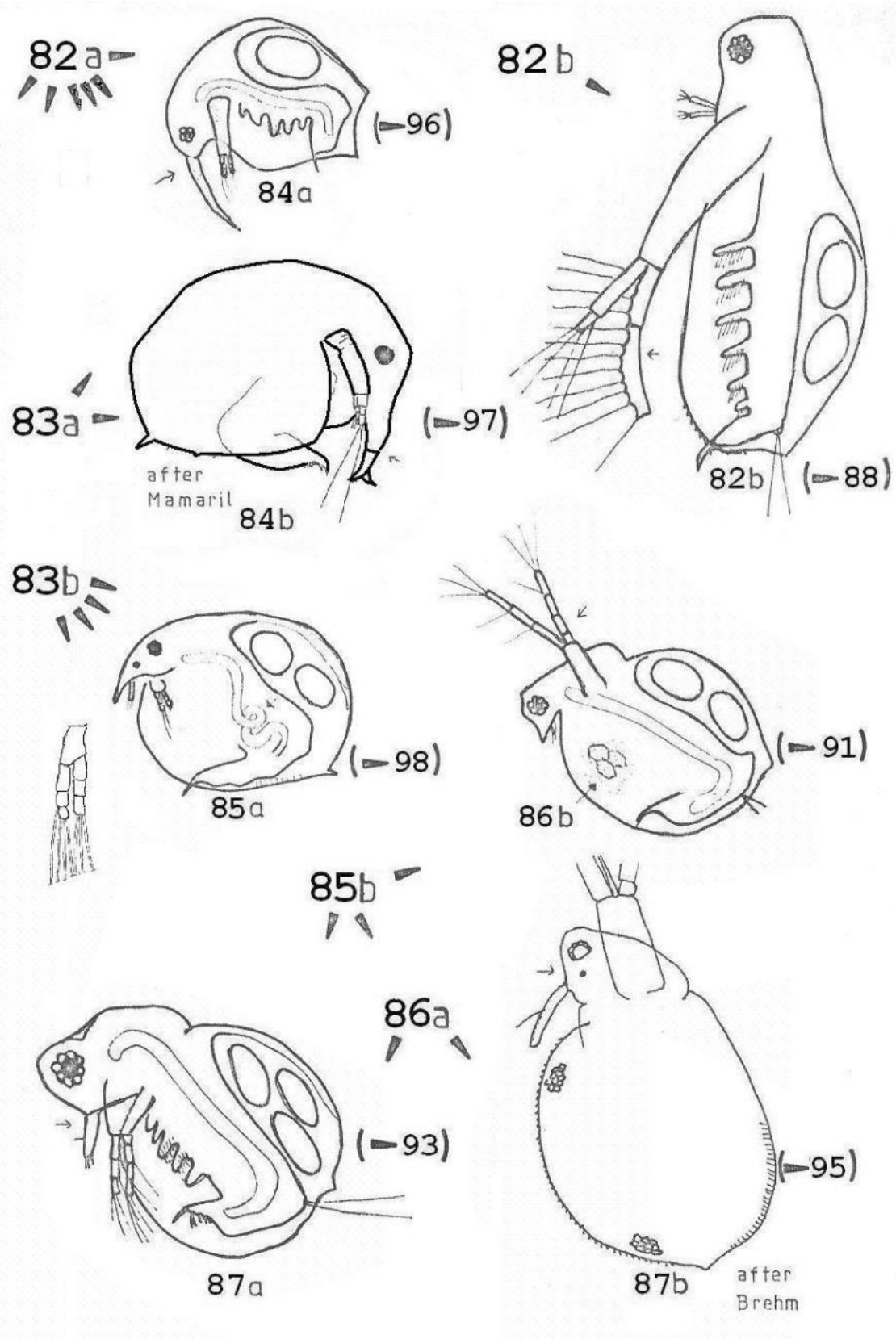

73a
ventral
arm
FR80
FR80
73b
after
R-K
var. oxyure.
jaws
FR80
FR80
FR80

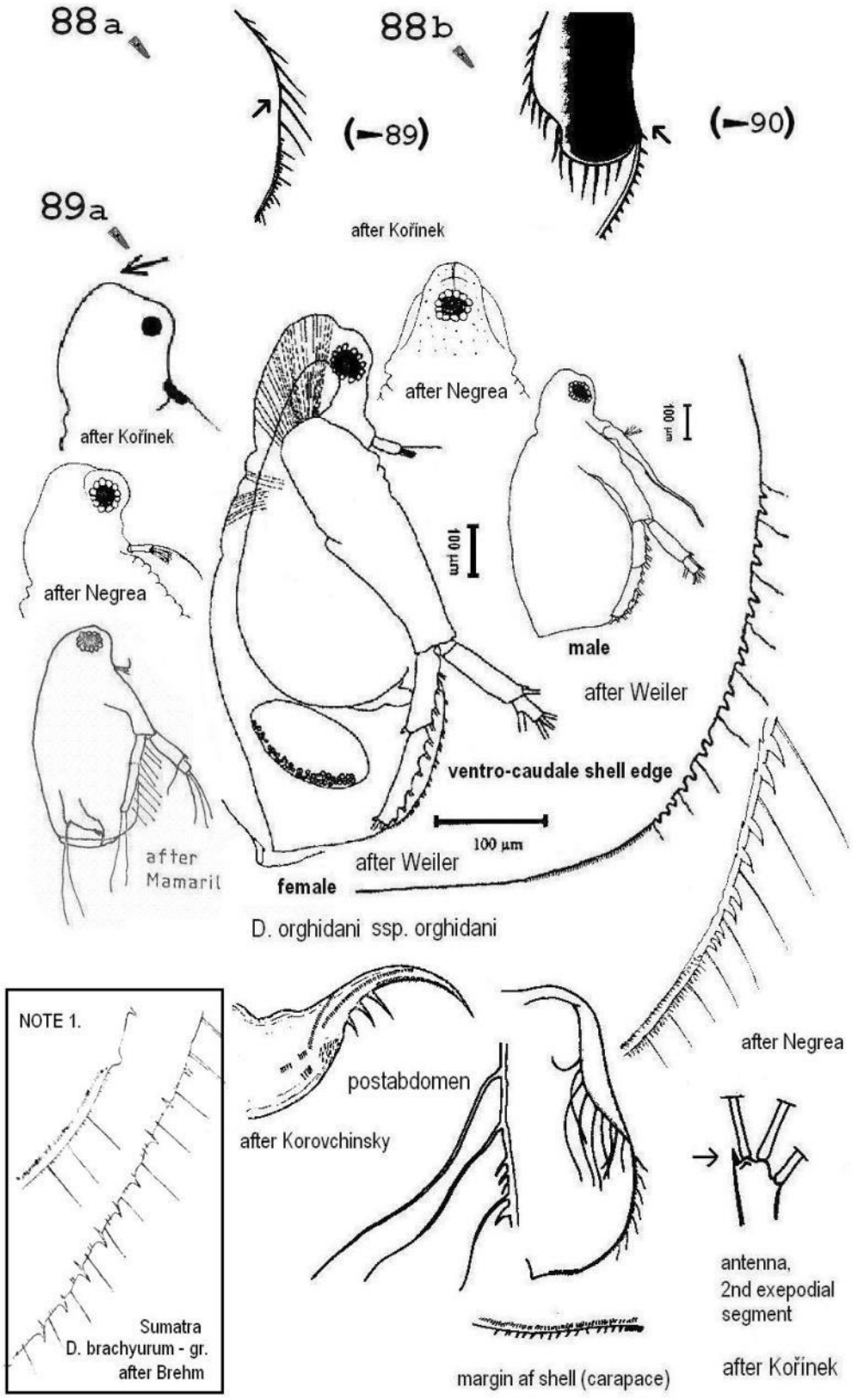

75a
antenna
mouth
ventral antenna
after
R-K
after
R-K
75b
dorsal antenna
after
Sudzuki, 1964
preserved
preserved
preserved
75b
after
Yamamoto 1960
live
live
preserved sugar coated

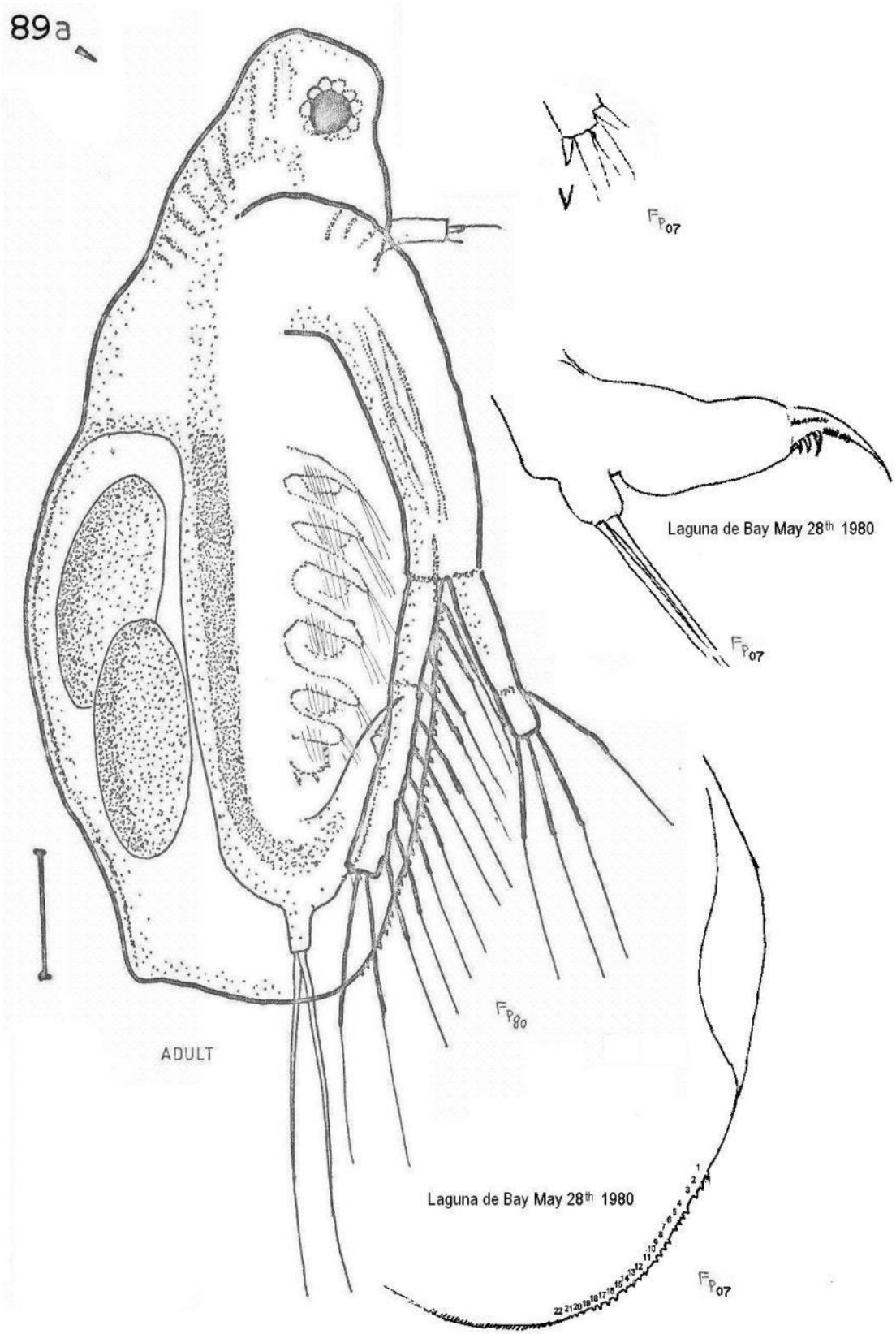

76a
after
R-K
after
Pontin
after
Pontin
mouth
antenna
after
R-K
C.hippocrepis
C.unicornis
Fφ80
sexual egg
coloni
after
R-K
Sampaloc Lake
preserved
Fφ80
COLONY
after
R-K


77
Laguna de Bay
77a after Pontin
77b after Pontin
77c

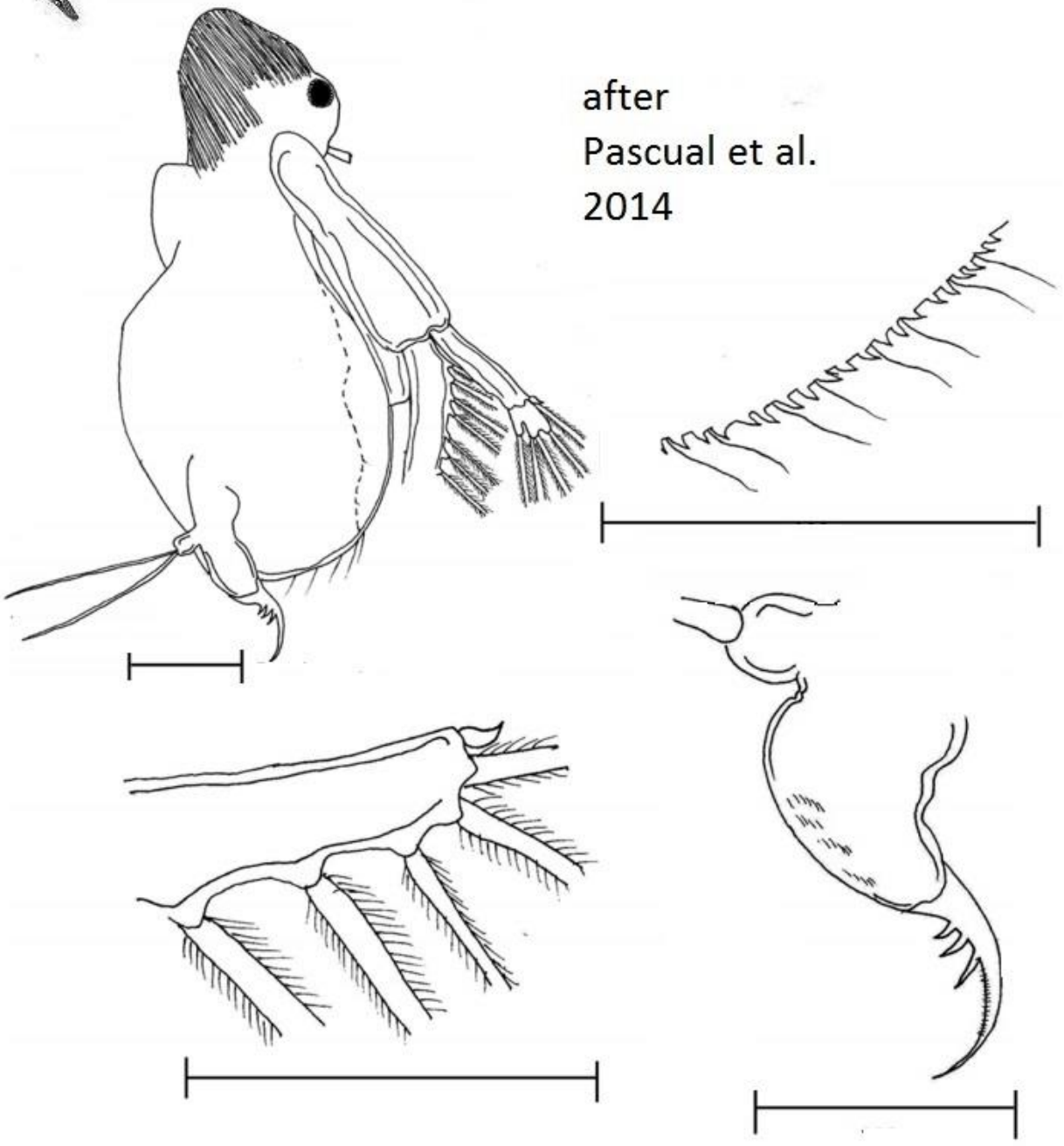

78a
79a
80a
81a
81b
81c
81d

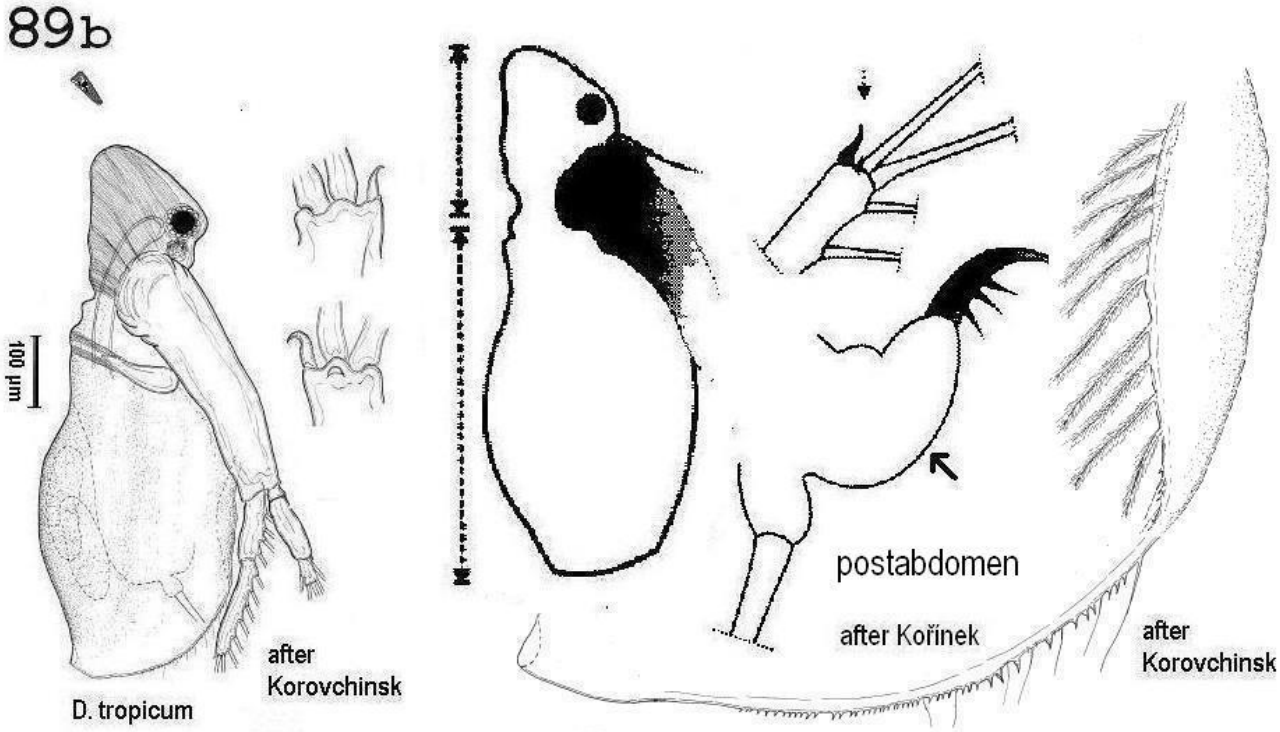

82a
(–96)
84a
82b
83a
(–97)
after
Mamaril
84b
82b
(–88)
83b
(–98)
85a
(–91)
86b
85b
86a
(–93)
87a
(–95)
87b
after
Brehm

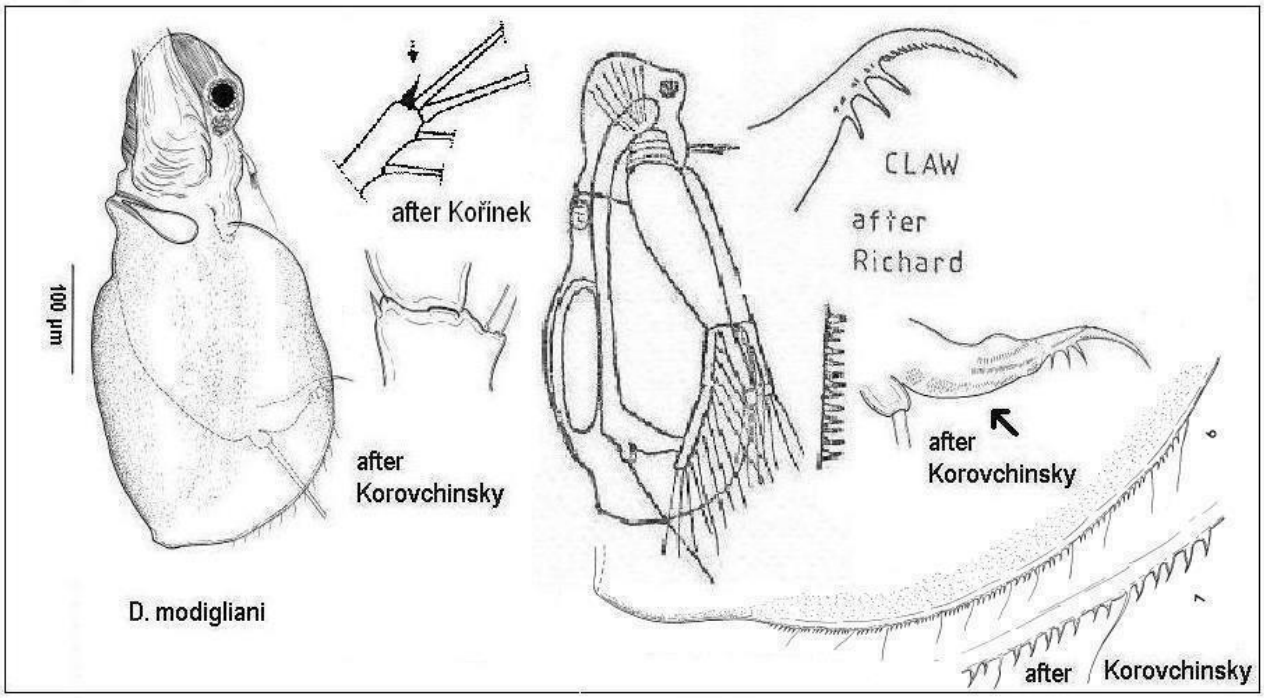

88a
(–89)
88b
(–90)
after Kořínek
89a
after Kořínek
after Negrea
after Negrea
100 µm
100 µm
male
after Weiler
ventro-caudale shell edge
100 µm
after Weiler
female
after Mamaril
D. orghidani ssp. orghidani
NOTE 1.
Sumatra
D. brachyurum - gr.
after Brehm
postabdomen
after Korovchinsky
after Negrea
antenna,
2nd exepodial
segment
after Kořínek
margin af shell (carapace)

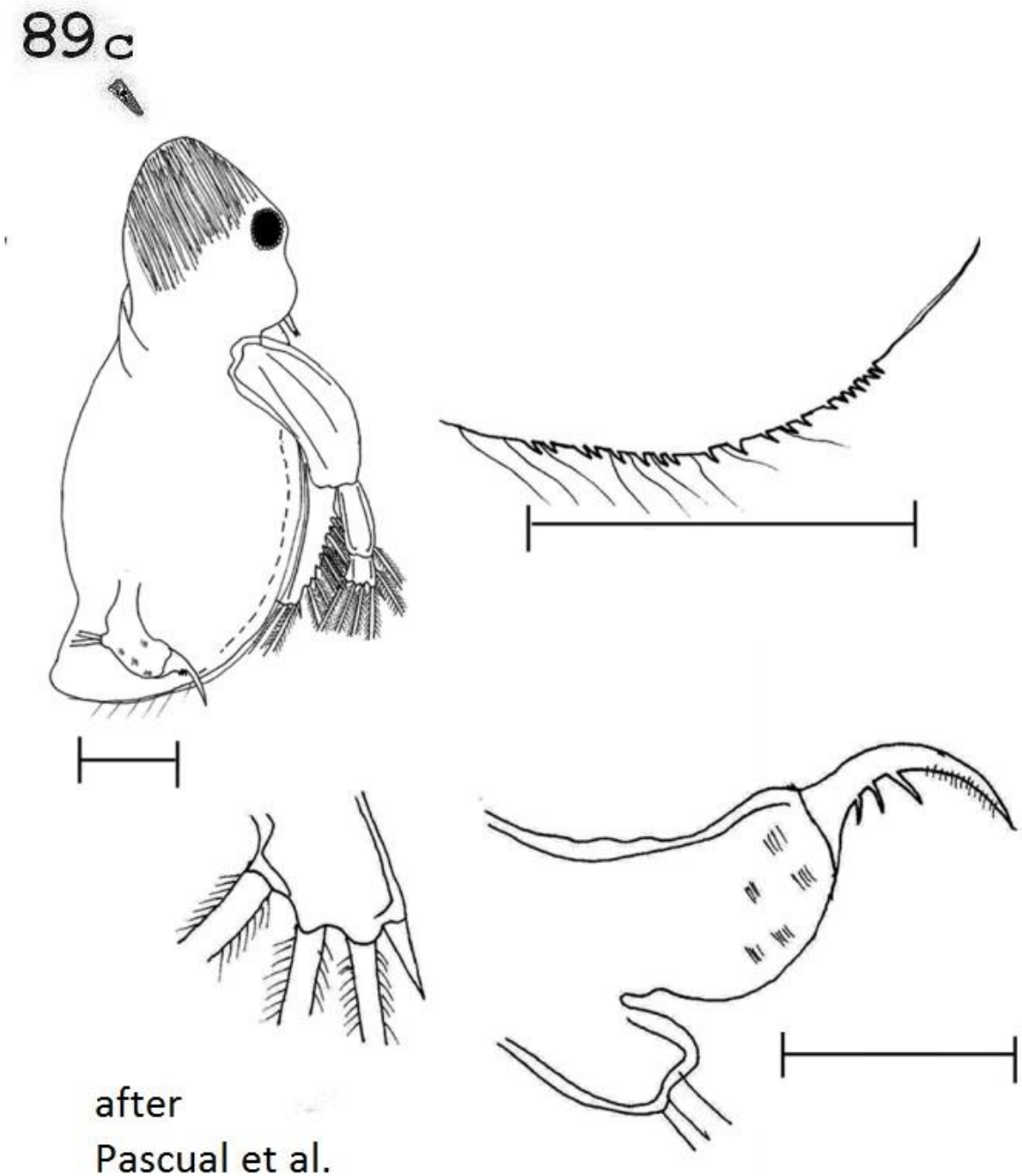

89a
V
FP07
Laguna de Bay May 28th 1980
FP07
FP80
ADULT
Laguna de Bay May 28th 1980
FP07

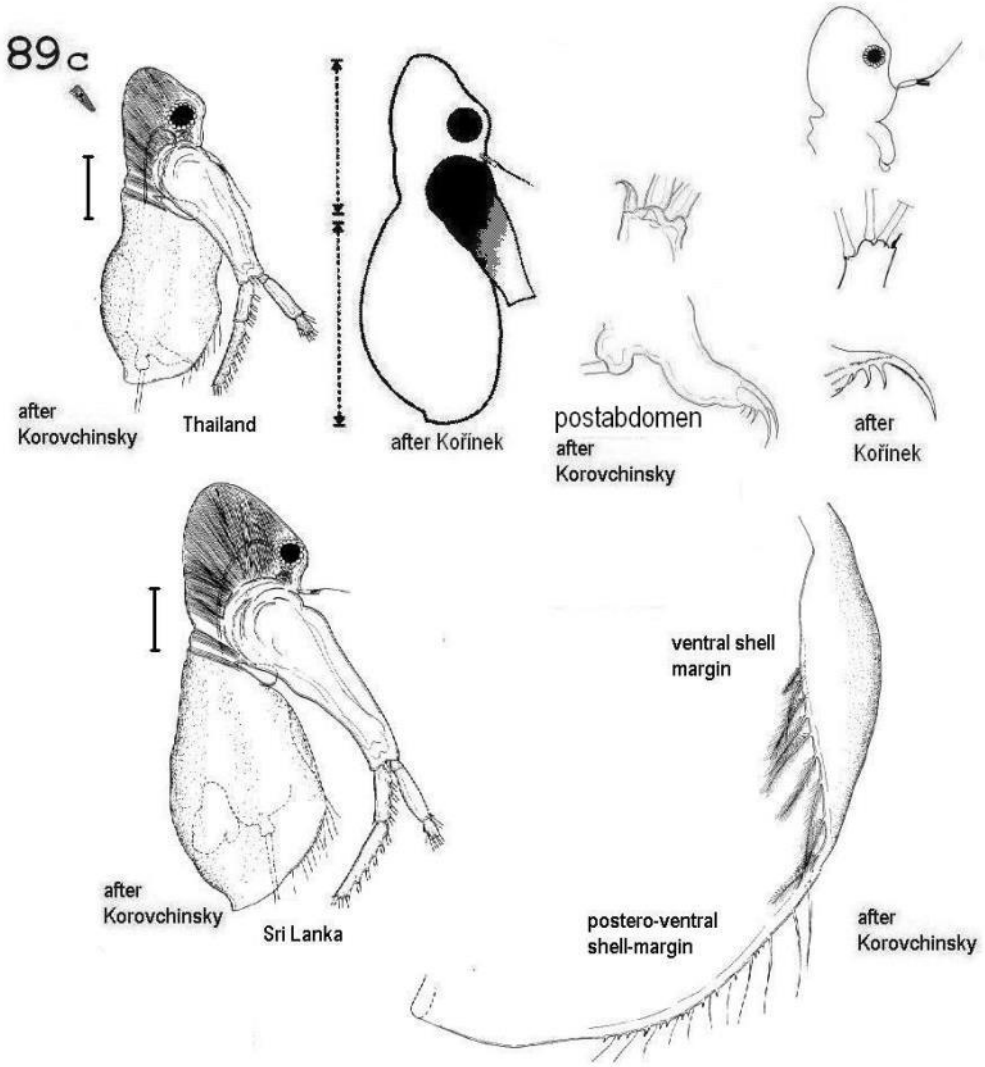
89b

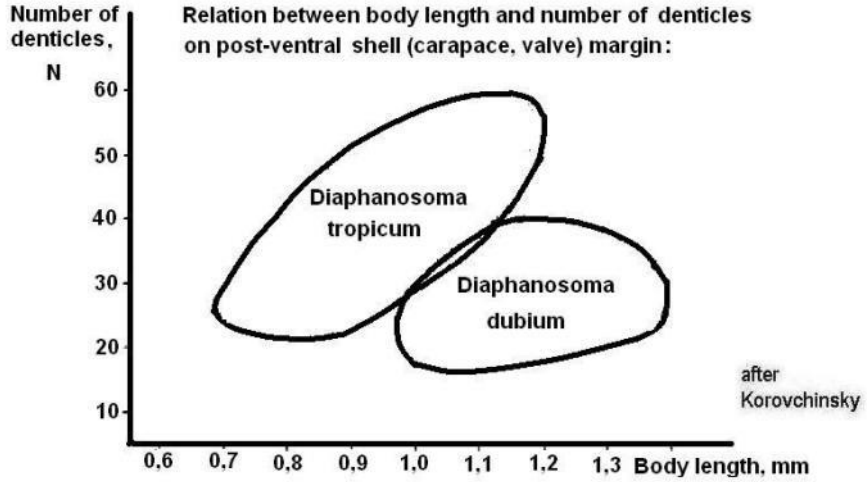


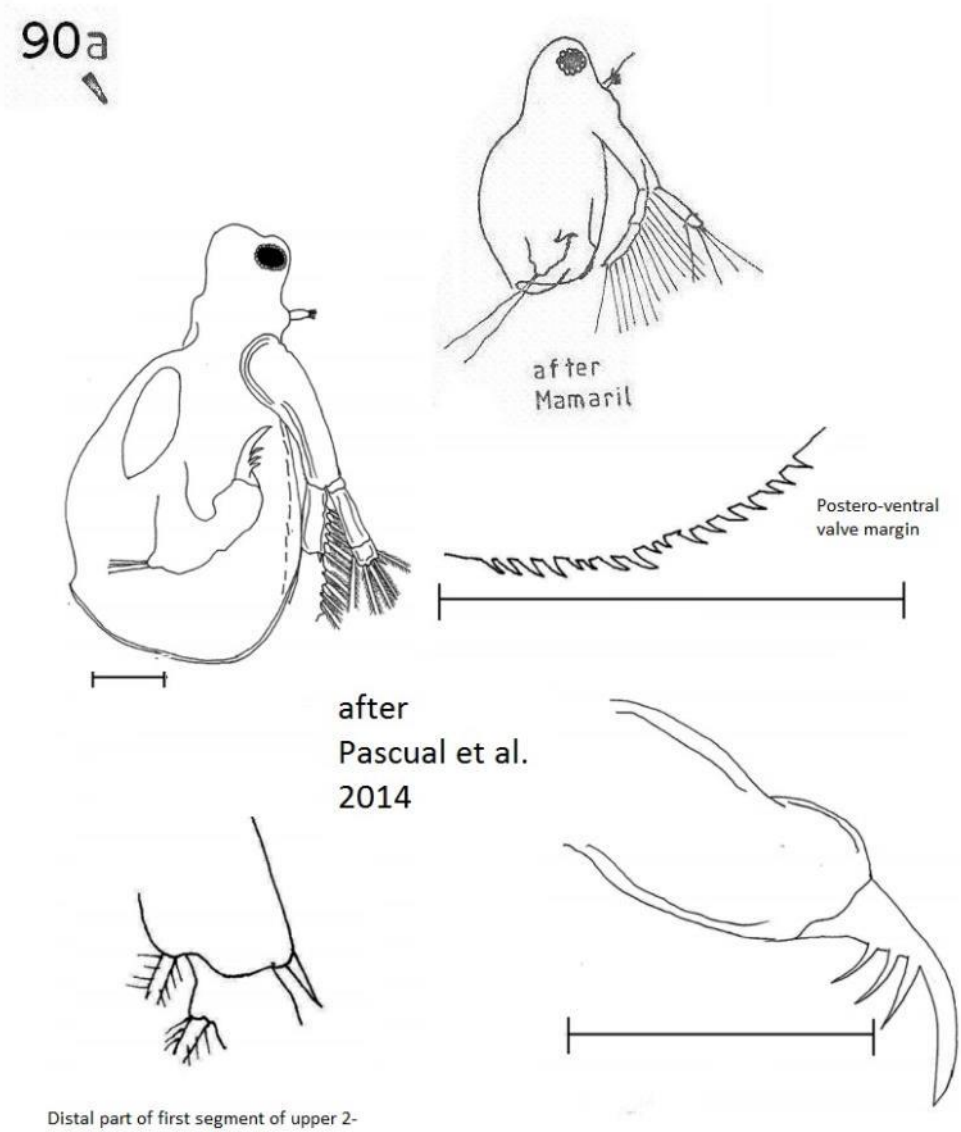

89b
100 µm
after
Korovchinsk
D. tropicum
postabdomen
after Kořinek
after
Korovchinsk


100 µm
after Kořinek
CLAW
after
Richard
after
Korovchinsky
D. modigliani
after Korovchinsky

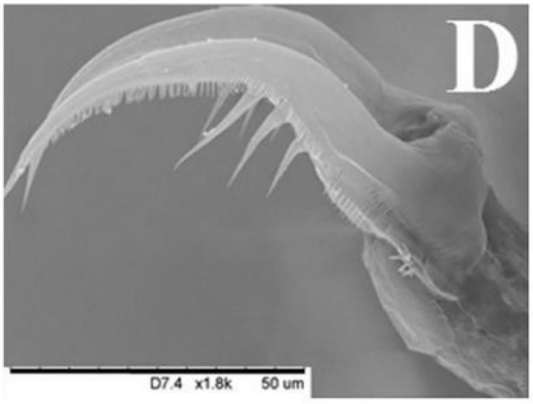

89c
after
Pascual et al.
2014


89c
after Korovchinsky
Thailand
after Kořinek
postabdomen
after Korovchinsky
after Kořinek
after Korovchinsky
Sri Lanka
ventral shell margin
postero-ventral shell-margin
after Korovchinsky

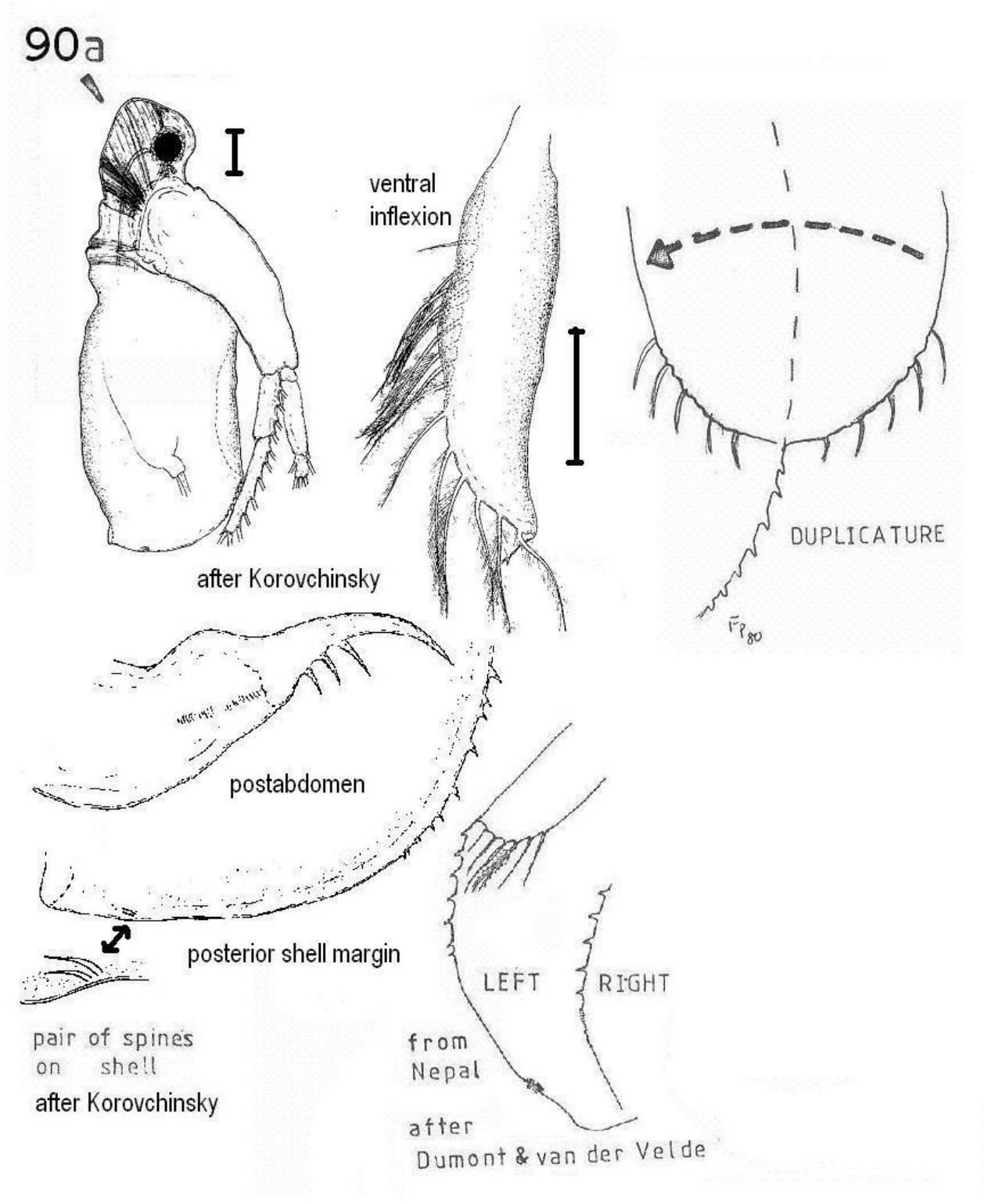

Number of denticles, N
Relation between body length and number of denticles on post-ventral shell (carapace, valve) margin:
60
50
40
30
20
10
Diaphanosoma tropicum
Diaphanosoma dubium
after Korovchinsky
0,6
0,7
0,8
0,9
1,0
1,1
1,2
1,3
Body length, mm

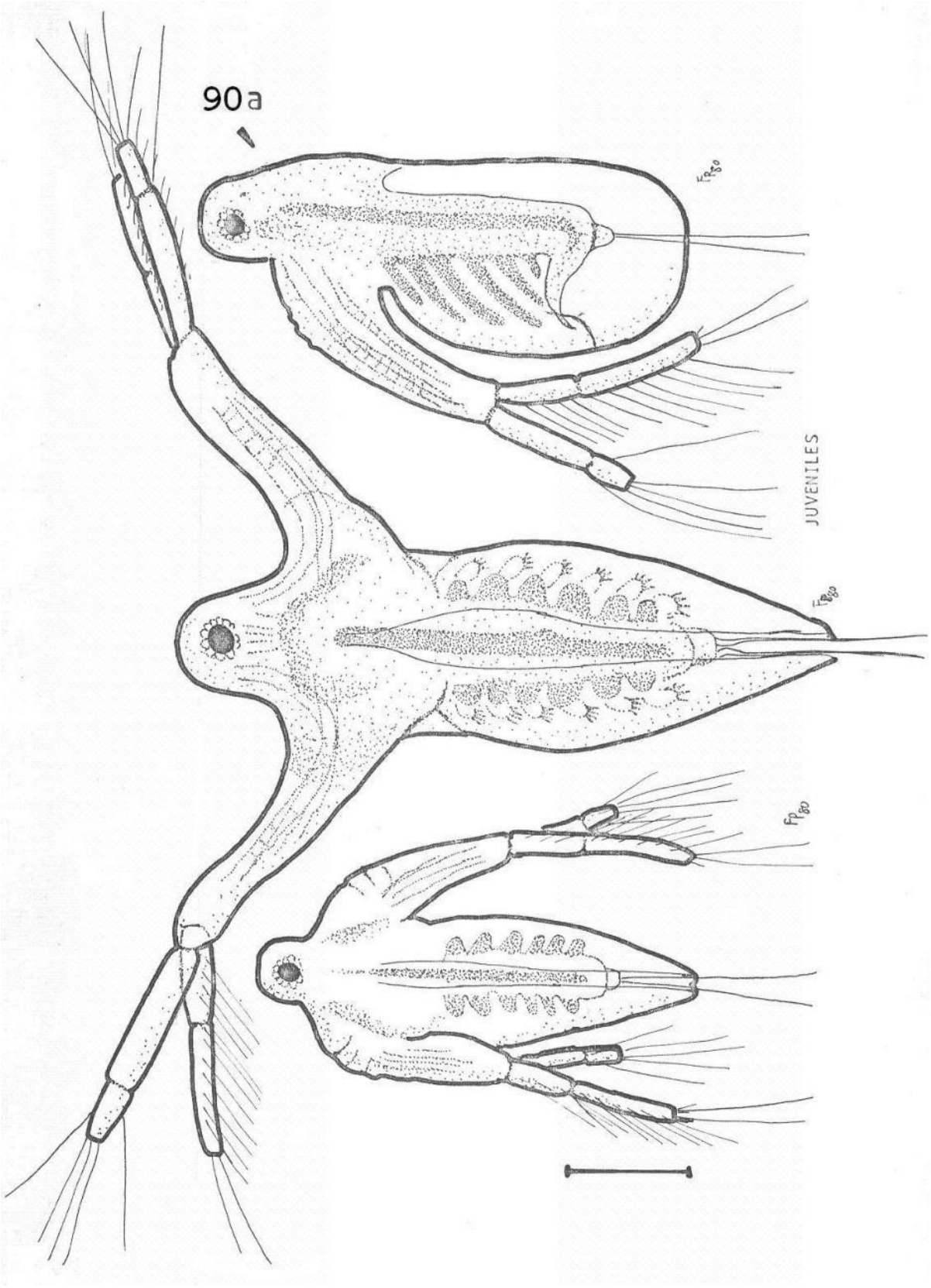


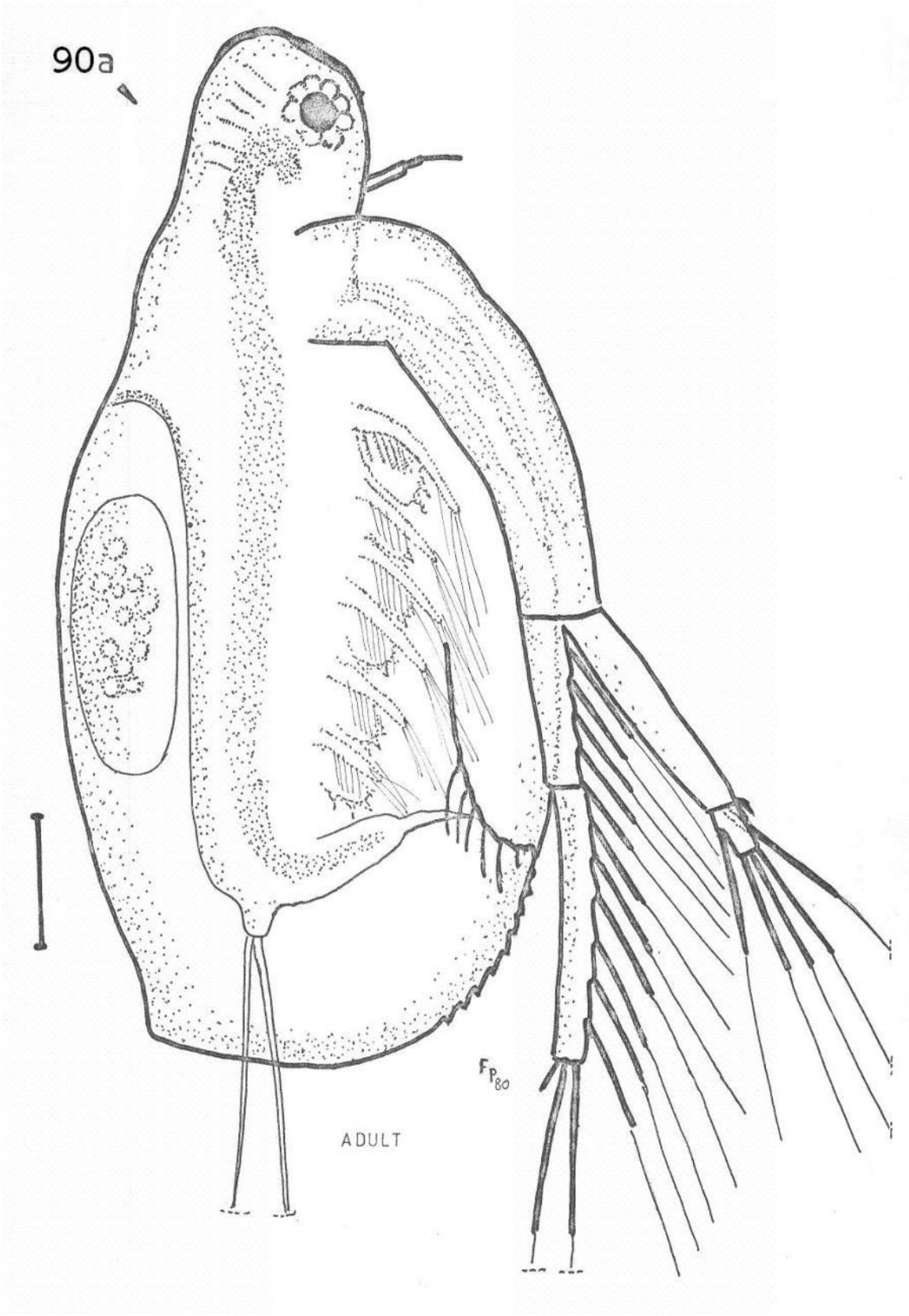
Distal part of first segment of upper 2-segmented antennal branch

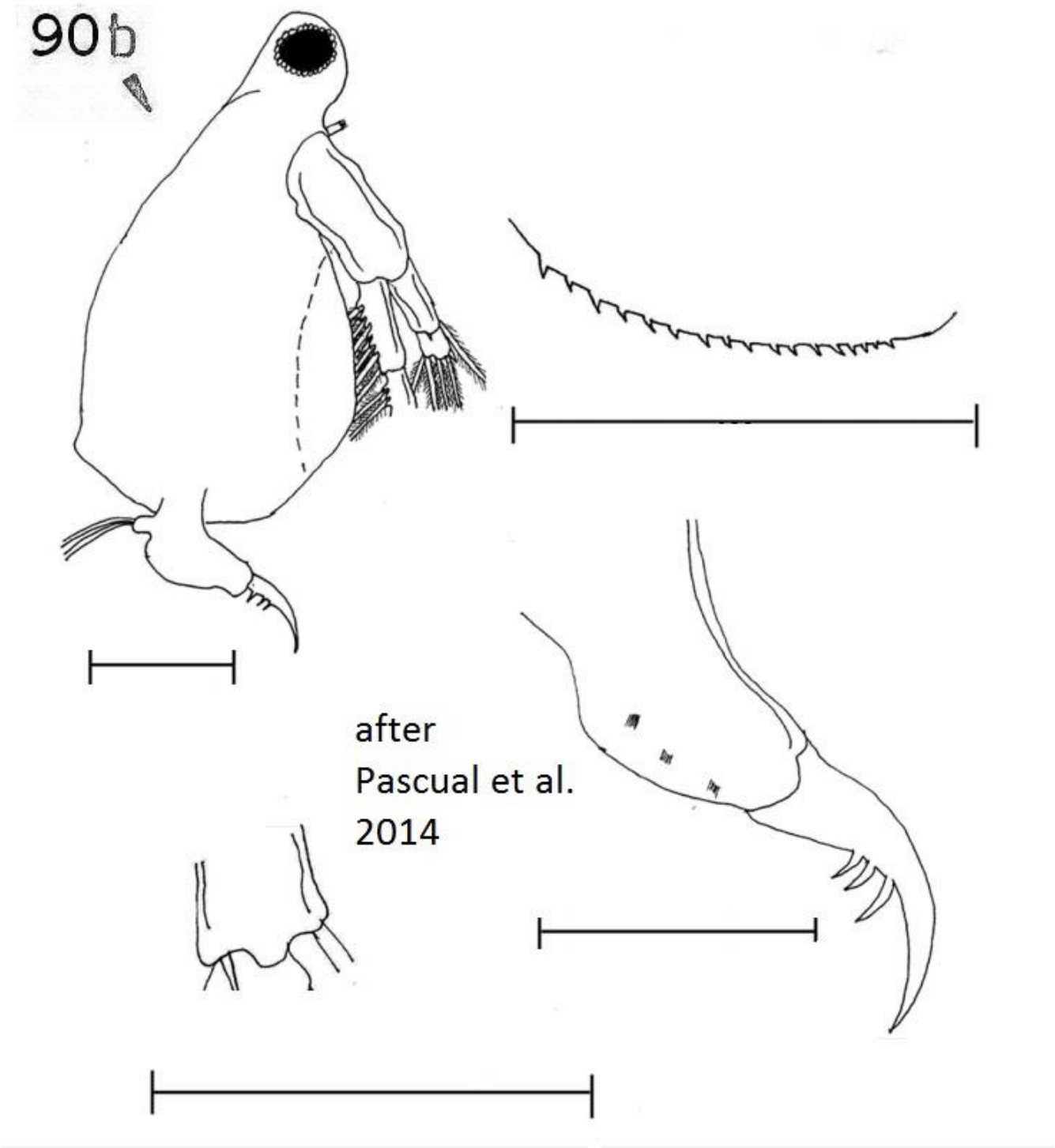


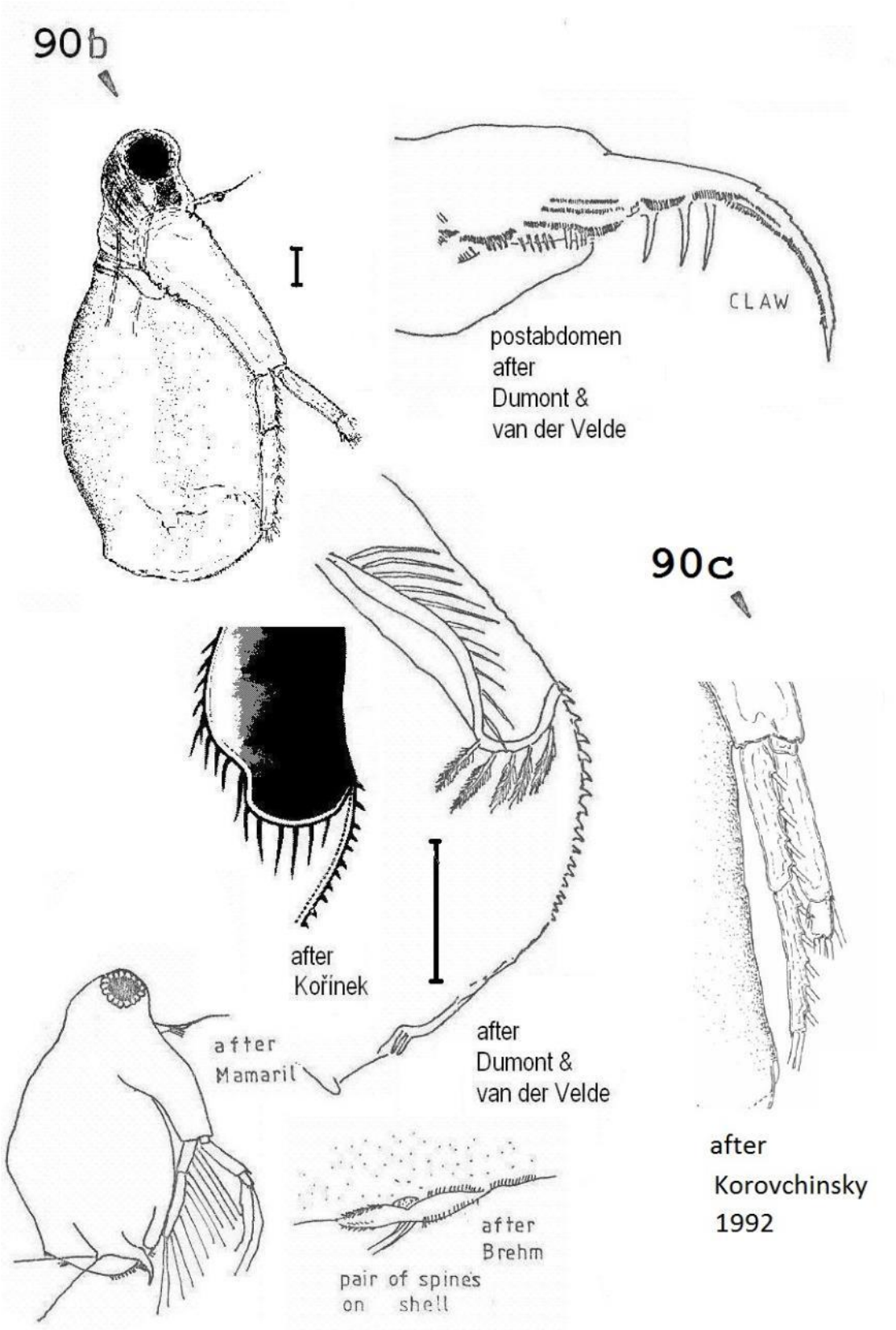
Terminal claw of postabdomen

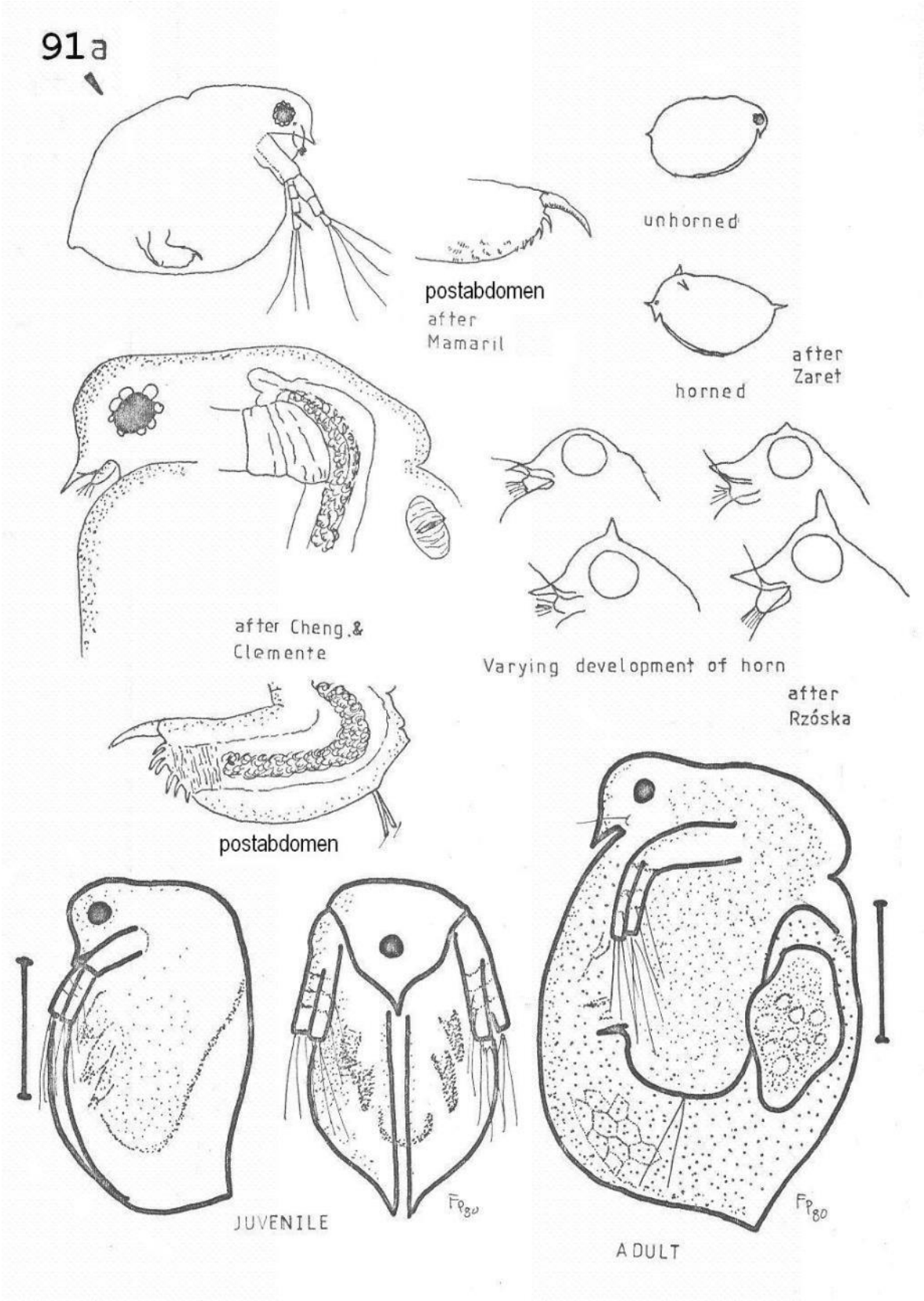

90a
ventral
inflexion
DUPLICATURE
after Korovchinsky
postabdomen
posterior shell margin
pair of spines
on shell
after Korovchinsky
LEFT
RIGHT
from
Nepal
after
Dumont & van der Velde

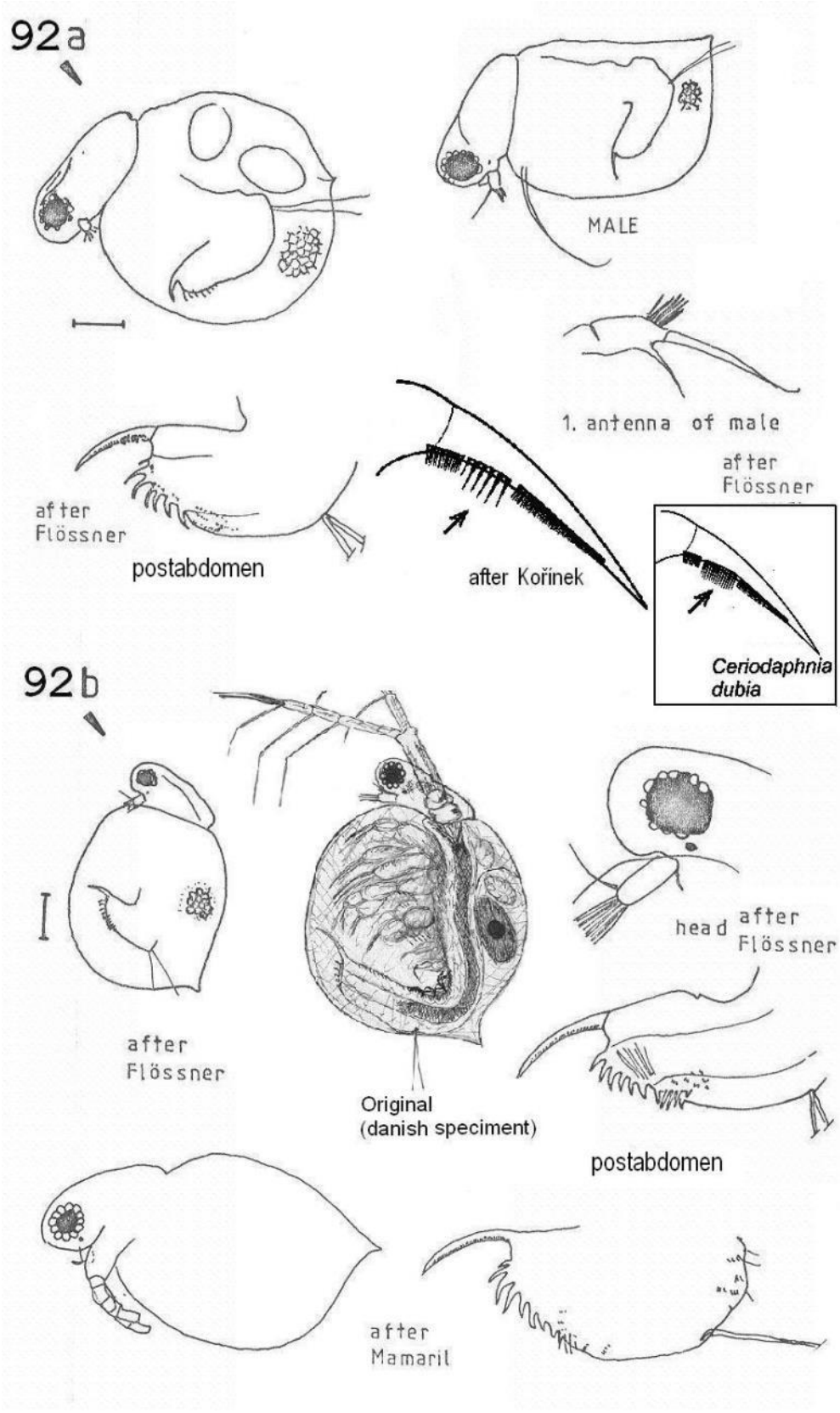

90a
JUVENILES

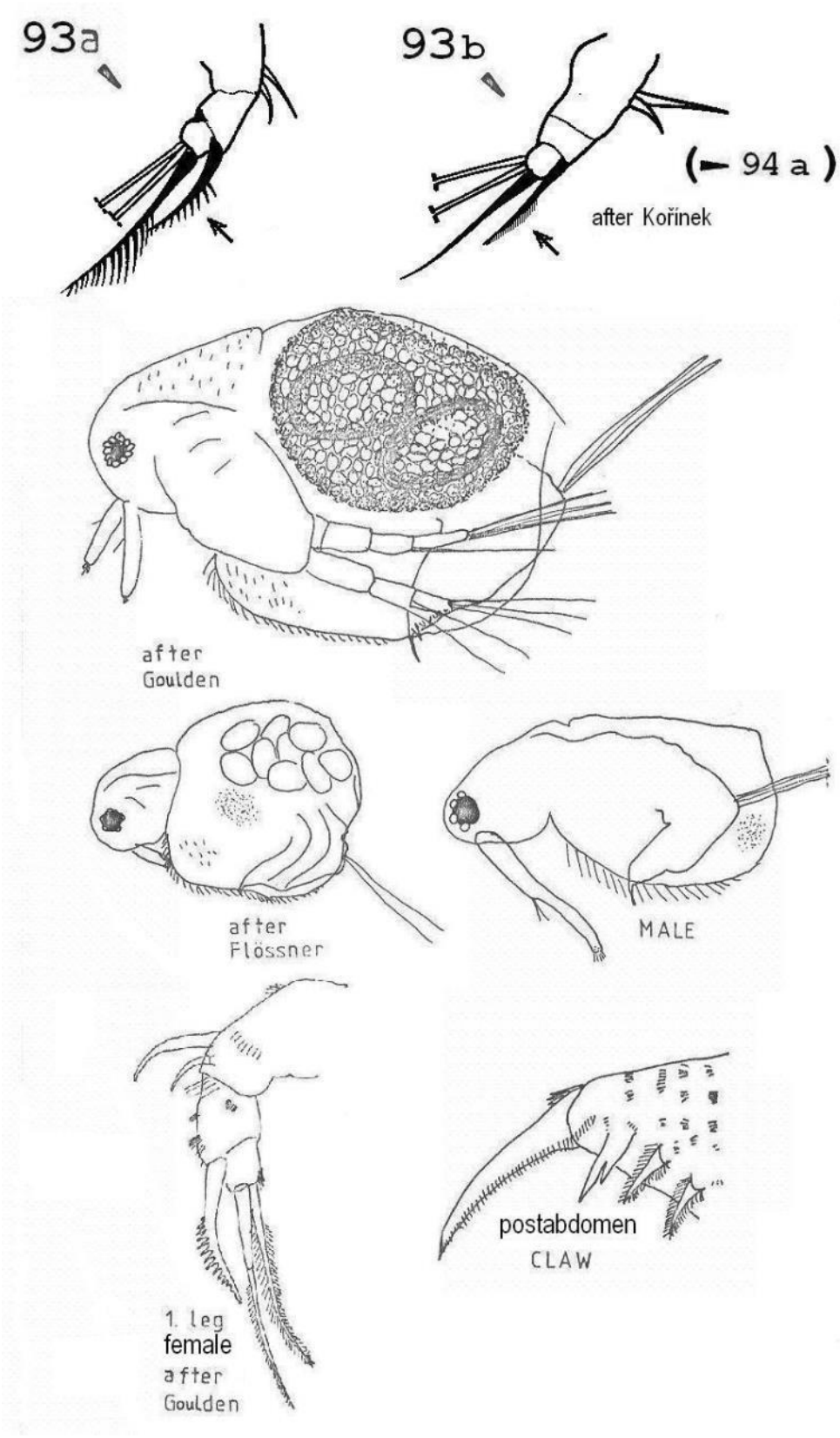

90a
FP80
ADULT

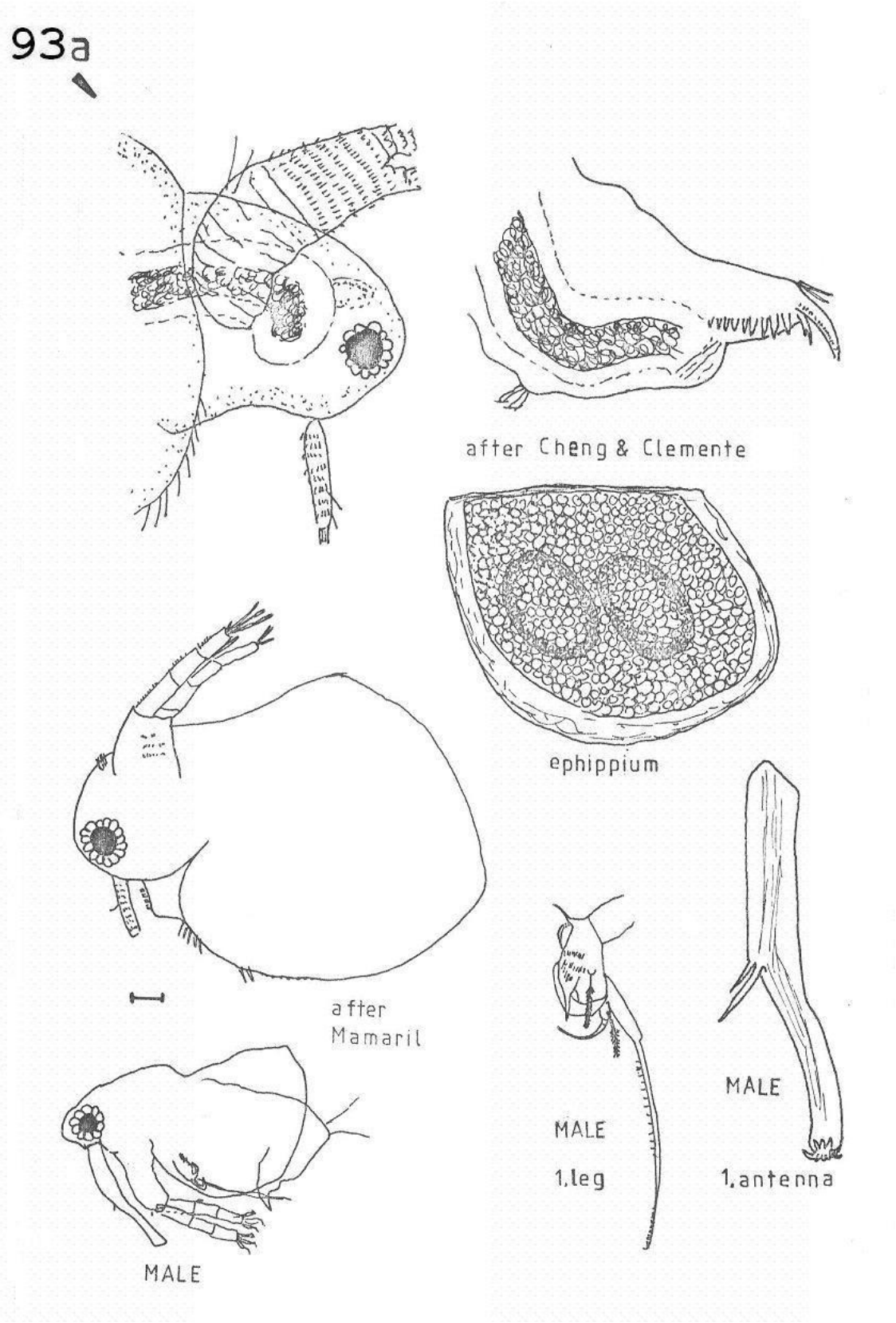

90 b
after
Pascual et al.
2014


90b
I
CLAW
postabdomen
after
Dumont &
van der Velde
90c
after
Kořínek
after
Dumont &
van der Velde
after
Mamaril
after
Korovchinsky
1992
after
Brehm
pair of spines
on shell

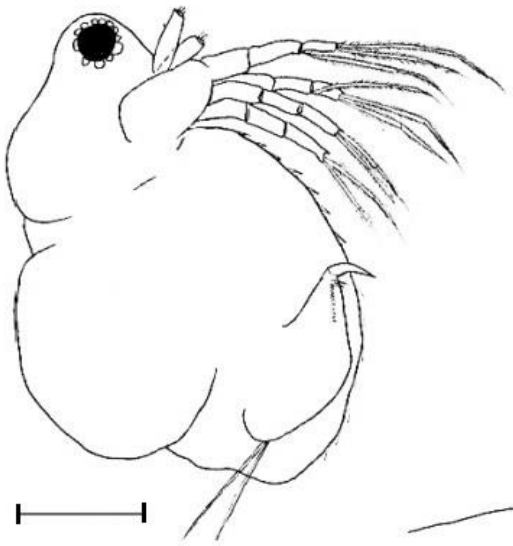

91a
postabdomen
after
Mamaril
unhorned
horned
after
Zaret
after Cheng.&
Clemente
Varying development of horn
after
Rzóska
postabdomen
JUVENILE
ADULT

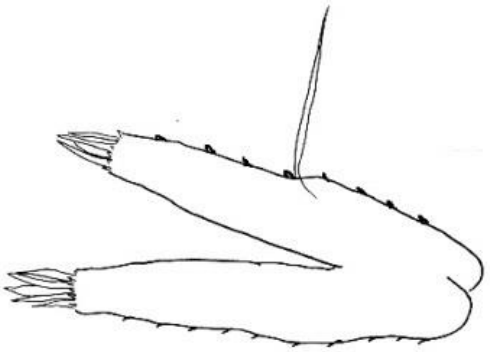

92a
MALE
1. antenna of male
after Flössner
after Flössner
postabdomen
after Kořinek
Ceriodaphnia dubia
92b
after Flössner
Original (danish speciment)
head after Flössner
postabdomen
after Mamaril


93a
93b
(– 94 a)
after Kořínek
after
Goulden
after
Flössner
MALE
postabdomen
CLAW
1. leg
female
after
Goulden

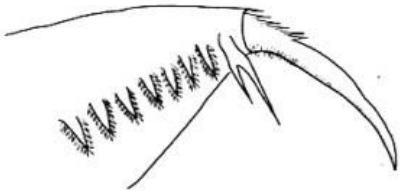

93a
after Cheng & Clemente
ephippium
after
Mamaril
MALE
MALE
1. leg
MALE
1. antenna

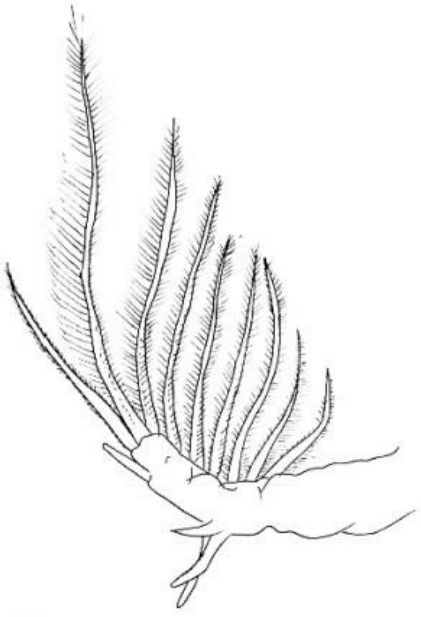
94a





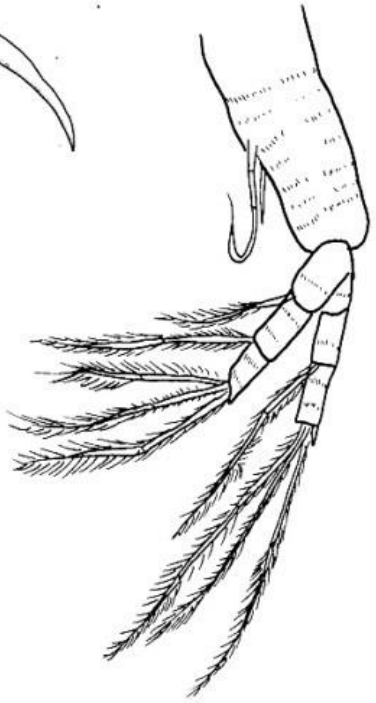
1. antenna with exepodit



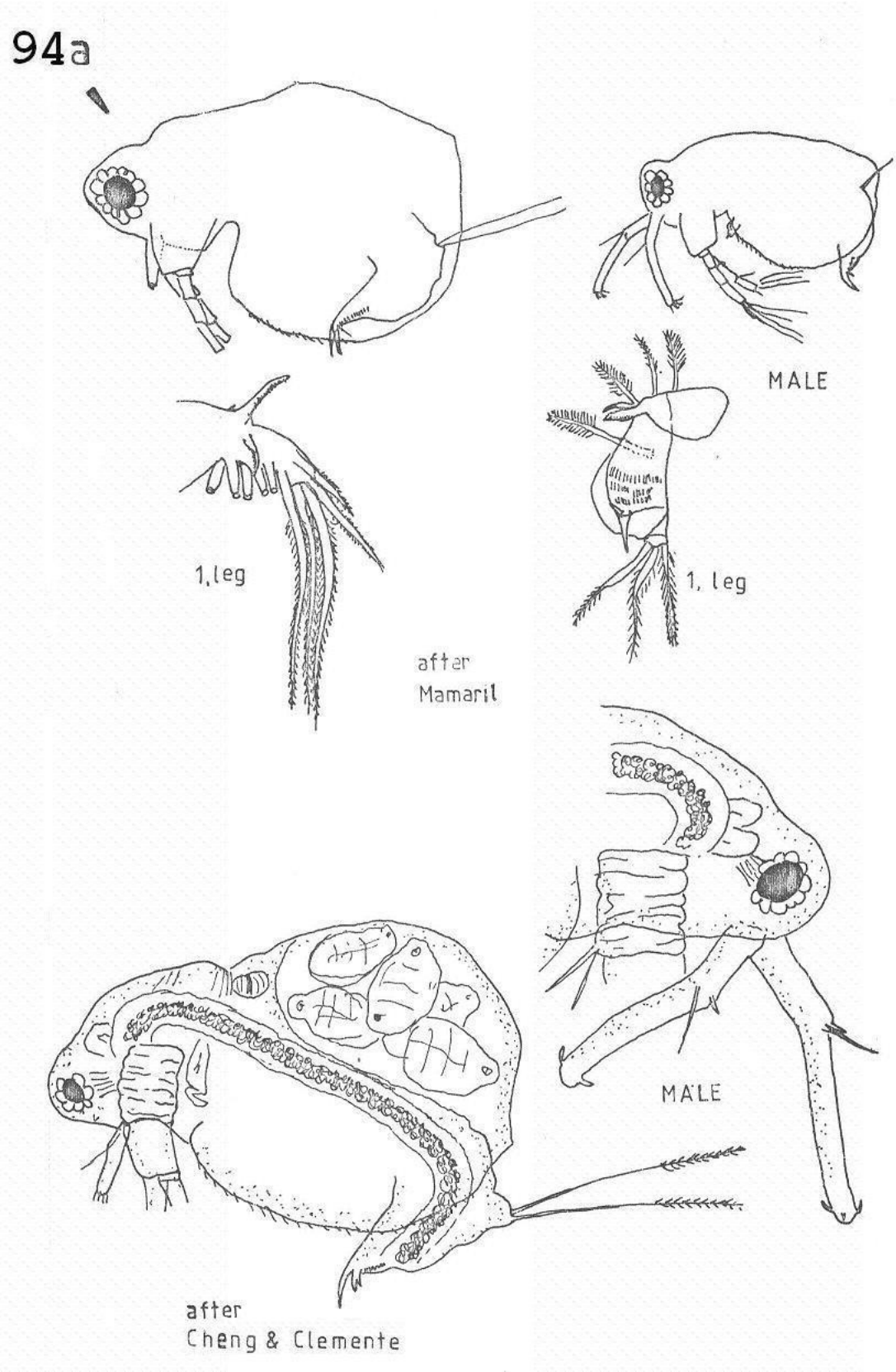


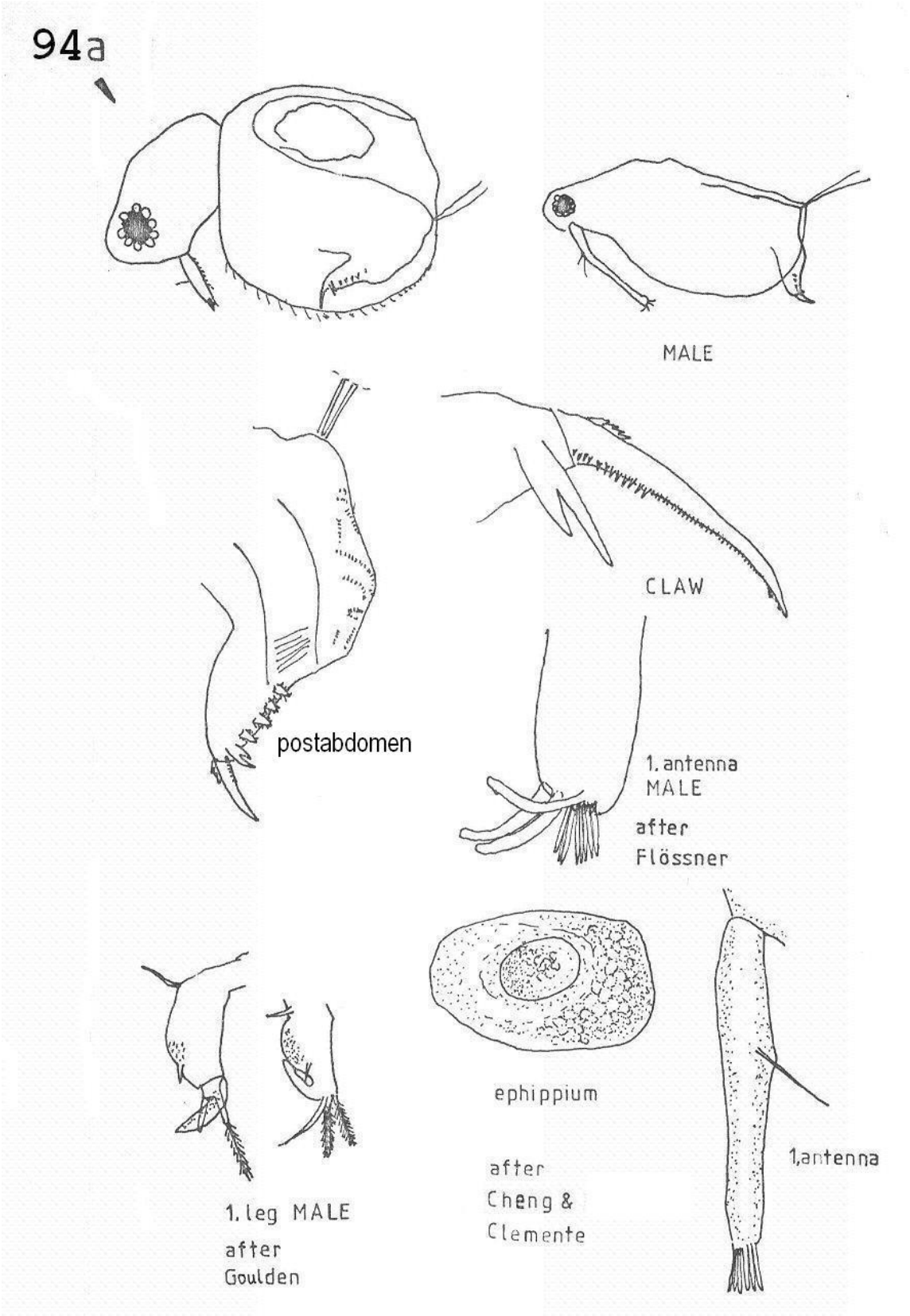
1. leg

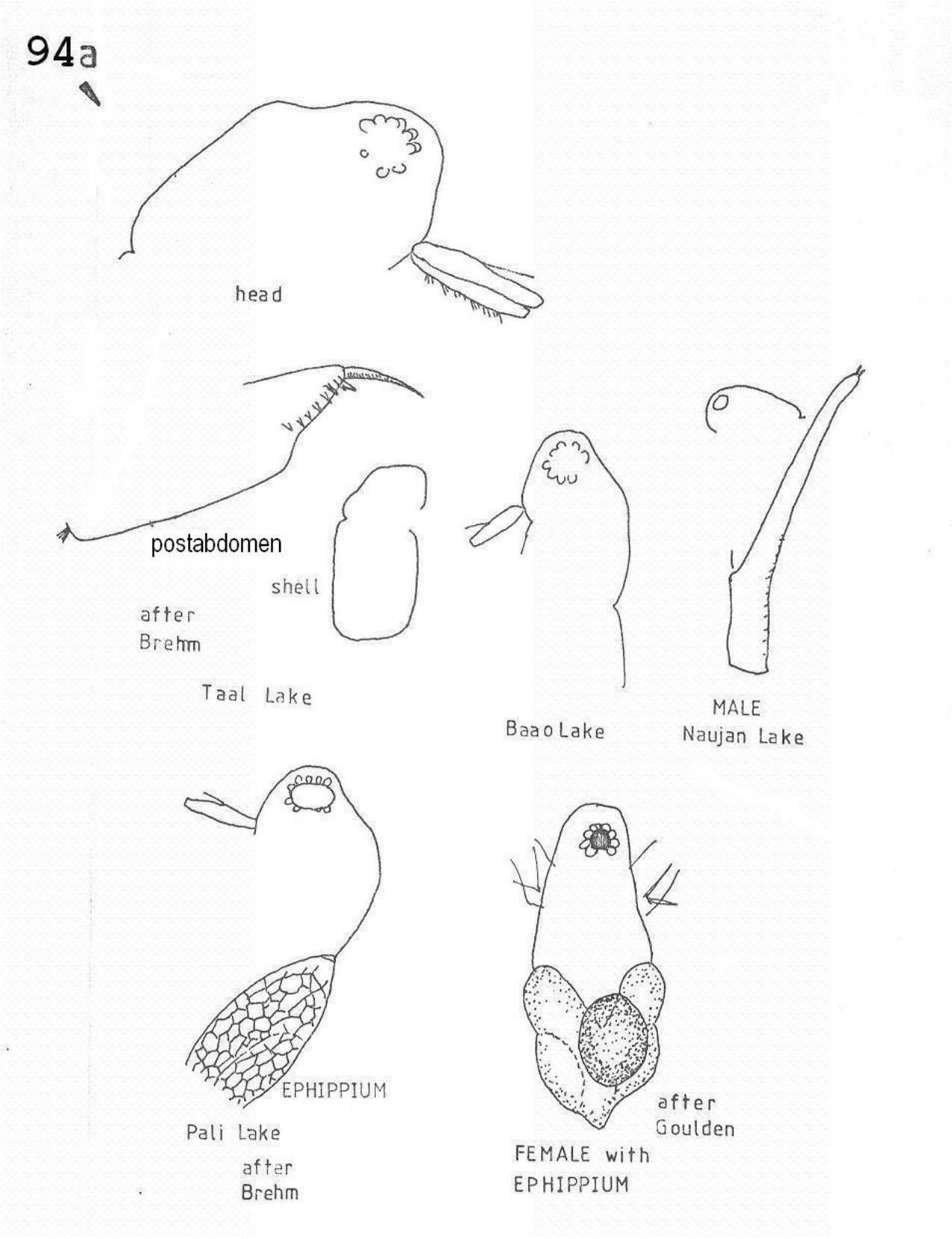
after
Pascual et al.
2014



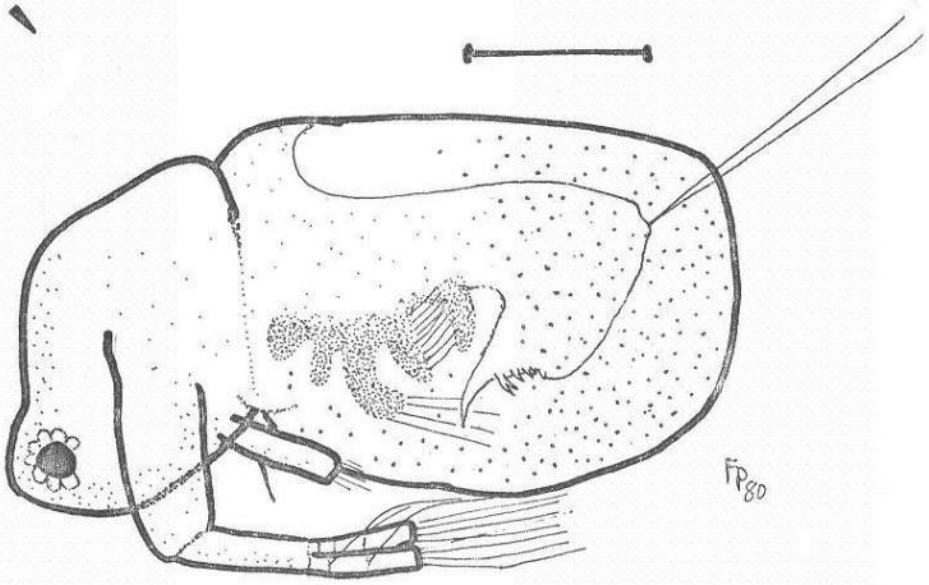
2. antenna


94a
MALE
1. leg
1. leg
after
Mamaril
MALE
after
Cheng & Clemente

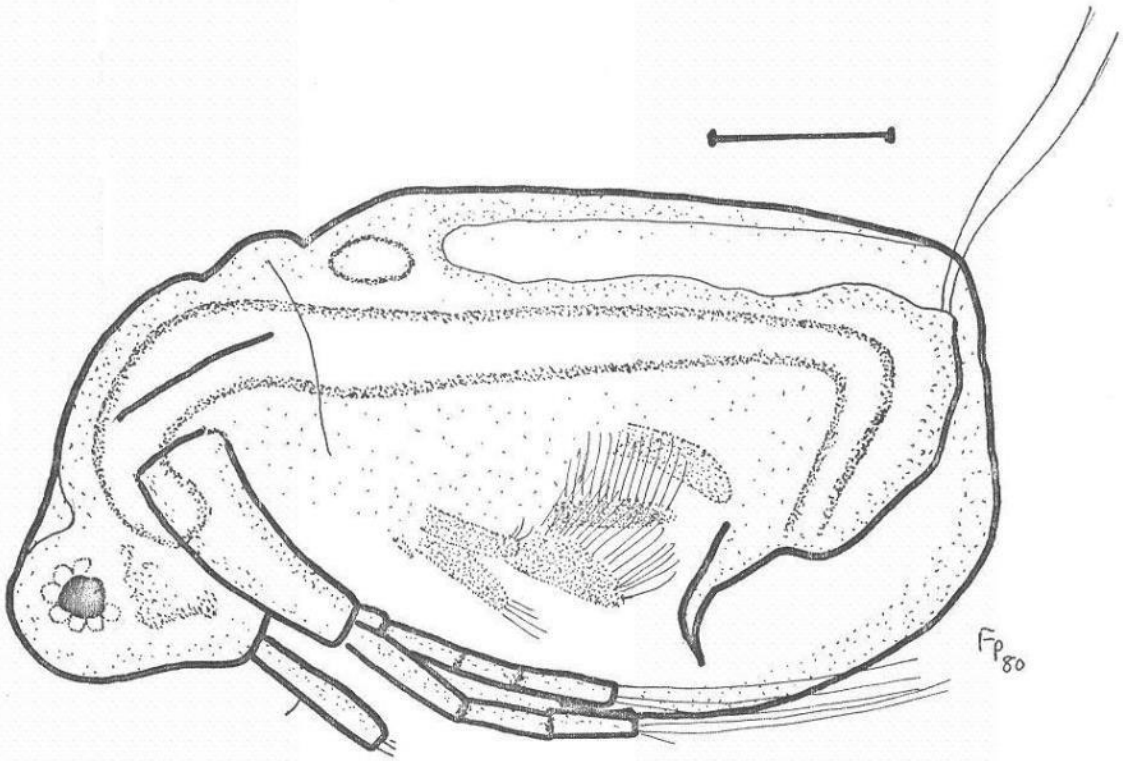

94a
MALE
CLAW
postabdomen
1. antenna
MALE
after
Flössner
ephippium
after
Cheng &
Clemente
1,antenna
1. leg MALE
after
Goulden


94a
head
postabdomen
shell
after
Brehm
Taal Lake
Baao Lake
MALE
Naujan Lake
EPHIPPIUM
Pali Lake
after
Brehm
after
Goulden
FEMALE with
EPHIPPIUM

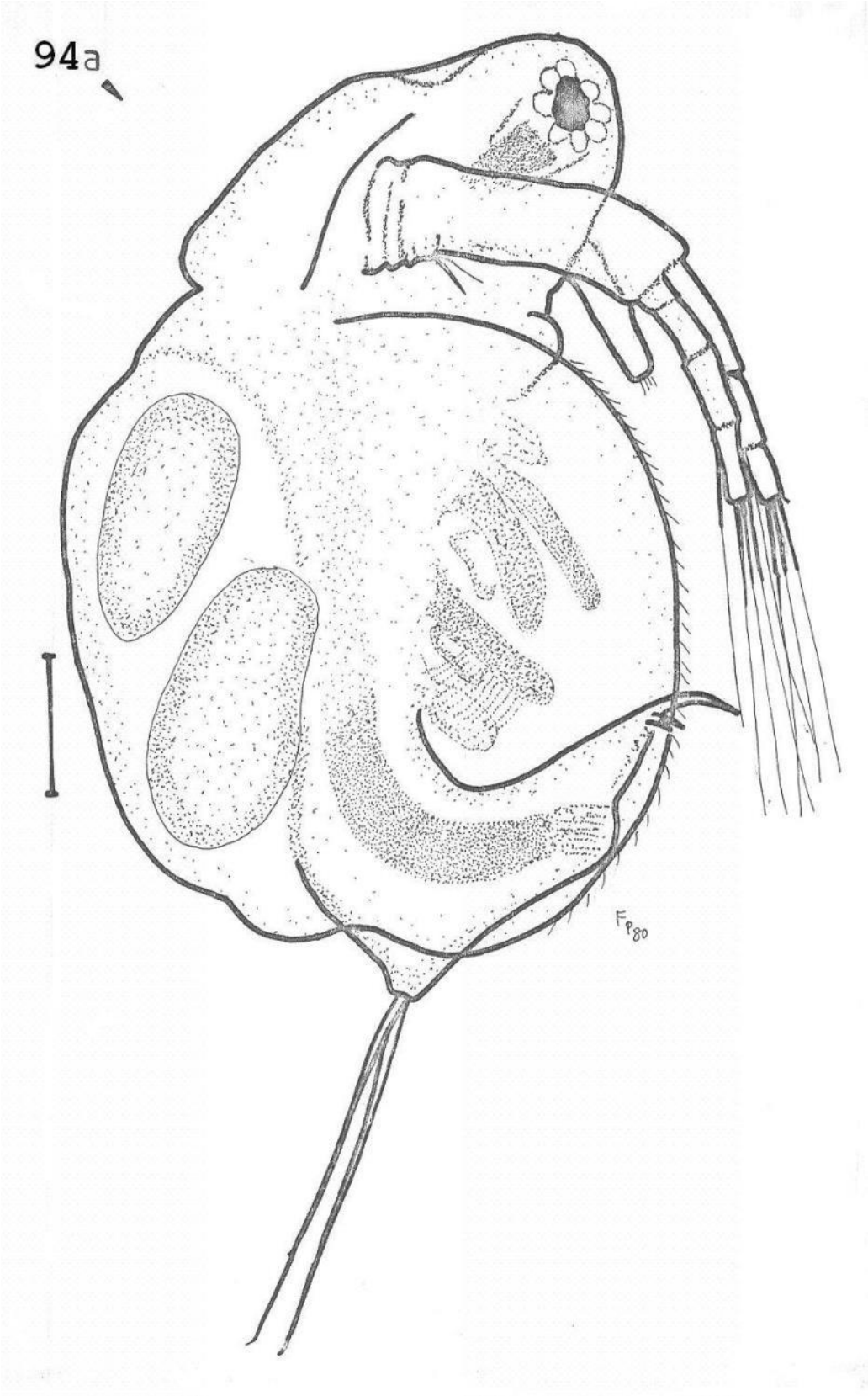
94a

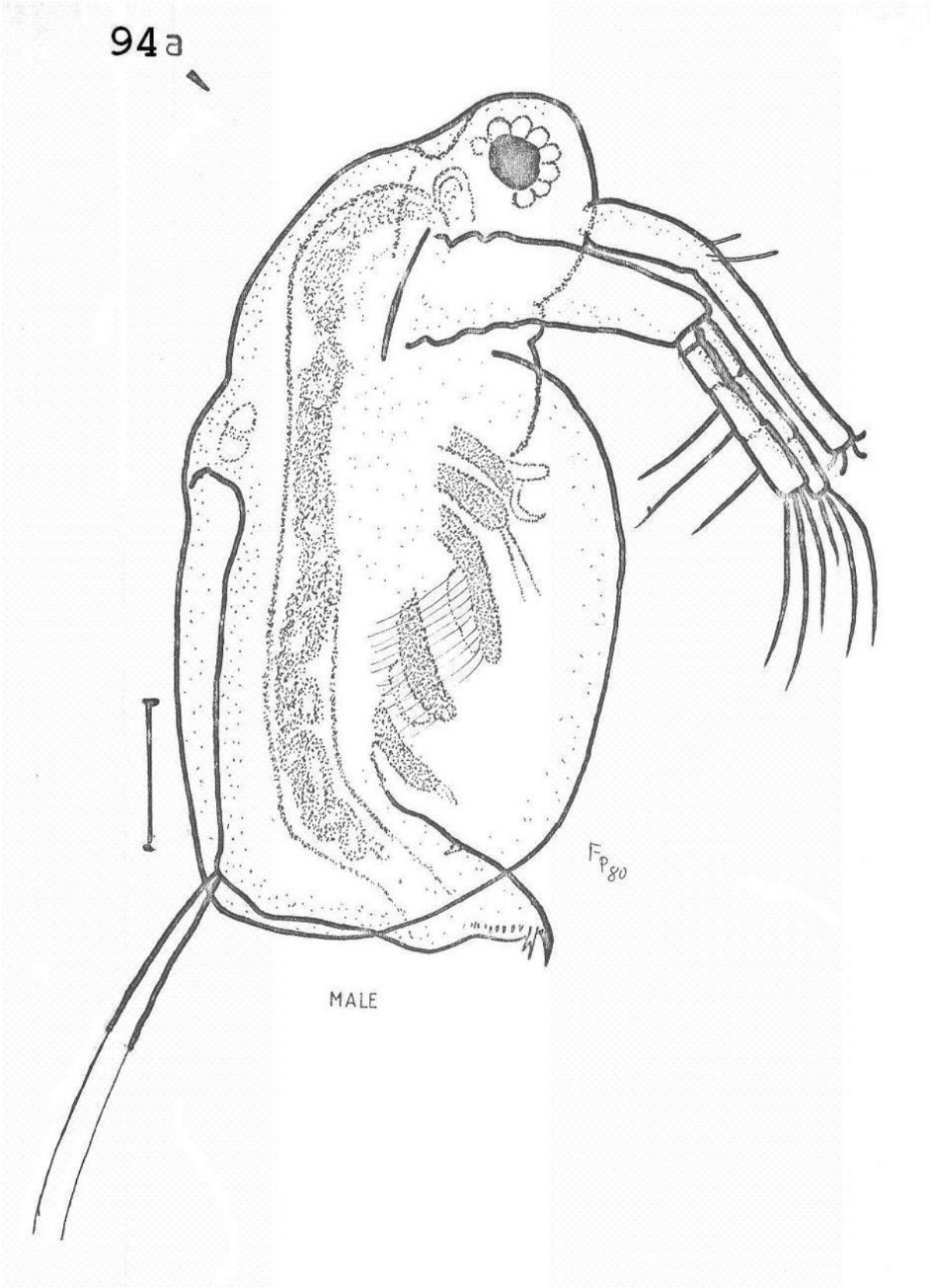


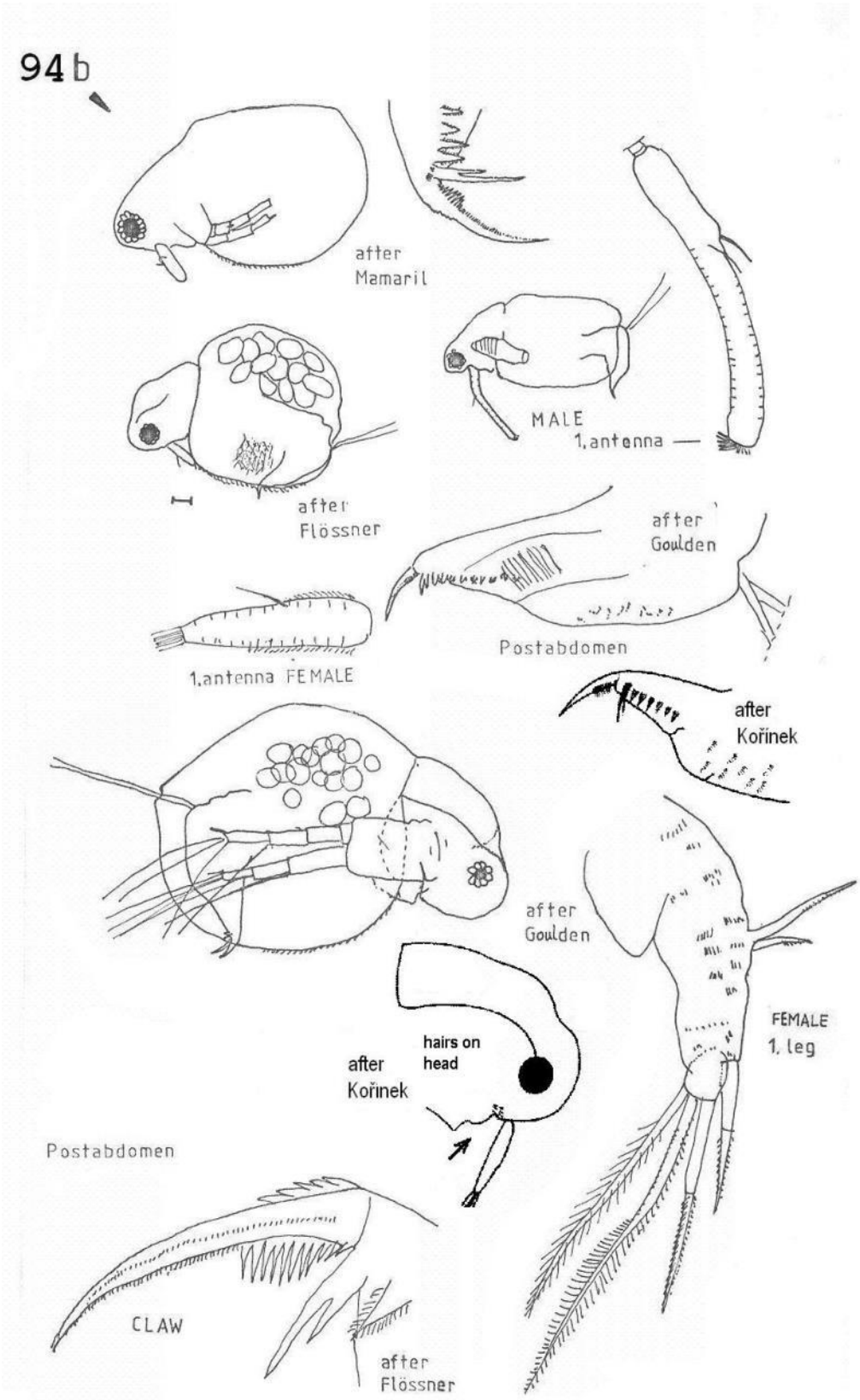
1, JUVENILE INSTAR

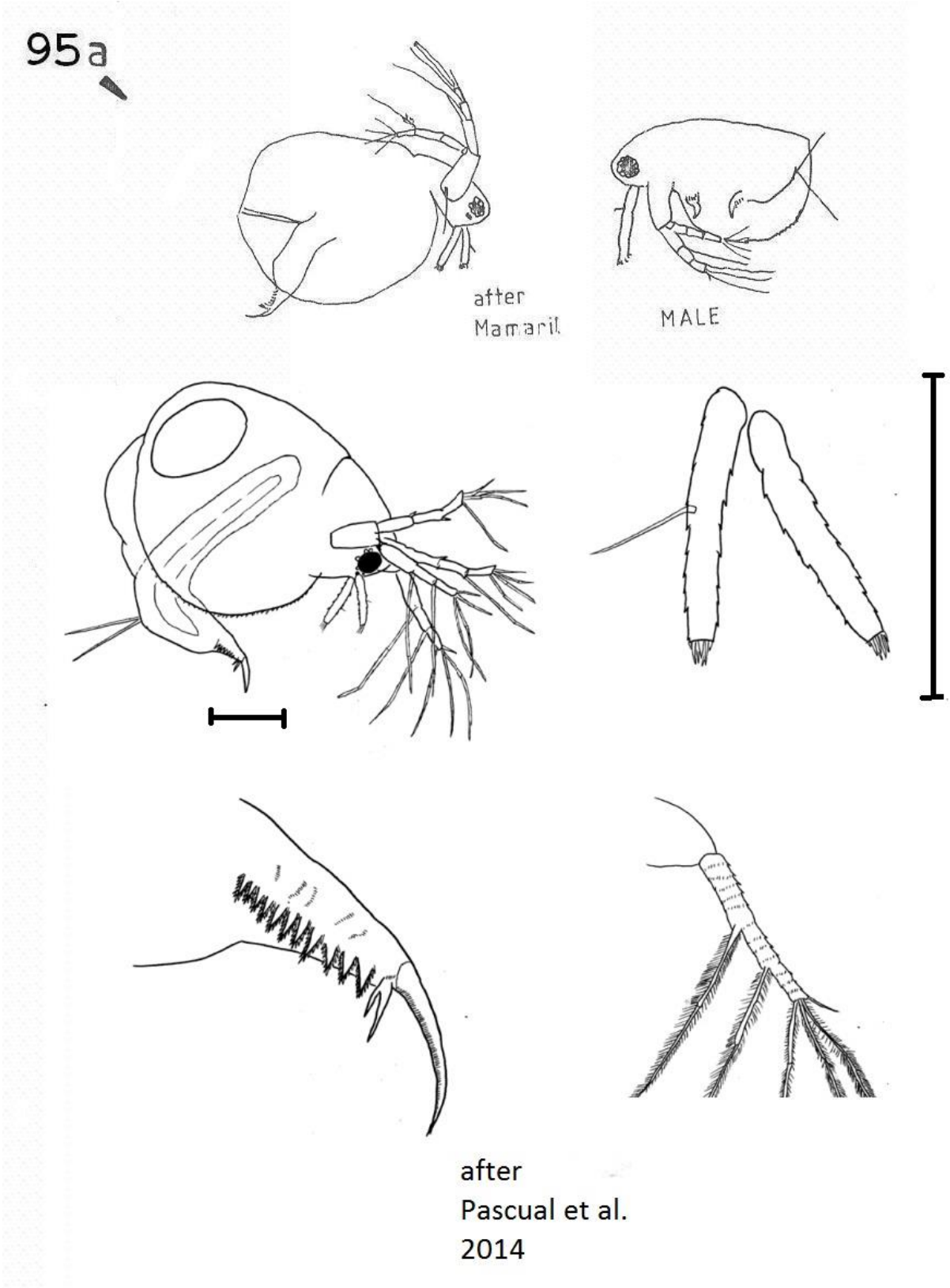


2, JUVENILE INSTAR

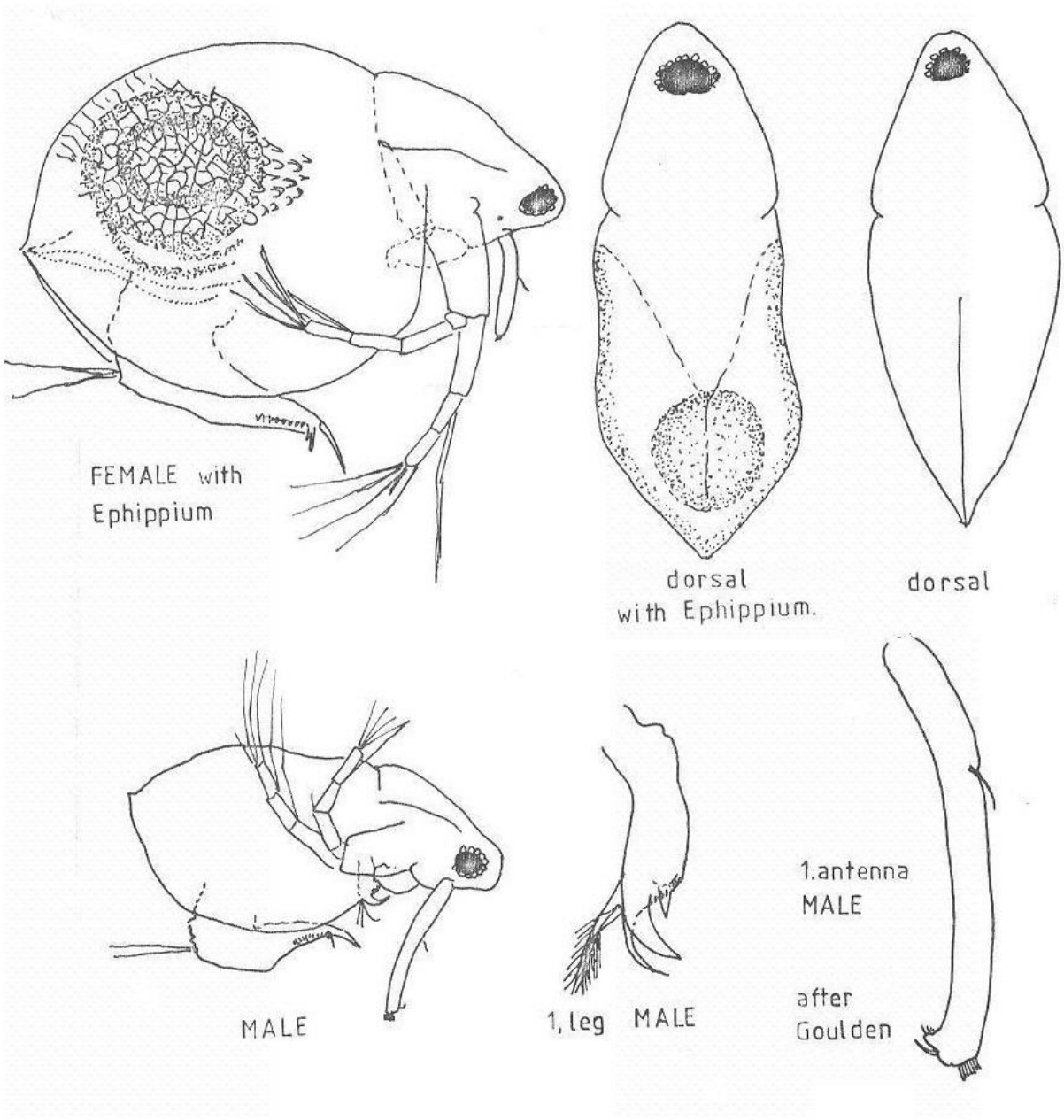

94a
F P 80

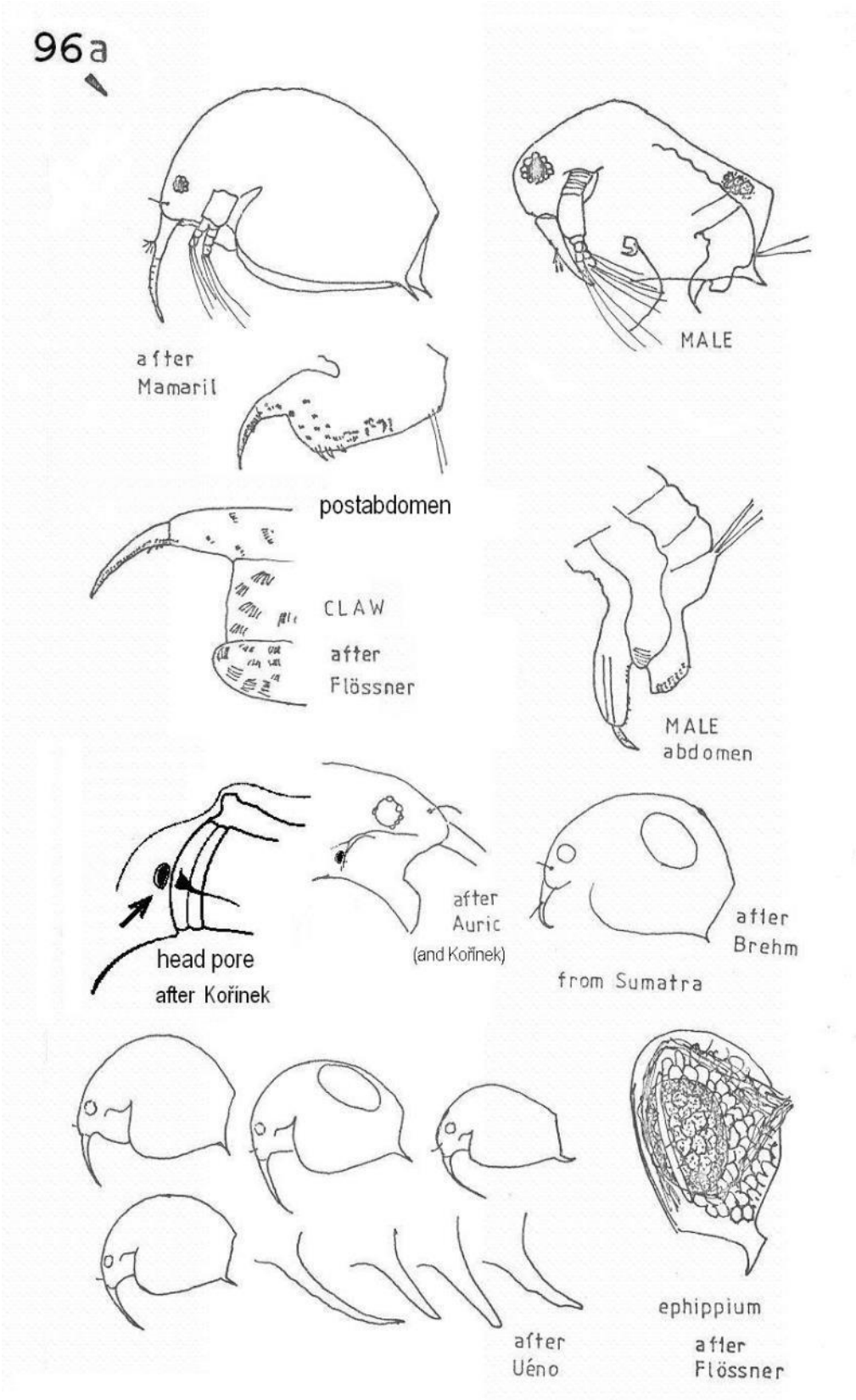

94 a
FP 80
MALE

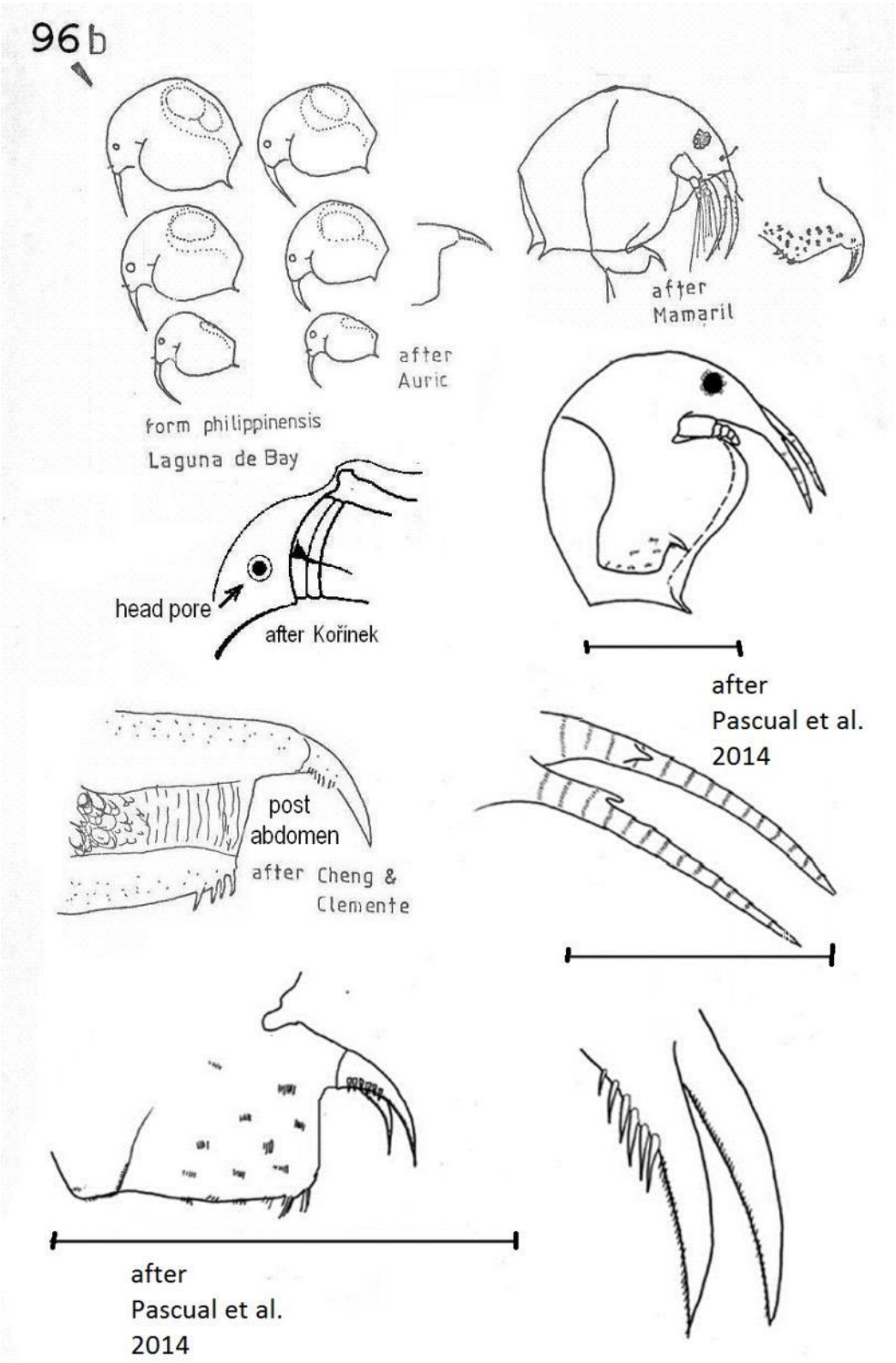

94 b
after
Mamaril
MALE
1. antenna
after
Flössner
after
Goulden
Postabdomen
1. antenna FEMALE
after
Kořinek
after
Goulden
FEMALE
1. leg
hairs on
head
after
Kořinek
Postabdomen
CLAW
after
Flössner

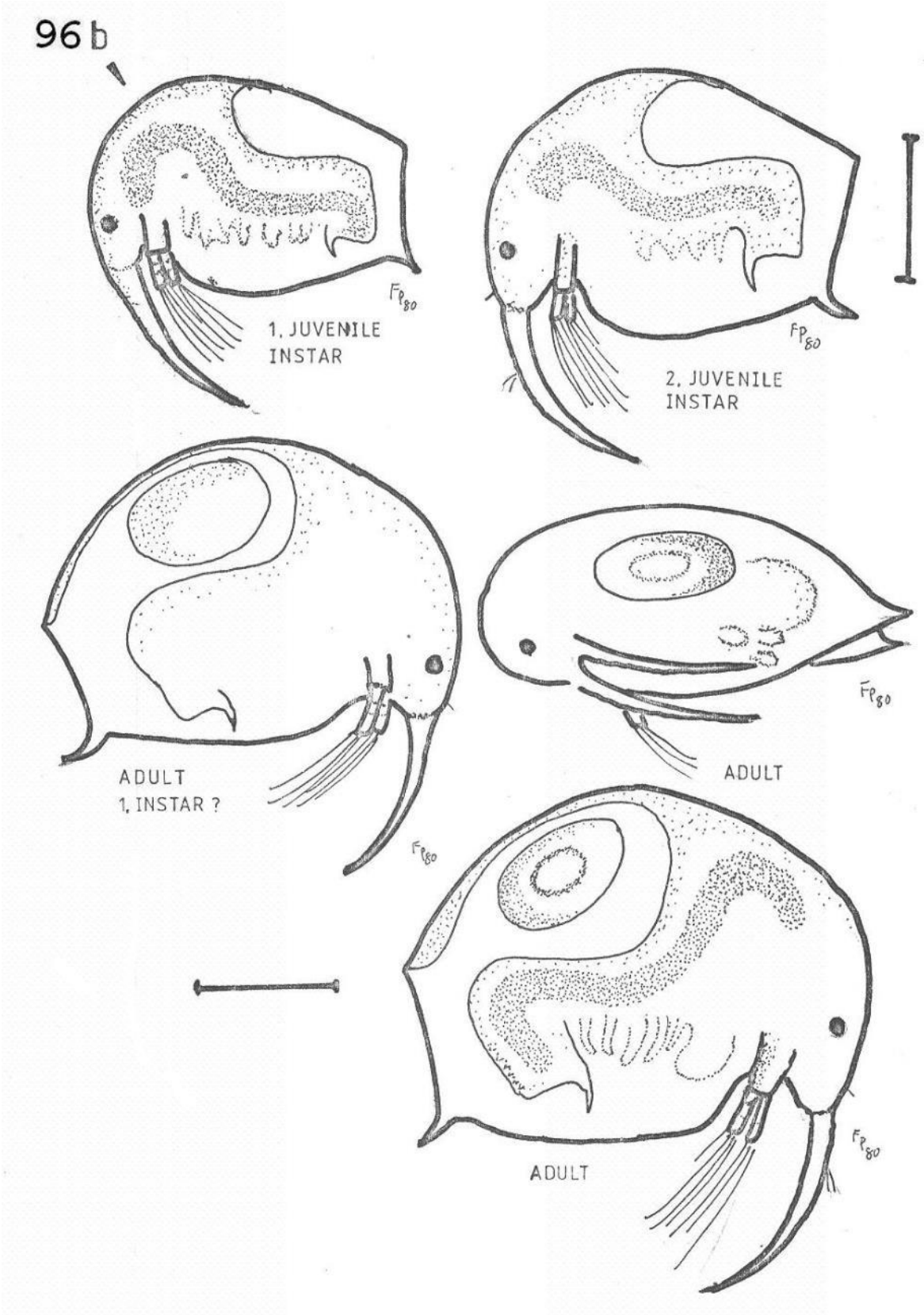

95a
after
Mamaril
MALE
after
Pascual et al.
2014

95a

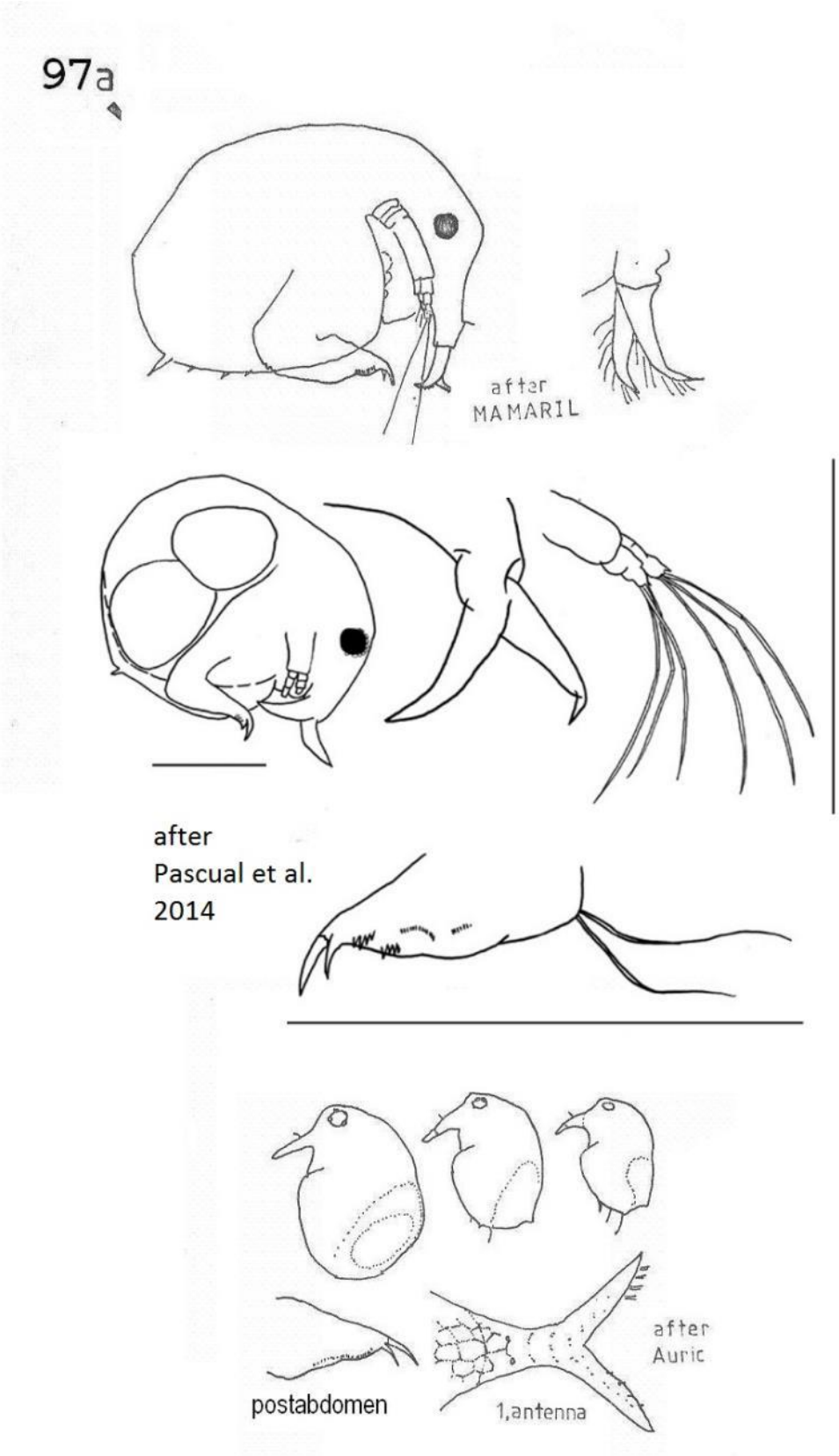

FEMALE with
Ephippium
dorsal
with Ephippium.
dorsal
MALE
1, leg MALE
1.antenna
MALE
after
Goulden

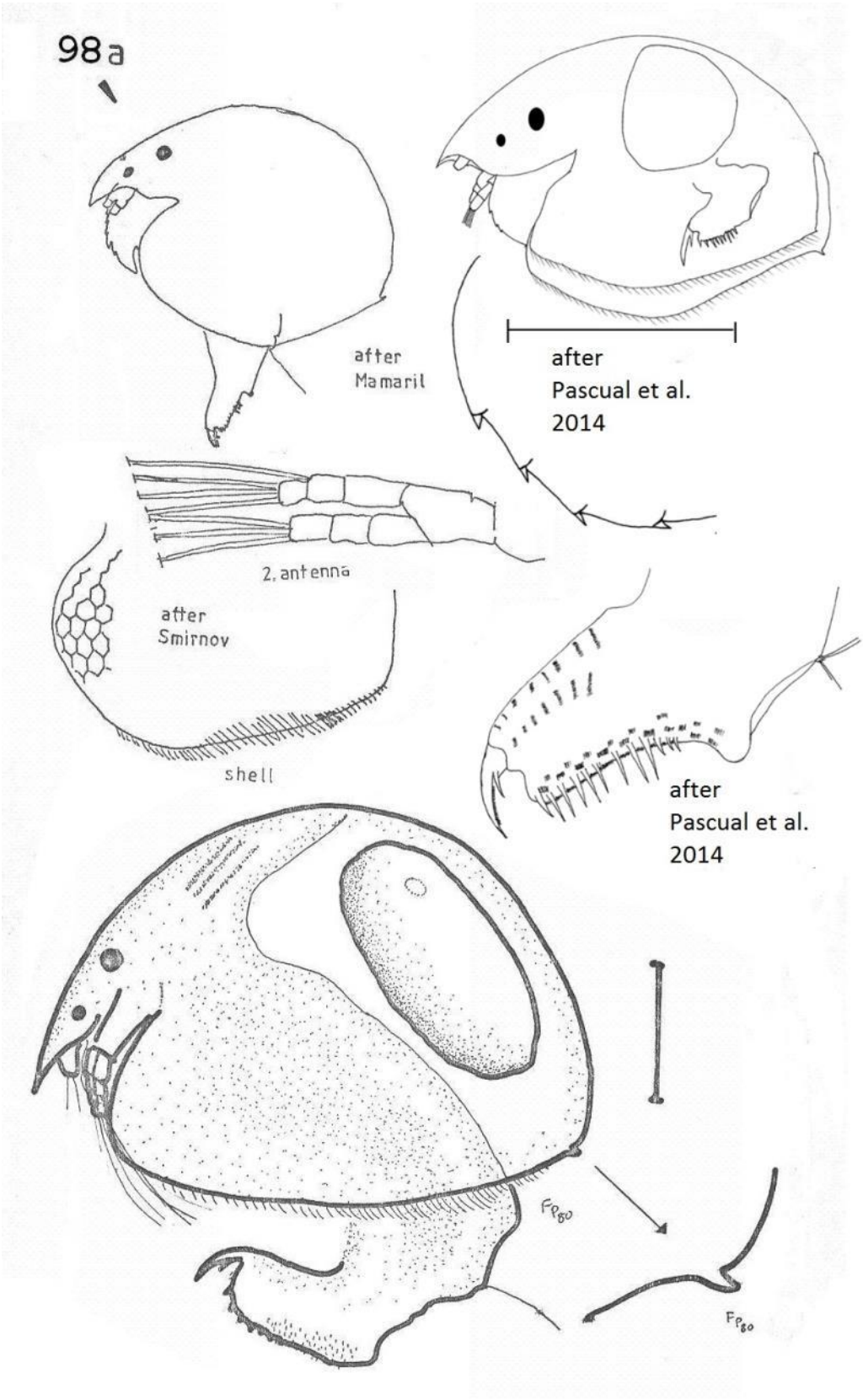

96a
after
Mamaril
MALE
postabdomen
CLAW
after
Flössner
MALE
abdomen
head pore
after Kořinek
after
Auric
(and Kořinek)
after
Brehm
from Sumatra
after
Uéno
ephippium
after
Flössner

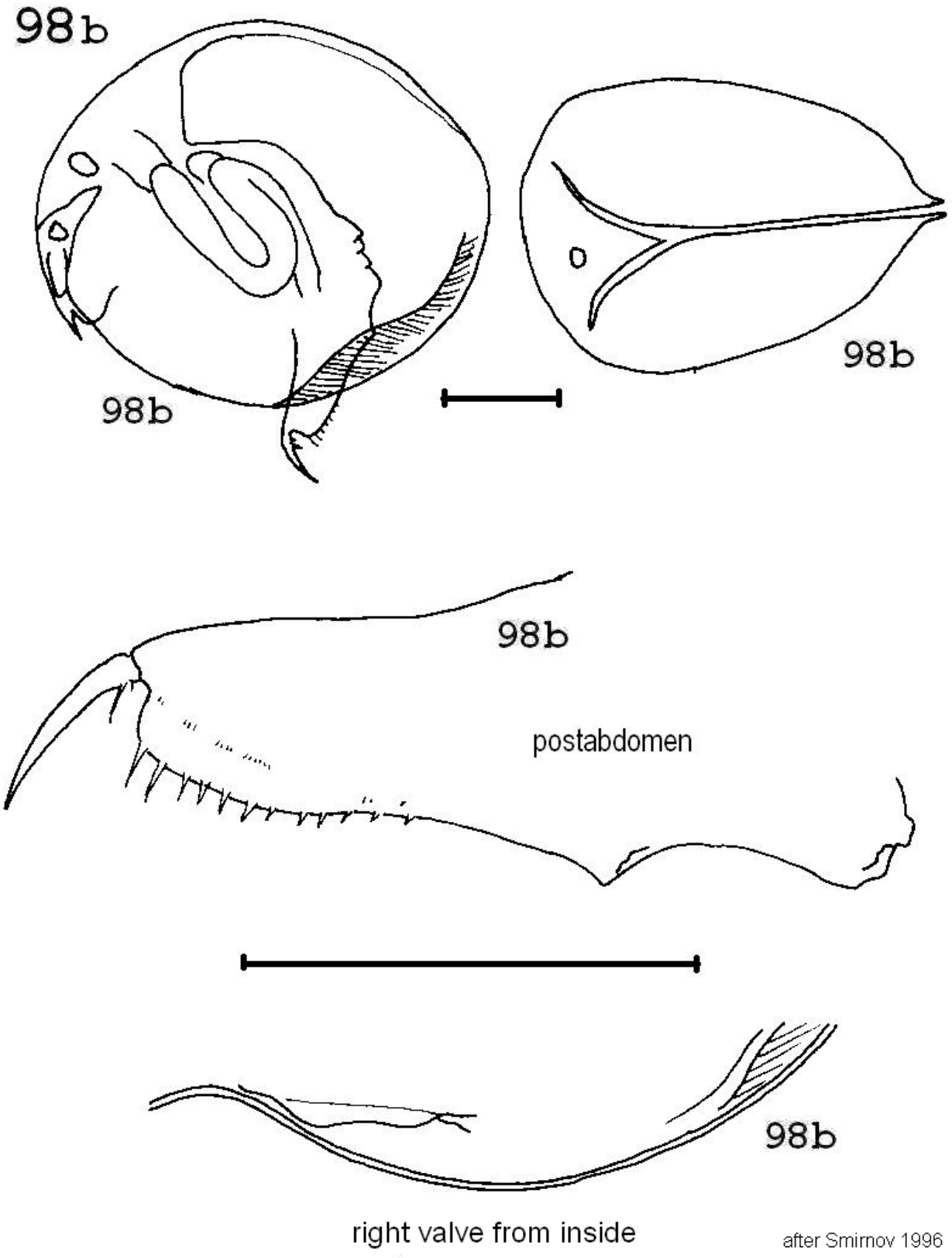

96b
after Auric
form philippinensis
Laguna de Bay
head pore
after Kořinek
after Mamaril
after Pascual et al. 2014
post abdomen
after Cheng & Clemente
after Pascual et al. 2014


96 b
1. JUVENILE INSTAR
2. JUVENILE INSTAR
ADULT 1. INSTAR ?
ADULT
ADULT

97a


after
MAMARIL
after
Pascual et al.
2014
postabdomen
1.antenna
after
Auric

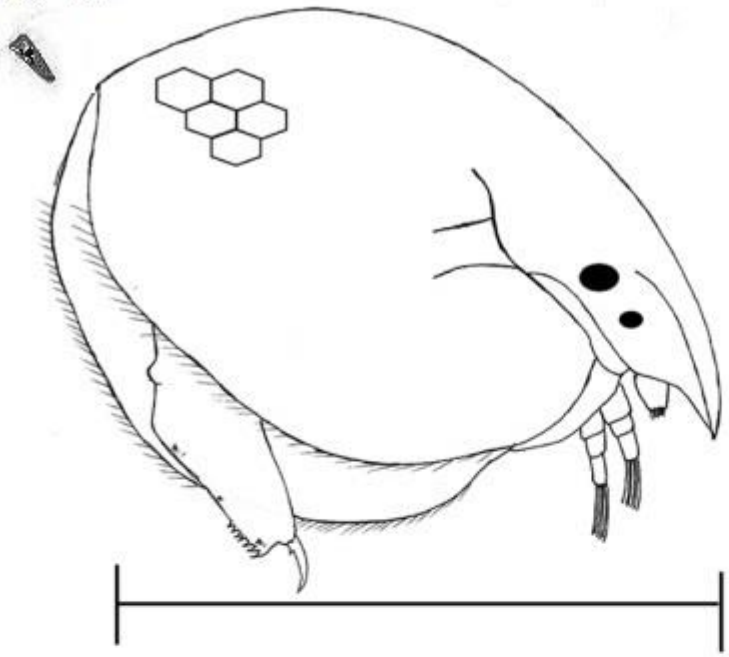

98a
after
Mamaril
after
Pascual et al.
2014
2. antenna
after
Smirnov
shell
after
Pascual et al.
2014
Fp60
Fp60



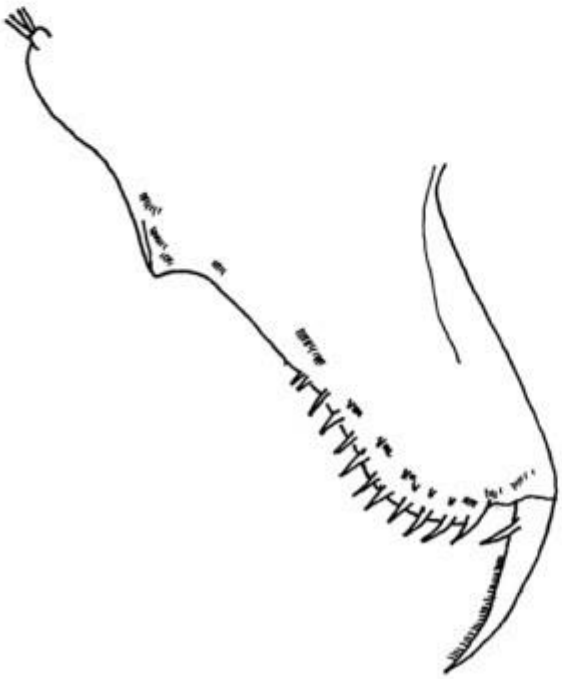
right valve from inside

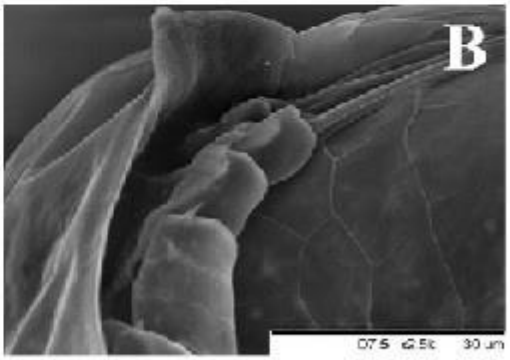
after Smirnov 1996

98 c

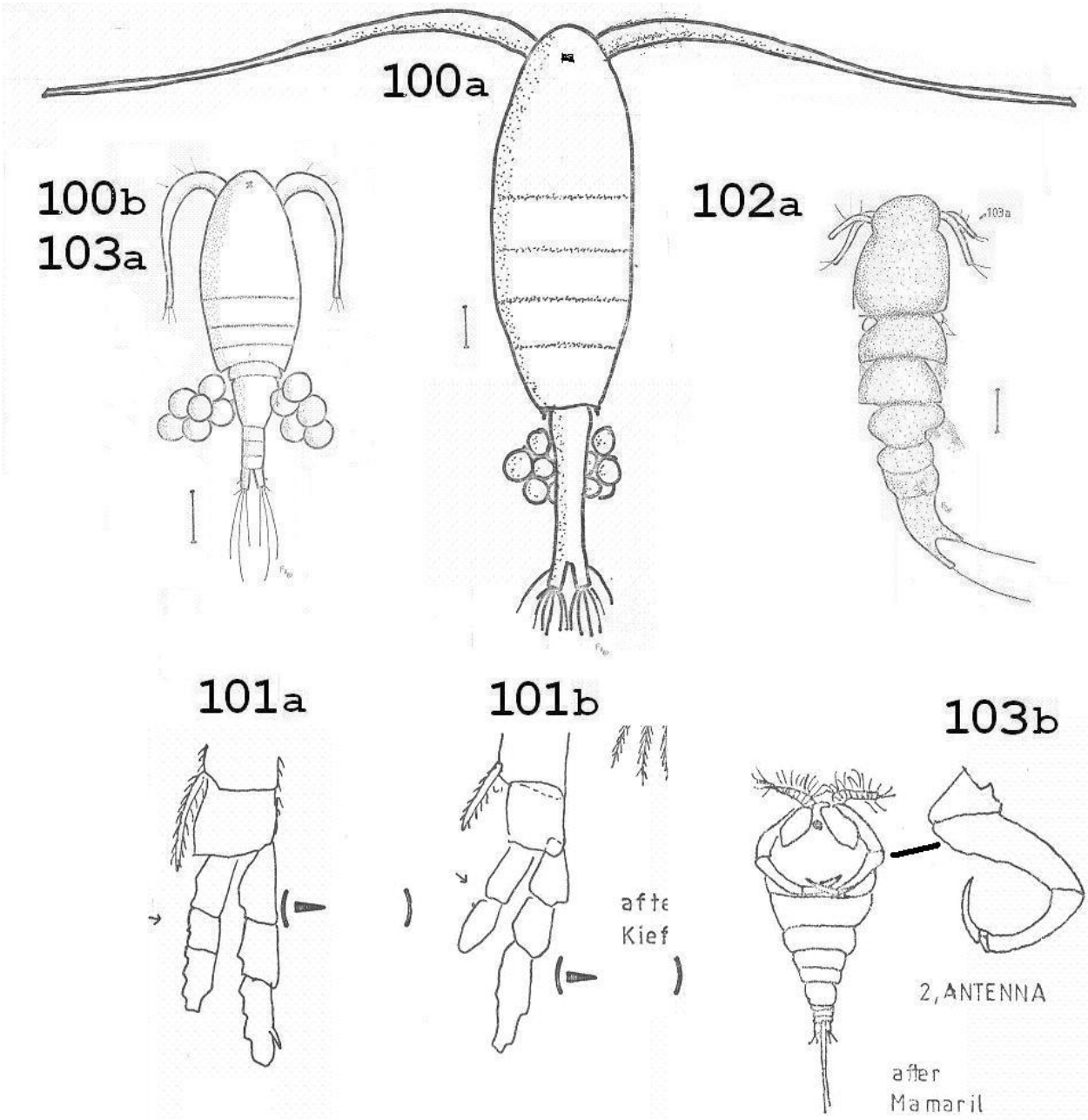


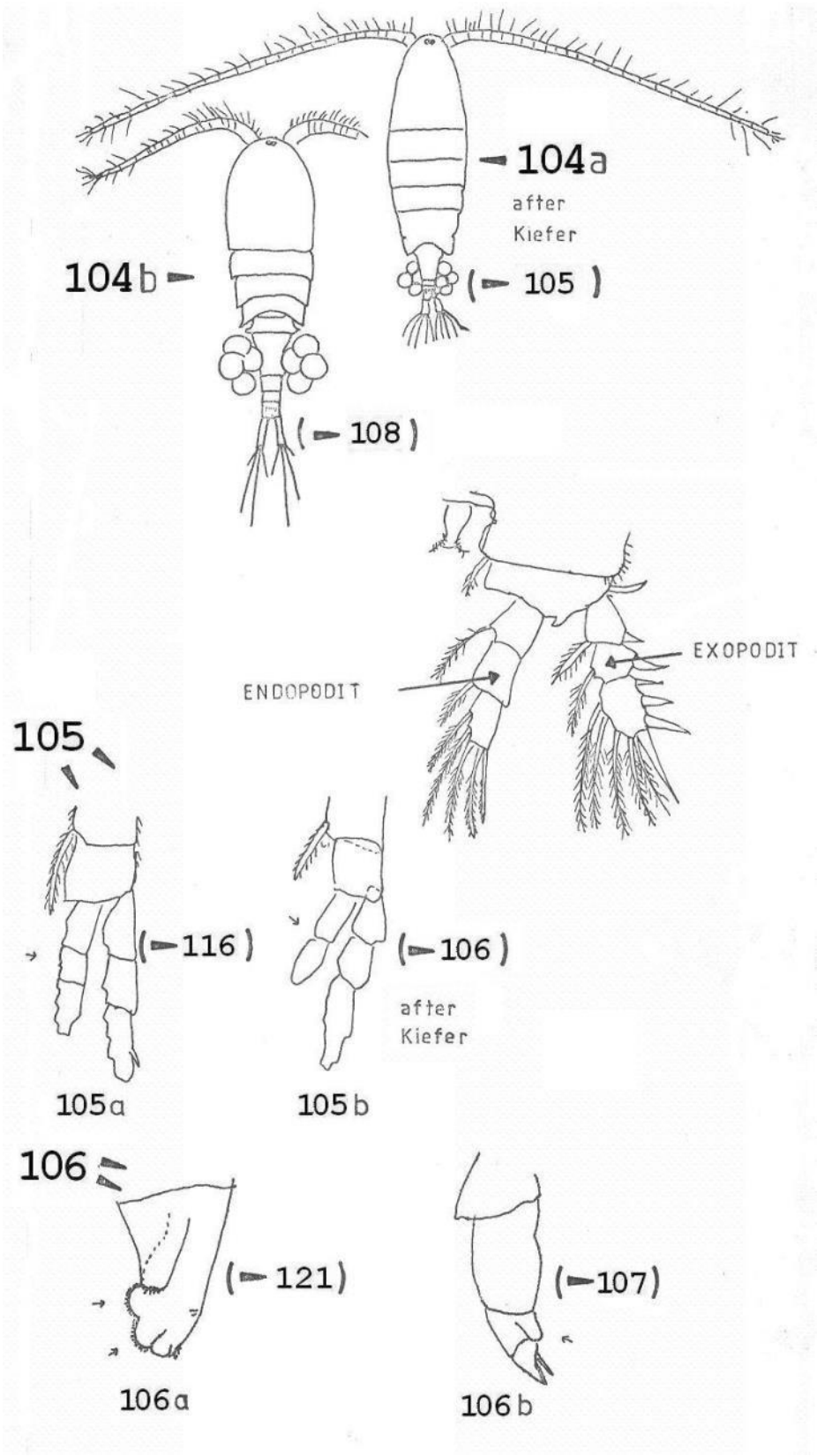


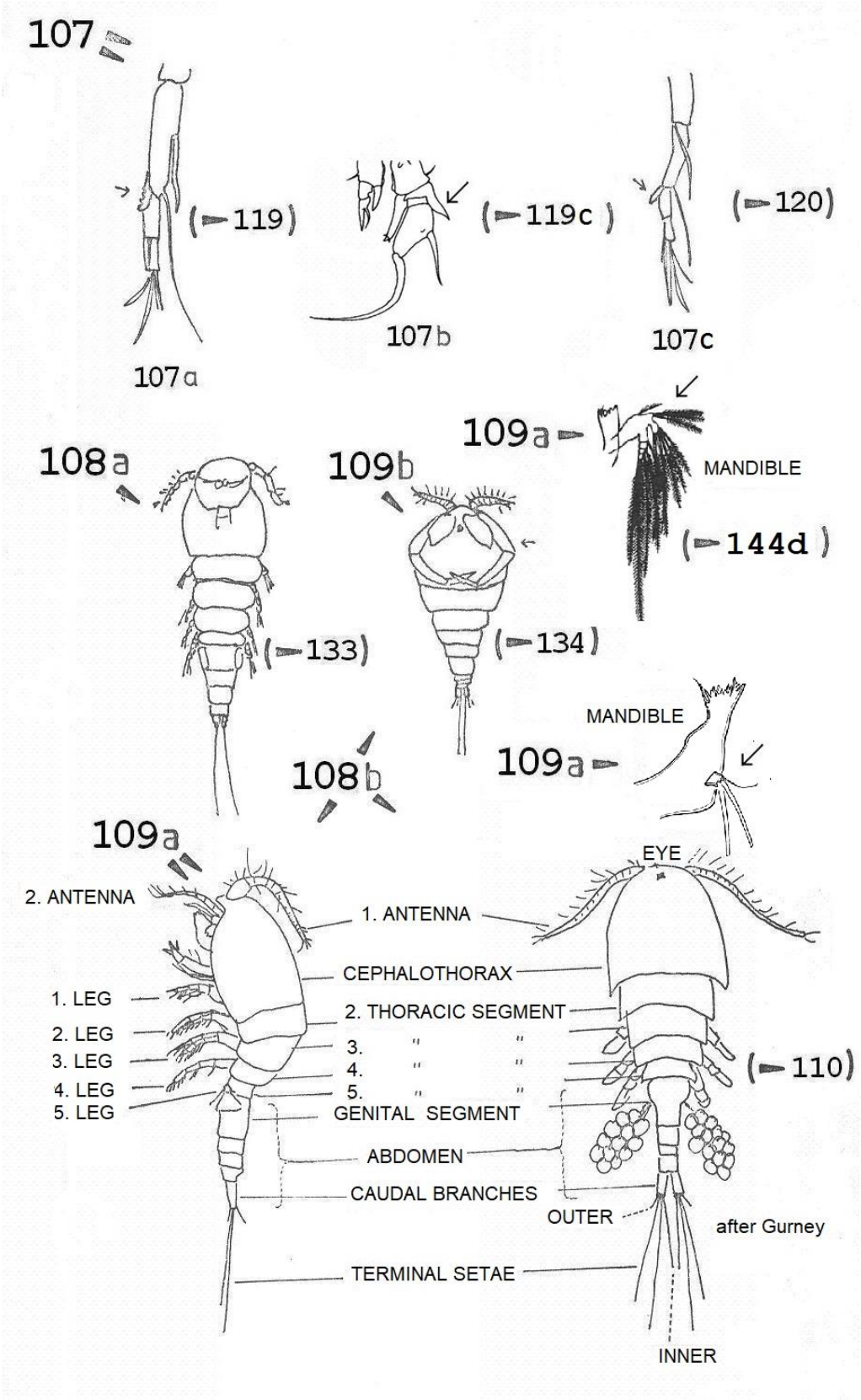


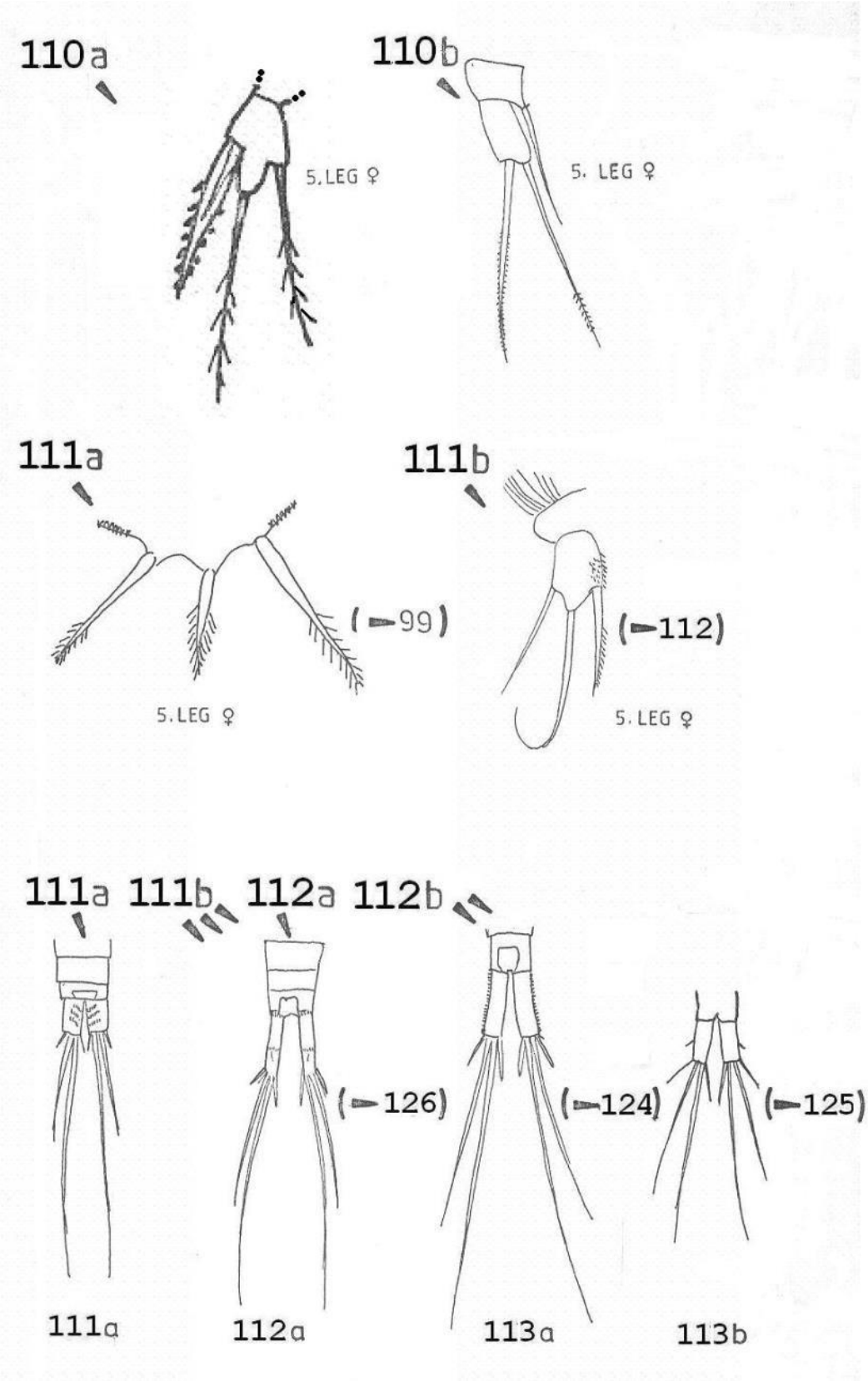


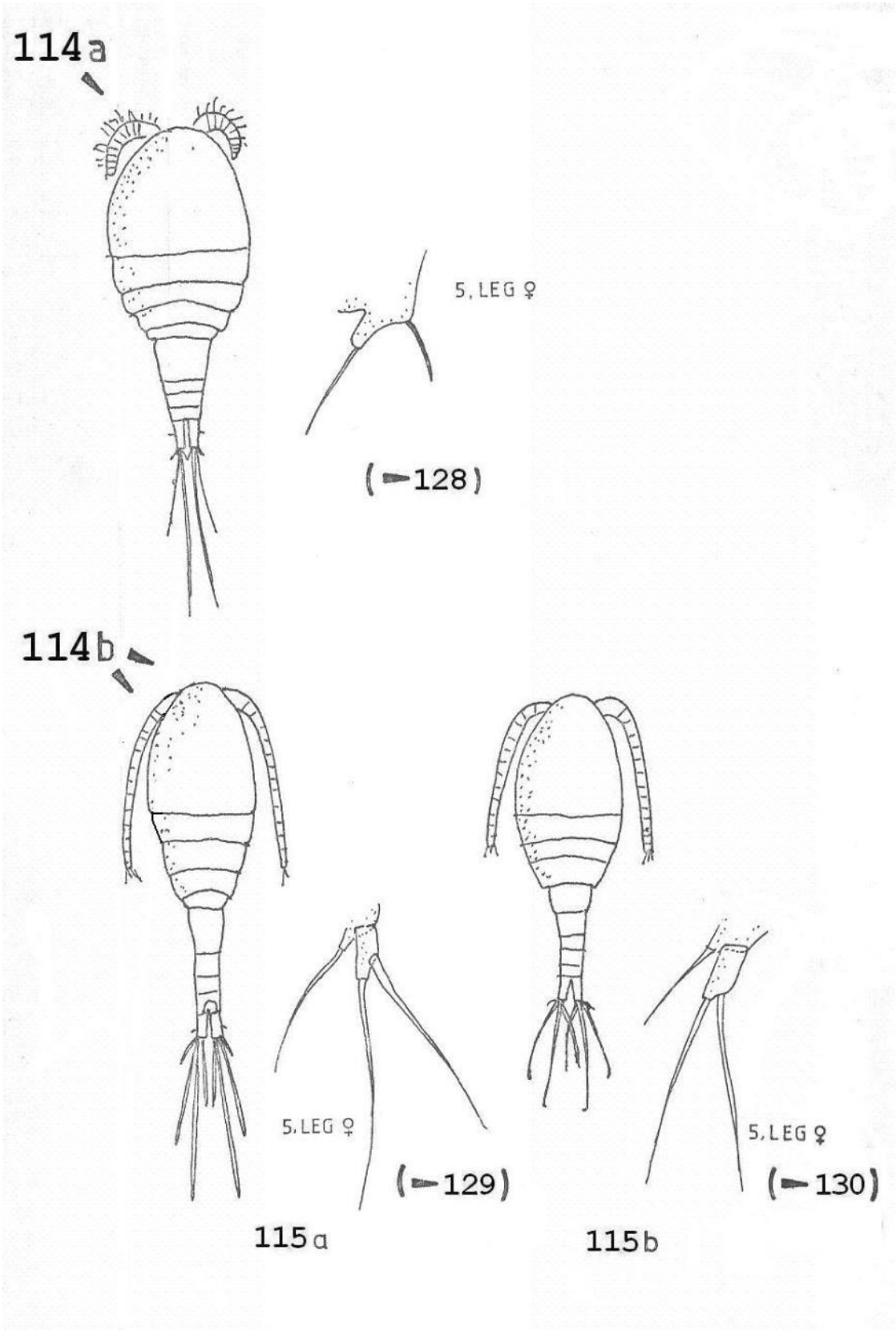
after
Pascual et al.
2014

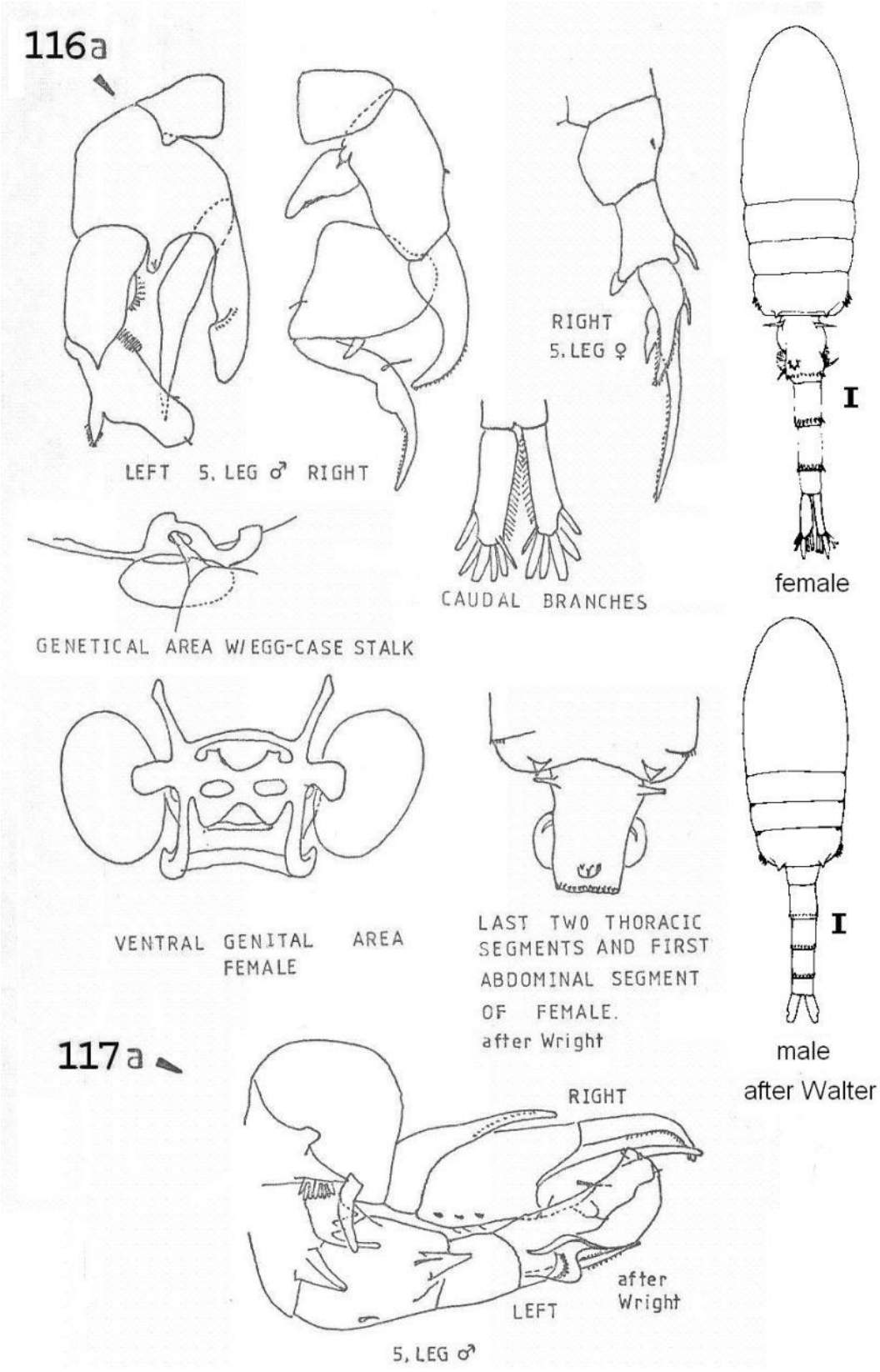

100a
100b
103a
102a
103a
101a
101b
afte
Kief
103b
2, ANTENNA
after
Mamaril

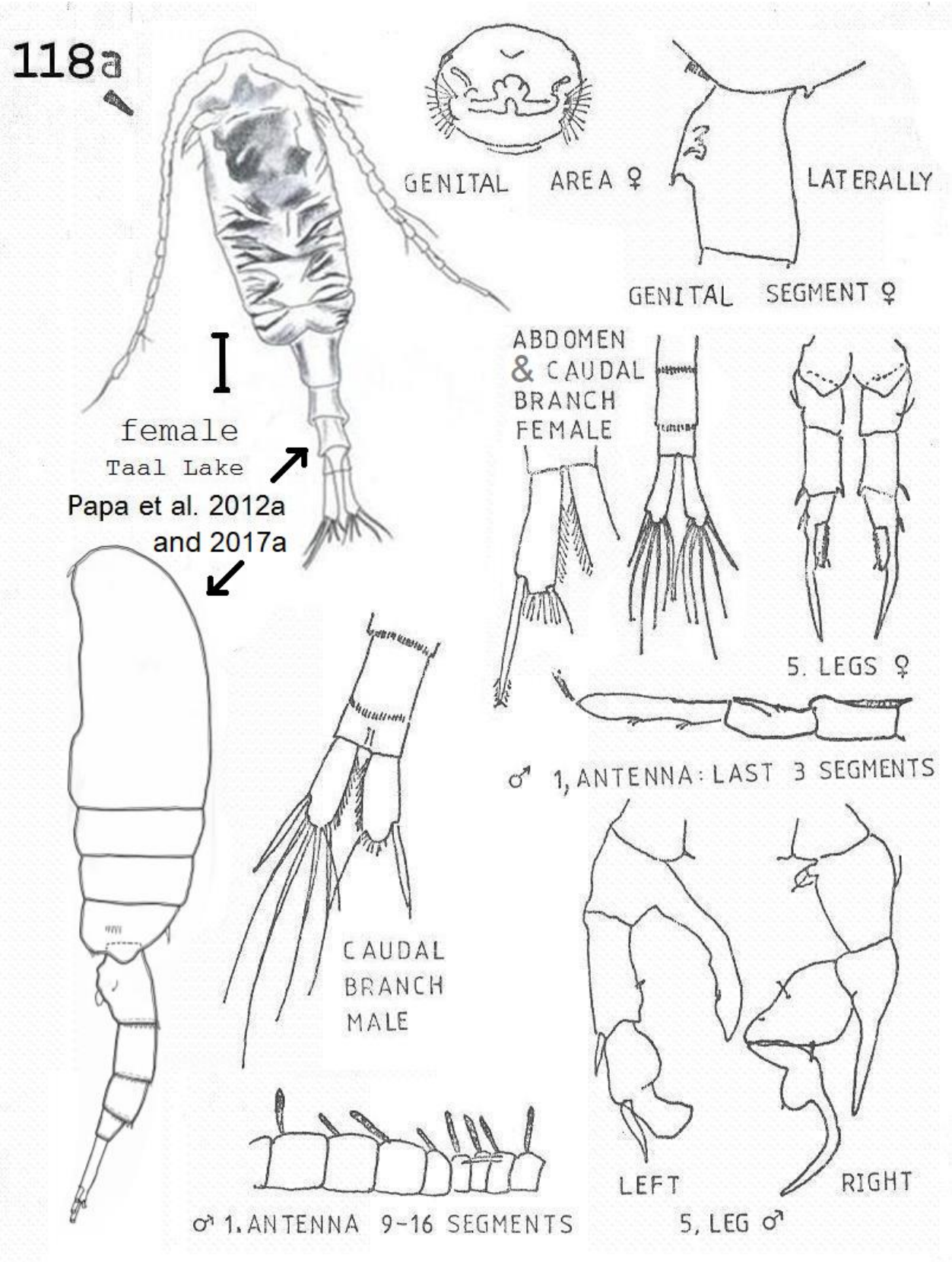

104a
after
Kiefer
104b
(105)
(108)
EXOPODIT
ENDOPODIT
105
(116)
(106)
after
Kiefer
105a
105b
106
(121)
(107)
106a
106b

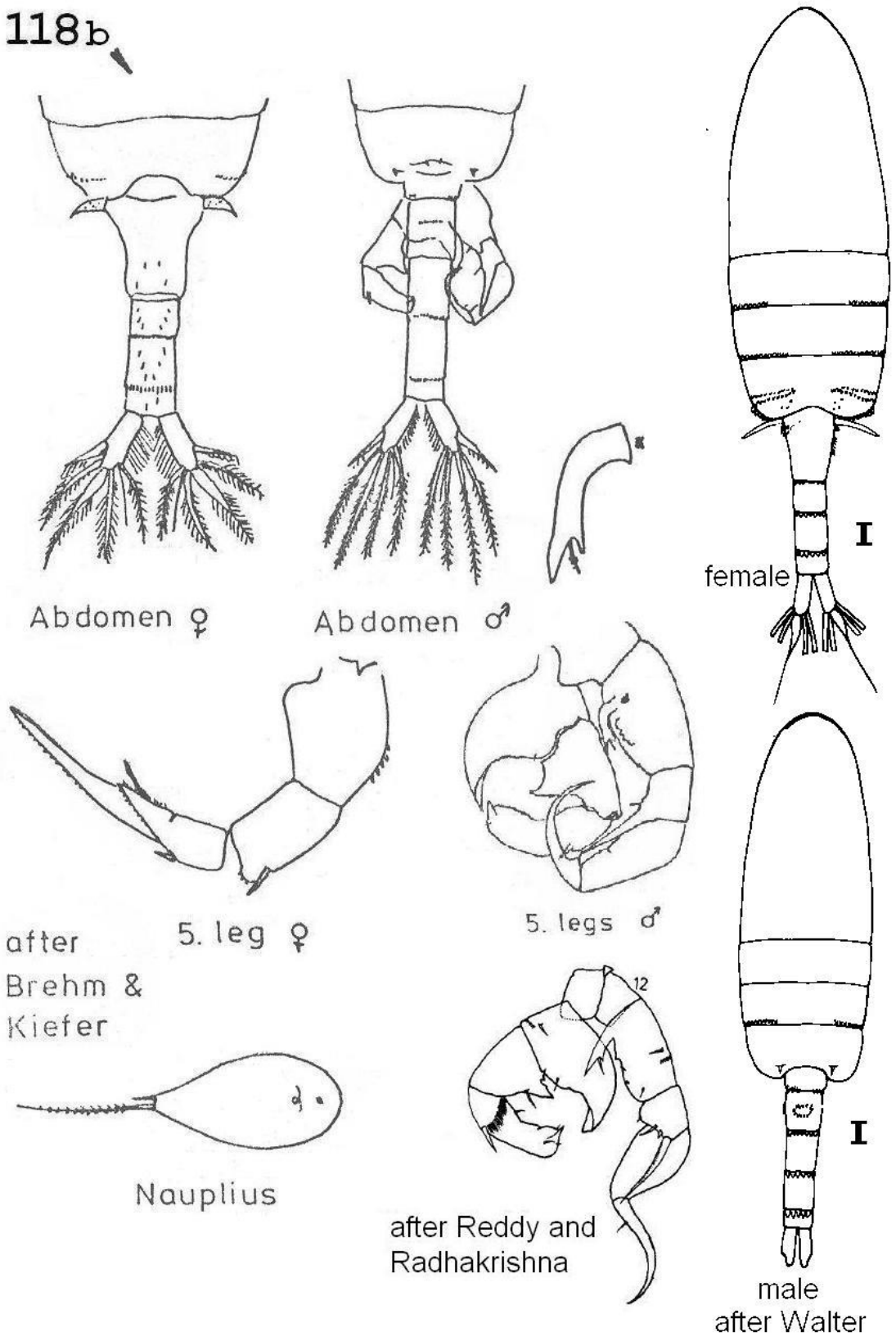

107
(–119)
107a
(–119c)
107b
(–120)
107c
109a
MANDIBLE
(–144d)
108a
(–133)
109b
(–134)
108b
109a
MANDIBLE
109a
EYE
2. ANTENNA
1. ANTENNA
CEPHALOTHORAX
1. LEG
2. LEG
3. LEG
4. LEG
5. LEG
2. THORACIC SEGMENT
3. " "
4. " "
5. " "
(–110)
GENITAL SEGMENT
ABDOMEN
CAUDAL BRANCHES
OUTER
after Gurney
TERMINAL SETAE
INNER

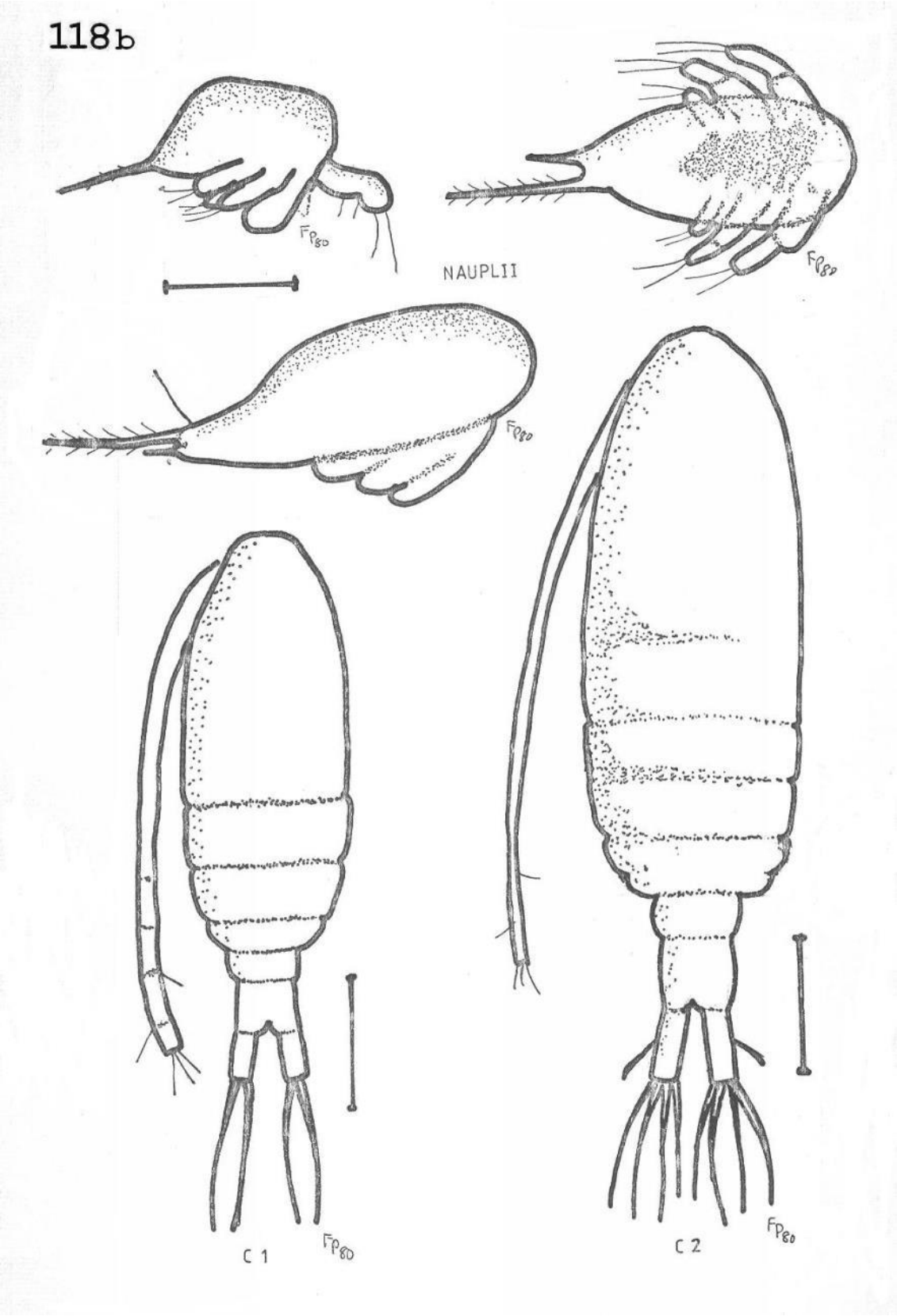

110a
5. LEG ♀
110b
5. LEG ♀
111a
(→99)
5. LEG ♀
111b
(→112)
5. LEG ♀
111a
111b
112a
112b
(→126)
(→124)
(→125)
111a
112a
113a
113b


114a
5. LEG ♀
(→128)
114b
5. LEG ♀
(→129)
5. LEG ♀
(→130)
115a
115b

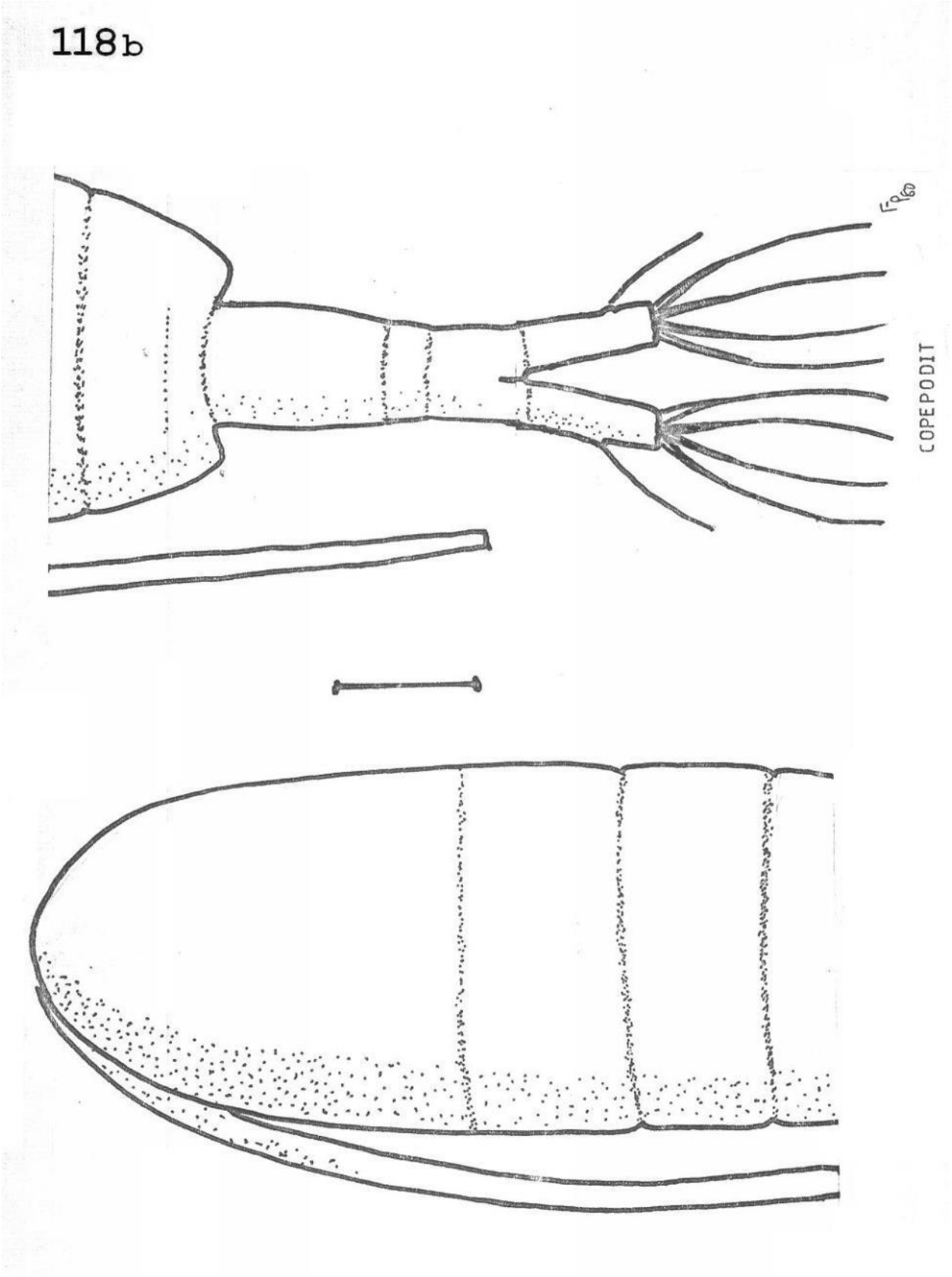

116a
LEFT 5. LEG ♂ RIGHT
RIGHT 5. LEG ♀
CAUDAL BRANCHES
GENETICAL AREA W/ EGG-CASE STALK
VENTRAL GENITAL AREA FEMALE
LAST TWO THORACIC SEGMENTS AND FIRST ABDOMINAL SEGMENT OF FEMALE. after Wright
I
female
I
male
after Walter
117a
RIGHT
LEFT
after Wright
5. LEG ♂

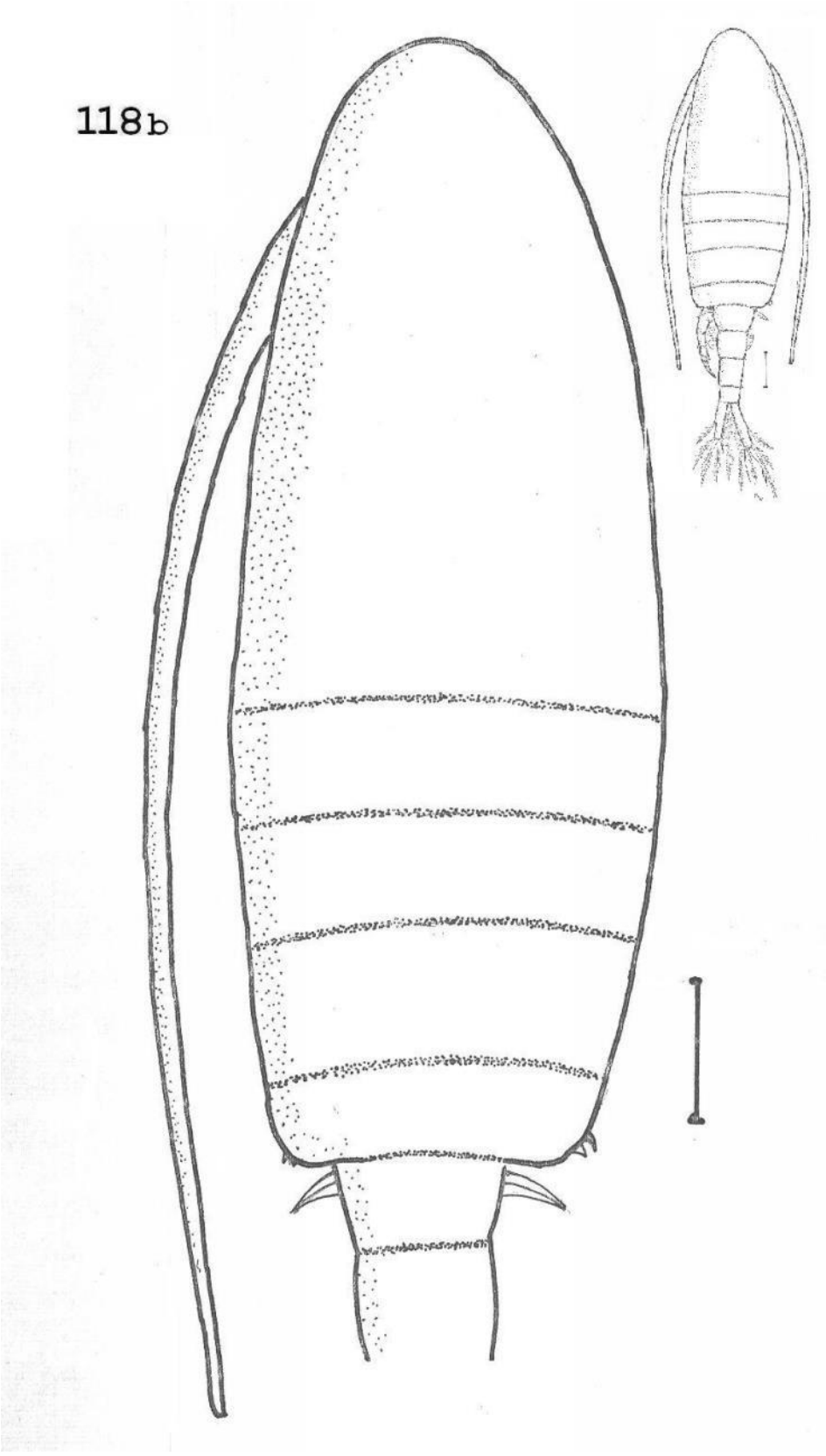

118a
female
Taal Lake
Papa et al. 2012a
and 2017a
GENITAL AREA ♀
LATERALLY
GENITAL SEGMENT ♀
ABDOMEN
& CAUDAL
BRANCH
FEMALE
5. LEGS ♀
♂ 1, ANTENNA: LAST 3 SEGMENTS
CAUDAL
BRANCH
MALE
♂ 1. ANTENNA 9-16 SEGMENTS
LEFT
RIGHT
5. LEG ♂

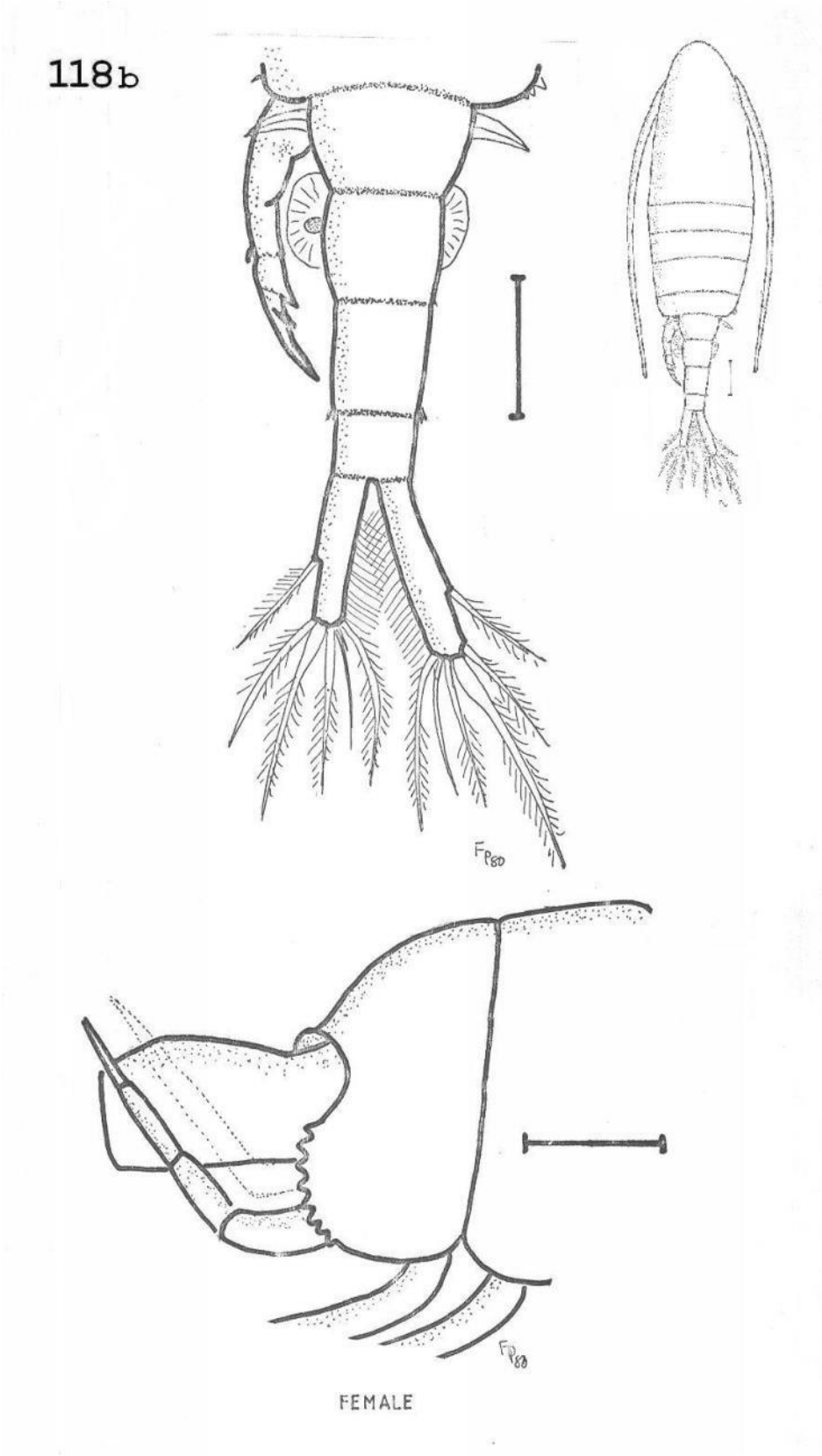

118b
Abdomen ♀
Abdomen ♂
female
I
5. leg ♀
5. legs ♂
after
Brehm &
Kiefer
Nauplius
12
after Reddy and
Radhakrishna
I
male
after Walter

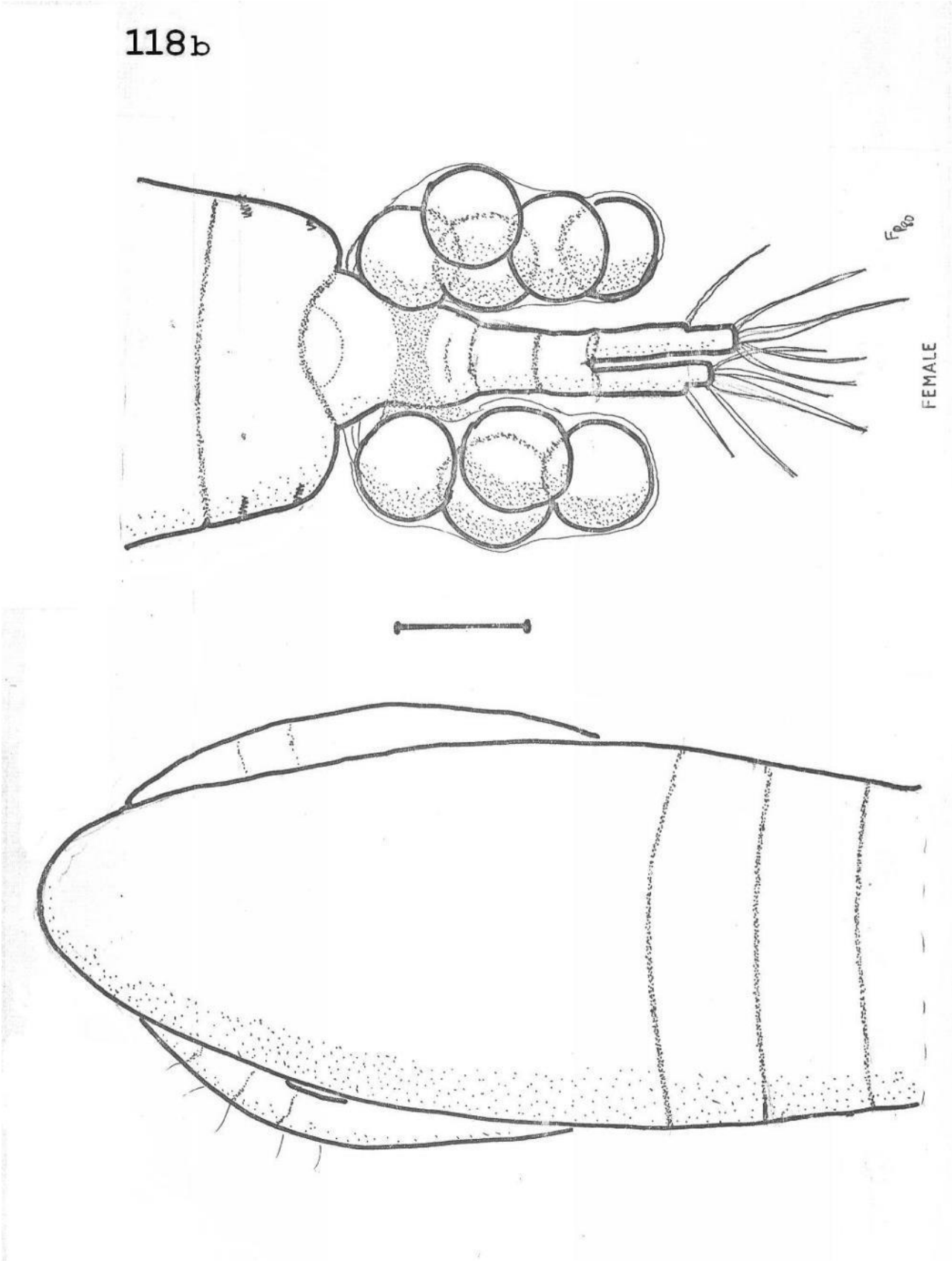

118b
NAUPLII
C 1
C 2

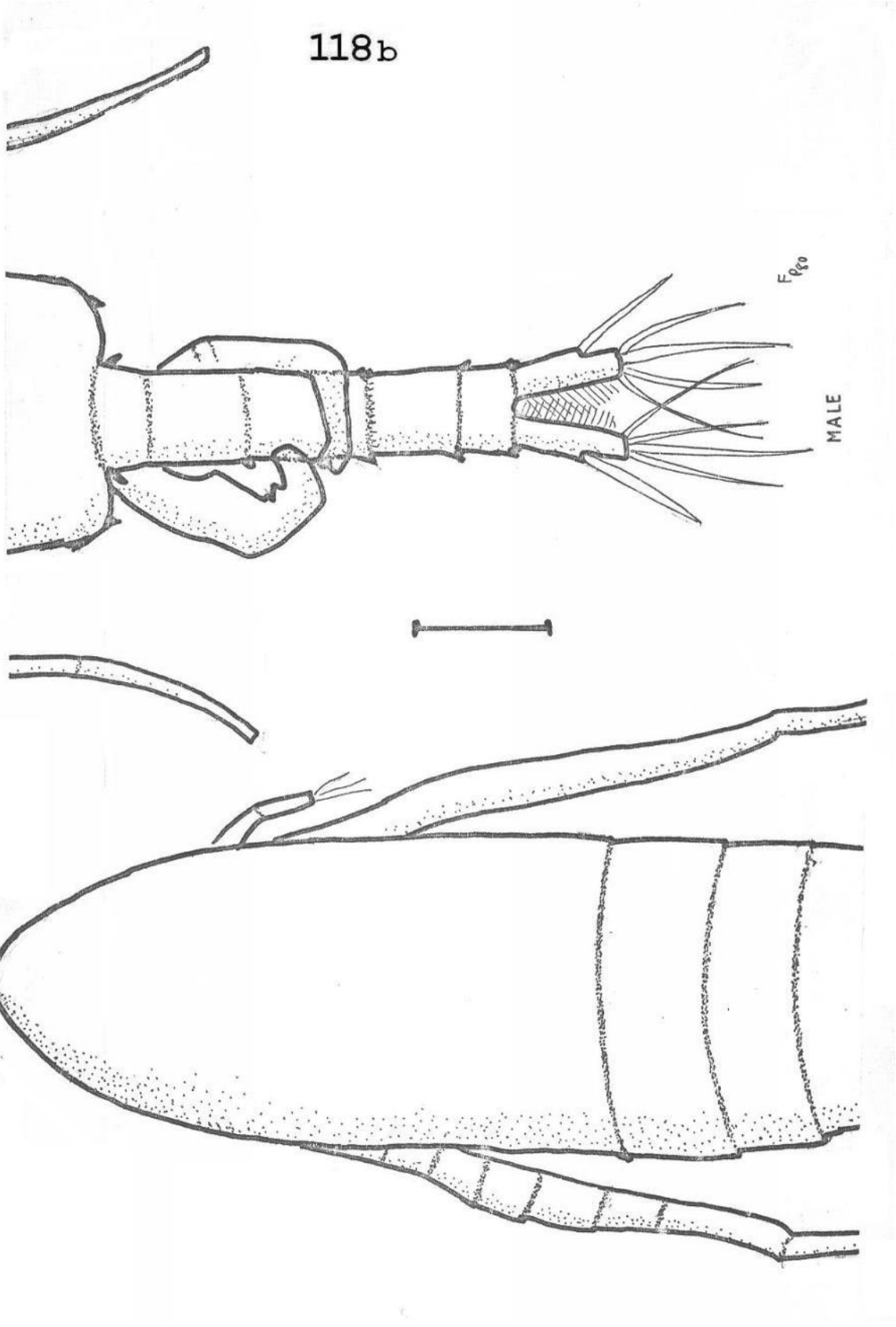
118b



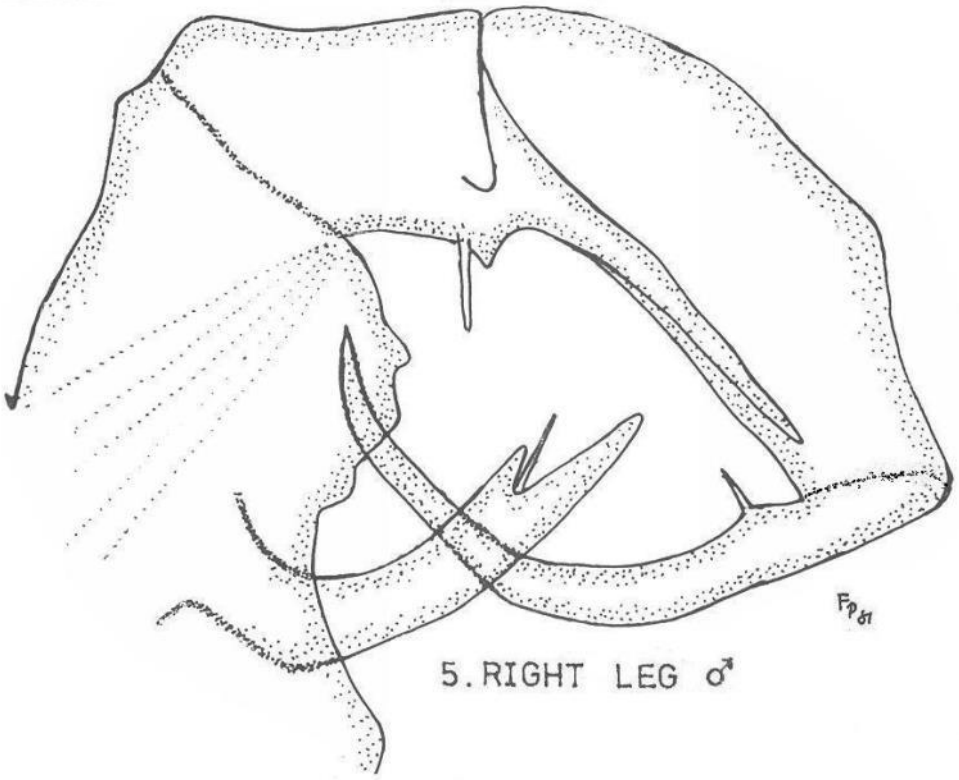

118b


118b
FEMALE

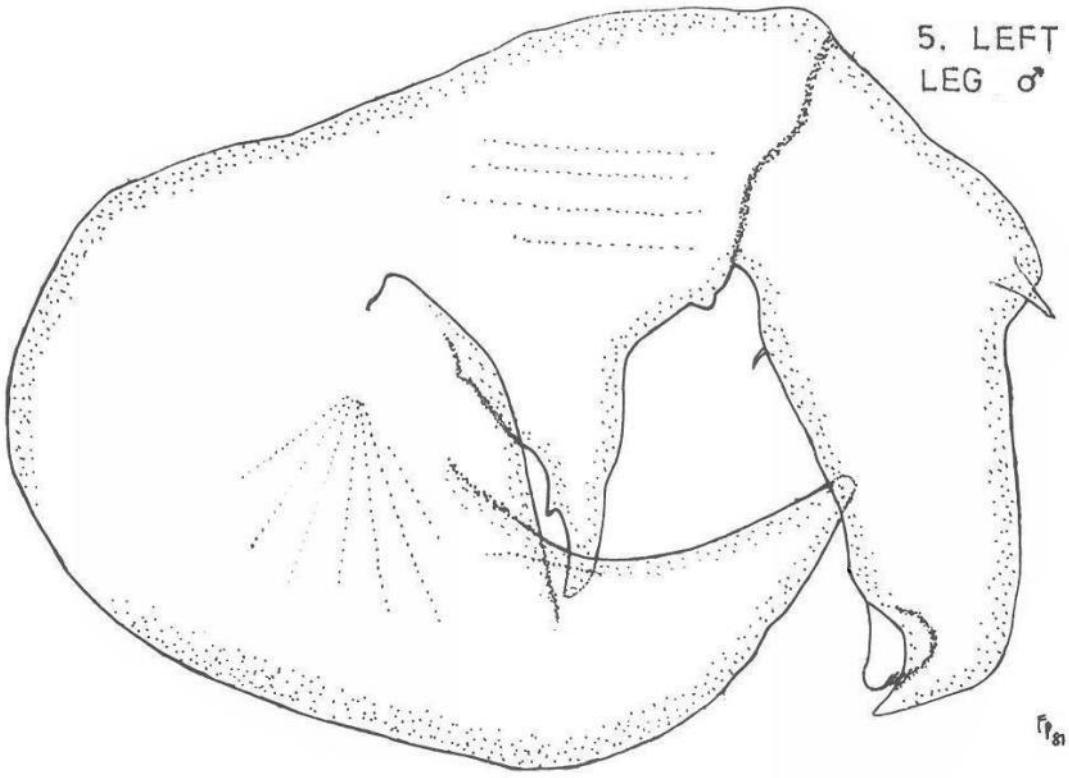

118b
FEMALE


118b
MALE

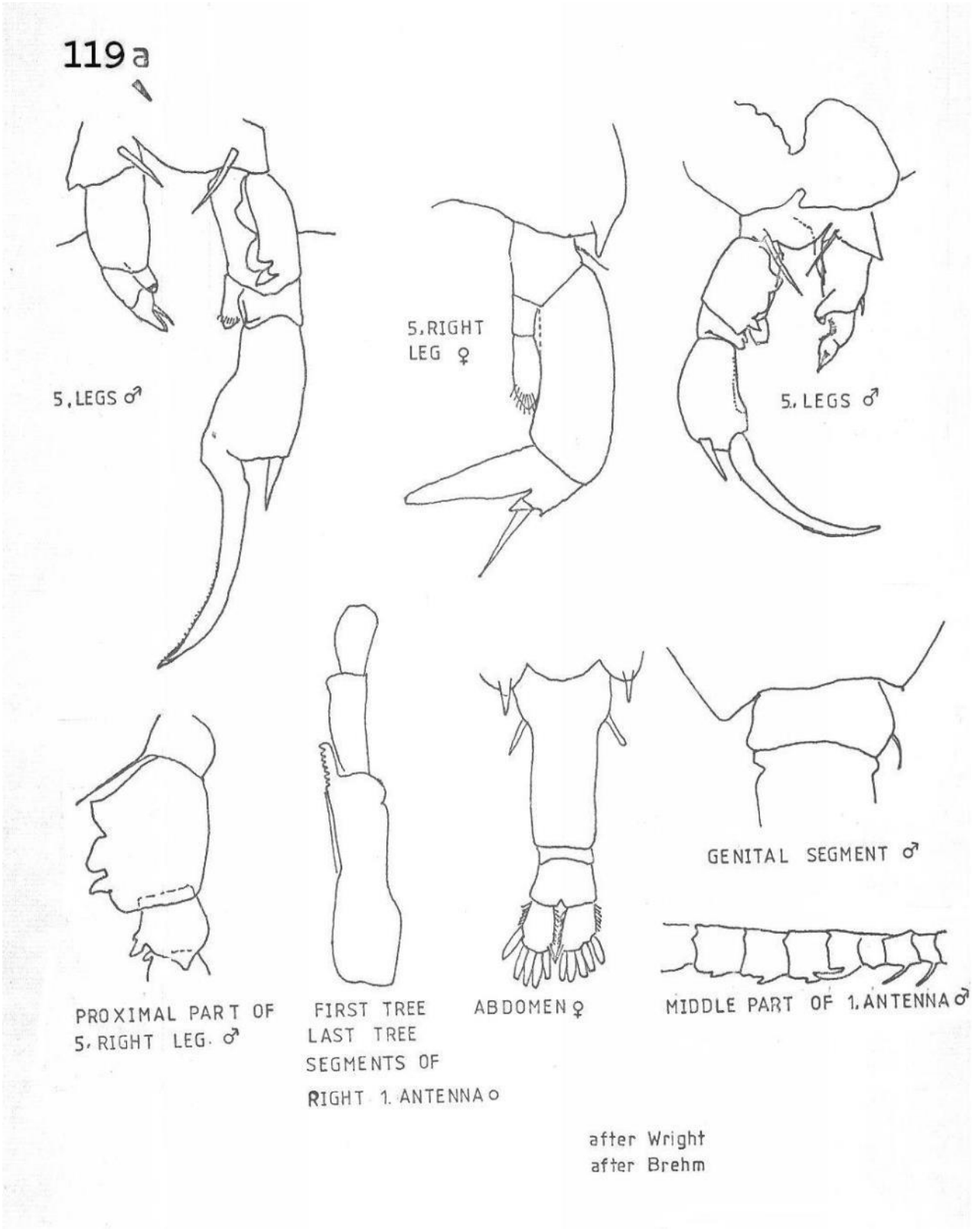
118b

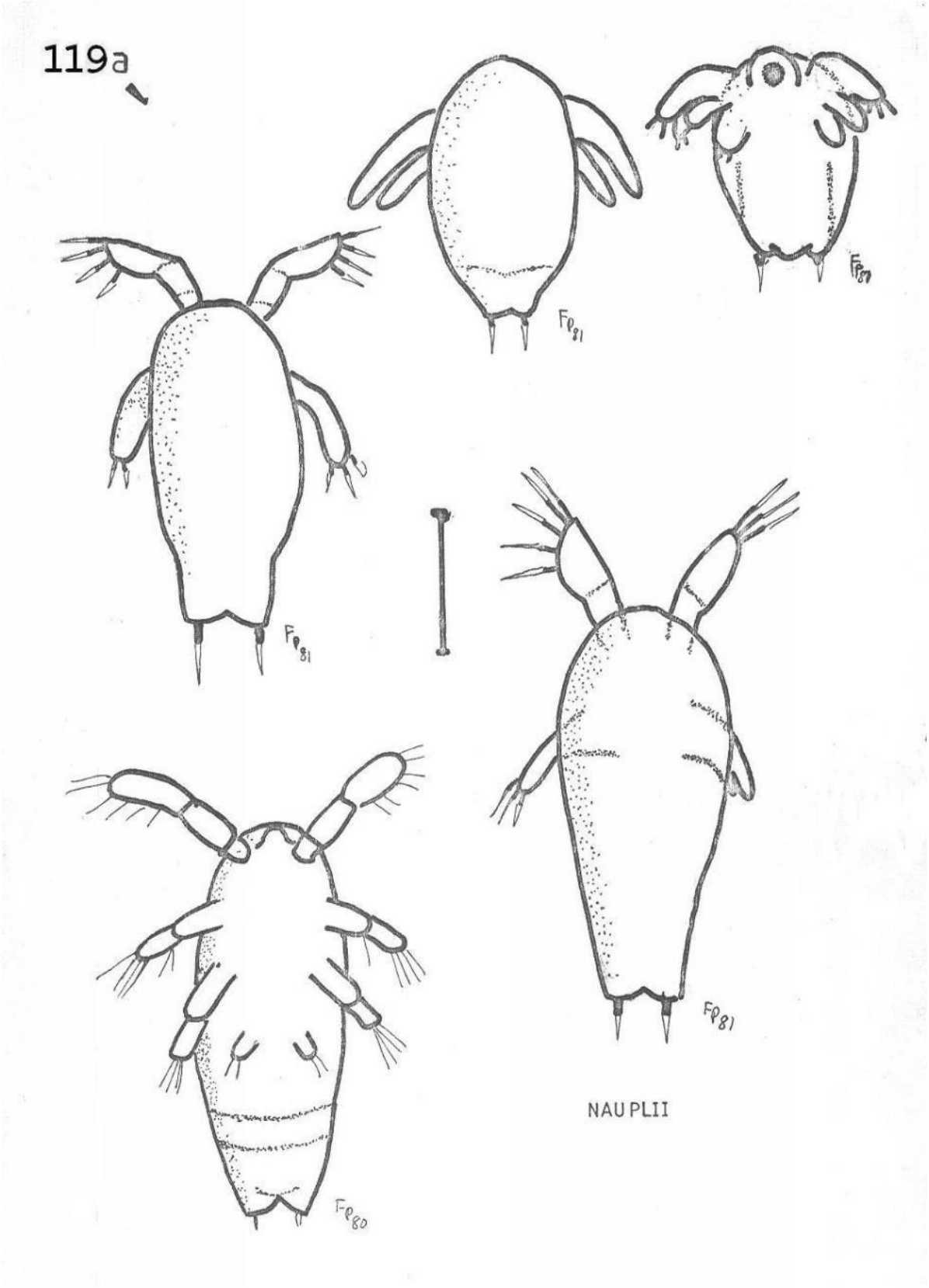


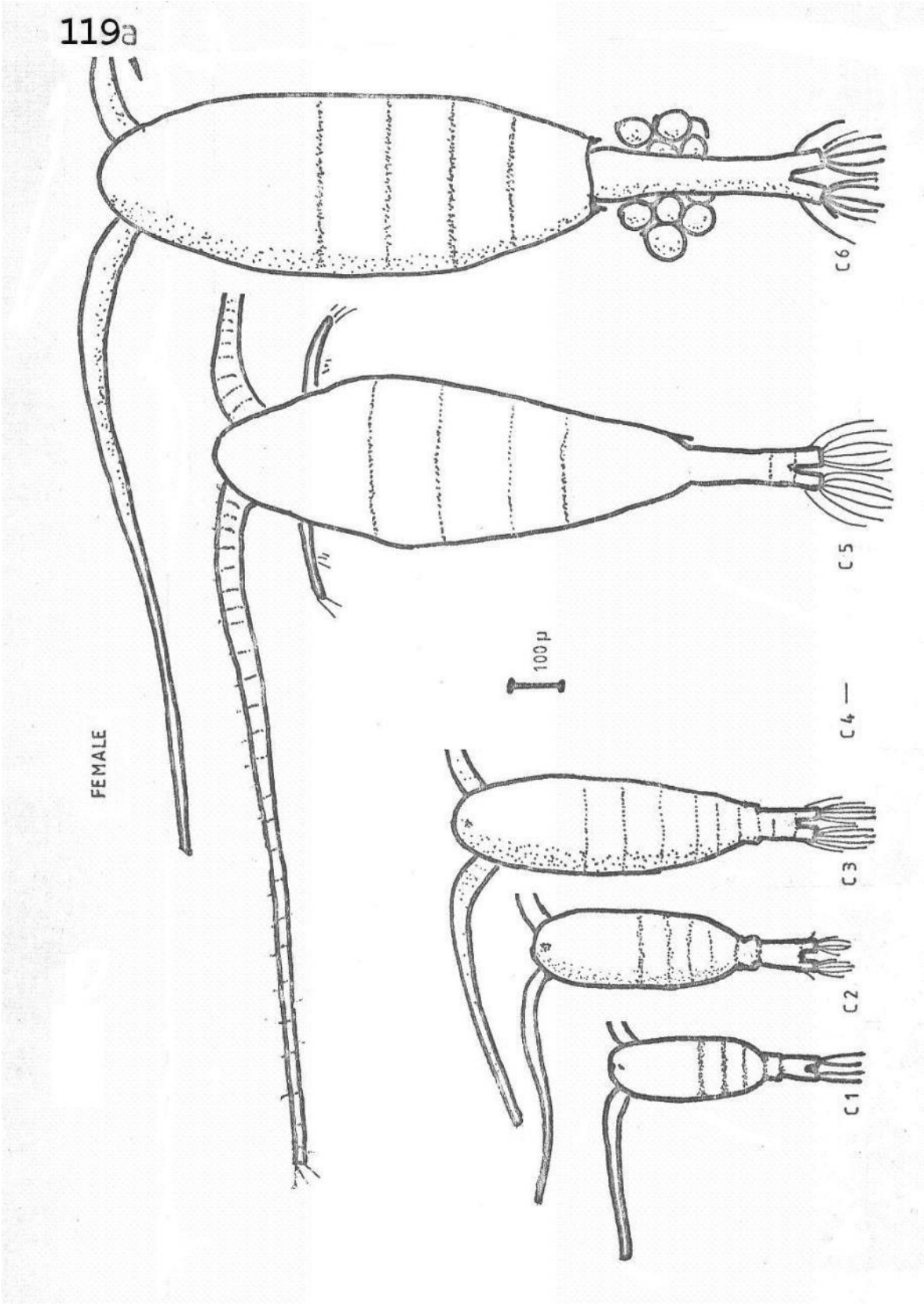
5. RIGHT LEG ♂

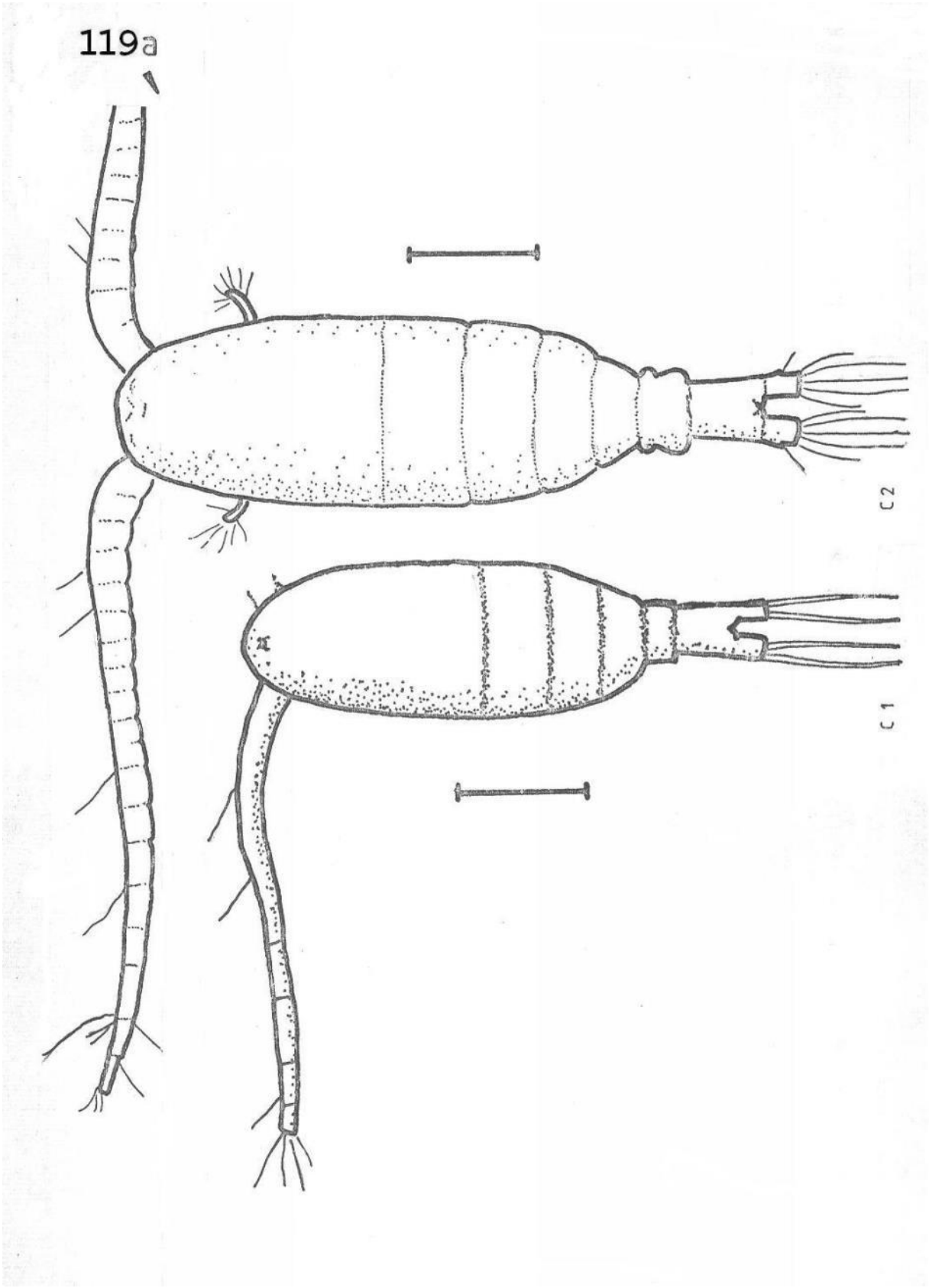


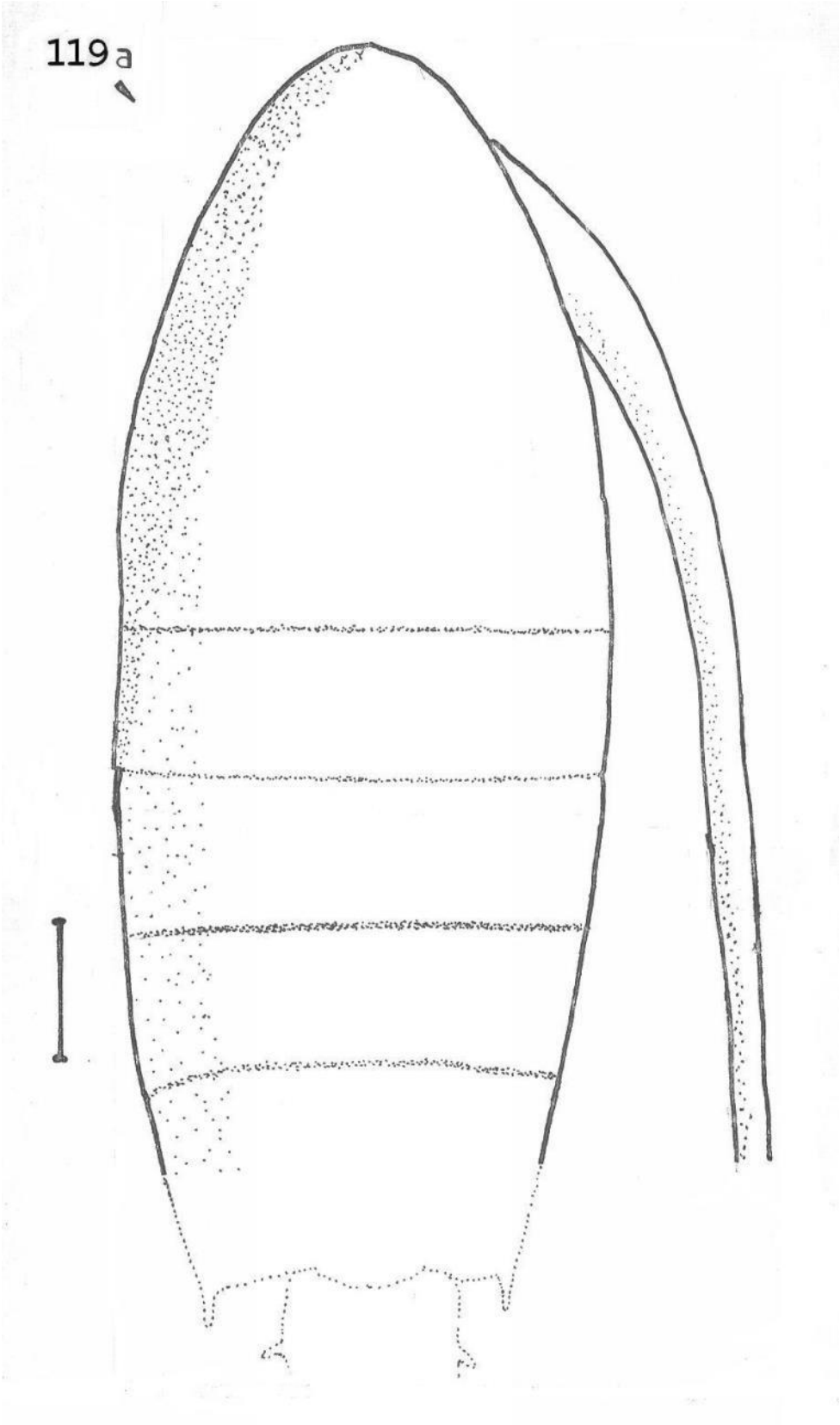
5. LEFT LEG ♂

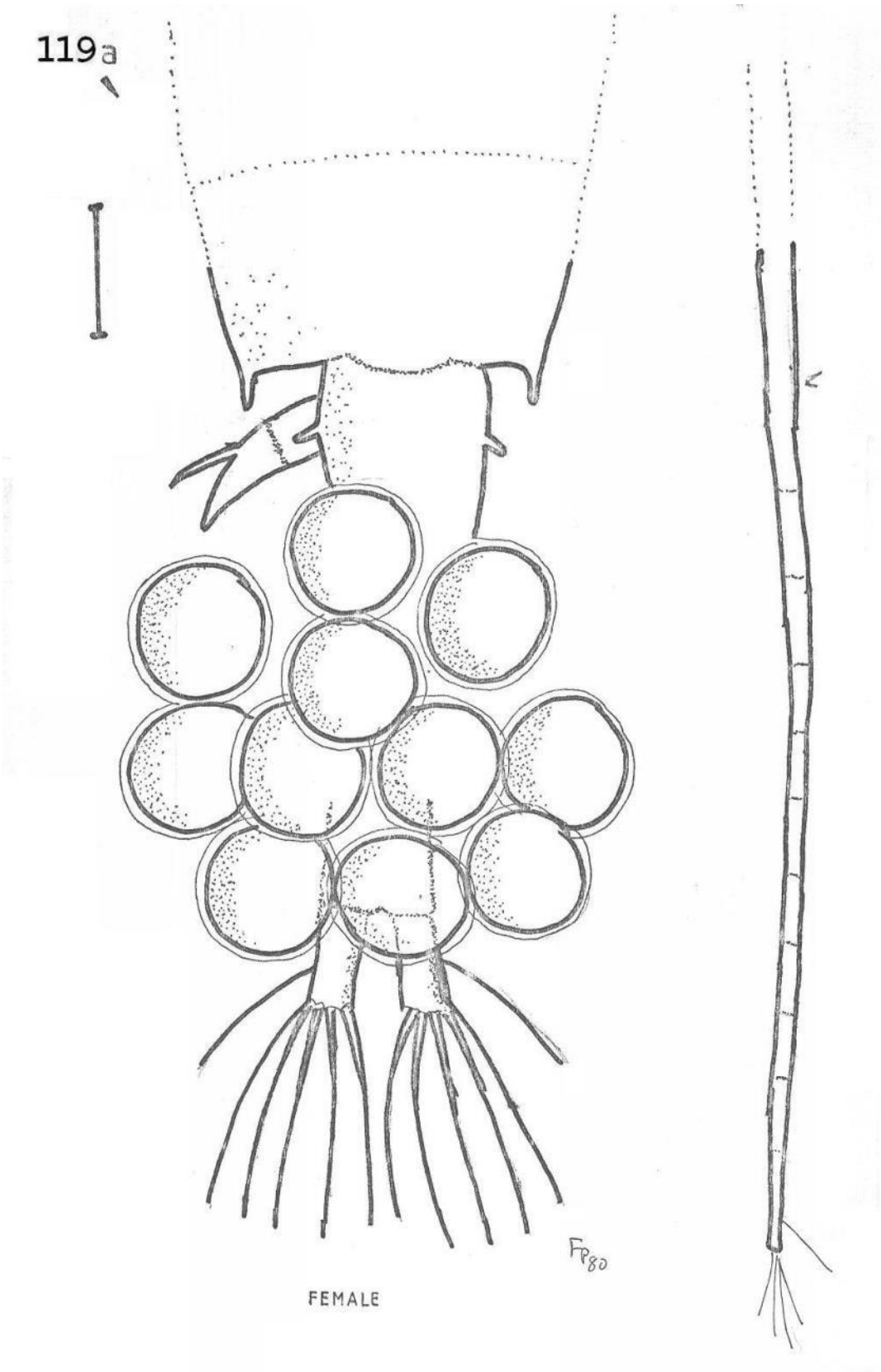

119 a
5. LEGS ♂
5. RIGHT LEG ♀
5. LEGS ♂
GENITAL SEGMENT ♂
PROXIMAL PART OF 5. RIGHT LEG. ♂
FIRST TREE LAST TREE SEGMENTS OF RIGHT 1. ANTENNA ♀
ABDOMEN ♀
MIDDLE PART OF 1. ANTENNA ♂
after Wright
after Brehm

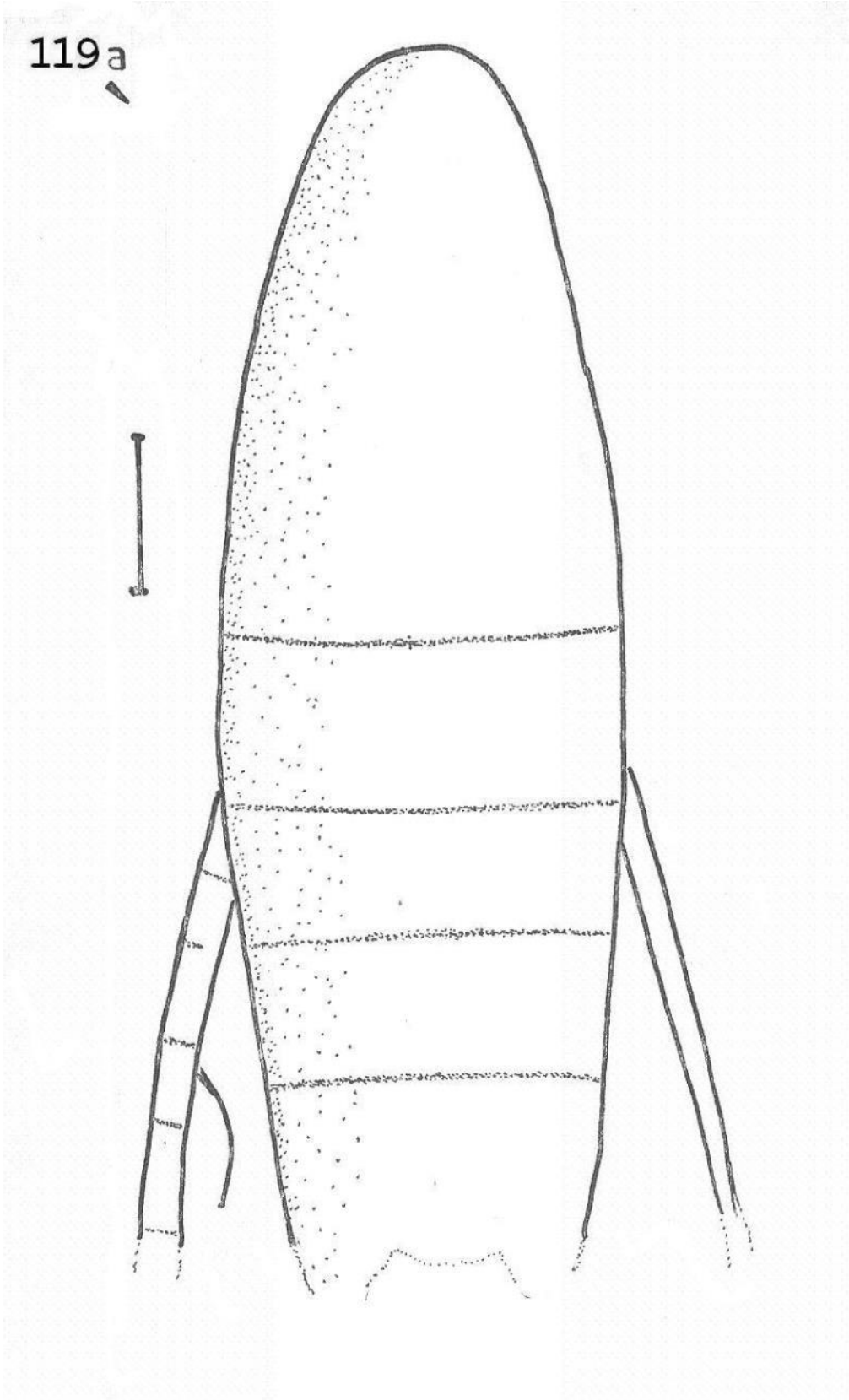

119a
NAUPLII

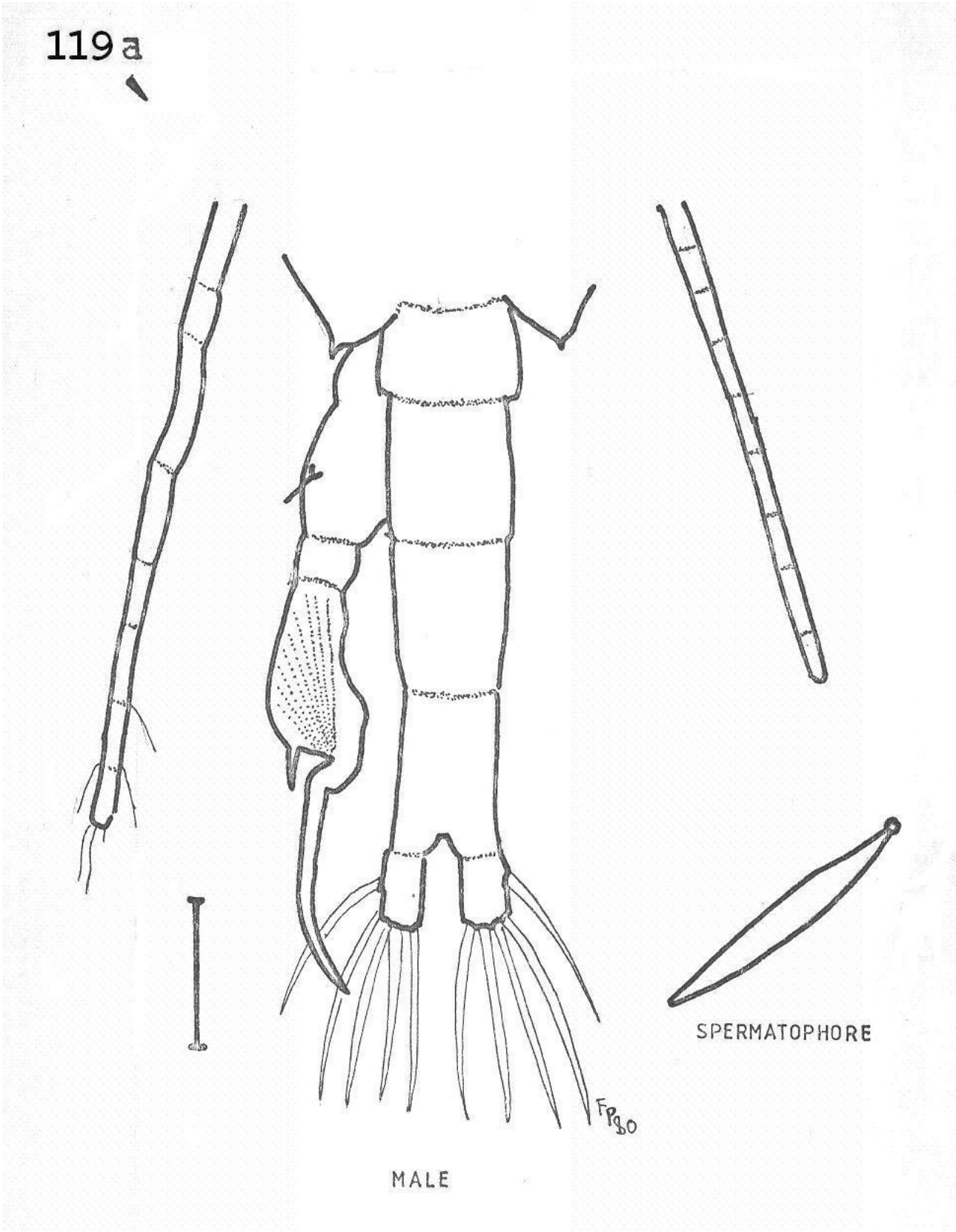

119a
FEMALE
100 µ
C6
C5
C4
C3
C2
C1

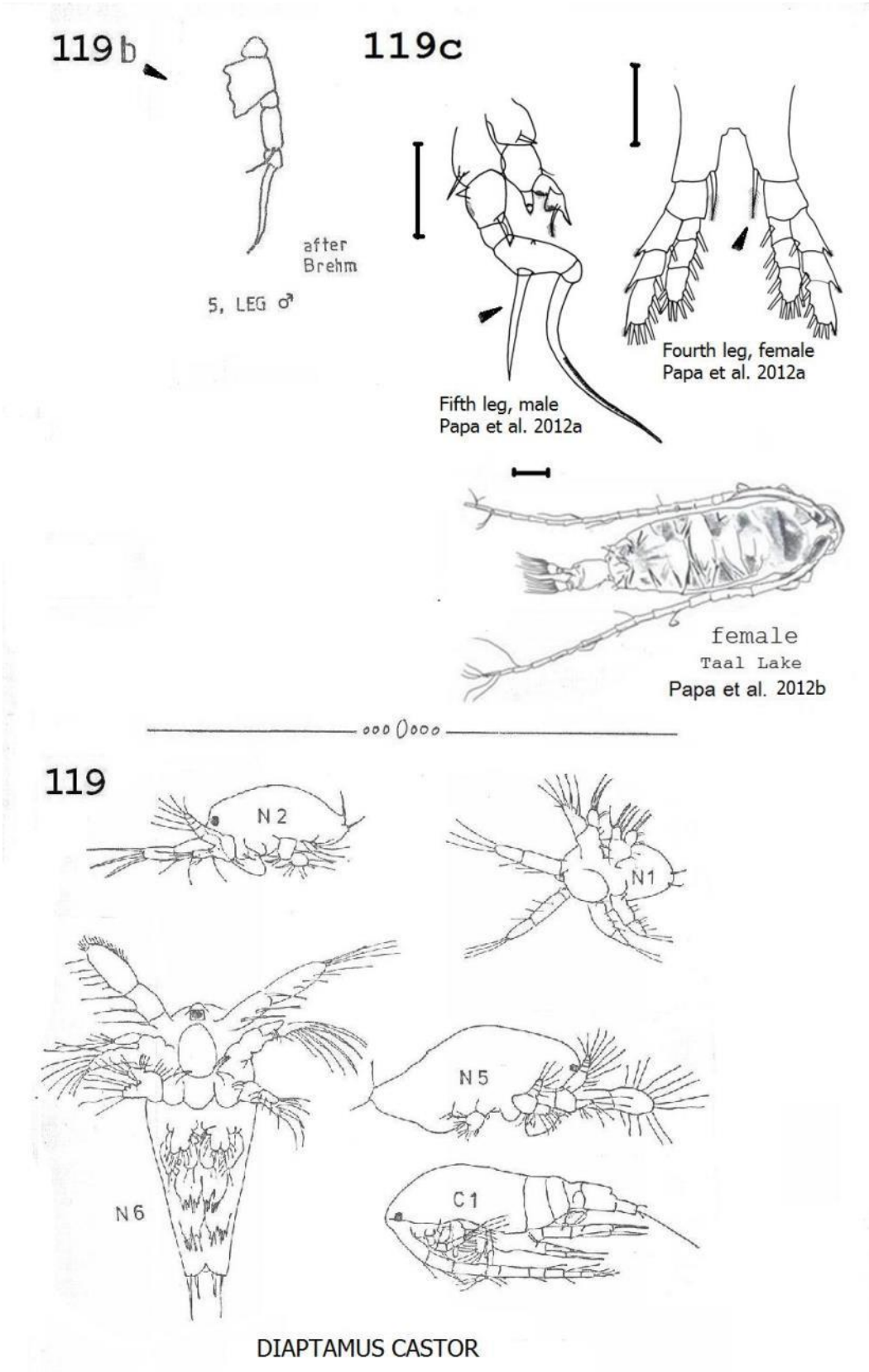

119a
C2
C1


119a

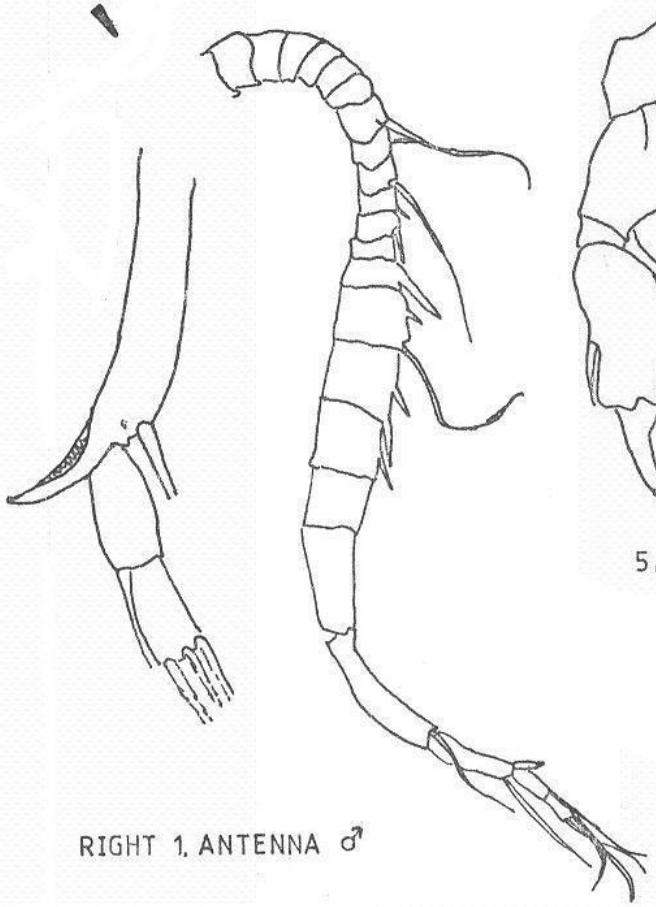

119a
FR80
FEMALE


119a

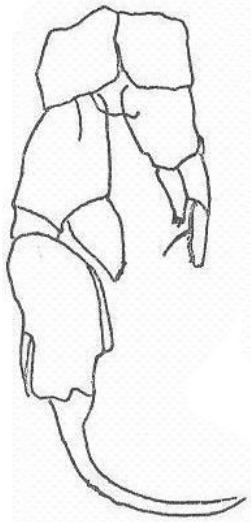

119a
SPERMATOPHORE
MALE


119b
after Brehm
5, LEG ♂
119c
Fifth leg, male
Papa et al. 2012a
Fourth leg, female
Papa et al. 2012a
female
Taal Lake
Papa et al. 2012b
119
N2
N1
N5
N6
C1
DIAPTAMUS CASTOR

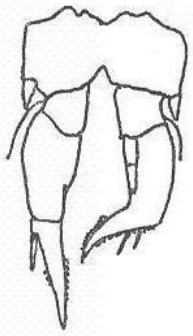
120a



RIGHT 1. ANTENNA ♂

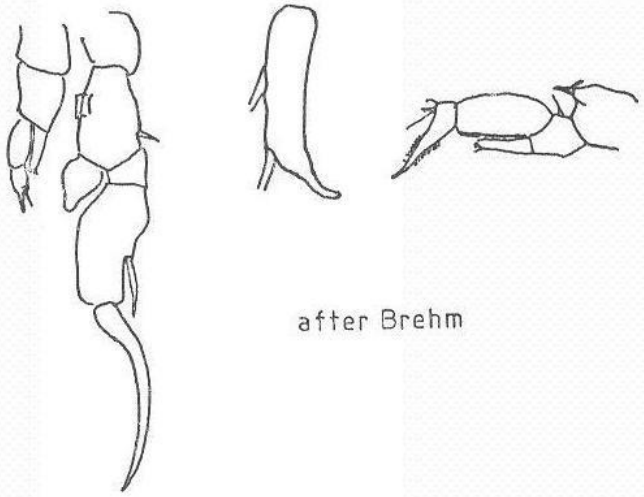


5. LEGS ♂

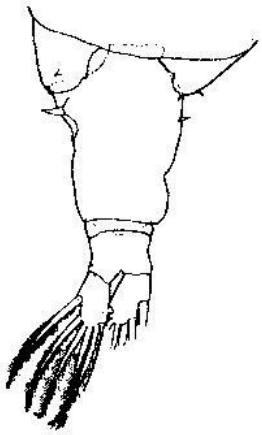


5. LEGS ♀

after Mamaril

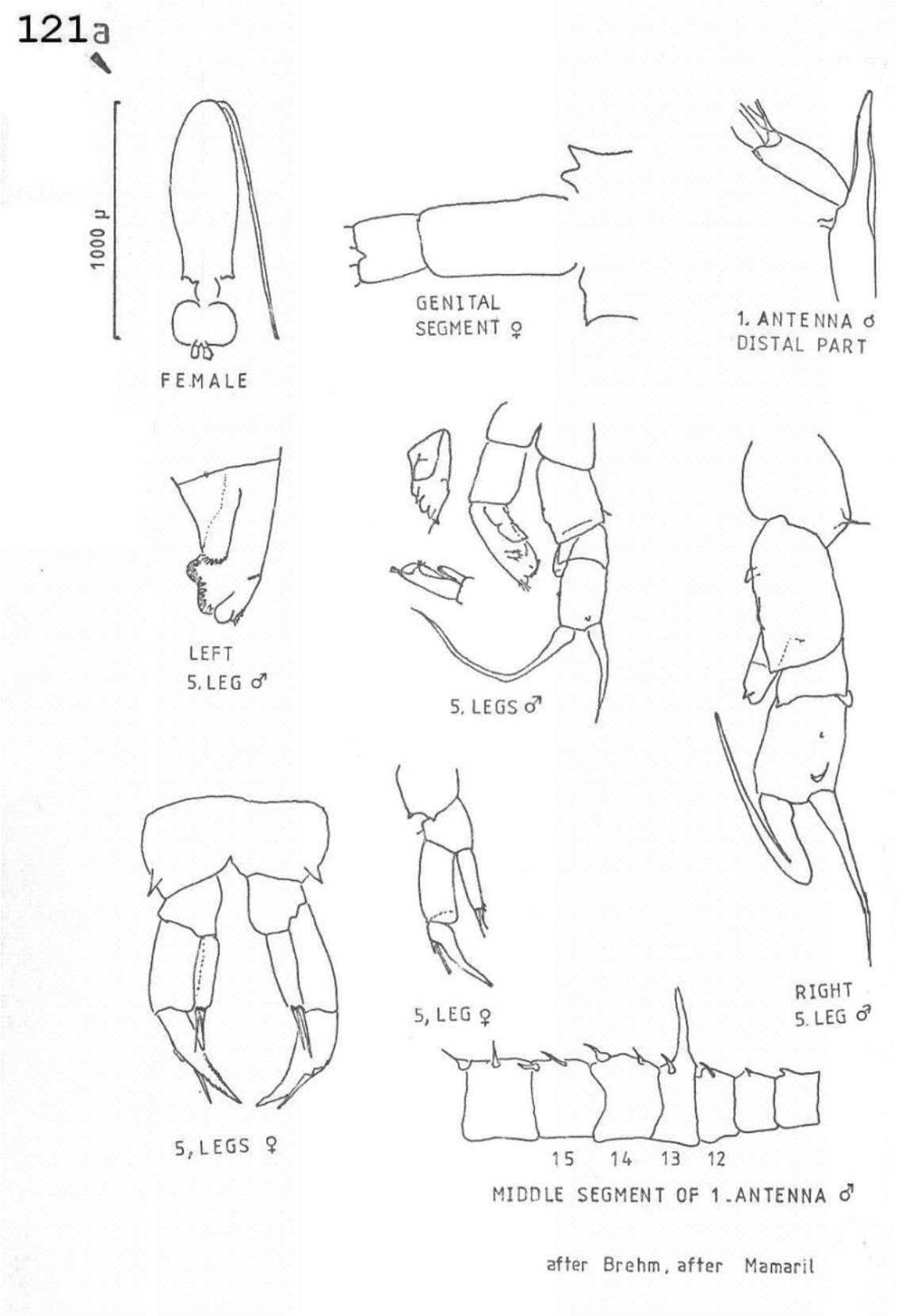


after Brehm



female urosome

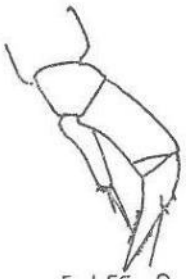
after Lai and Fernando


121a
1000 µ
FEMALE
GENITAL SEGMENT ♀
1. ANTENNA ♂ DISTAL PART
LEFT 5. LEG ♂
5. LEGS ♂
RIGHT 5. LEG ♂
5, LEG ♀
5, LEGS ♀
15 14 13 12
MIDDLE SEGMENT OF 1. ANTENNA ♂
after Brehm, after Mamaril

122a (=123b)

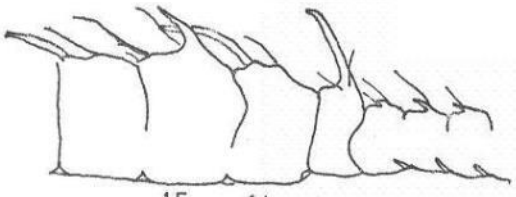


5. LEGS ♂



after Brehm

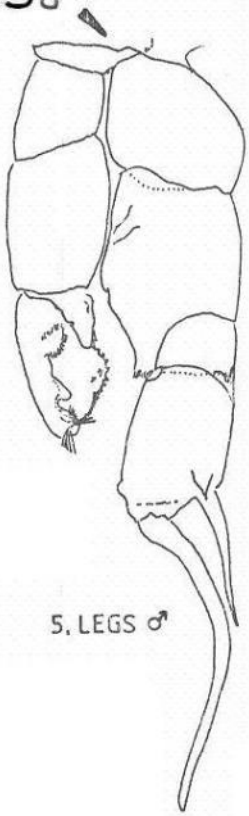
5. LEG ♀



15 14 13

MIDDLE SEGMENT 1. ANTENNA ♂

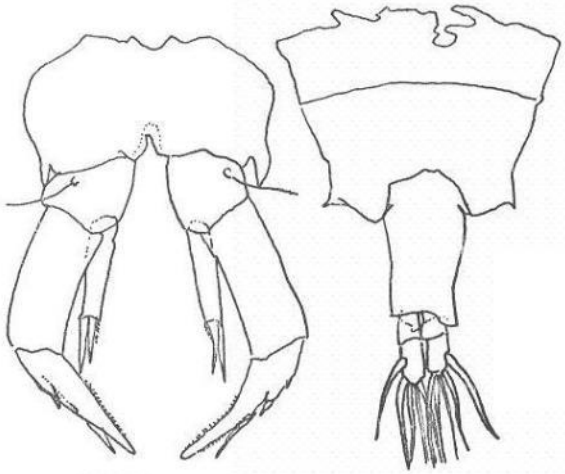
123a



5. LEGS ♂

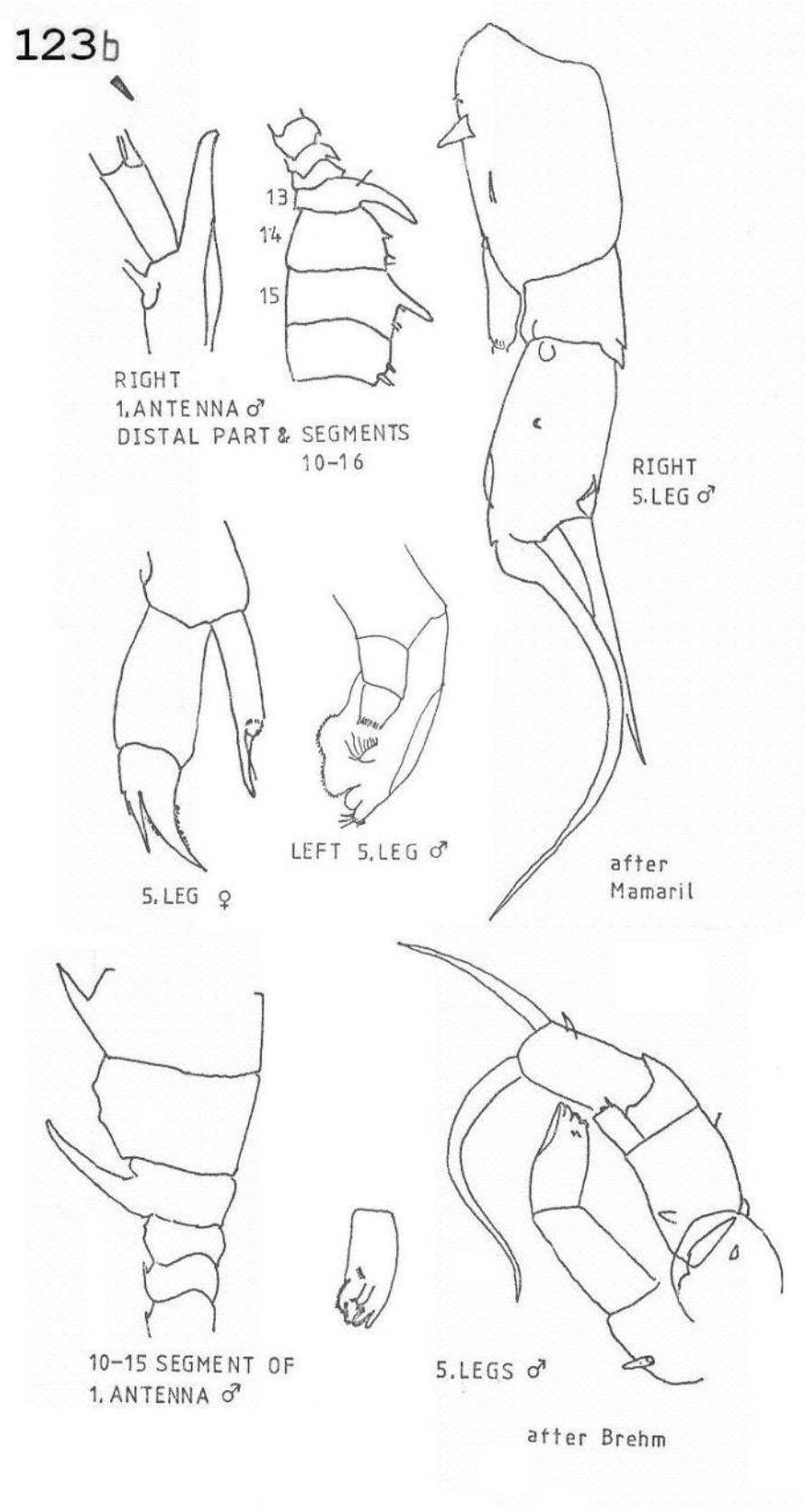


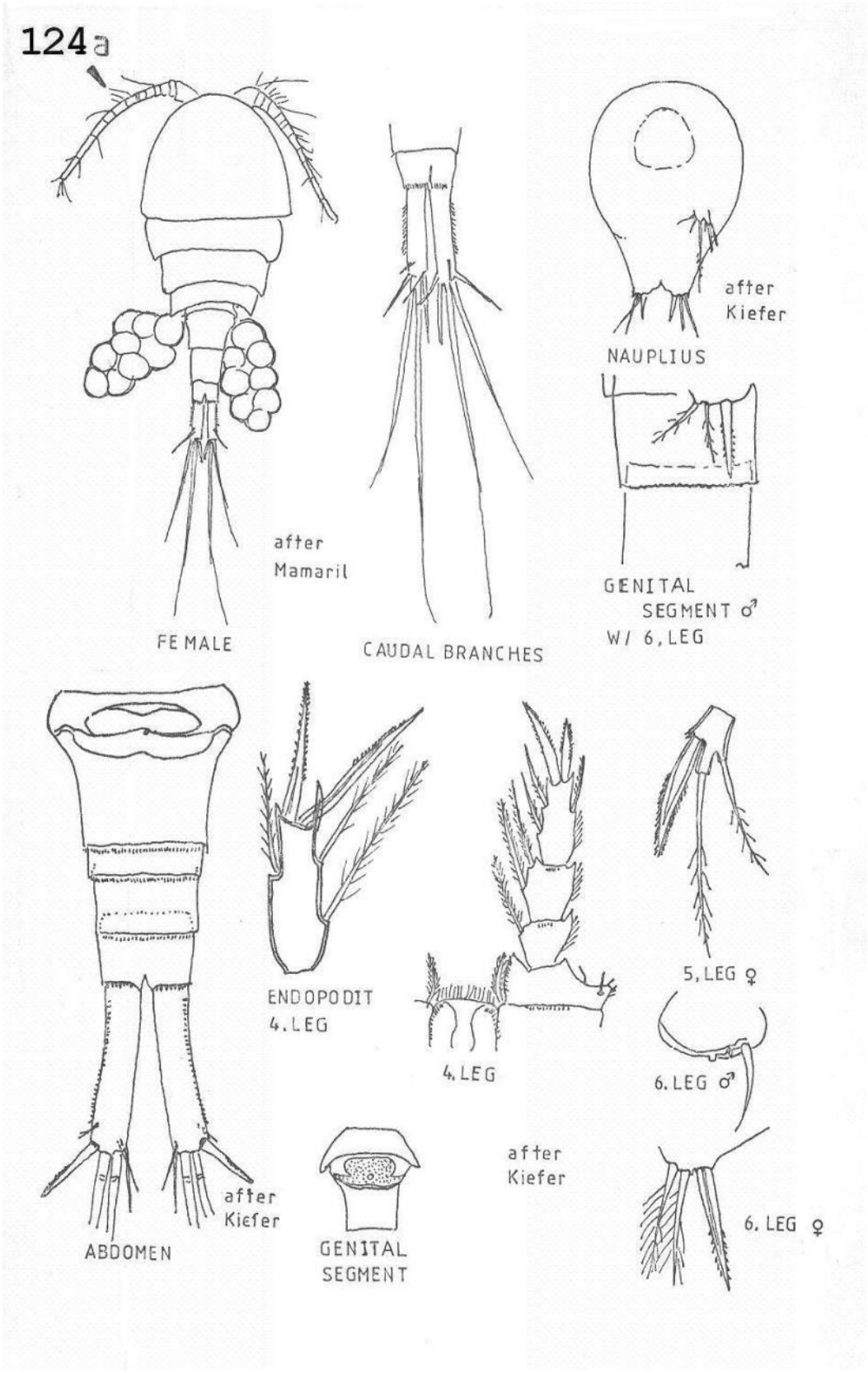
RIGHT 1. ANTENNA ♂

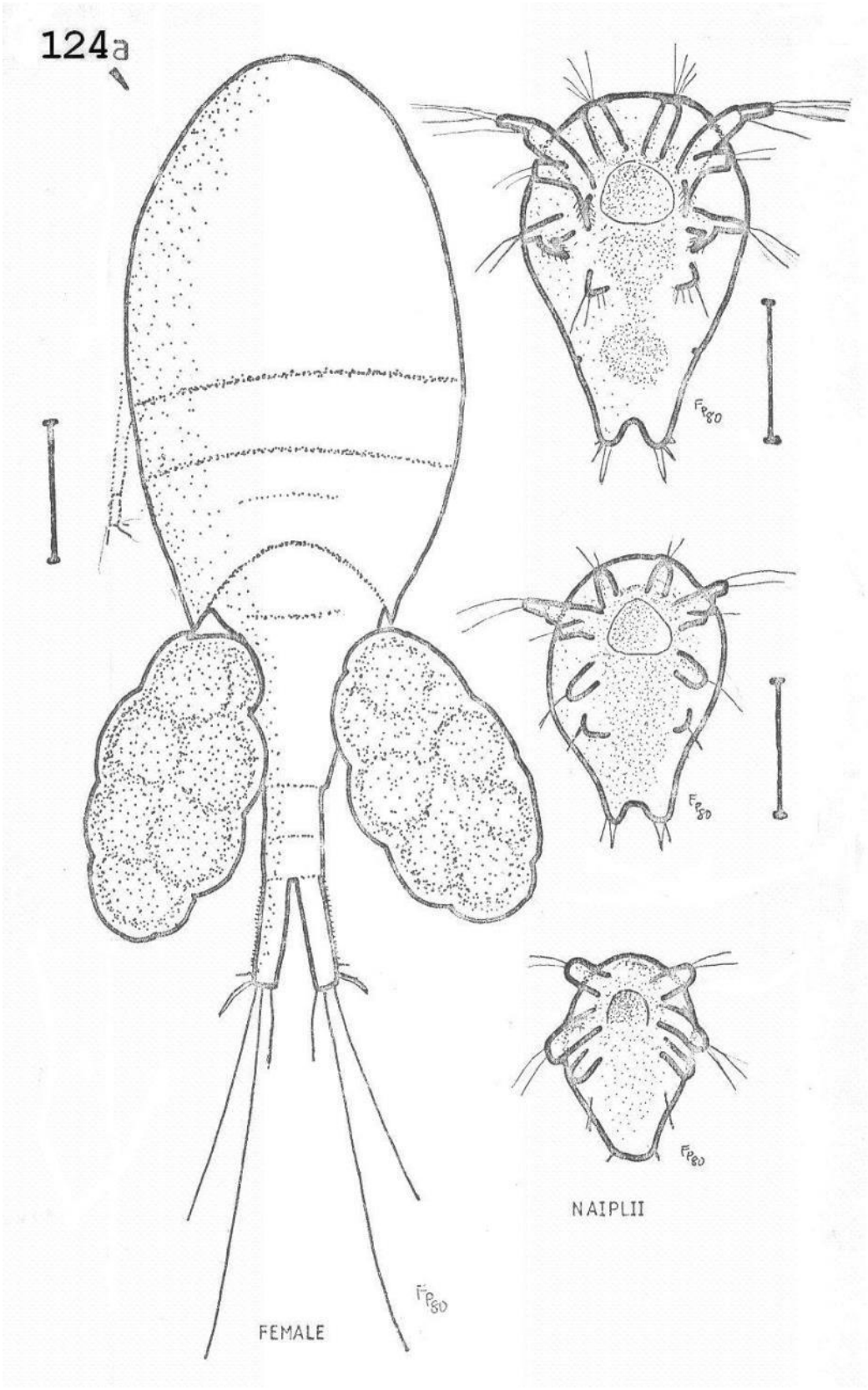


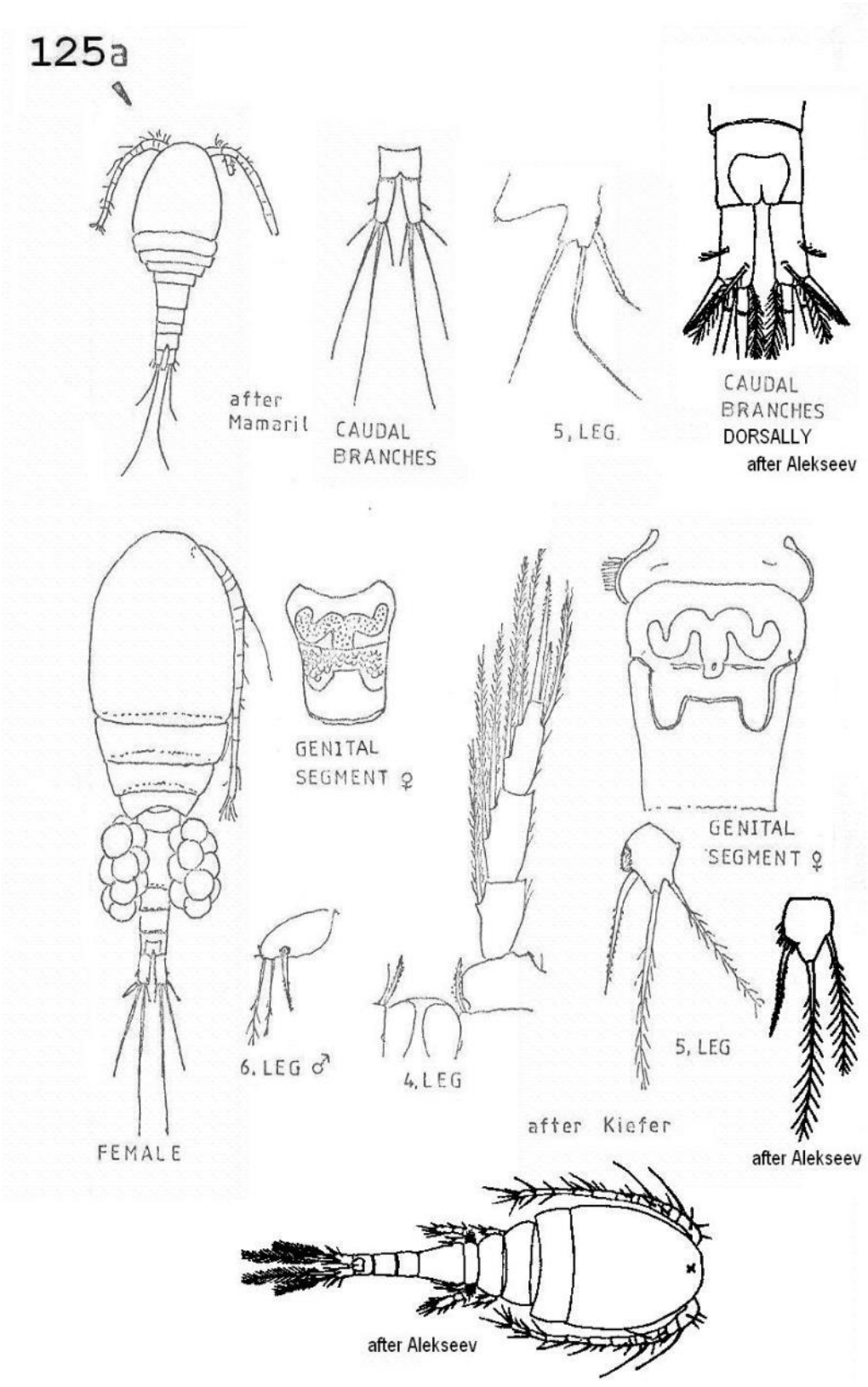
5. LEGS ♀ POSTERIOR BODY ♀

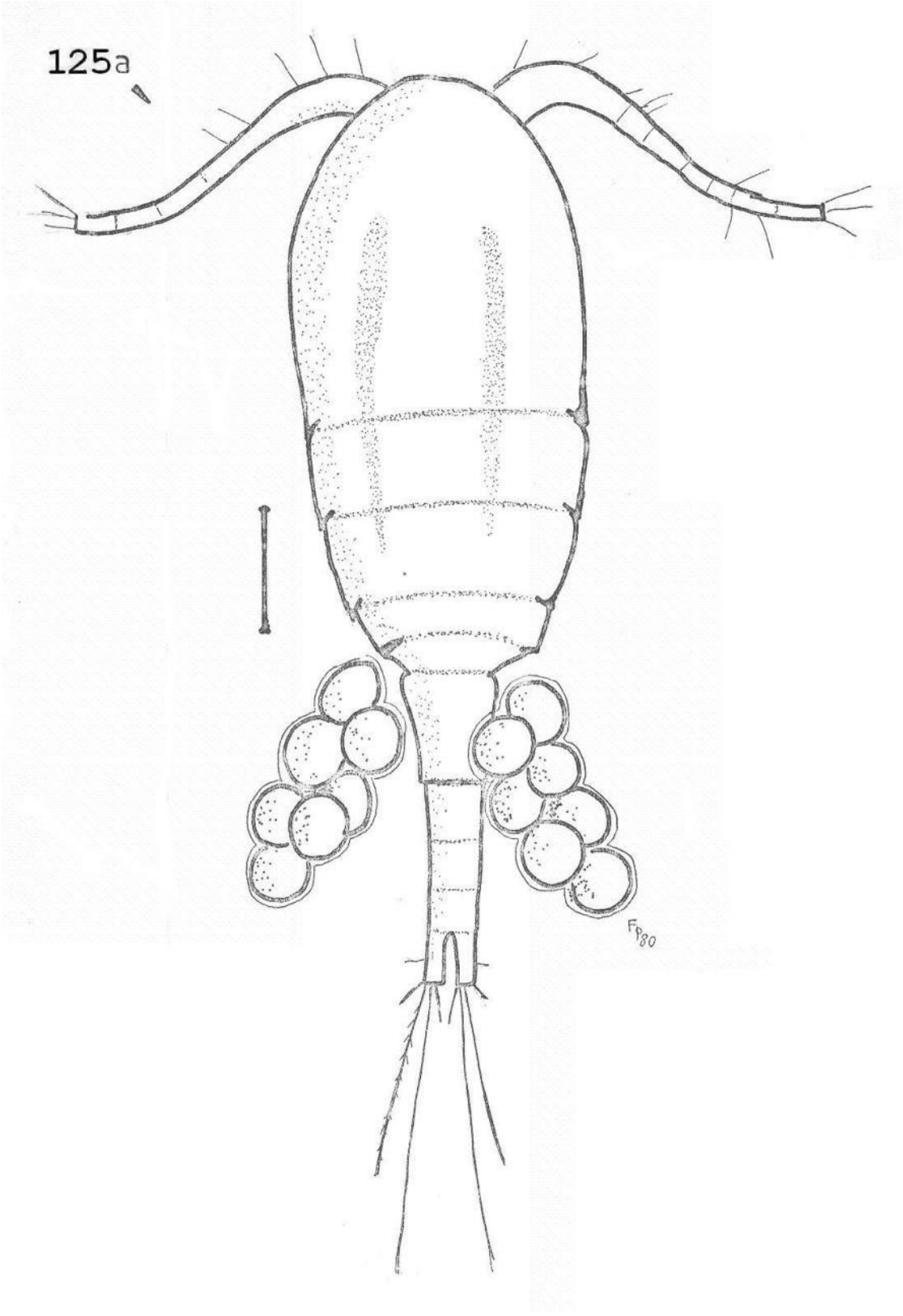
after Mamaril

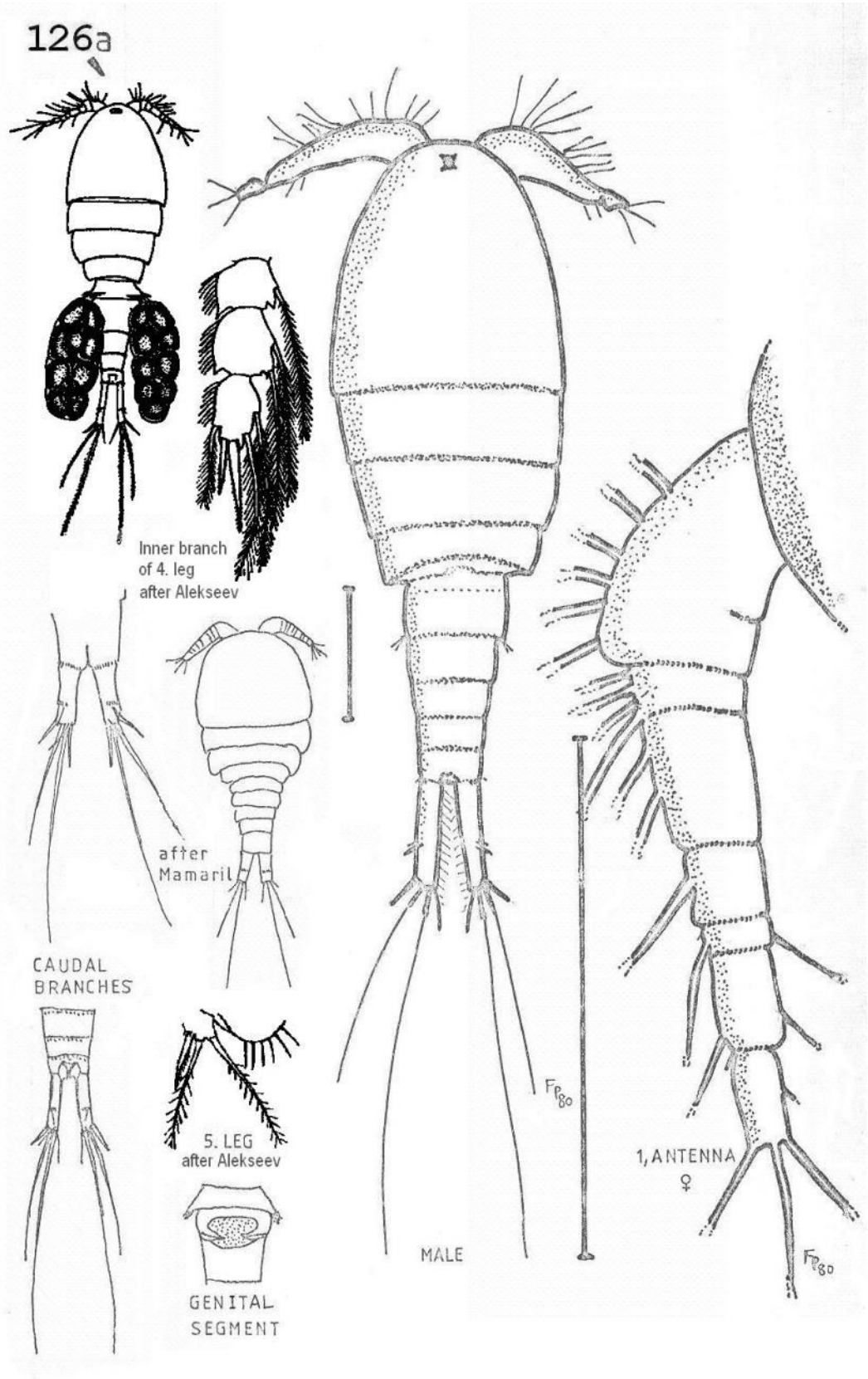

123b
13
14
15
RIGHT
1. ANTENNA ♂
DISTAL PART & SEGMENTS
10-16
RIGHT
5. LEG ♂
5. LEG ♀
LEFT 5. LEG ♂
after
Mamaril
10-15 SEGMENT OF
1. ANTENNA ♂
5. LEGS ♂
after Brehm

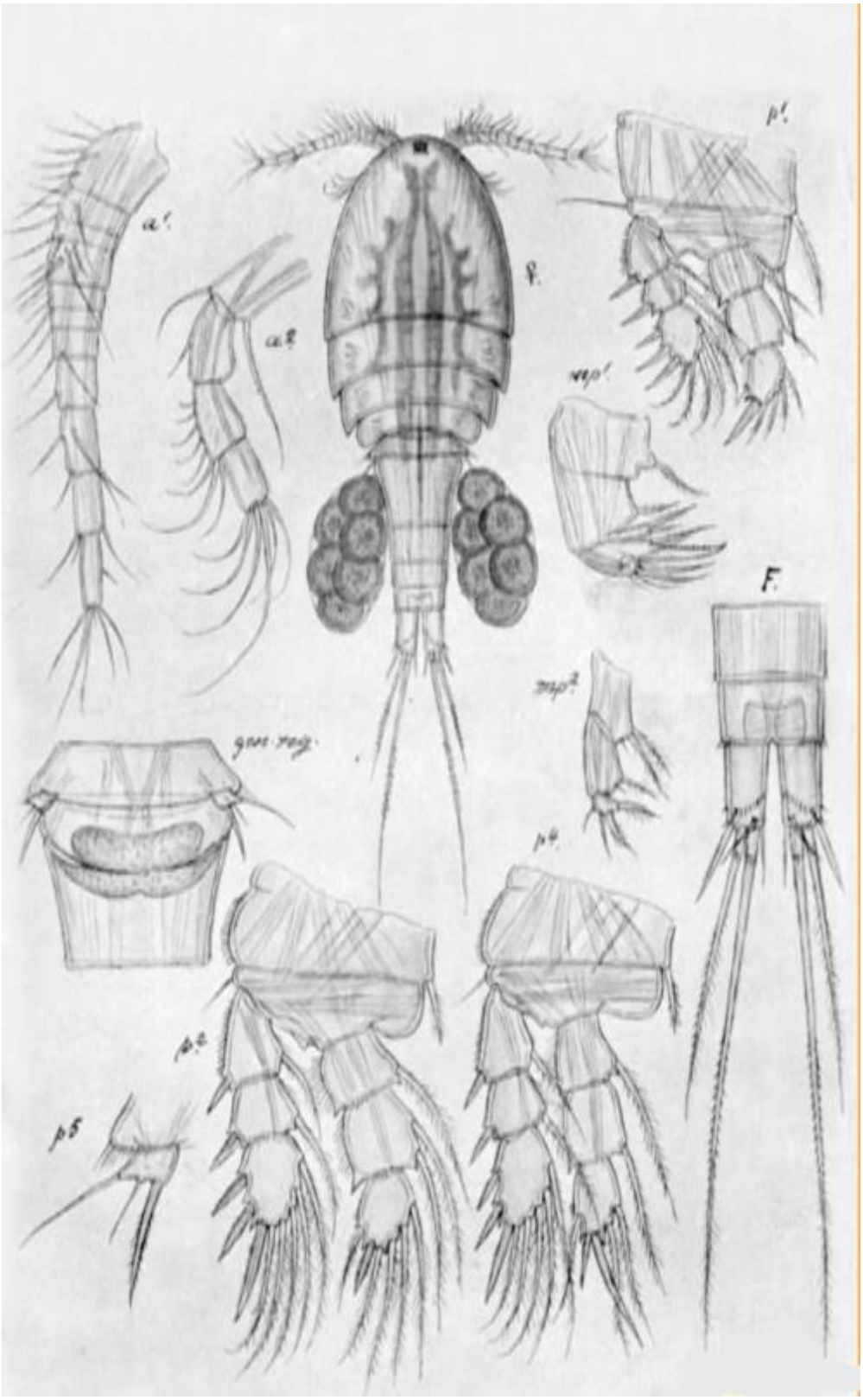

124a
after
Mamaril
FEMALE
CAUDAL BRANCHES
after
Kiefer
NAUPLIUS
GENITAL
SEGMENT ♂
W/ 6. LEG
ENDOPODIT
4. LEG
4. LEG
5. LEG ♀
6. LEG ♂
6. LEG ♀
after
Kiefer
ABDOMEN
after
Kiefer
GENITAL
SEGMENT

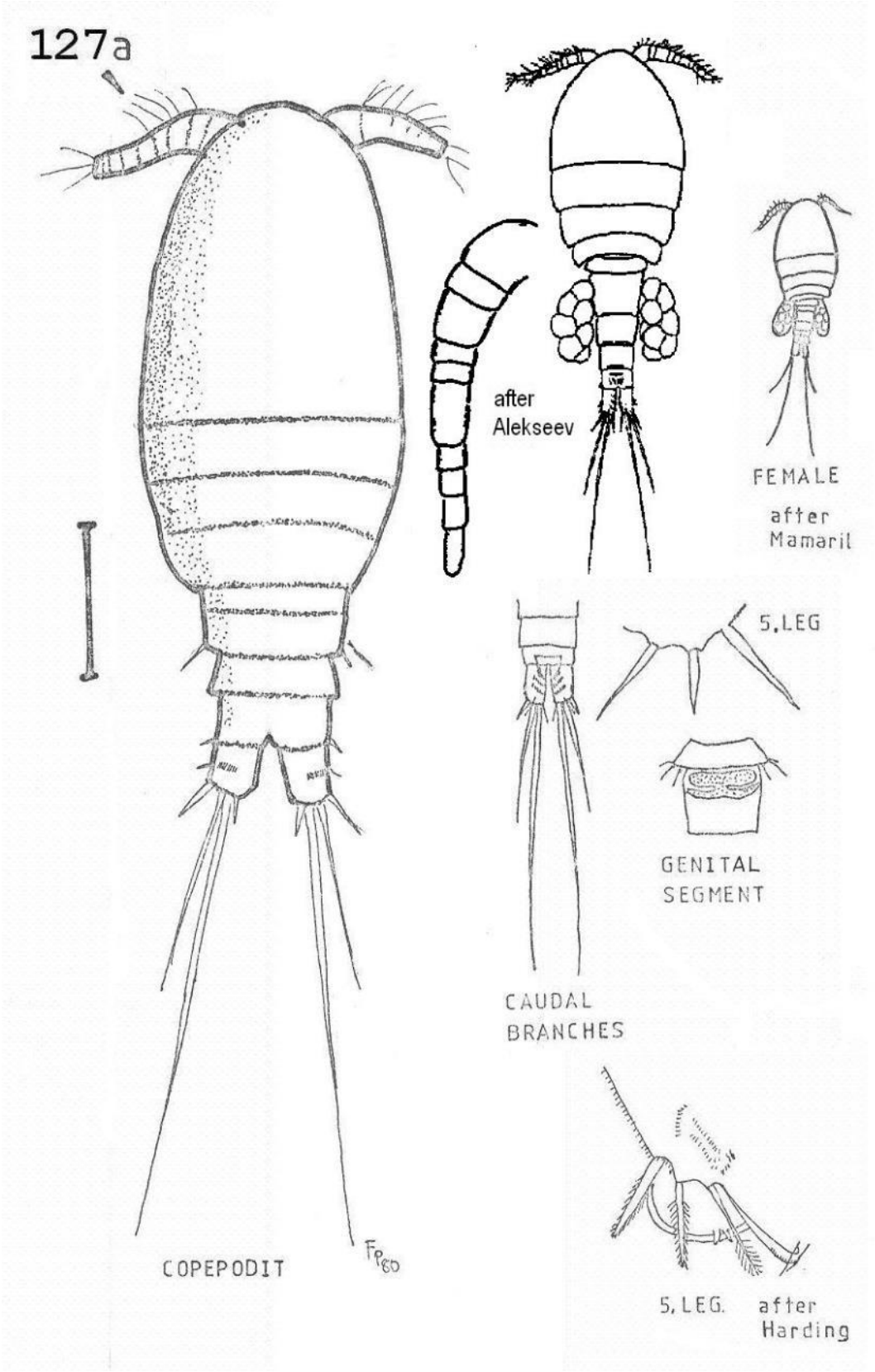

124a
FEMALE
NAIPLII

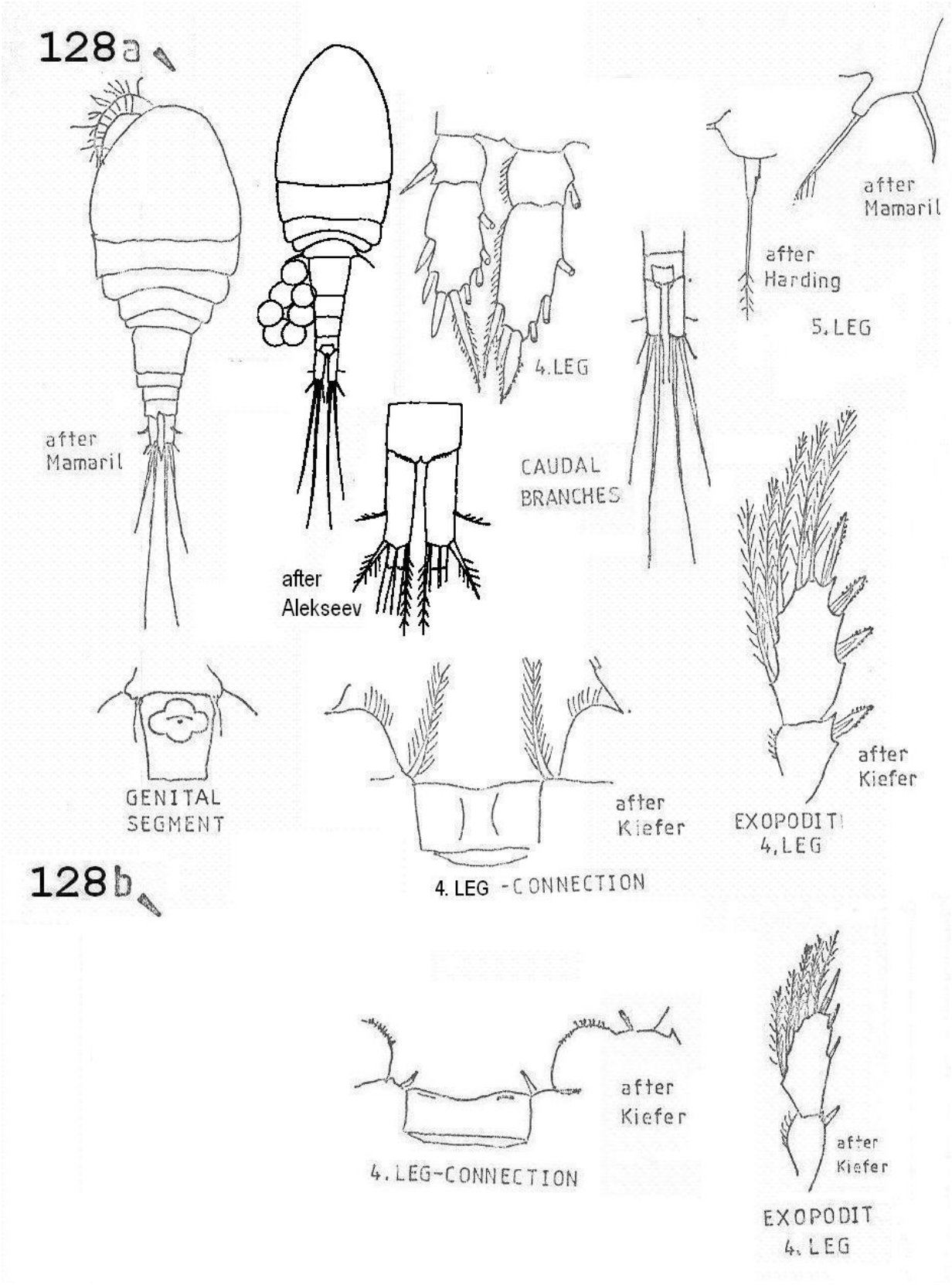

125a
after Mamaril
CAUDAL BRANCHES
5, LEG.
CAUDAL BRANCHES DORSALLY
after Alekseev
GENITAL SEGMENT ♀
FEMALE
6. LEG ♂
4. LEG
GENITAL SEGMENT ♀
5, LEG
after Kiefer
after Alekseev
after Alekseev

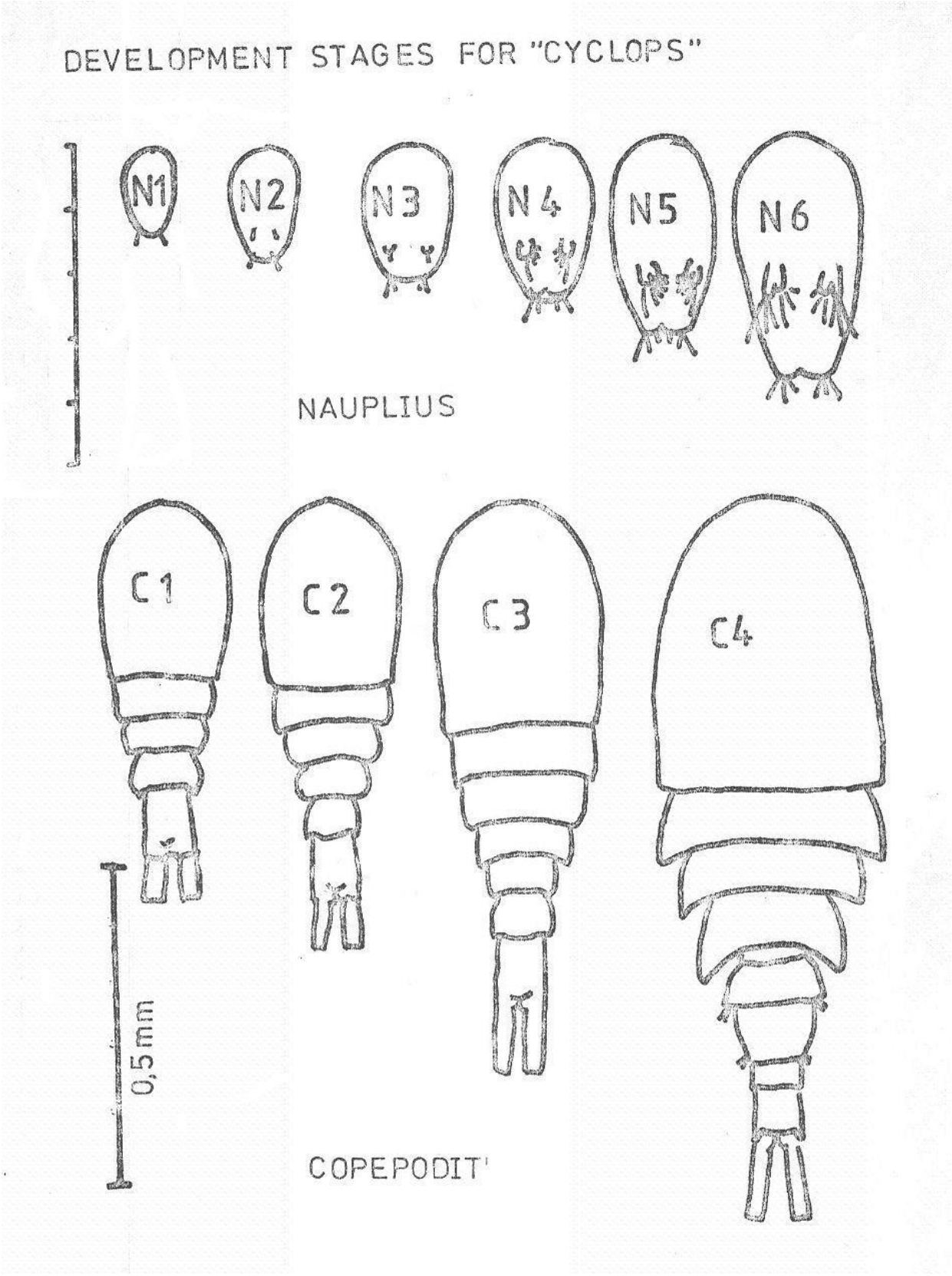

125a
FP80

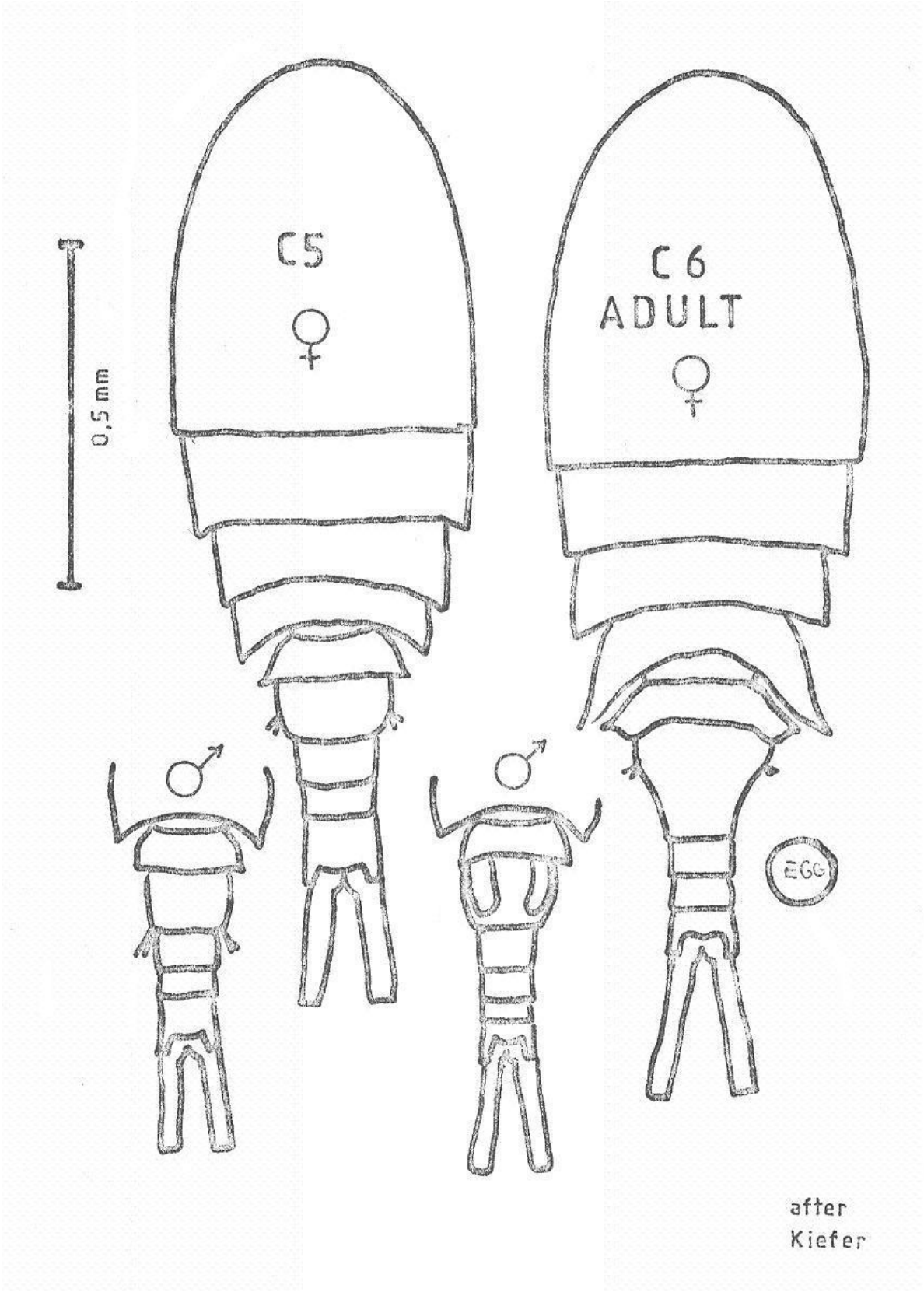

126a
Inner branch
of 4. leg
after Alekseev
after
Mamaril
CAUDAL
BRANCHES
5. LEG
after Alekseev
GENITAL
SEGMENT
MALE
1, ANTENNA
♀

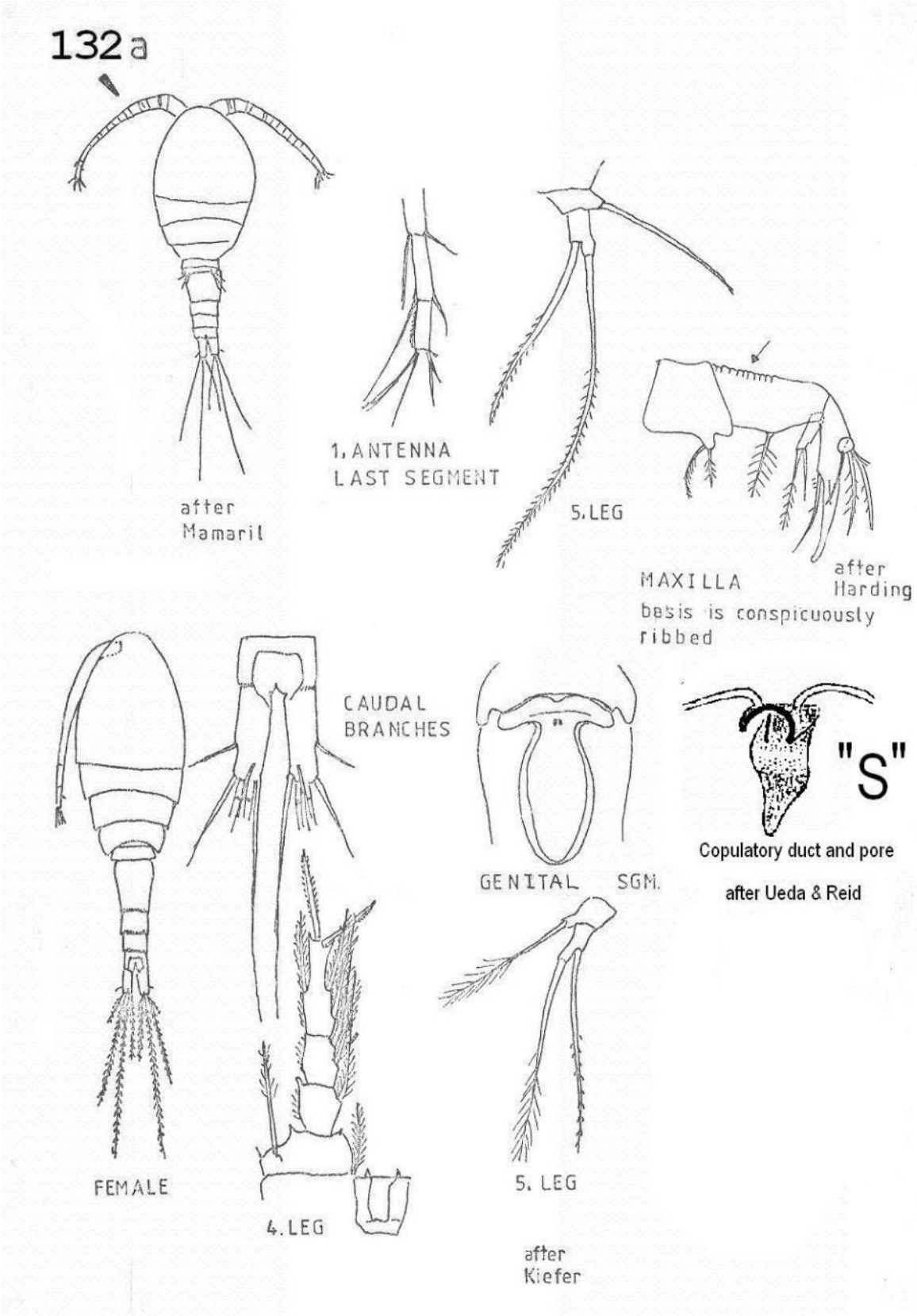

a1
a2
P
p1
mp1
F
mp2
gen. seg.
p4
p2
p5


127a
after
Alekseev
FEMALE
after
Mamaril
5.LEG
GENITAL
SEGMENT
CAUDAL
BRANCHES
COPEPODIT
5.LEG. after
Harding

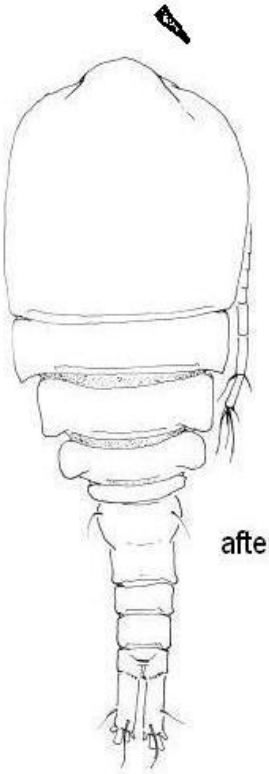

128a
after Mamaril
after Alekseev
4.LEG
CAUDAL BRANCHES
after Harding
after Mamaril
5.LEG
GENITAL SEGMENT
after Kiefer
4. LEG -CONNECTION
after Kiefer
EXOPODIT 4.LEG
128b
after Kiefer
4.LEG-CONNECTION
after Kiefer
EXOPODIT 4.LEG

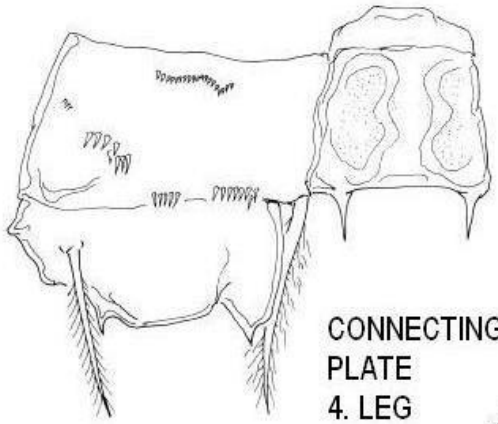

DEVELOPMENT STAGES FOR "CYCLOPS"
N1
N2
N3
N4
N5
N6
NAUPLIUS
C1
C2
C3
C4
0,5 mm
COPEPODIT


C5
C6
ADULT
0,5 mm
EGG
after
Kiefer


132 a
after
Mamaril
1. ANTENNA
LAST SEGMENT
5. LEG
MAXILLA
after
Harding
basis is conspicuously
ribbed
CAUDAL
BRANCHES
"S"
Copulatory duct and pore
after Ueda & Reid
GENITAL SGM.
FEMALE
4. LEG
5. LEG
after
Kiefer

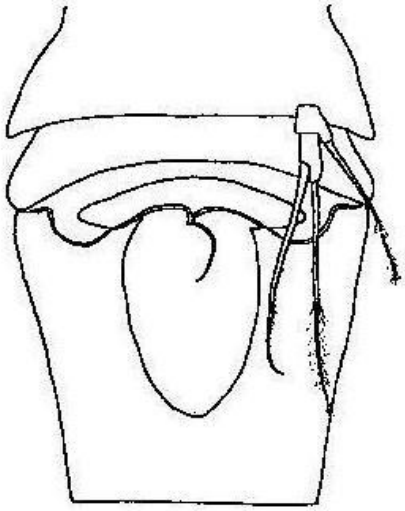
133 a





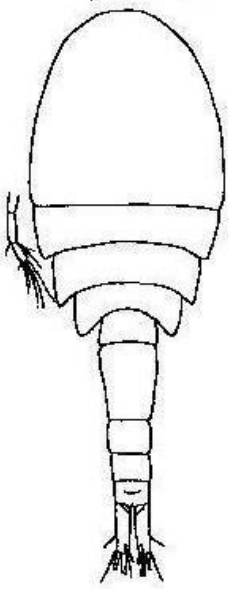
CONNECTING
PLATE
4. LEG

after Suárez-Morales et al.

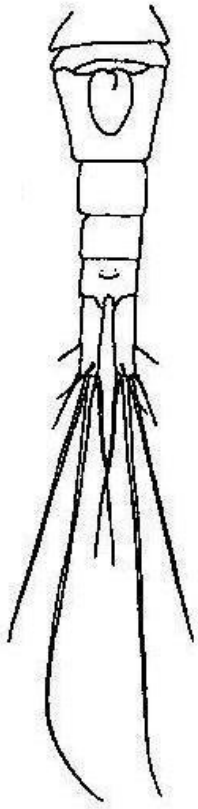


Genital segment

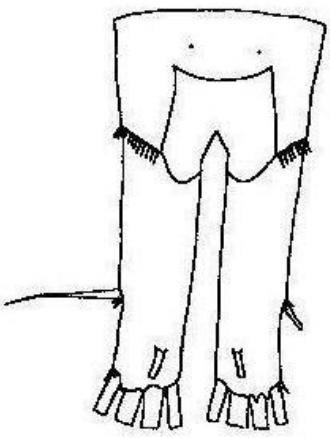
after
Ueda & Reid



FEMALE



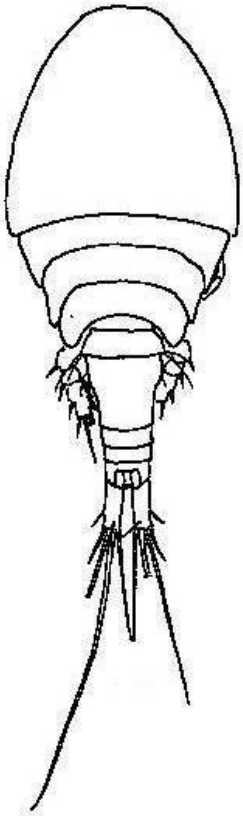
UROSOME

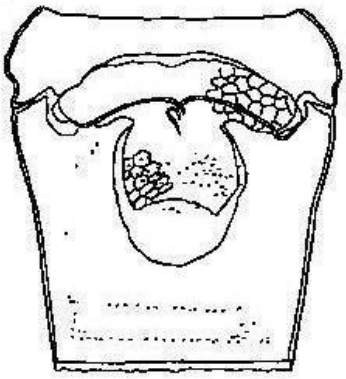


RAMI

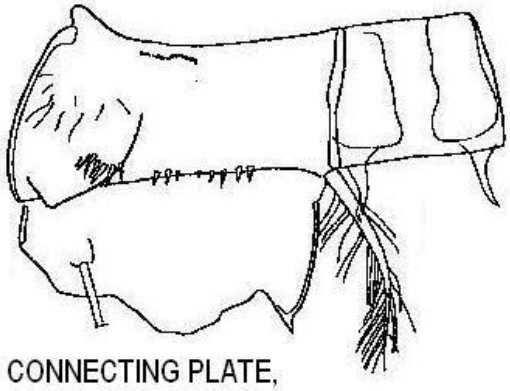
after Ueda & Reid

133b



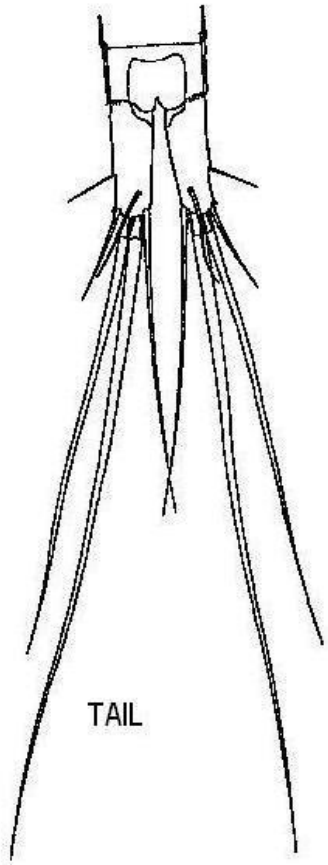


GENITAL SEGMENT

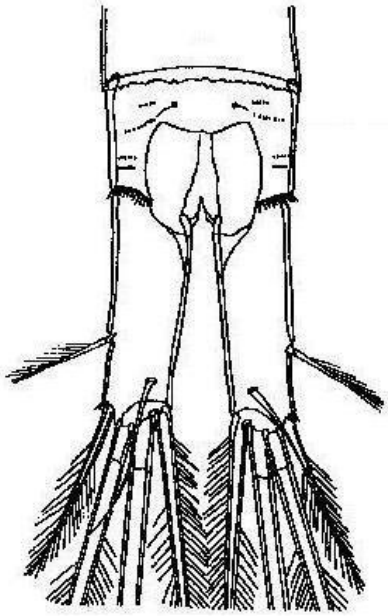


CONNECTING PLATE,
4. LEG

after Ueda & Reid

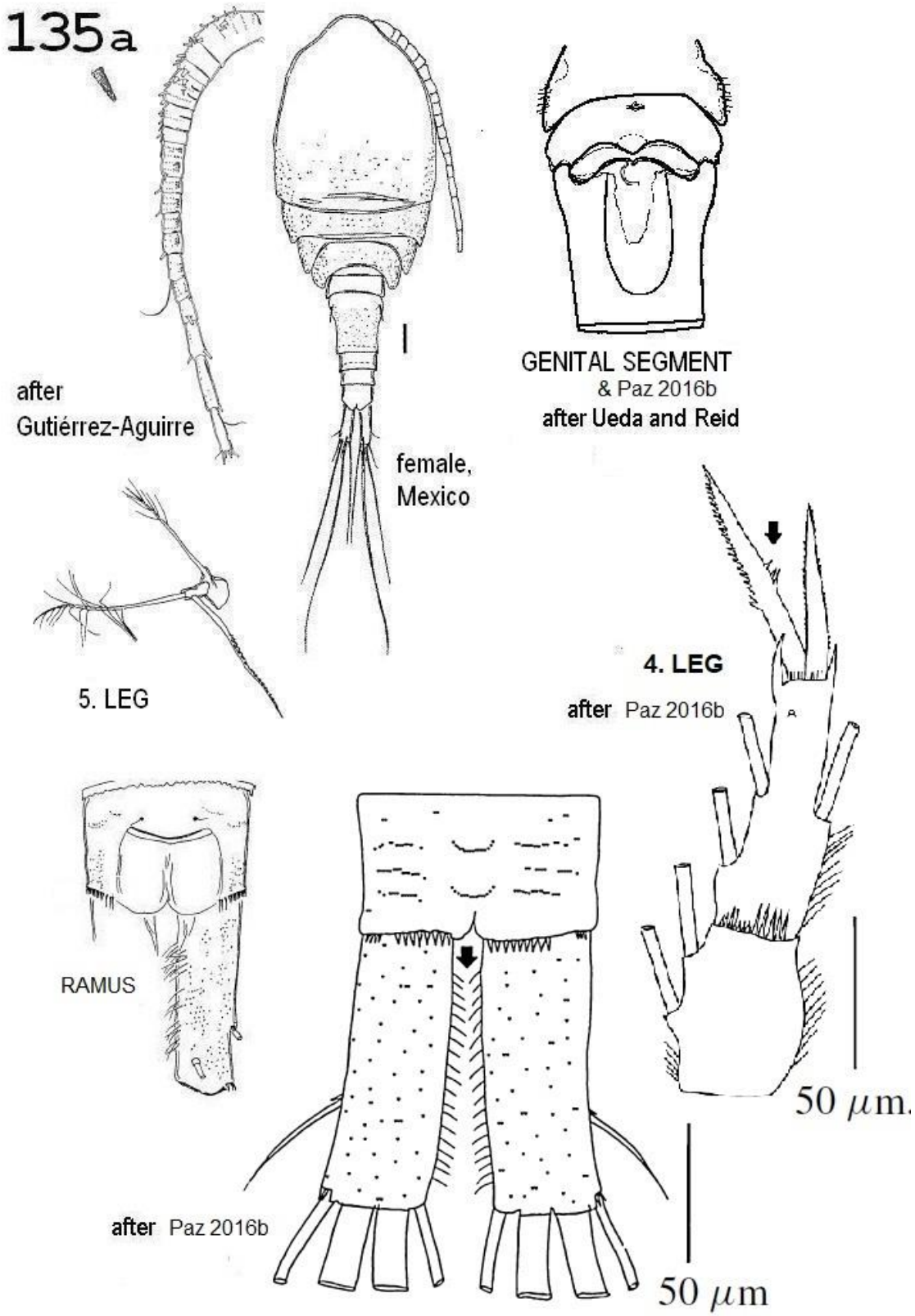


TAIL

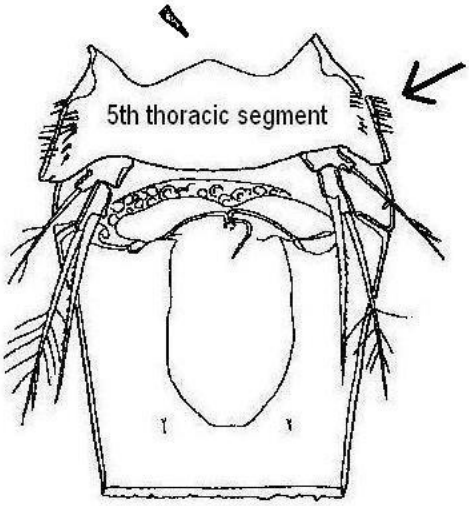


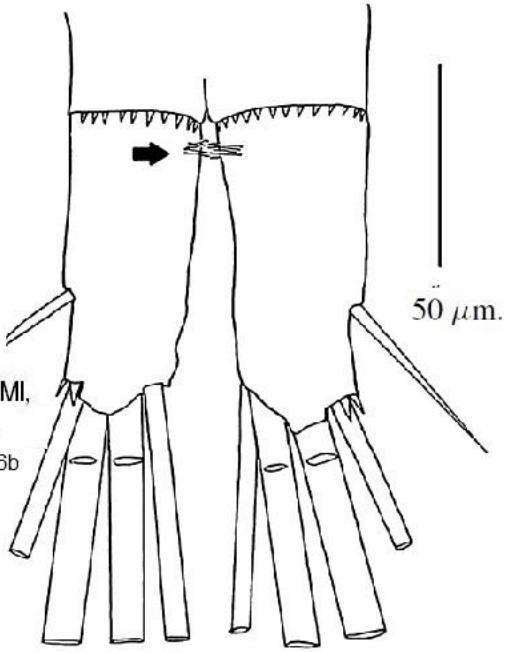
RAMI

after Ueda & Reid


135a
after
Gutiérrez-Aguirre
female,
Mexico
GENITAL SEGMENT
& Paz 2016b
after Ueda and Reid
5. LEG
4. LEG
after Paz 2016b
RAMUS
50 µm.
after Paz 2016b
50 µm

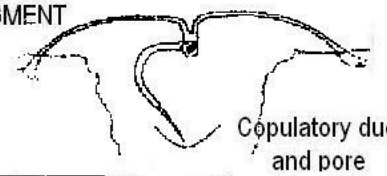
135b



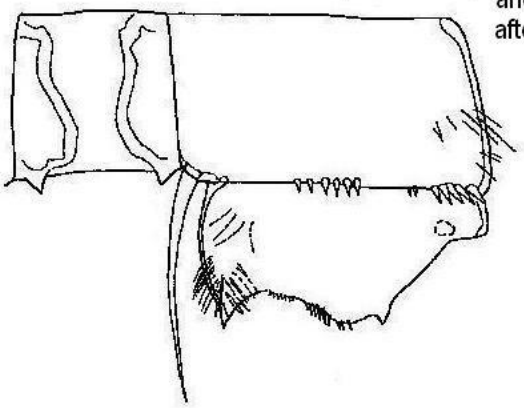


CAUDAL RAMI, VENTRAL
after Paz 2016b

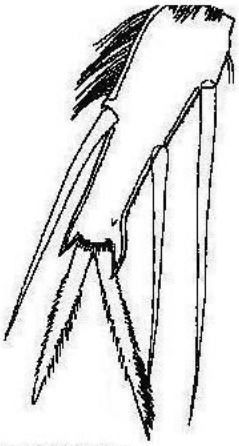
GENITAL SEGMENT
After UEDA & RAID



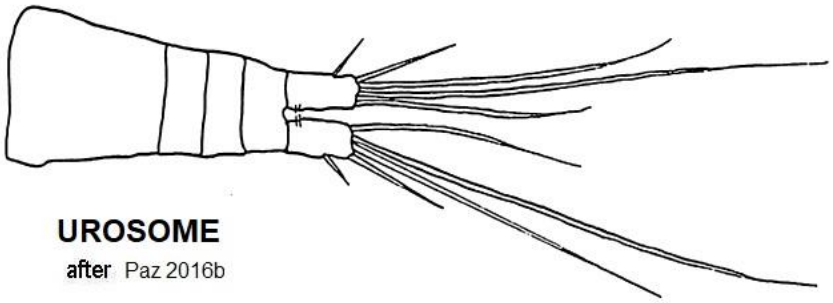
Copulatory duct and pore after Kiefer



CONNECTING PLATE OF 4. LEG
After UEDA & RAID

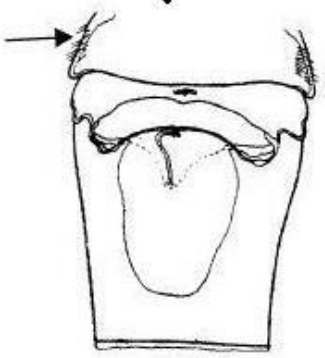


3. SEGMENT OF ENDPODITE OF 4. LEG
After UEDA & RAID

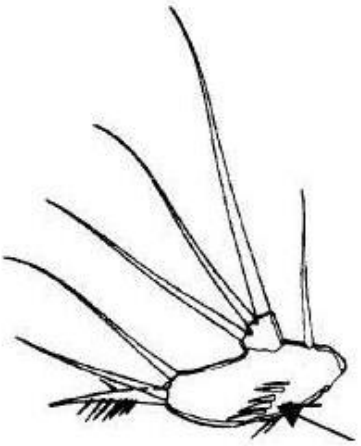


UROSOME
after Paz 2016b

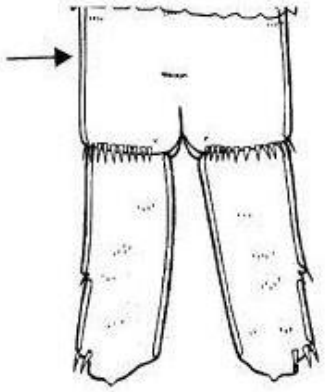
137a



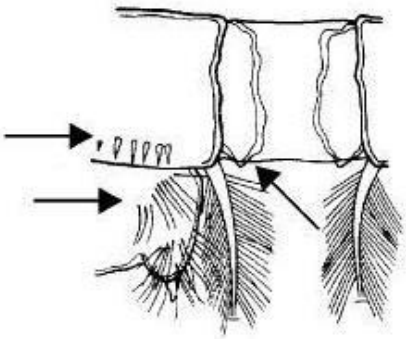
GENICAL SEGMENT



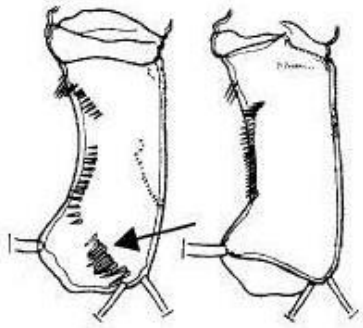
MAXILLULARY PALP



CAUDAL RAMI

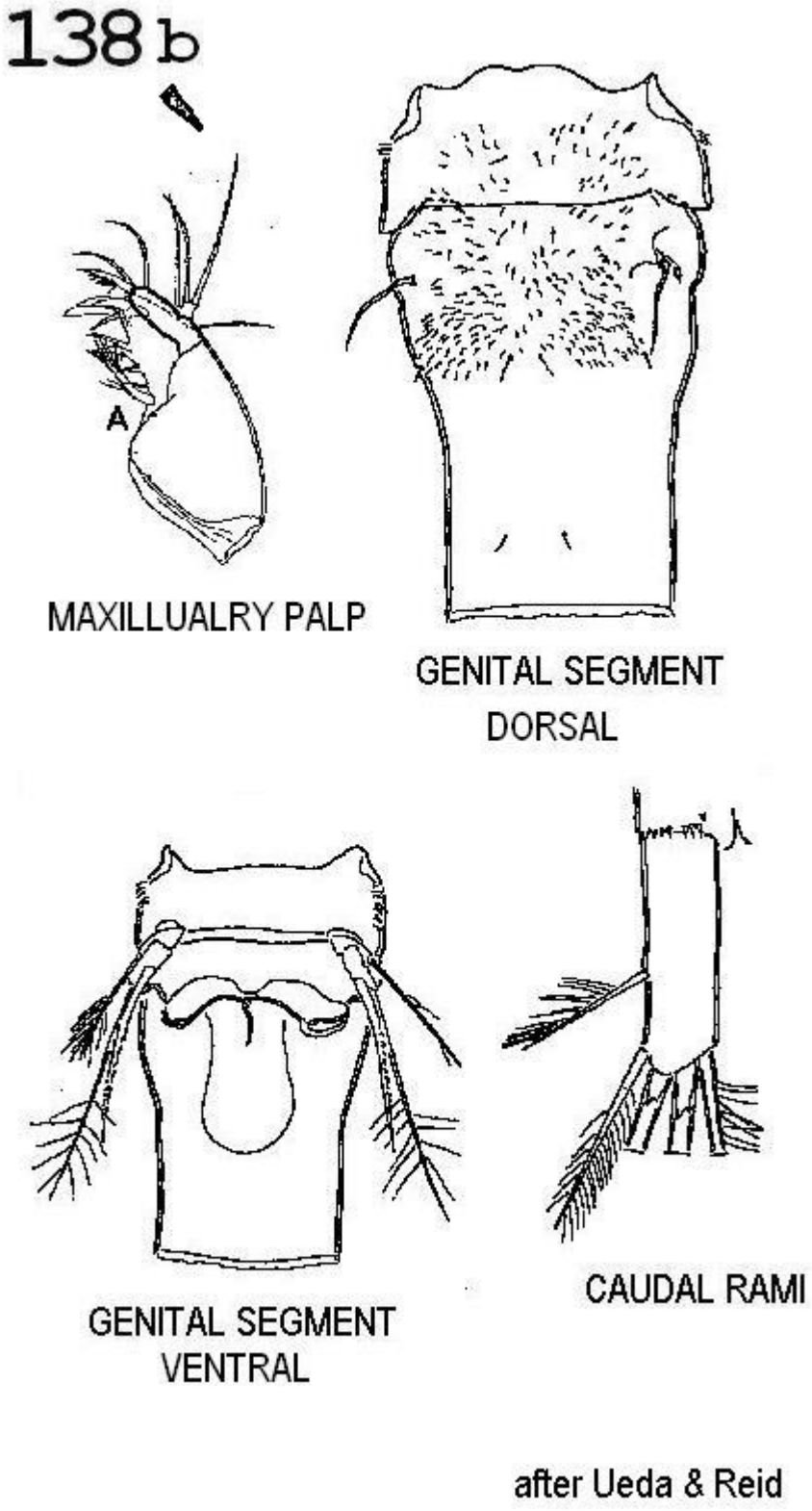


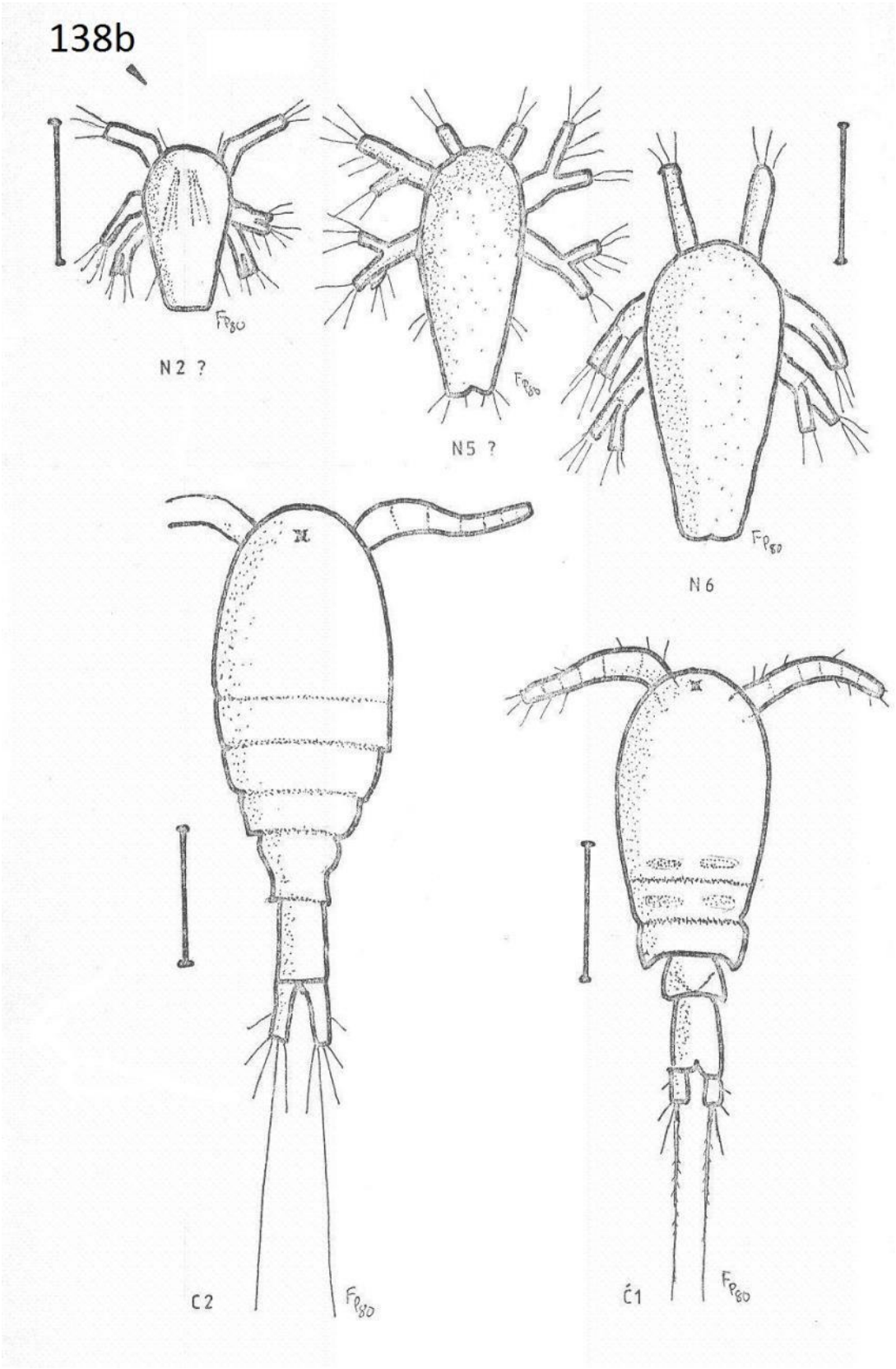
CONNECTING PLATE OF 4. LEGS

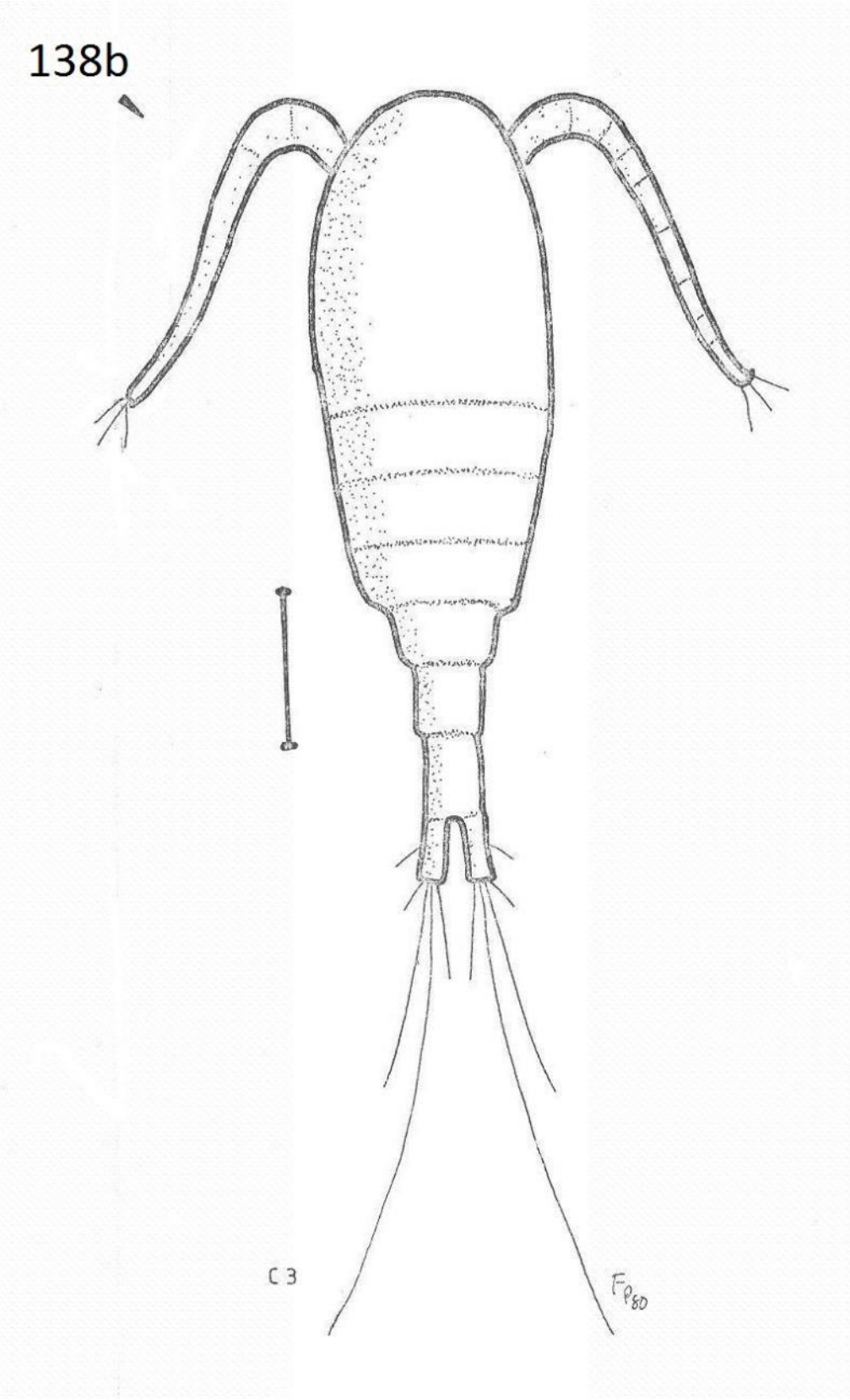


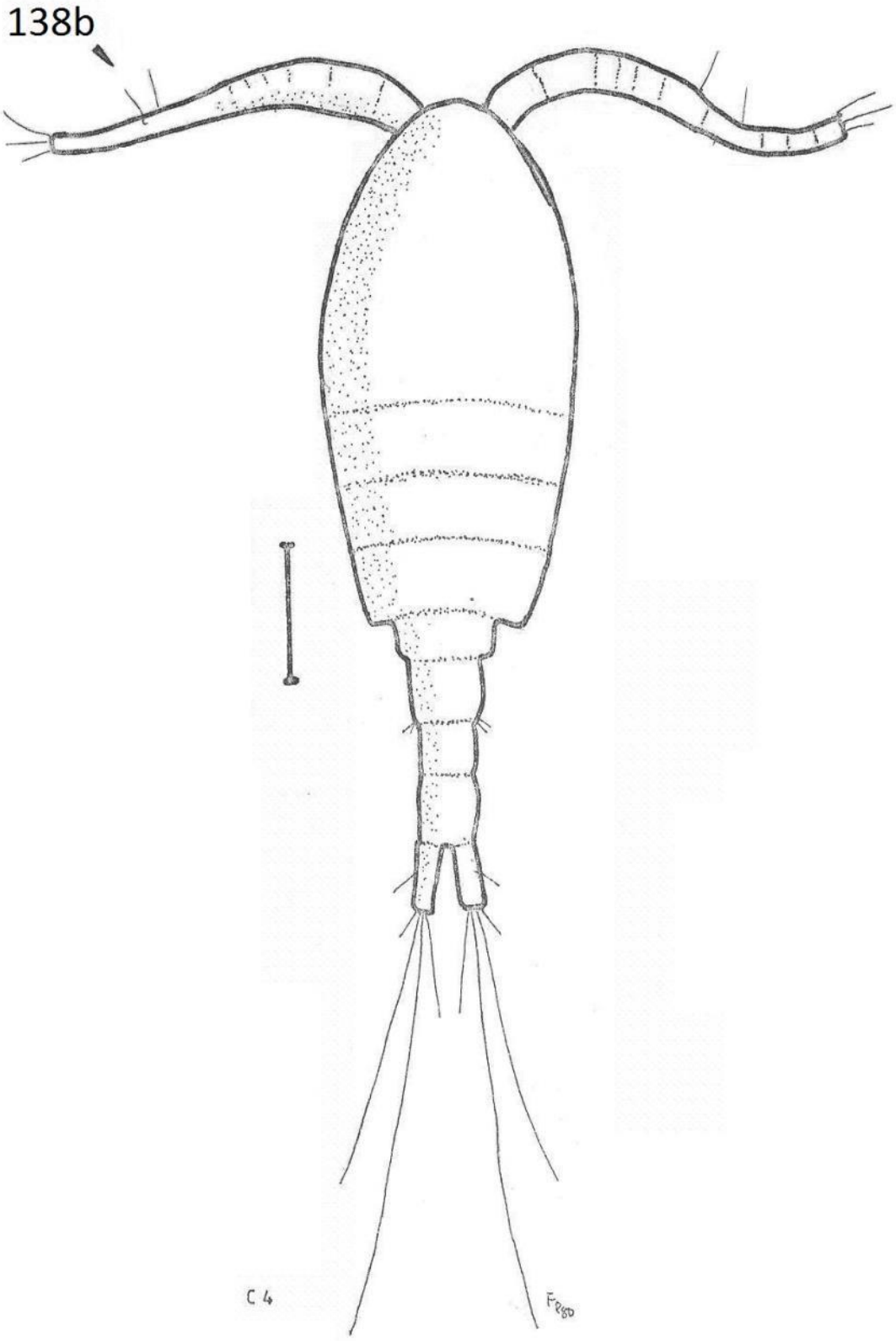
BASIPODITE OF ANTENNA

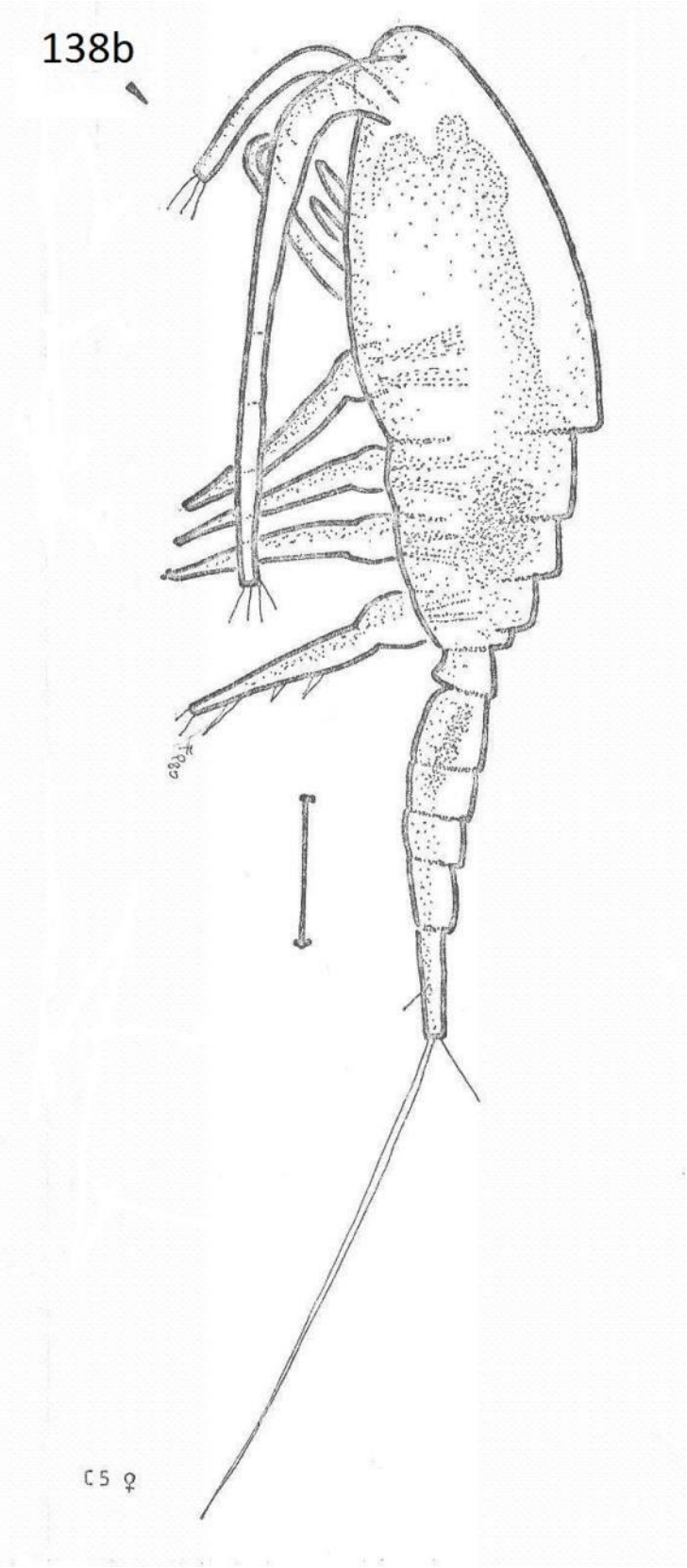
after
MATSUMURA-TUNDISI
& SILVA

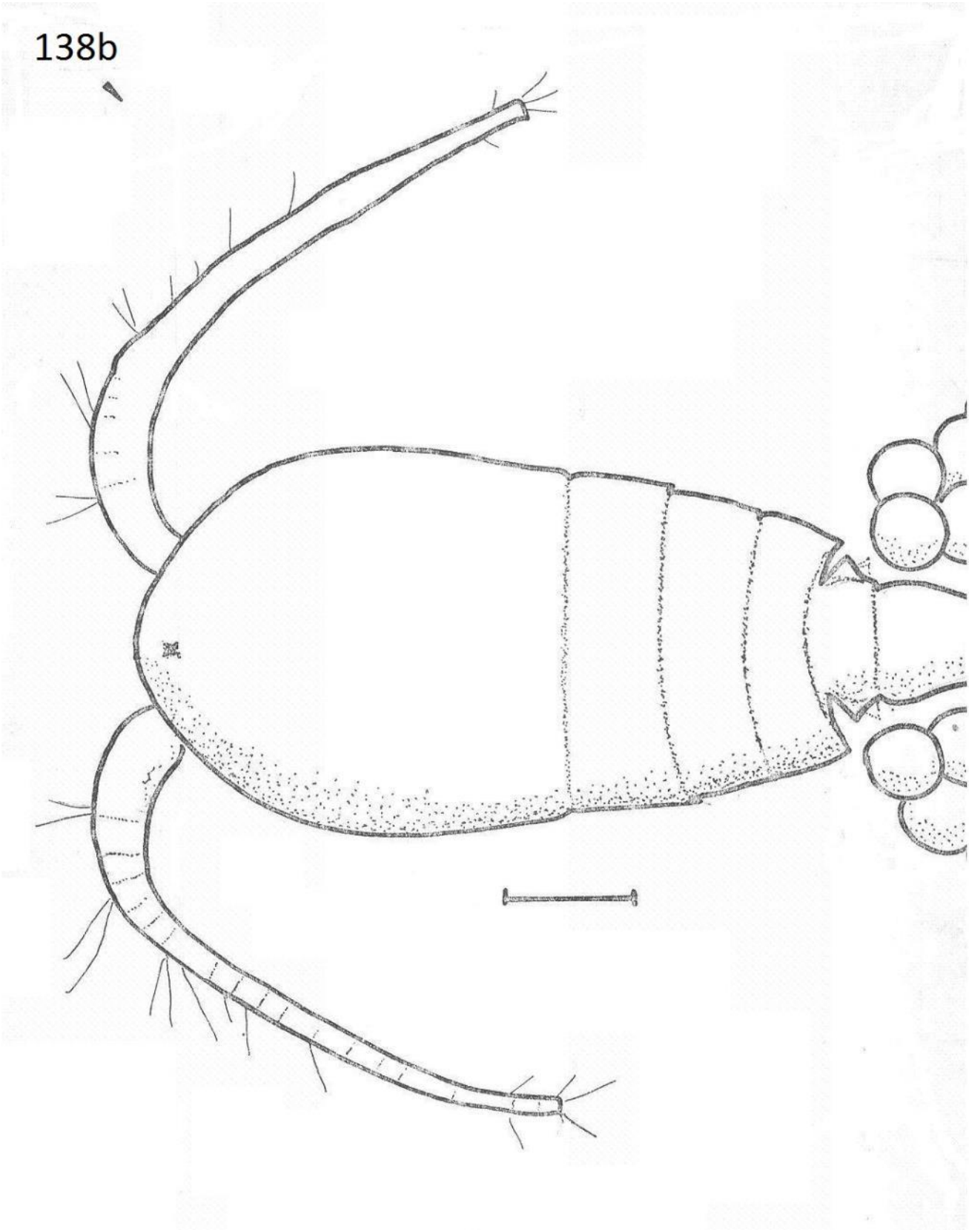

138 b
A
MAXILLUALRY PALP
GENITAL SEGMENT
DORSAL
GENITAL SEGMENT
VENTRAL
CAUDAL RAMI
after Ueda & Reid


138b
N2 ?
N5 ?
N6
C2
Ć1

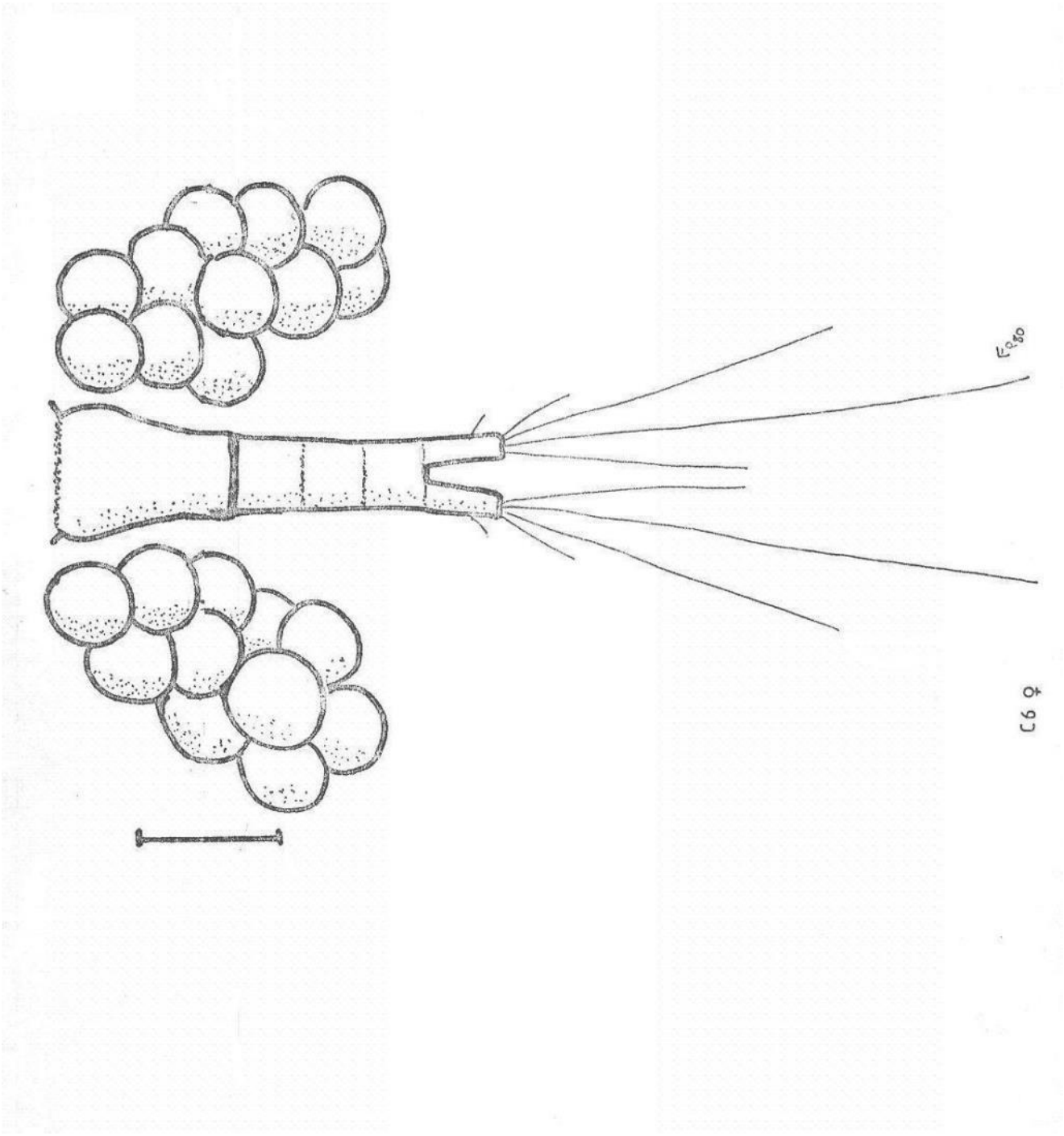

138b
C 3
FP80

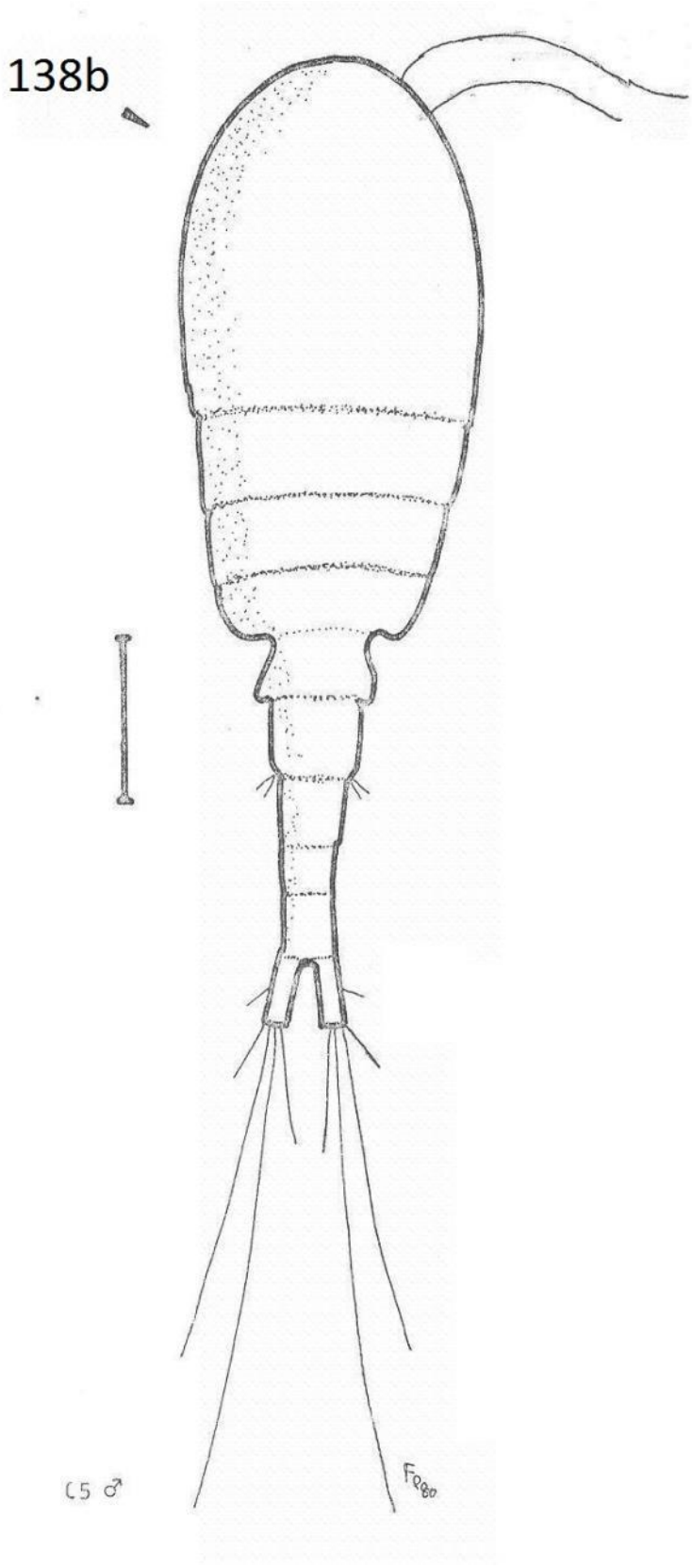

138b
C 4
FRSD

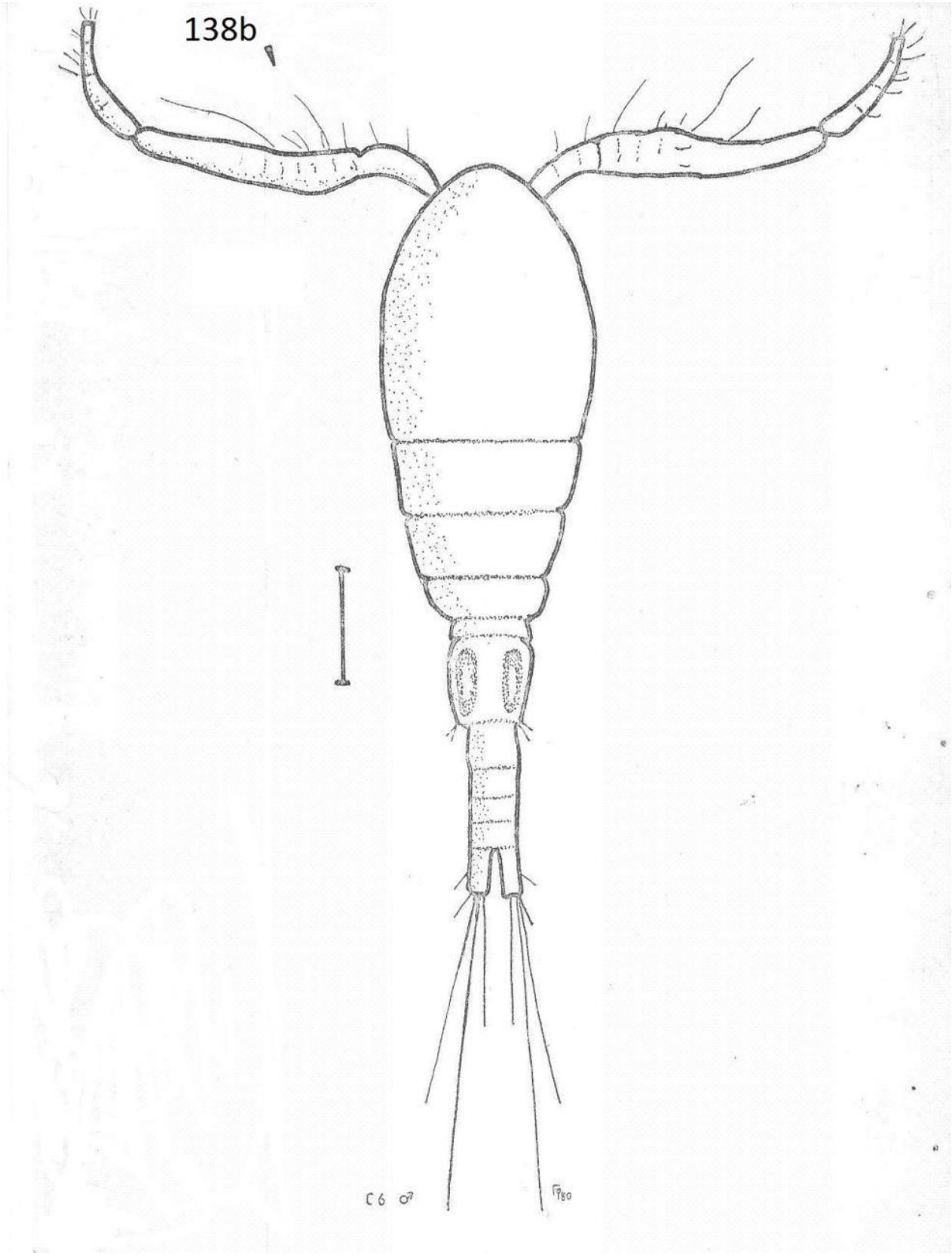

138b
C5 ♀


138b

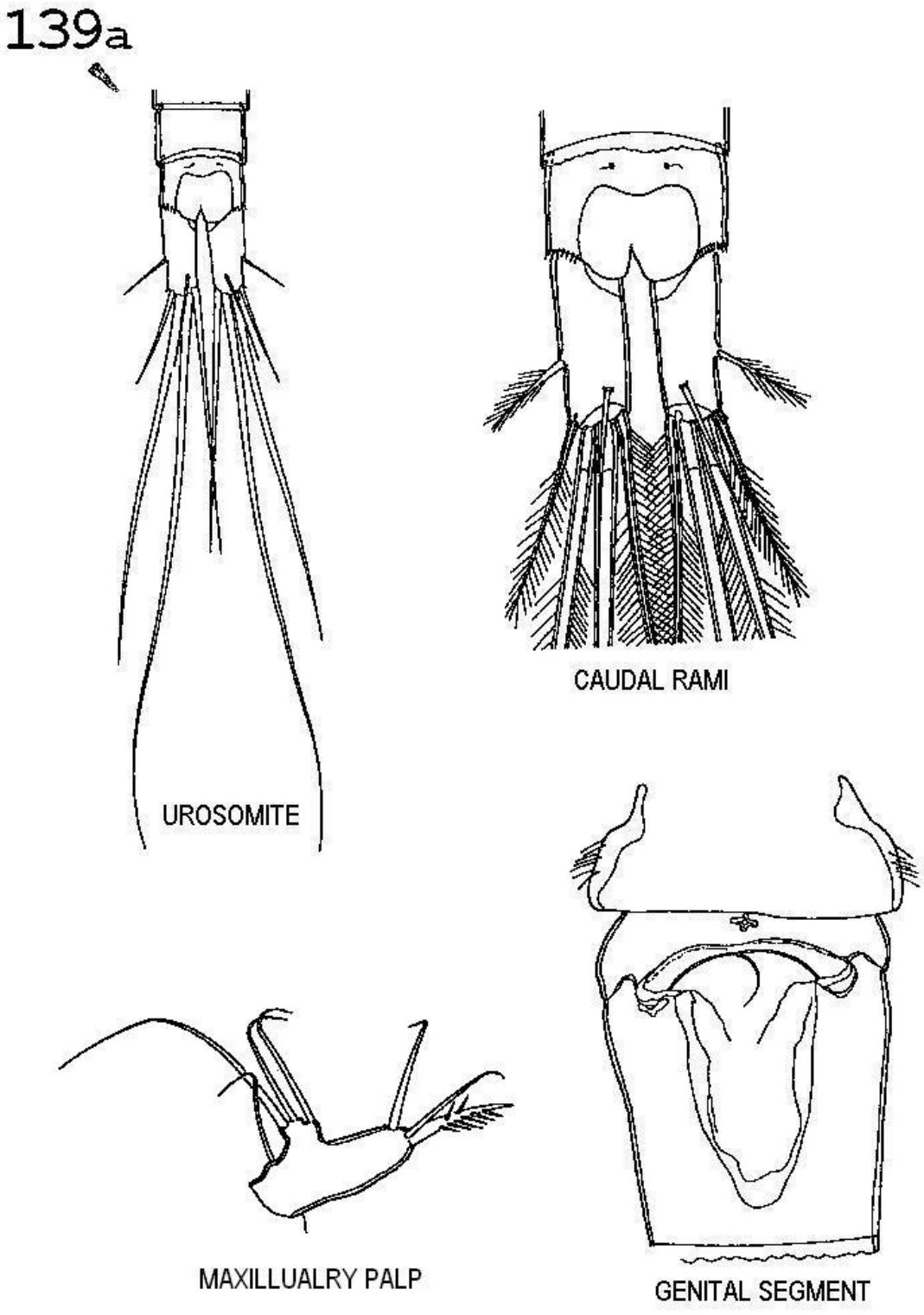
138b



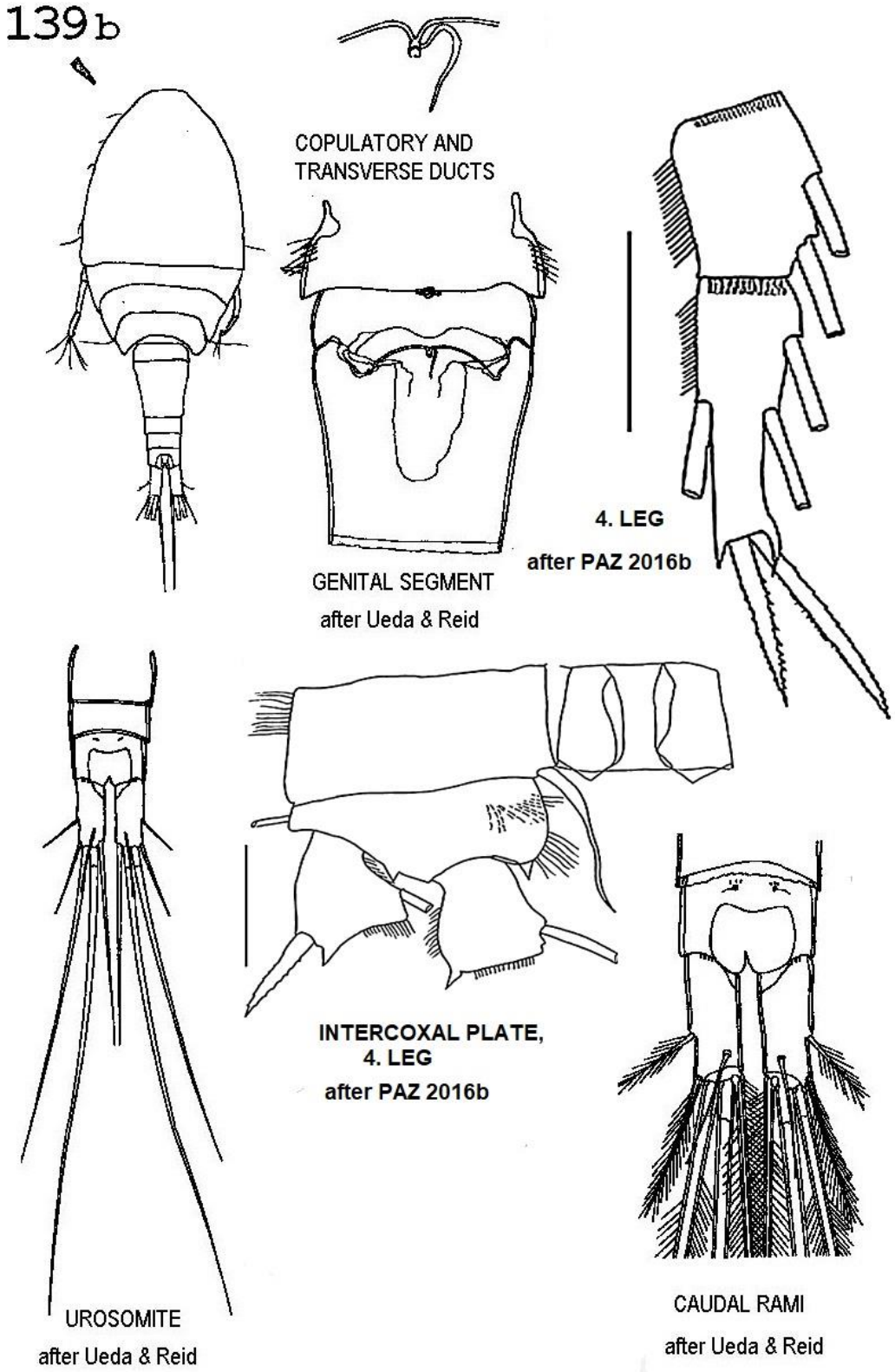

138b
C5 ♂
Fo80


138b
C6 ♂

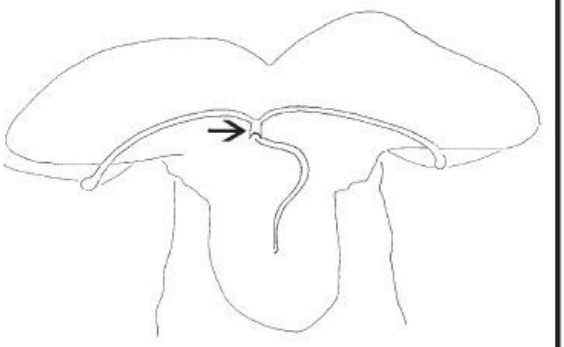
129a
MESOCYCLOPS
♀ M
♂ M
138b
THERMOCYCLOPS
♀ T
♂ T
BODY LENGTH
300 µ
400 µ
500 µ
600 µ
700 µ
800 µ
LENGTH OF TERMINAL SETAE
100 µ
200 µ
300 µ
400 µ
x
129a 138b



after Ueda & Reid

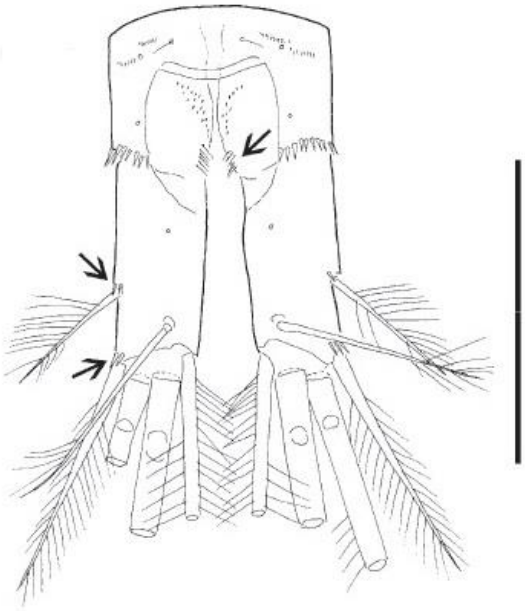

139b
COPULATORY AND
TRANSVERSE DUCTS
GENITAL SEGMENT
after Ueda & Reid
4. LEG
after PAZ 2016b
INTERCOXAL PLATE,
4. LEG
after PAZ 2016b
UROSOMITE
after Ueda & Reid
CAUDAL RAMI
after Ueda & Reid

139 c

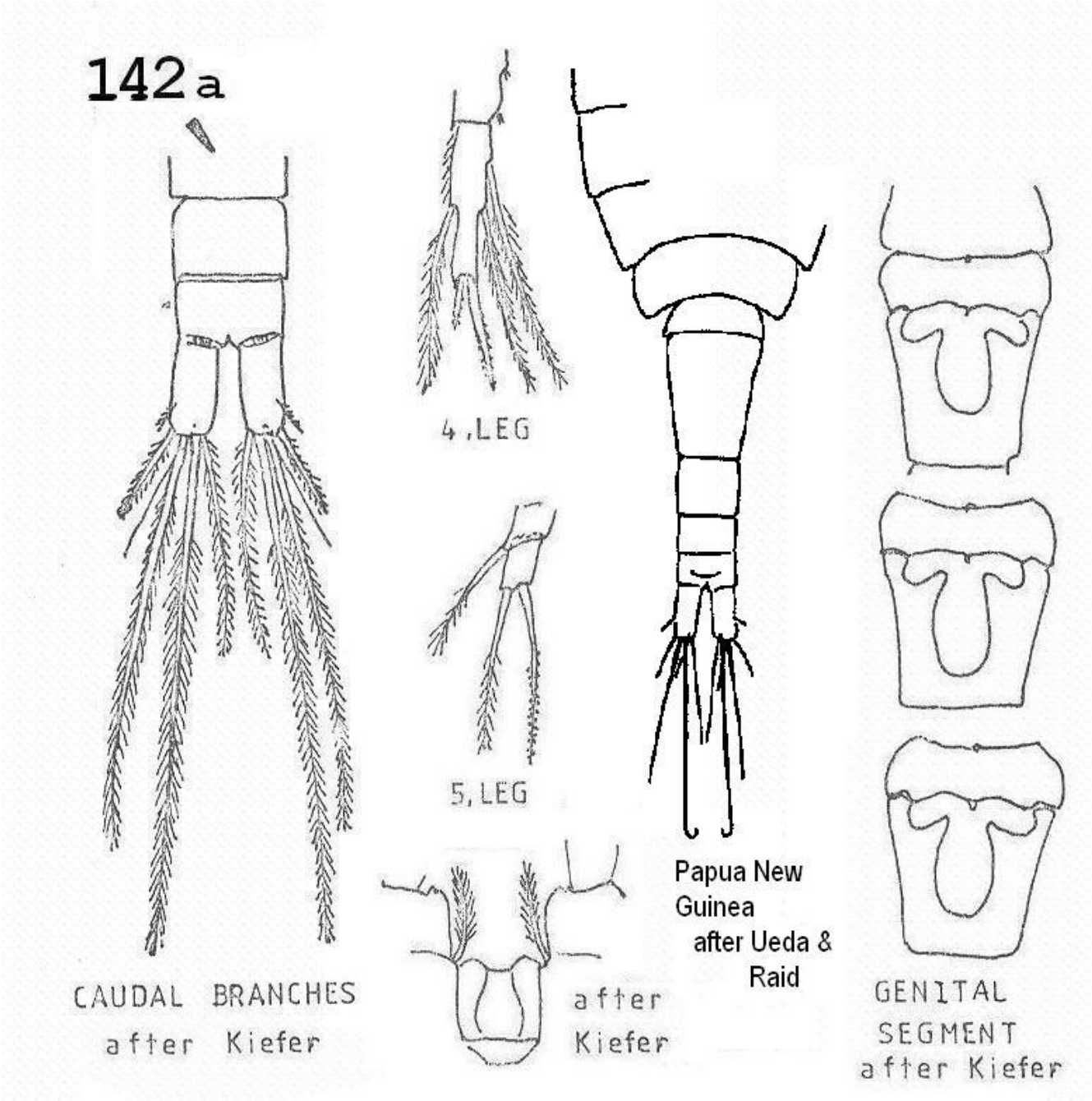


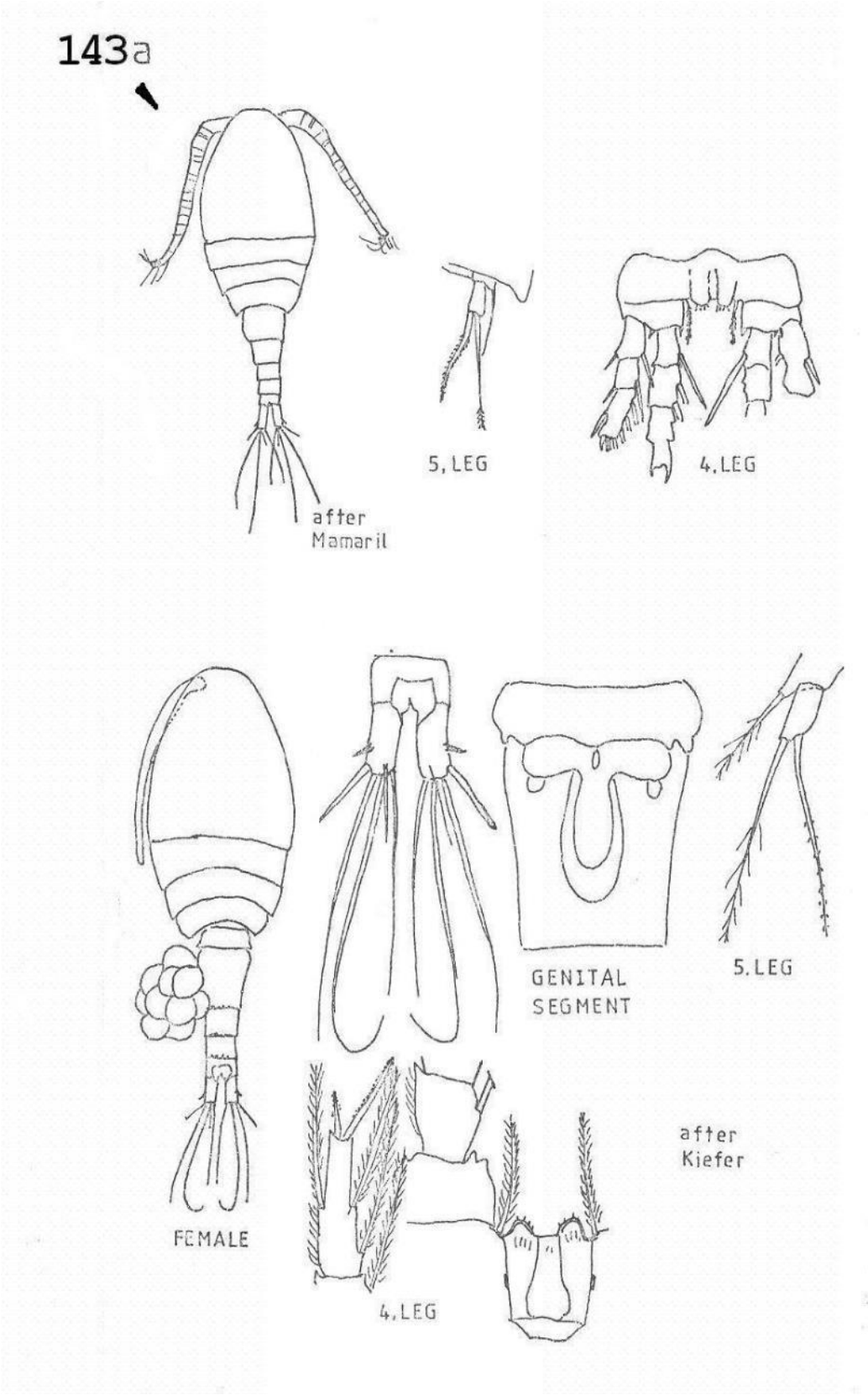
after Papa and Hołyńska (2013)

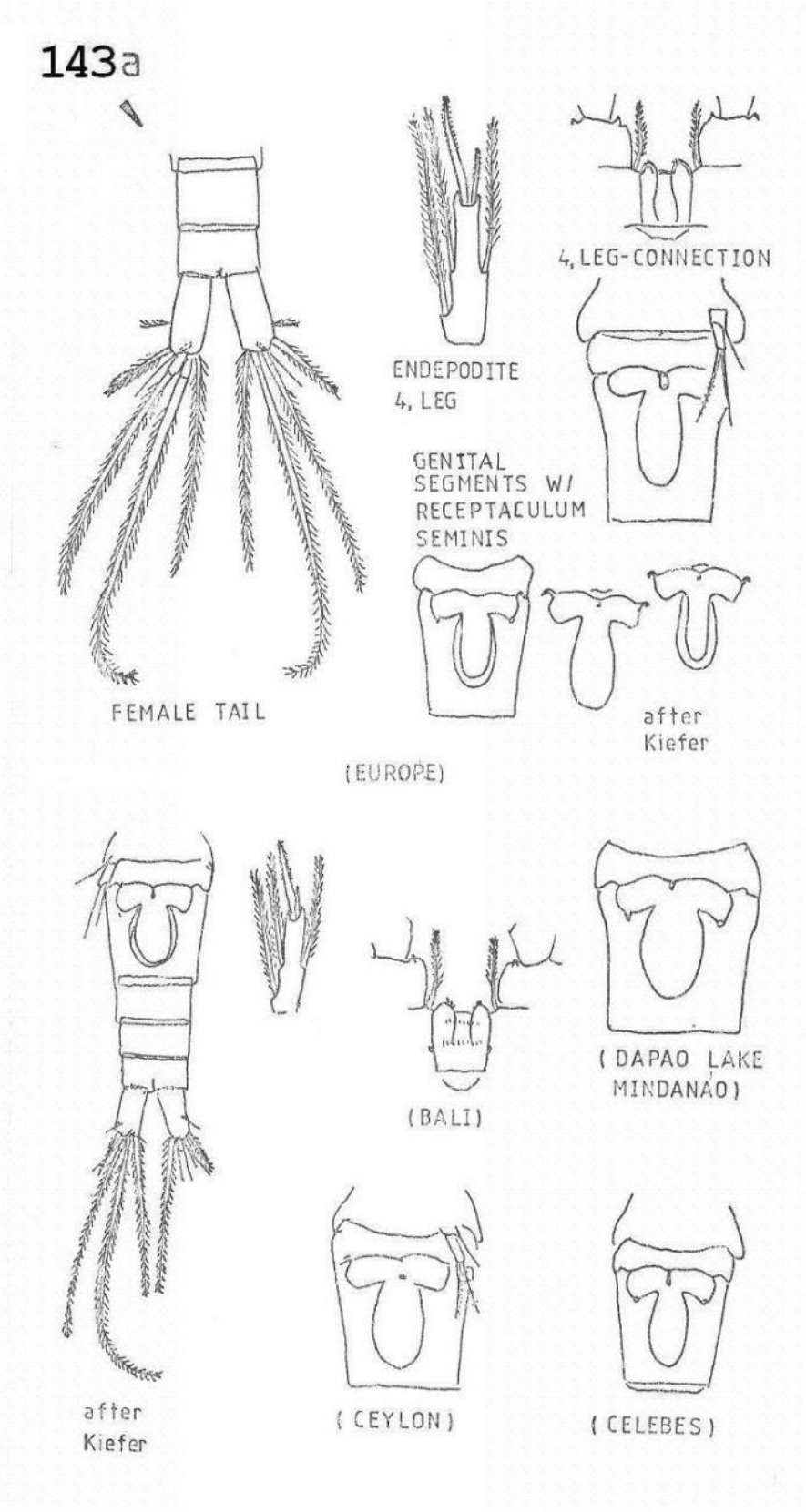
139 c

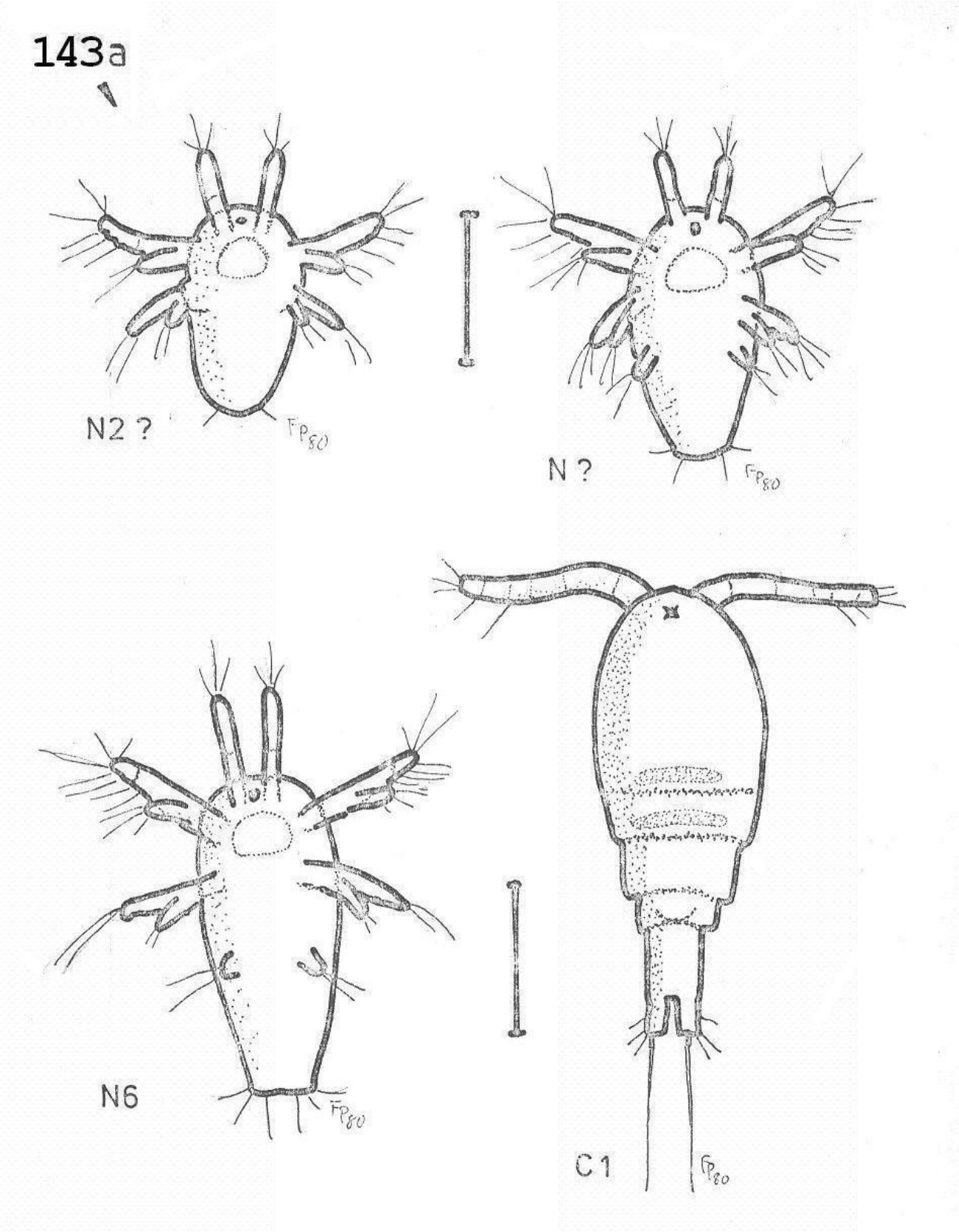


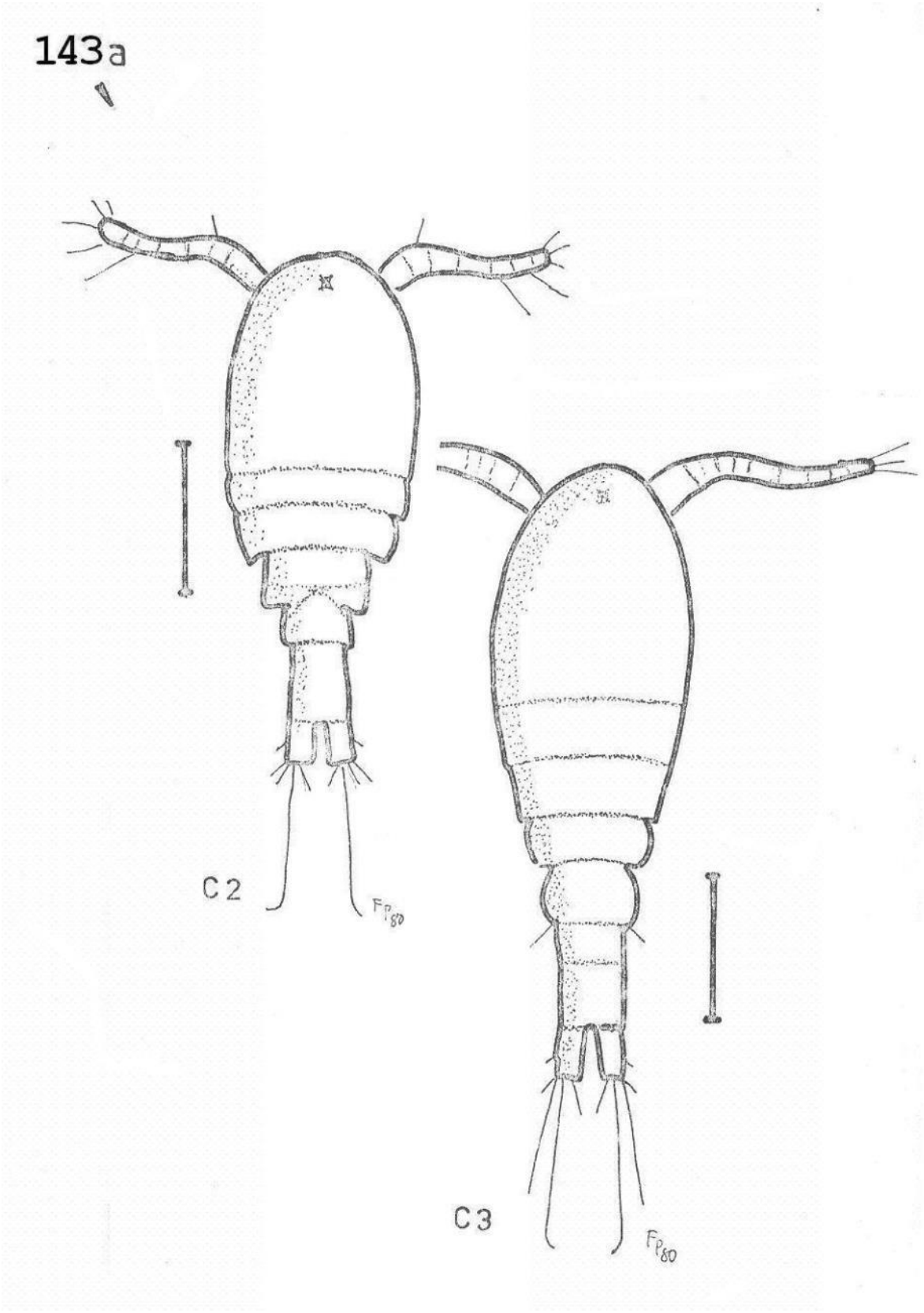
after Papa and Hołyńska (2013)

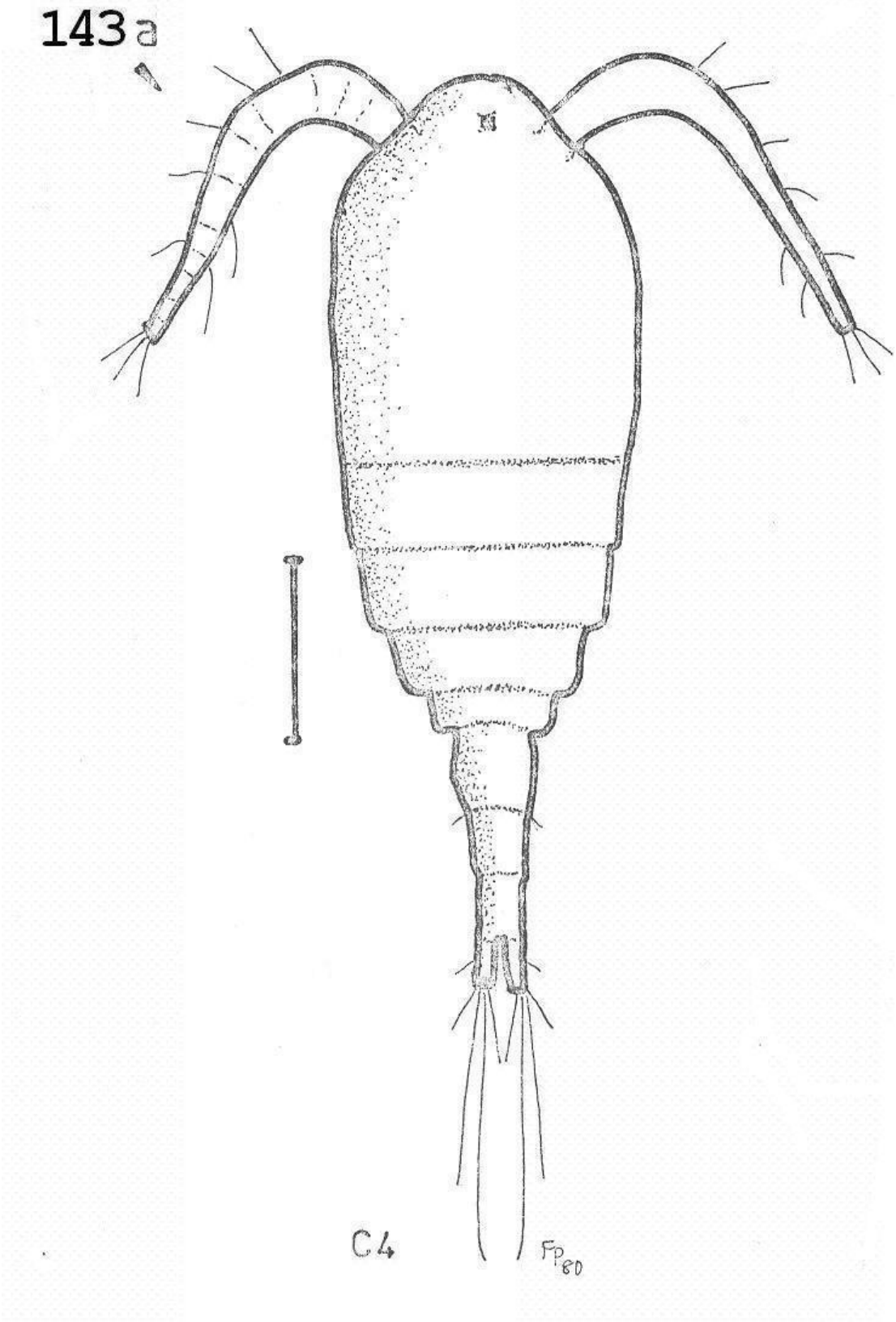

142 a
4. LEG
5. LEG
Papua New Guinea
after Ueda & Raid
CAUDAL BRANCHES
after Kiefer
after Kiefer
GENITAL SEGMENT
after Kiefer

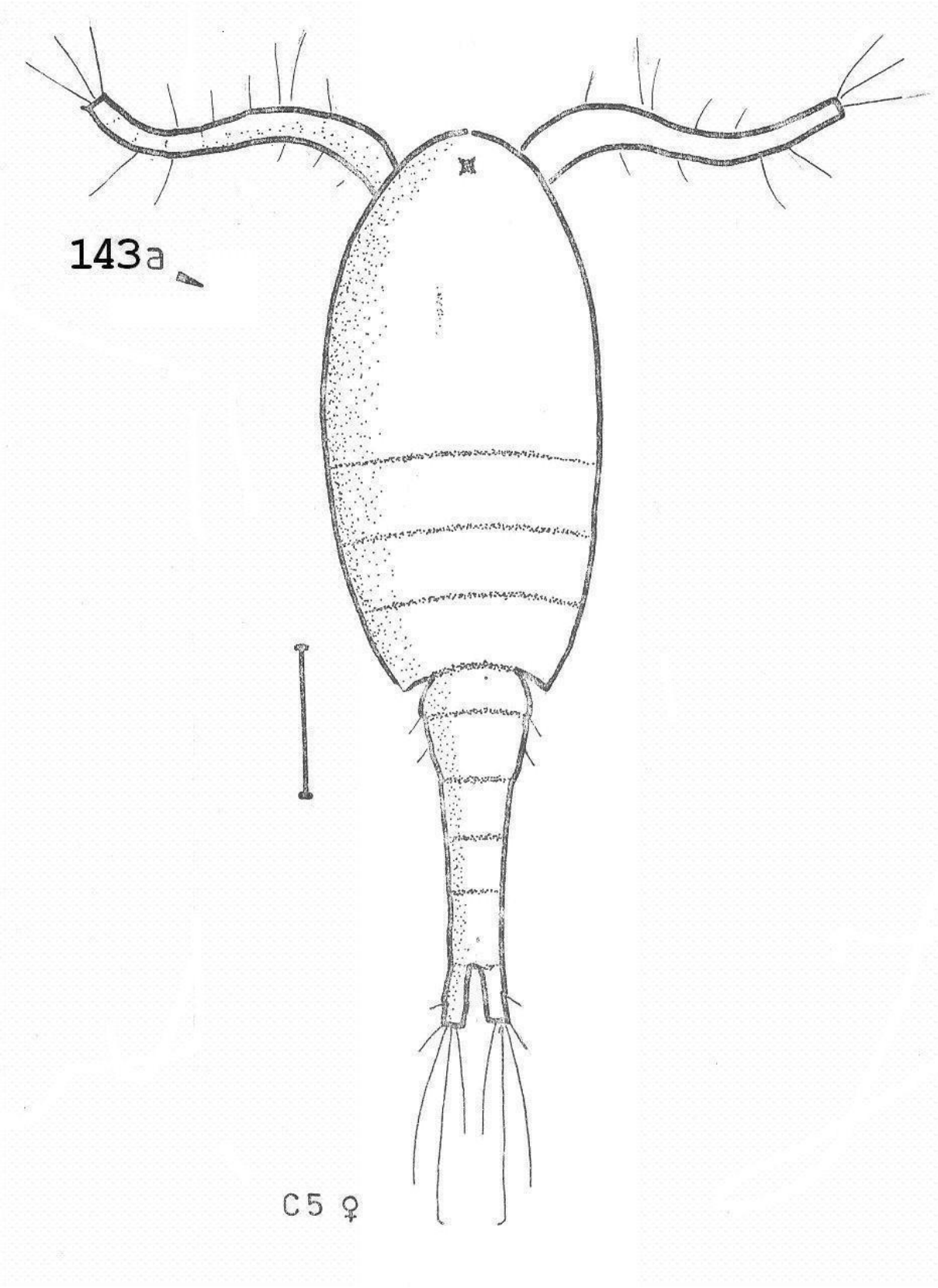

143a
after
Mamaril
5. LEG
4. LEG
FEMALE
GENITAL
SEGMENT
5. LEG
4. LEG
after
Kiefer

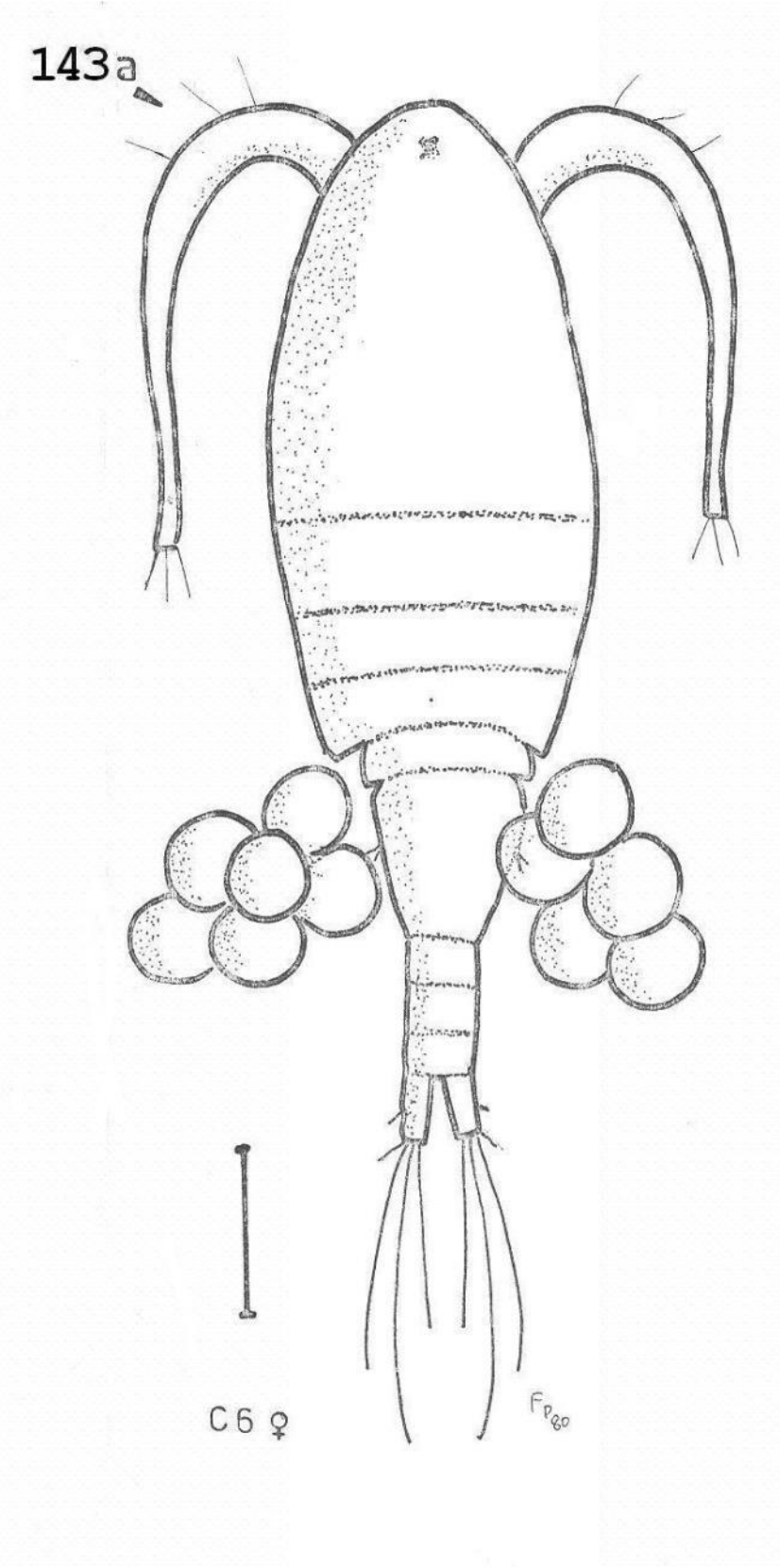

143a
FEMALE TAIL
ENDEPODITE
4, LEG
4, LEG-CONNECTION
GENITAL
SEGMENTS W/
RECEPTACULUM
SEMINIS
after
Kiefer
(EUROPE)
(BALI)
(DAPAO LAKE
MINDANAO)
after
Kiefer
(CEYLON)
(CELEBES)


143a
N2 ?
FP80
N ?
FP80
N6
FP80
C1
FP80

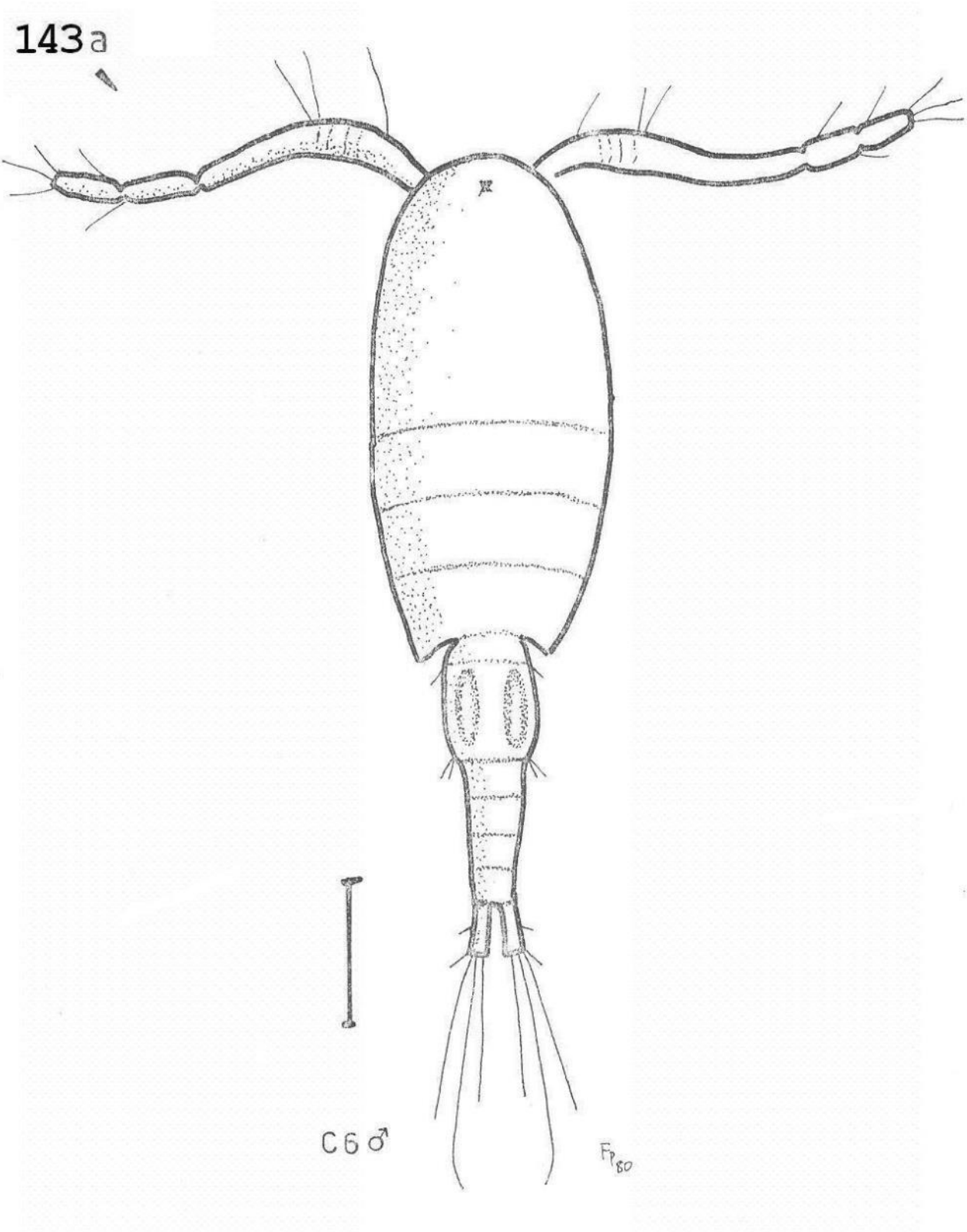

143a
C2
FP80
C3
FP80


143 a
C4
FP 80

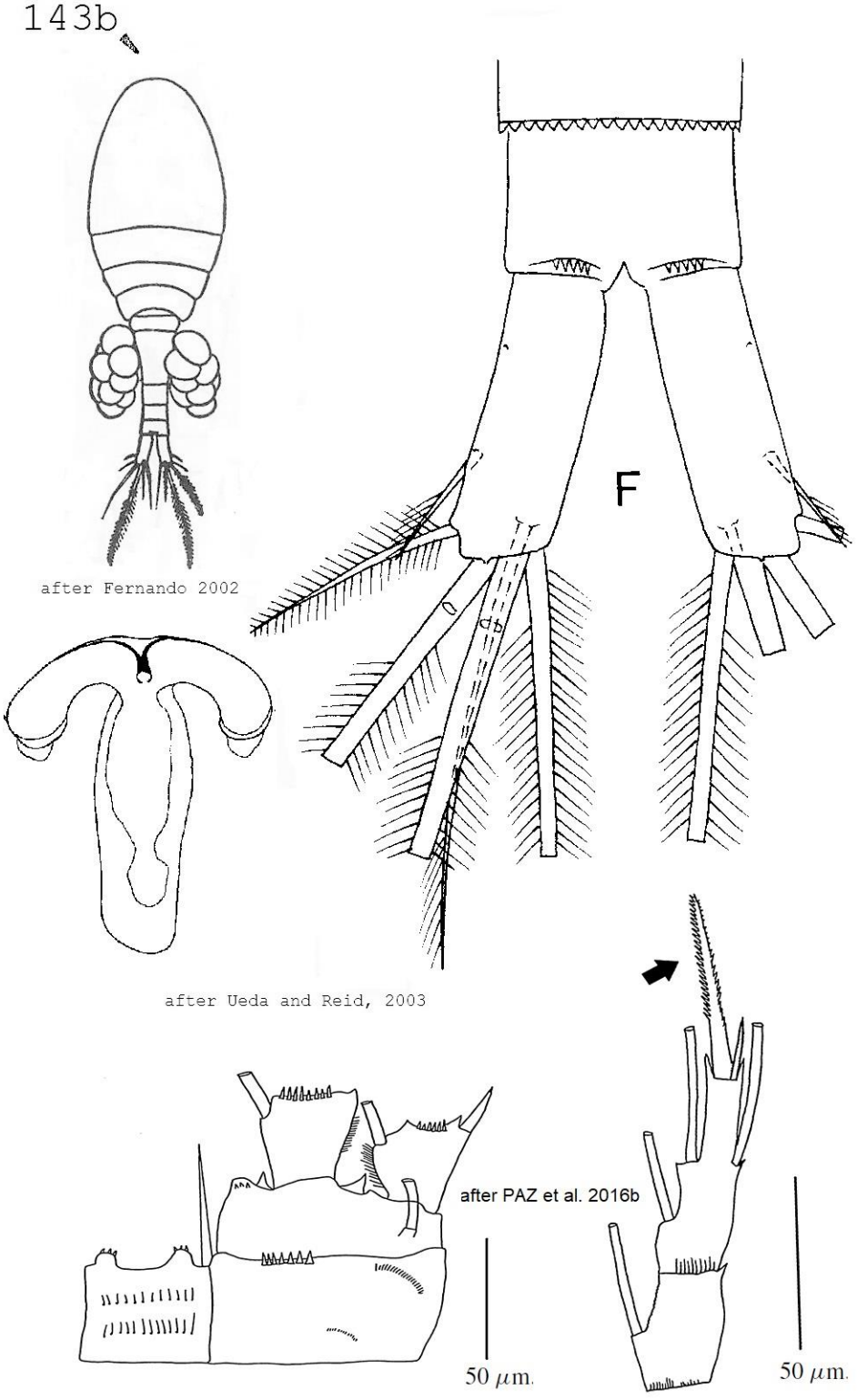

143a
C5 ♀

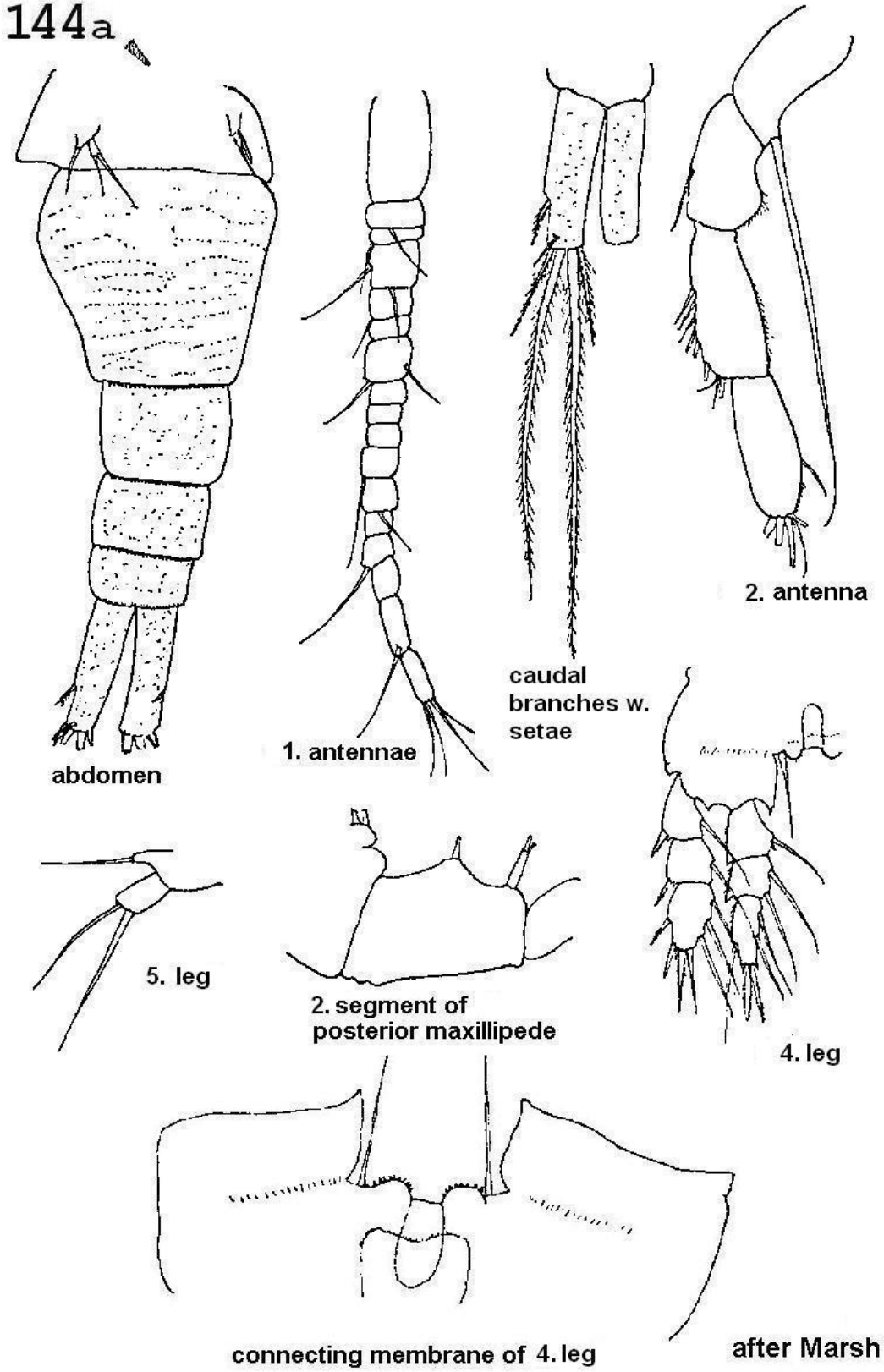


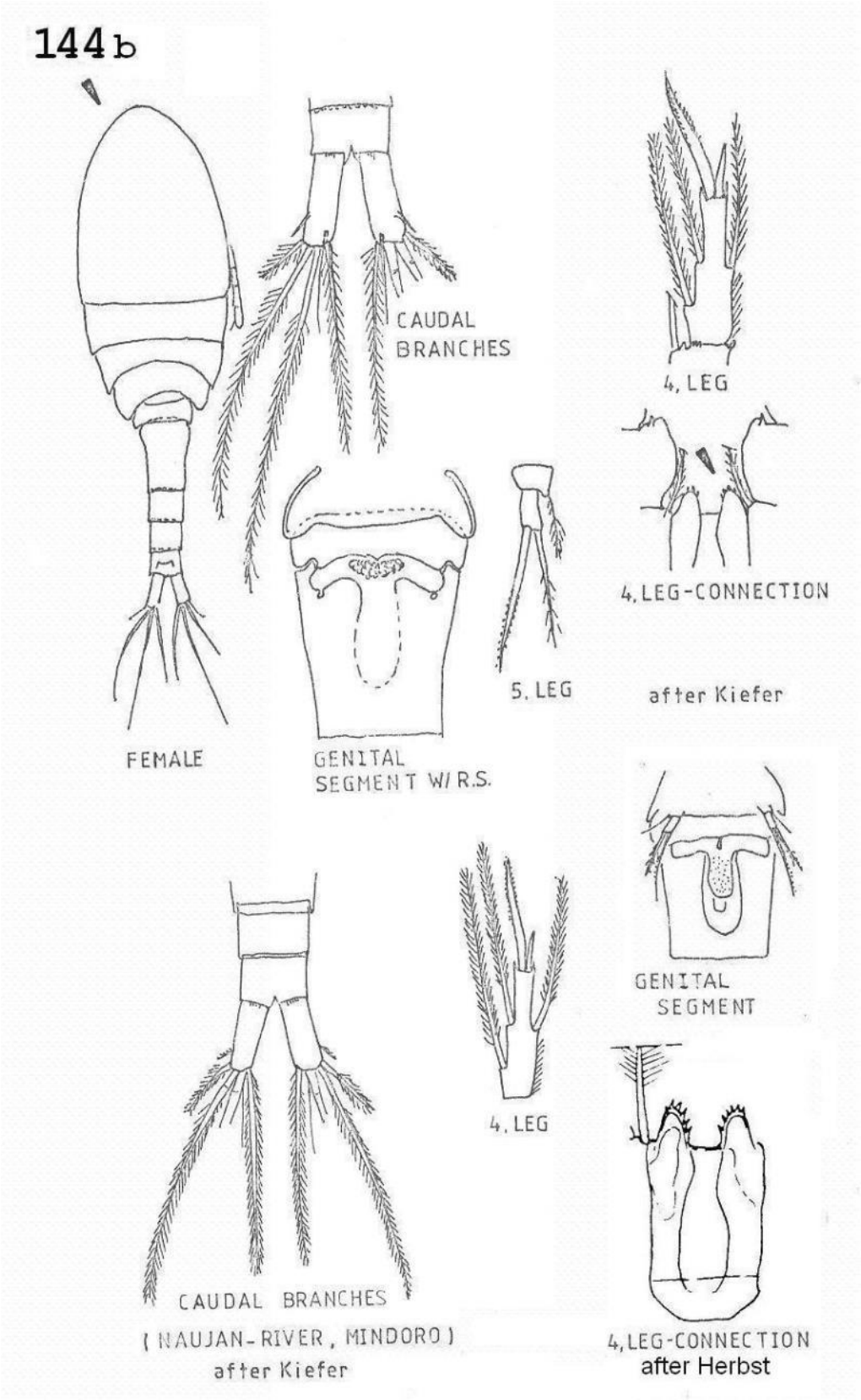
key143a


143a
C6♂

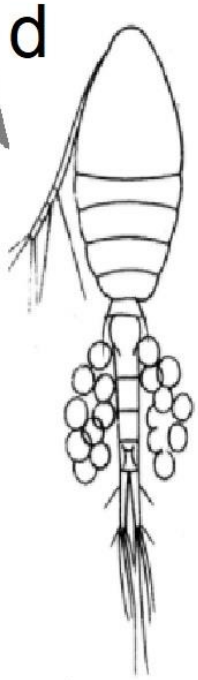
143b


F
after Fernando 2002
after Ueda and Reid, 2003
after PAZ et al. 2016b
50 μm.
50 μm.

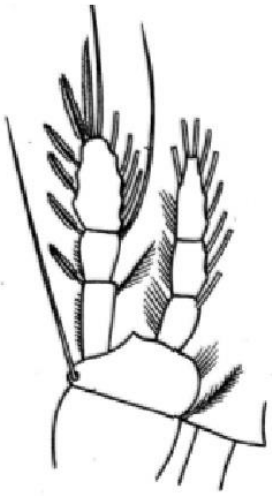

144a
abdomen
1. antennae
caudal branches w. setae
2. antenna
5. leg
2. segment of posterior maxillipede
4. leg
connecting membrane of 4. leg
after Marsh


144 b
CAUDAL BRANCHES
4. LEG
4. LEG-CONNECTION
after Kiefer
5. LEG
FEMALE
GENITAL SEGMENT W/ R.S.
GENITAL SEGMENT
4. LEG
CAUDAL BRANCHES
(NAUJAN-RIVER, MINDORO)
after Kiefer
4. LEG-CONNECTION
after Herbst

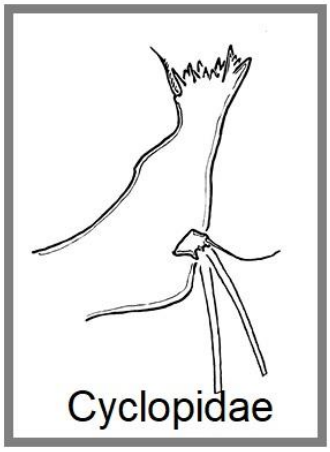
144 d





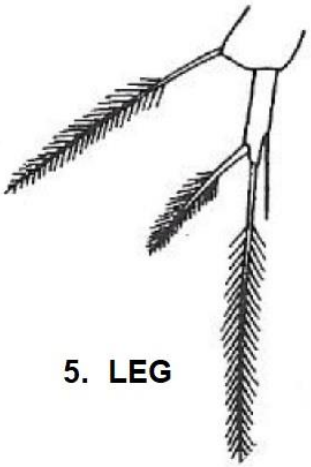


FEMALE DORSALLY CAUDAL RAMI 2. LEG



Cyclopidae

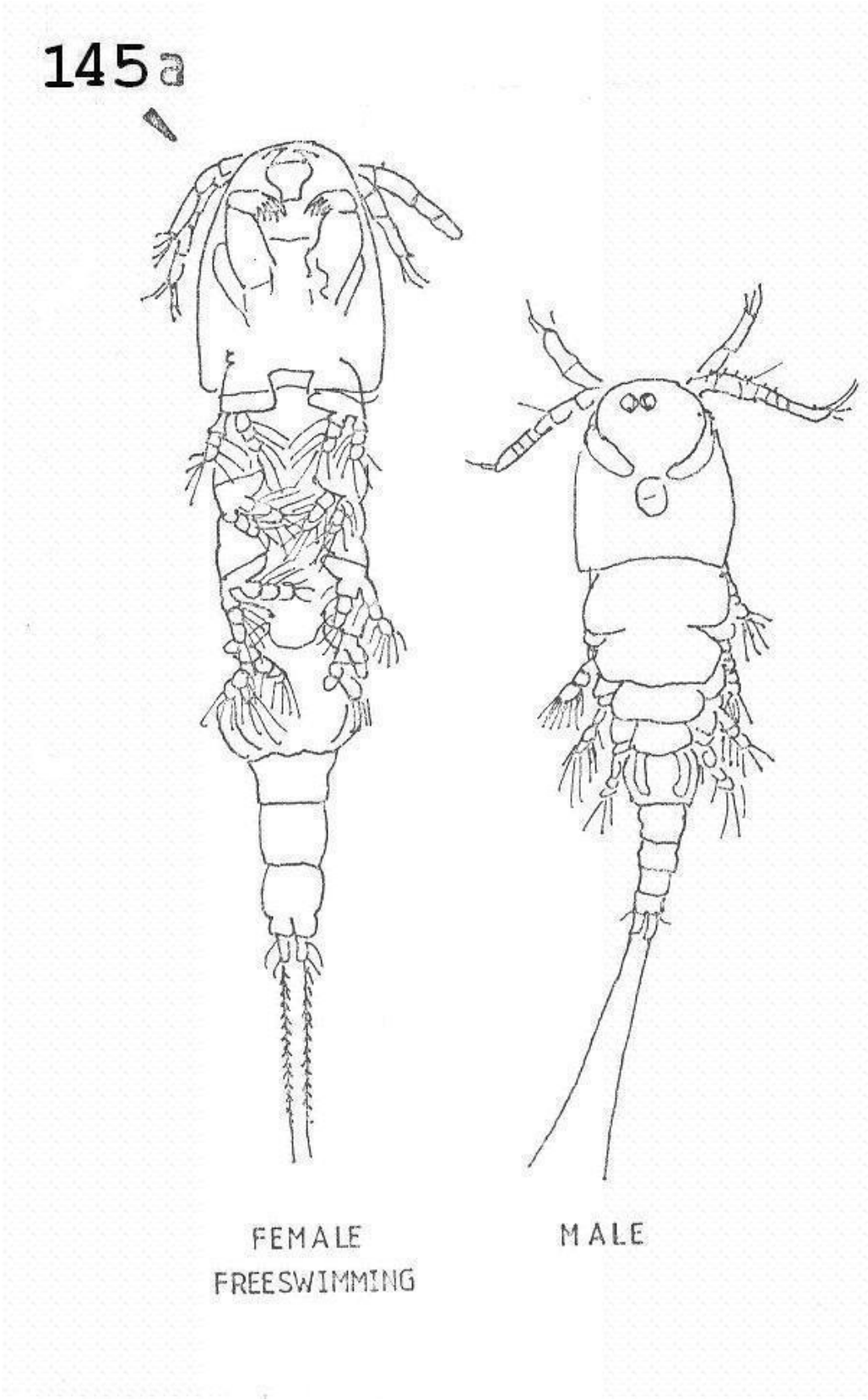




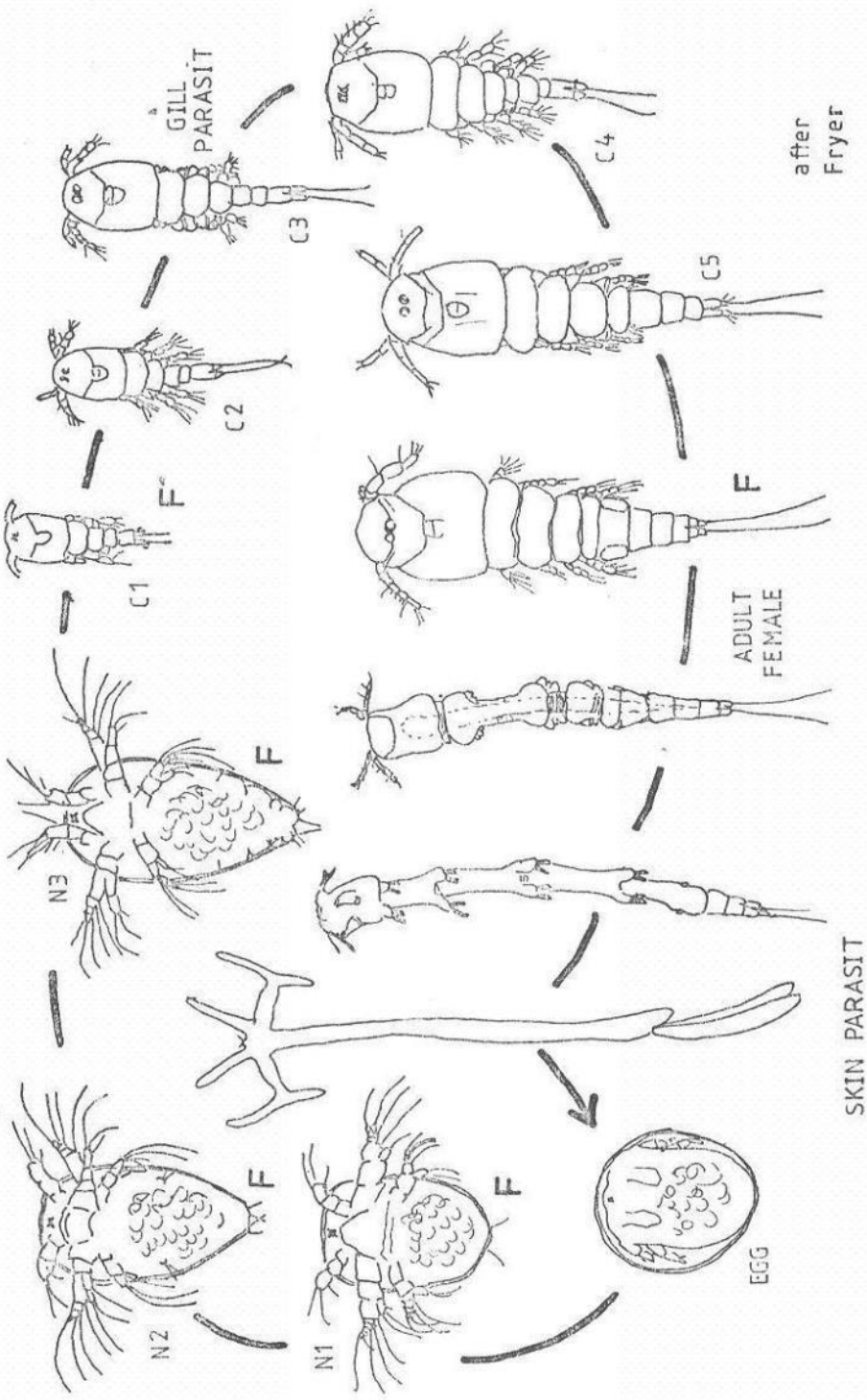
5. LEG

MANDIBLES

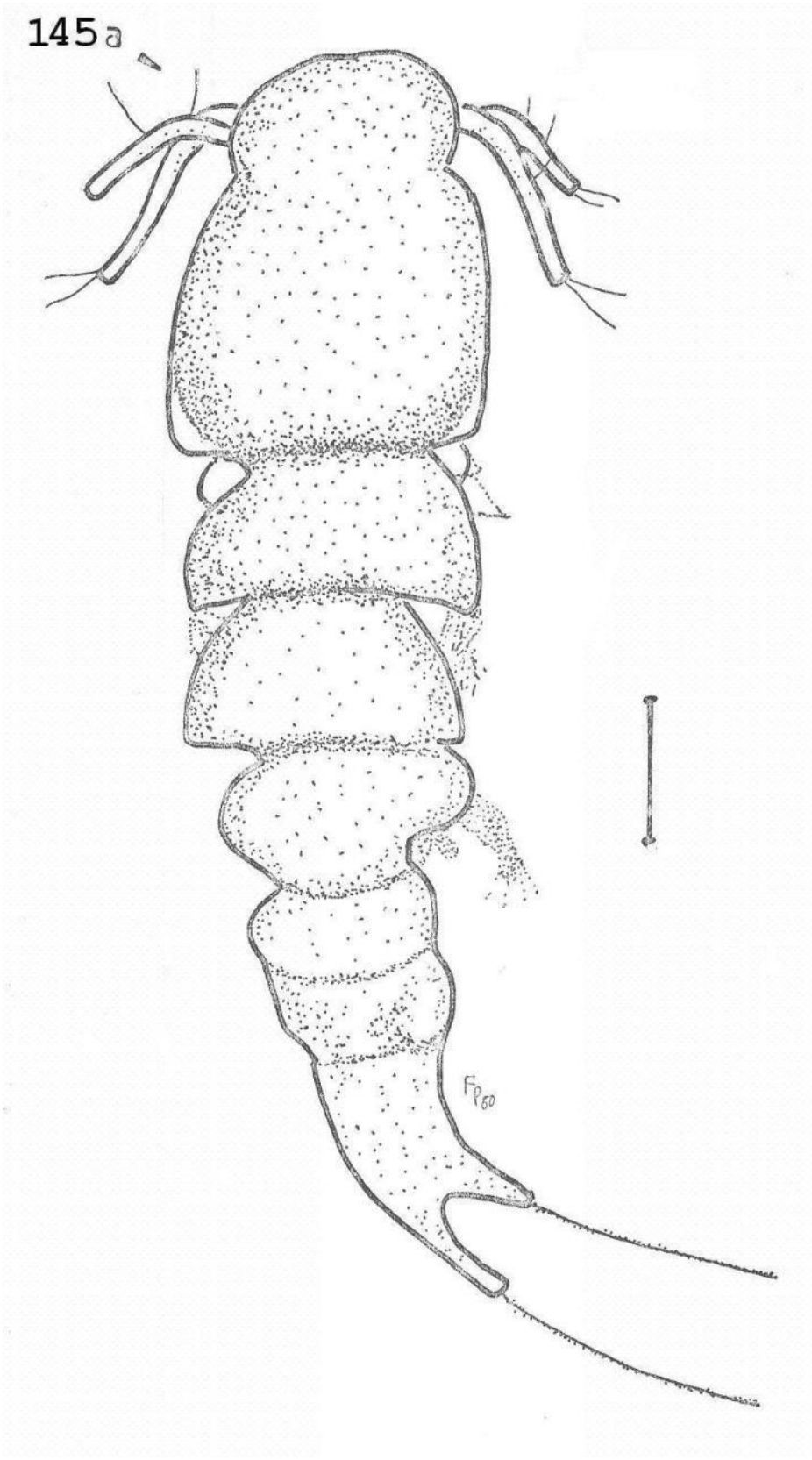
from Fernando 2002

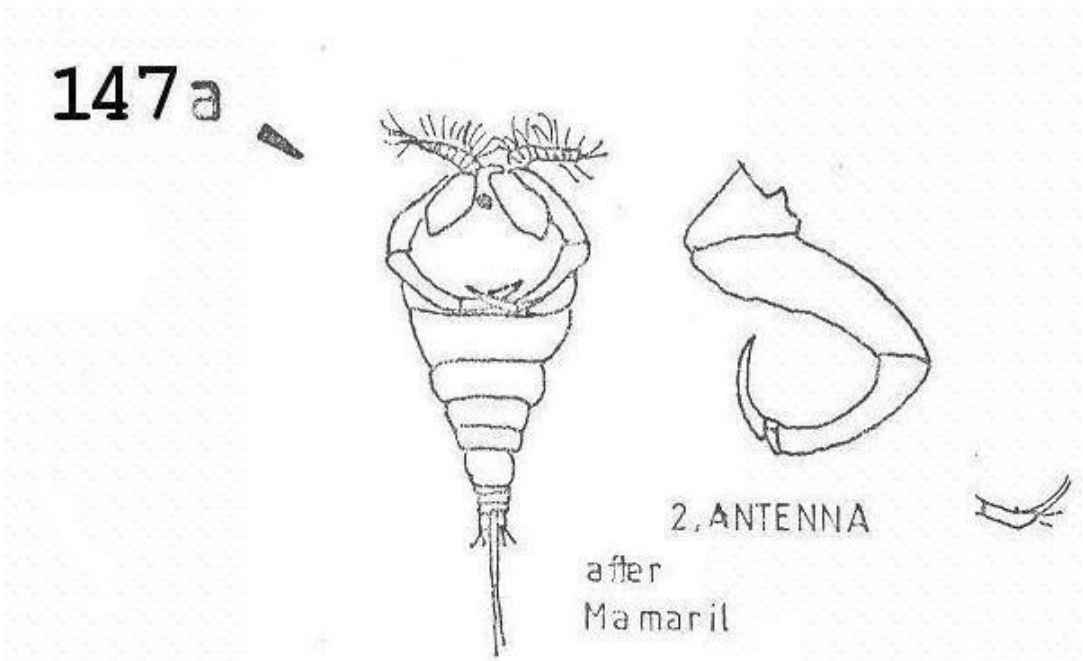

145a
FEMALE
FREESWIMMING
MALE

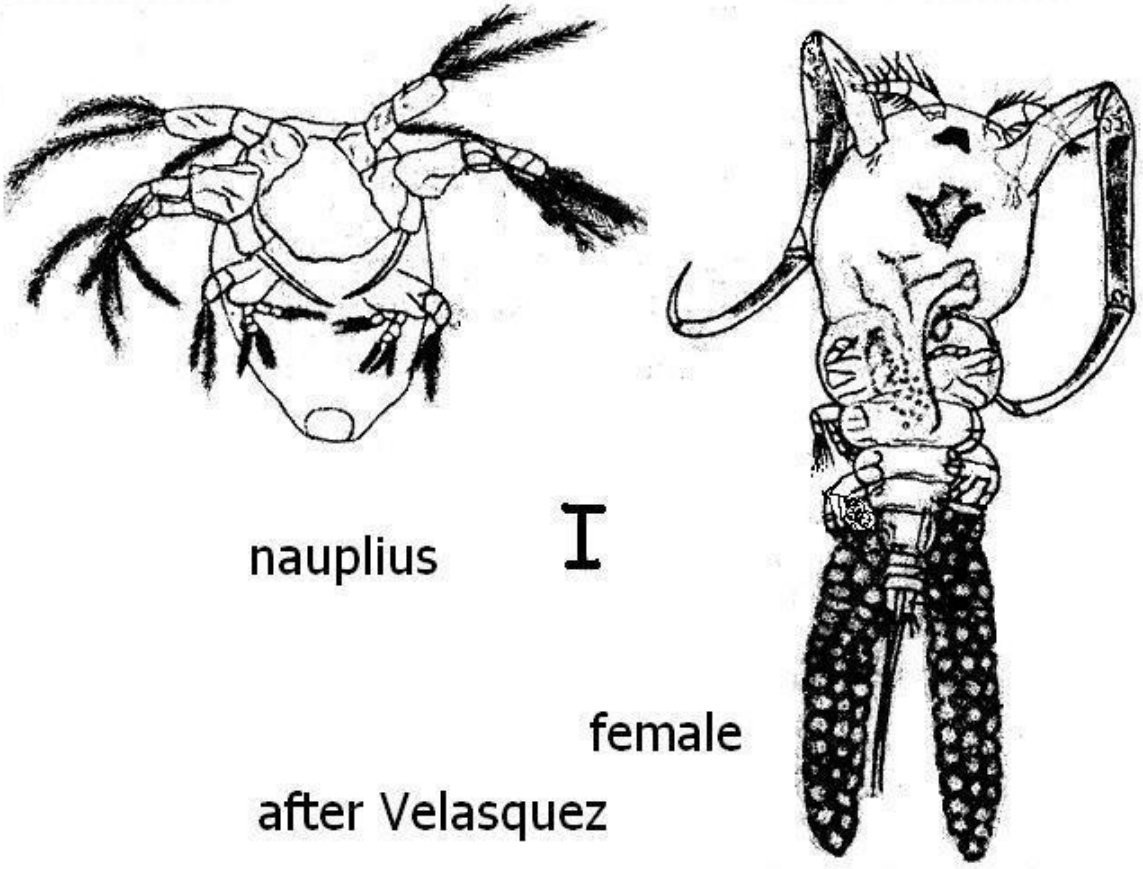
145a



Life cycle of LERNAEA, nauplii, copepodit stages and the adult female.
Free-living stages are indicated by F.


145a
Fp60


147a
2. ANTENNA
after
Mamaril


nauplius I
female
after Velasquez

6. References

6.a. List of Special Key Literature - Chronological

To LIST OF LITERATURE – ALFABETICAL
Back to content

1872 SEMPER, C.
1875 SEMPER, C.
1895 DE ELERA, C.
1928a WRIGHT, S.
1928b KIEFER, F.
1928c WRIGHT, S.
1930a KIEFER, F.
1930b CHAPPUIS, P.
1932, MARSH, C. D.
1933a BREHM, V.
1933b BREHM, V.
1933c BREHM, V.
1933d BREHM, V.
1934a AURICH, H.
1934b BREHM, V.
1936 ROXAS, H. A.
1937a BELLOSILLO, G. C.
1937b BREHM, V.
1937c WRIGHT, S.
1937d TRESLER, W. L.
1937e WOLTERECK, W.
1939a KIEFER, F.
1939b KIEFER, F.
1939c BREHM, V.
1941a WOLTERECK, W.
1941b HAUER, J.
1951 VELASQUEZ, C.C.
1954 CHENG TSI-CHUNG AND CLEMENTE, S.
1966 UENO, M
1968 GOULDEN, C. E.

1969 FREY, D. G.
1971 SMIRNOV, N. N.
1973 LEWIS, W. M. JR.
1974 SOGREAH-REPORT.
1977 PEJLER, B.
1978a MAMARIL, A.
1978b MAMARIL, A.C. SR AND FERNANDO, C. H.
1978c PONTIN, R. M.
1978d LEWIS, W. M. JR.
1979a LAI, H.C., MAMARIL, A. AND FERNANDO, C.H.
1979b LEWIS, W. M. JR.
1980a PETERSEN, F.
1981a VICTOR, R. AND FERNANDO, C.H.
1981b VICTOR, R. AND FERNANDO, C.H.
1981c KIEFER, F.
1981d NEALE, J. W.
1981e VICTOR, R. AND FERNANDO, C.H.
1984a PETERSEN, F. AND CARLOS, M.
1984b VAND DE VELDE, I.
1985 LEWIS, W. M., Jr.
1986a MAMARIL, AUGUSTUS SR.
1986b WALTER, T. C.
1986c HERBST, H. V.
1988 HABITO, C. V.
1990 DAVIS, J. AND GREEN, J.
1991 KOROVCHINSKY, N. M.
1992 KOROVCHINSKY, N. M.
1995 KOROVCHINSKY, N. M.
1997 ARTHUR, J. R. AND LUMANLAN-MAYO, S.
1998a KOROVCHINSKY, N. M.
1998b SCHOENLY et al.
1999 TUYOR, J.B. AND SEGERS, H.
2000a KOROVCHINSKY, N. M.
2000b KOROVCHINSKY, N. M.
2001a MAMARIL, A. C.

2001b SEGERS, H.
2001c BERBANO, M. L. M. et all.
2001d TUYOR J. B. AND BAAY M. O.
2001e PALOMAR & MAMARIL
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6.b. List of Literature – Alphabetical:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

LIST OF SPECIAL KEY LITERATURE – CHRONOLOGICAL

To content

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