SYMBIOCLOEON: A NEW GENUS OF *BAETIDAE* FROM THAILAND (*INSECTA, EPHEMEROPTERA*)

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During a zoological expedition to Thailand in 1971, devoted mainly to the collection of freshwater clams, the junior author, Dr. W. H. HEARD, collected specimens of the clam *Hyriopsis myersiana* (LEA) (*Bivalvia, Schizodontà, Unionidae*). Investigation of this material in the laboratory in Tallahassee revealed that some of the clams contained mayfly nymphs. These animals were forwarded to Dr.W. L. PETERS, Laboratory of Aquatic Entomology, Florida A & M University, Tallahassee. Dr. PETERS found these nymphs to represent a new genus in the family *Baetidae* and asked the senior author, Dr.I. MÜLLER-LIEBENAU, to publish the new genus.

Symbiocloeon Müller-Liebenau gen. n.

TYPE-SPECIES.–*Symbiocloeon heardi* MÜLLER-LIEBENAU sp. n.
IMAGO and SUBIMAGO of both sexes are not known.
MATURE NYMPH (Fig. 1). — Body long and slender compared with other genera in family. Head relatively small compared to body. Hind margin of head shorter than front margin of pronotum. Head directed a little downward, appearing triangular from above. Hind wing pads absent. Mouthparts in general baetine-like, but labrum (Fig. 2 A) without submedian submarginal bristles as in most other genera in the family; maxillary palpi (Fig. 3 C) only one segmented, 6–9 bristles in outer apical angle of galea on ventral surface. Labium (Fig. 3 A and B) distinct from labium in other genera in family: 2nd and 3rd segments almost completely fused together to form one large stout segment, which is bilobed at apex. Ventral lobe, with a few strong short bristles at inner apical edge, seems to correspond to third segment in other baetid genera; dorsal lobe, with an irregular row of 7 or more

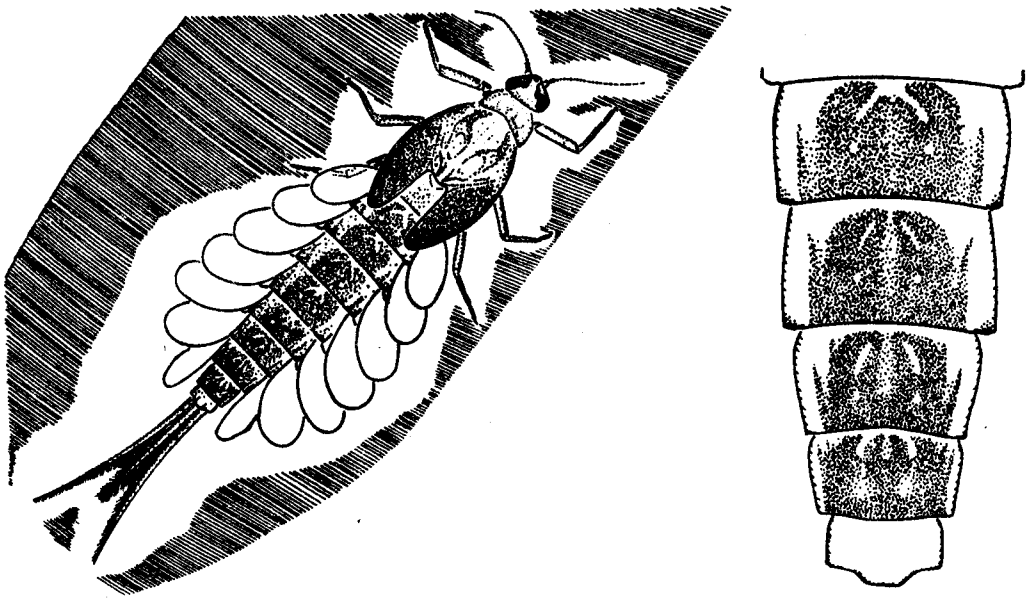


Fig. 1. Nymph of *Symbiocloeon heardi* n. gen., n. sp. (JAN PETERS del.)

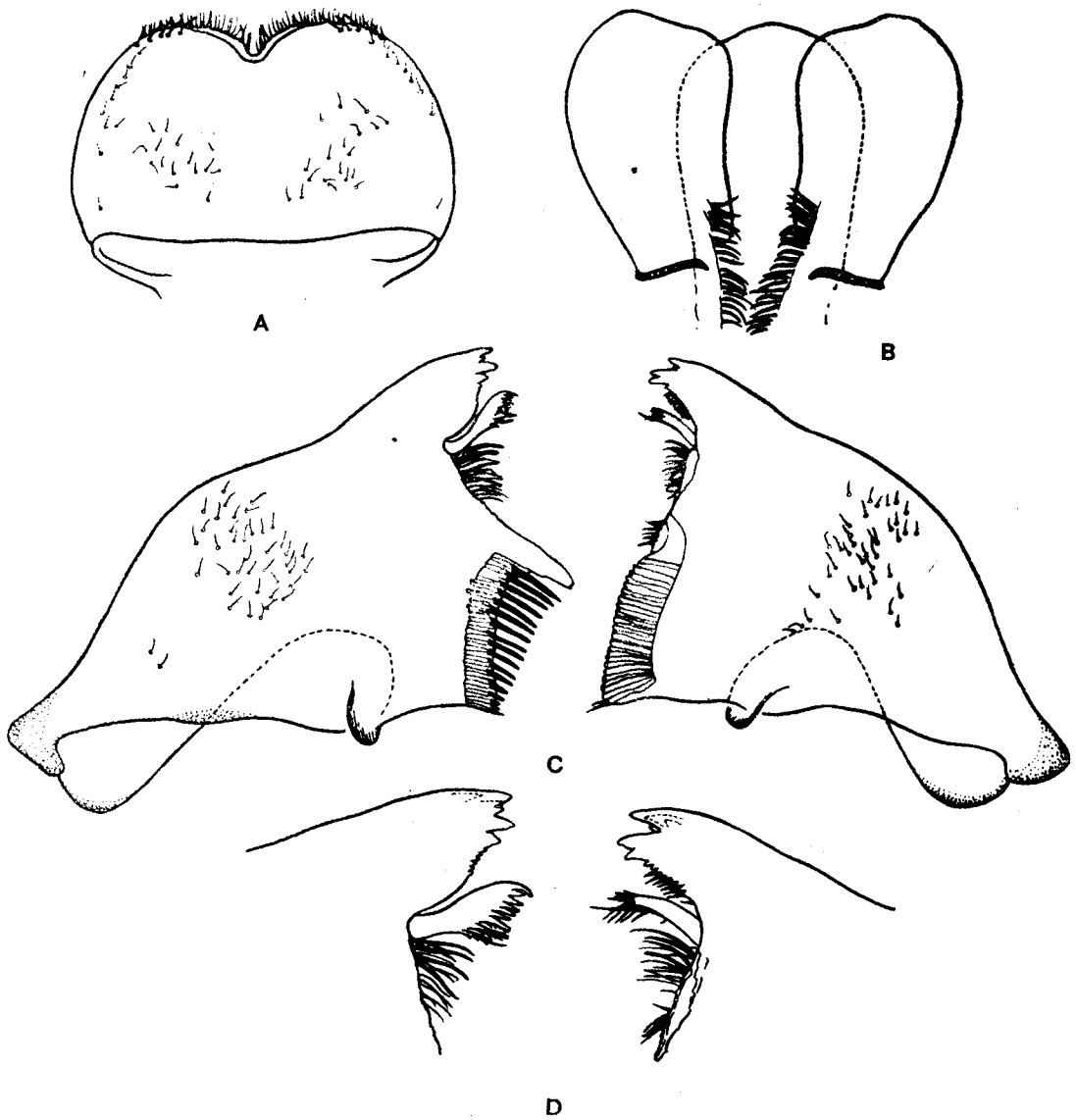


Fig. 2. Nymph of *Symbiocloeon heardi* n. gen., n. sp. A — labrum, B — hypopharynx, C — left and right mandibles, D — canini area of mandibles

bristles on dorsal surface seems to correspond to 2nd segment in other baetid-genera. Seven pairs of abdominal gills. Gills large (Fig. 1), including those of first segment; gills of 4th and 5th pair longer than two segments of body. Gill margins completely without teeth, only a few fine bristles. Bristles almost completely lacking on outer margins of femora, tibiae and tarsi (Fig. 4 A). Apical curvation of femora with a deep incision (Fig. 4 B). Tarsal claws (Fig. 4 C and D) without teeth, strongly hooked at apex, near apex a number of sense organs.

Symbiocloeon heardi **Müller-Liebenau sp. n.**

MATURE NYMPH. — Length: body 11,2 mm, cerci 4,6 mm, terminal filament 3,1 mm, antennae 2,1 mm (this specimen, a female, the most mature specimen).
COLOR PATTERN (Fig. 1): on pronotum not clearly defined; on dorsum of abdomen well defined yellowish-white muscle insertions on darker background on segments 2–9; last segment yellowish-brown. Large gills milky; tracheae clearly visible, but not darkened.
SPINATION: a) Mouthparts. Labrum (Fig. 2 A): a few strong bristles near front margin on both sides. Lateral margins on ventral surface with a submarginal row of short and strong bristles. — Mandibles

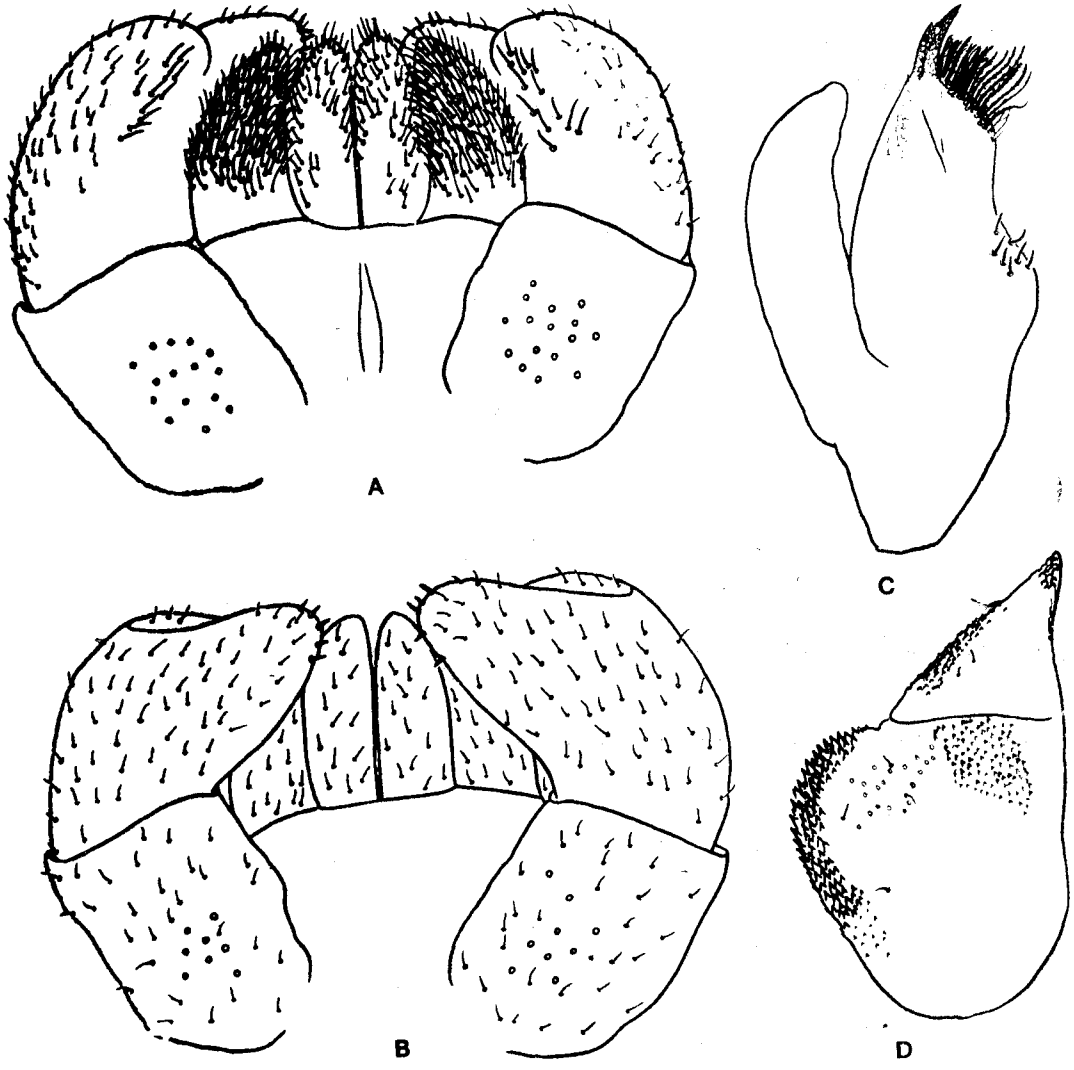


Fig. 3. Nymph of *Symbiocloeon heardi* n. gen., n. sp. A — labium dorsal, B — labium ventral, C — maxilla, D — paraproct

(Fig. 2 C and D) stout, in general baetid-like, vaulted dorsally in middle part and there beset with bristles, and curved in middle of outer margin. — Hypopharynx (Fig. 2 B) with three large lobes, beset with larger fields of different bristles (bristles not drawn in Fig. 1 B). — Maxillary palpi (Fig. 3 C) one-segmented, stout, nearly without bristles, shorter than galealacinia. Six to 9 bristles in outer apical angle of galea on ventral surface; few bristles in a field submarginal in the middle of inner margin of lacinia. — Labium (Fig. 3 A and B): Labium as discussed above. Beyond the mentioned spination, basal segments of labial palpi on both surfaces with a number of chloride cells, as usual in the family. Glossae and paraglossae of almost same length; both of them densely covered with many bristles on dorsal surface, less bristles on ventral surface.

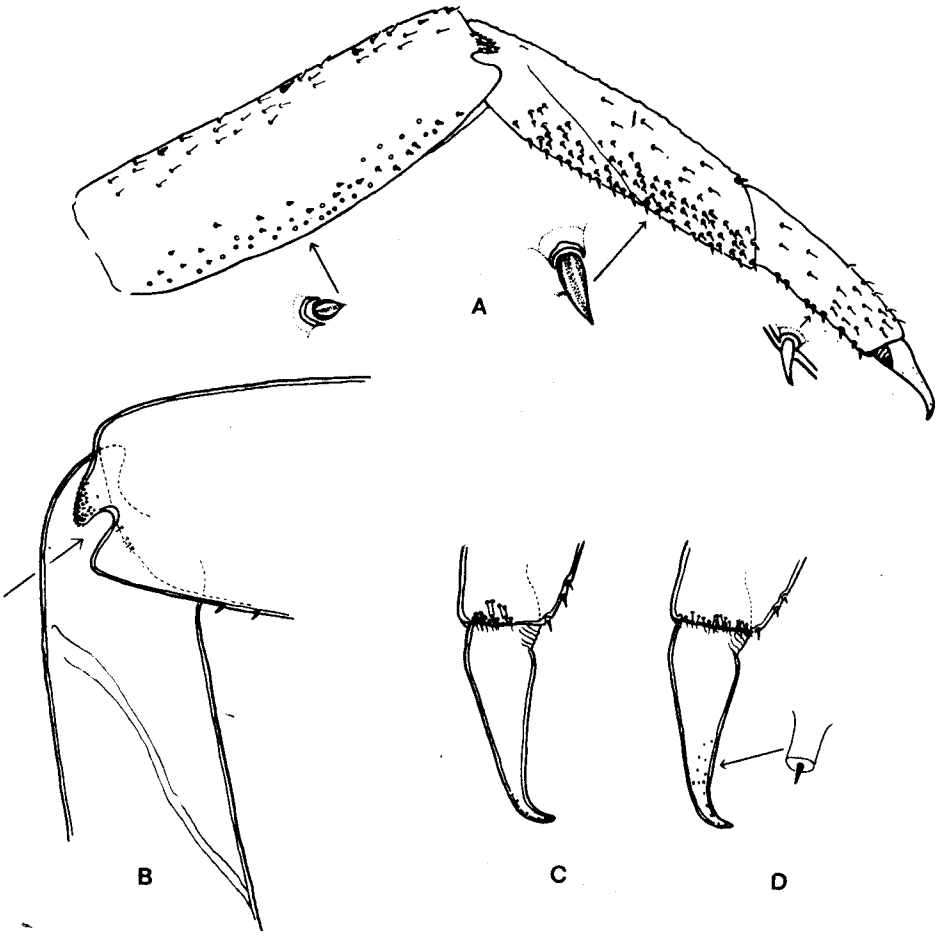


Fig. 4. Nymph of *Symbiocloeon heardi* n. gen., n. sp. A — leg, B — incison at apex of femur, C — tarsal claw, dorsal, B — tarsal claw, ventral, both with sense organs

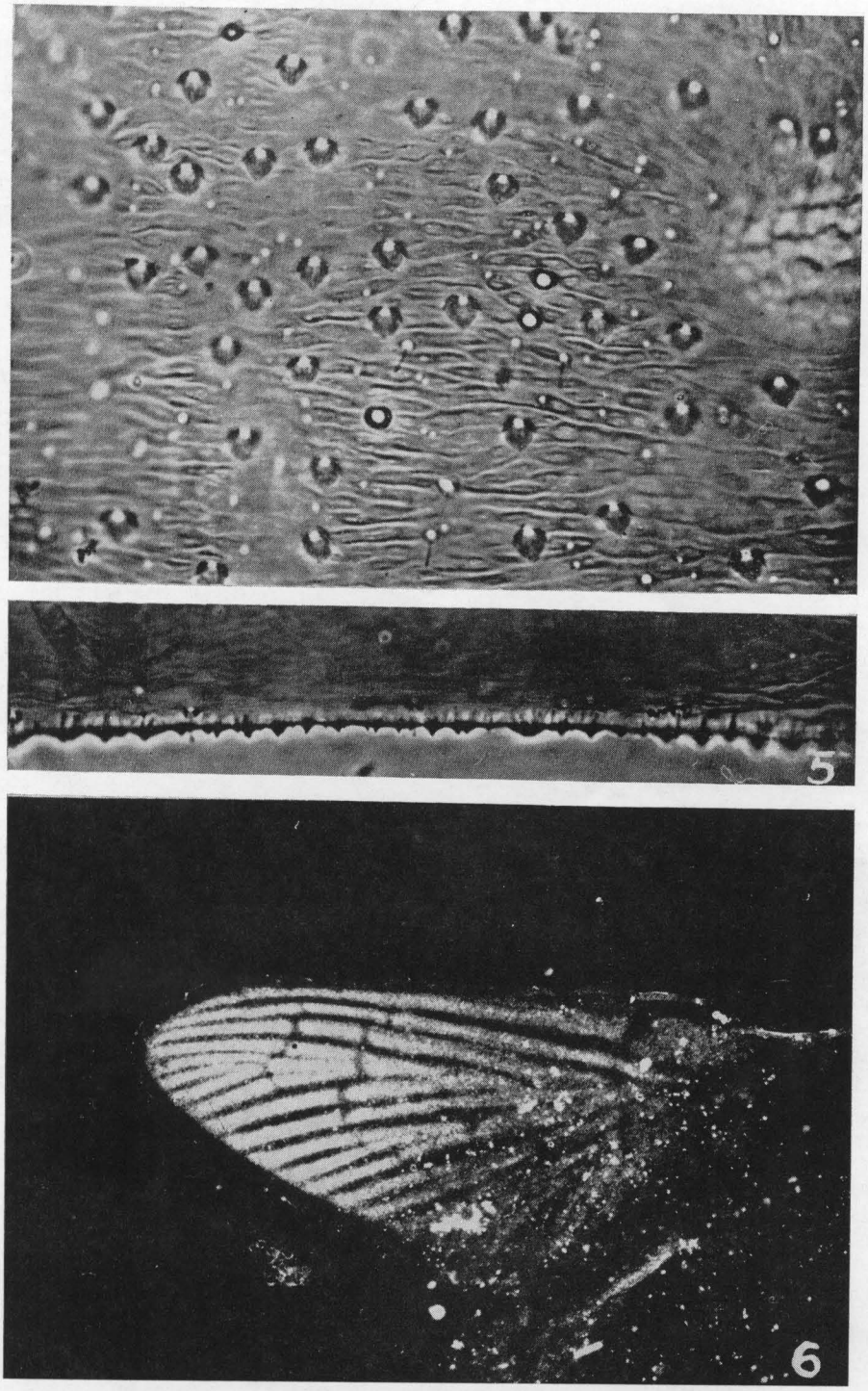
b) Pronotum. — Covered with some small and fine bristles of different sizes; scale-like bristles probably absent.

c) Abdominal terga (Fig. 5). — With light wavy lines; scale-like bristles broad, pointed at apex; many fine and few larger pores; chitinous notches at hind margin scarce, a few small ones in the middle part, some more and larger ones on both sides; sterna also with some scale-like bristles and pores.

d) Paraprocts (Fig. 3 D). — Along the inner margin and submarginal with chitinous notches in 3 or 4 pantile-like rows; surface with a few fine bristles and small pores.

e) Caudal filaments. — Fine long bristles on inner margin of cerci and both sides of terminal filament.

f) Legs (Fig. 4). — Extremely few bristles. Outer margin of femora with only 2 to 4 short strong bristles, nearly no fine bristles; inner margin without bristles, submarginal a number of very short



Figs 5–6. Nymph of *Symbiocloeon heardi* n. gen., n. sp. 5 — surface and hind margin of abdominal tergum; 6 — fore wing pad with folved subimago fore wing

strong bristles and chloride cells. Apical curvation of femora with chitinous notches and with a conspicuous incision (Fig. 4 B). Outer margin of tibiae and tarsi nearly without bristles. Tibiae on inner margin and submarginal with a number of strong bristles; inner margin of tarsi some short strong bristles. Tarsal claws (Fig. 4 C and D) without teeth, strongly hooked at apex, with a number of sense organs on dorsal and ventral surface near apex.

This species is named for Dr. W. H. HEARD, the collector of the nymphs.

HOLOTYPE: 1 medium-sized ♂ nymph still attached to *Hyriopsis myersiana* (LEA), in alcohol. Thailand, Kanchanaburi Prov., Mae Nam Khwae Yai at Bang Nong Bua (12,3 km NW of Kanchanaburi on Hwy.–323, and then 2,5 km south) 10–IV–71 William H. HEARD leg. T–125.

PARATYPES: 1 mature ♀ nymph in alcohol; 2 nearly mature ♀ nymphs mounted on slides in Canada balsam; 1 clam with 1 ♂ nymph attached between demibranches of the clam: one dried clam with dried nymph attached; same data as for holotype.

Holotype and three paratypes are deposited in the U. S. National Museum of Natural History, Washington. Two mounted nymphs on slides in Canada balsam in I. MÜLLER-LIEBENAU'S collection in Plön, Max-Planck-Institut of Limnology, Department of General Limnology.

Systematic position

The main nymphal characters that distinguish the new genus from all other *Baetidae* are given in the generic description as above. Among the most important of them are: (1) unusual shaped labium with the 2nd and 3rd segments almost completely fused together to form one large stout segment;

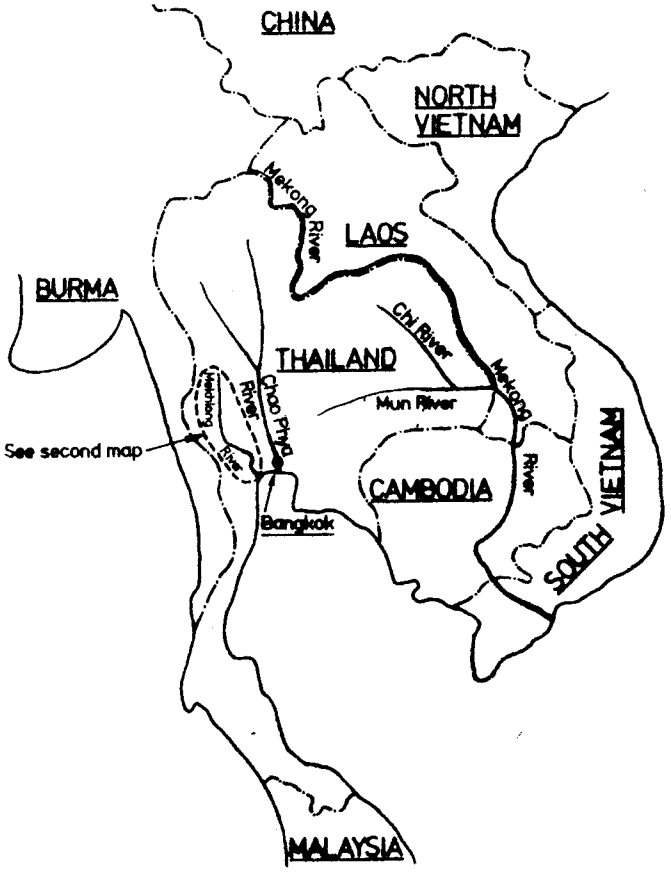


Fig. 7. Map of Thailand (after Heard), where *Hyriopsis myersiana* was collected

(2) bristles are almost completely lacking on outer margins of all three segments of the legs; (3) tarsal claws without teeth and strongly hooked at apex.

Reared material, especially males, is needed to clarify definitively the relationship to other genera in the family. — On a subimago fore wing, taken from a fore wing pad of a mature nymph and mounted unfolded as well as possible, no intercalaries appear between the longitudinal veins. One folded fore wing in the wing pad of a mature nymph shows the main venation (Fig. 6). Hind wings are absent.

Geographical distribution of *Hyriopsis myersiana* (Lea)

The distribution is, cited after BRANDT, 1974:276, as follows:

"In Thailand found in Meklong River and its tributaries Maenam Kwae Noi and Maenam Kwae Yai. Upper reaches of the Chao Praya River and its tributaries Pasak River, Ping River and Nan River, Kaek River and Kwae Noi River in Pitsanulok Province, Prachinburi River (Patrang River, Srakeo River); in S-Thailand only known from the Klong San in Pattalang Province".

W. H. HEARD collected clams at the following collecting sites in the Mae Klong River drainage (10 April 1971) (Fig. 7 and 8):

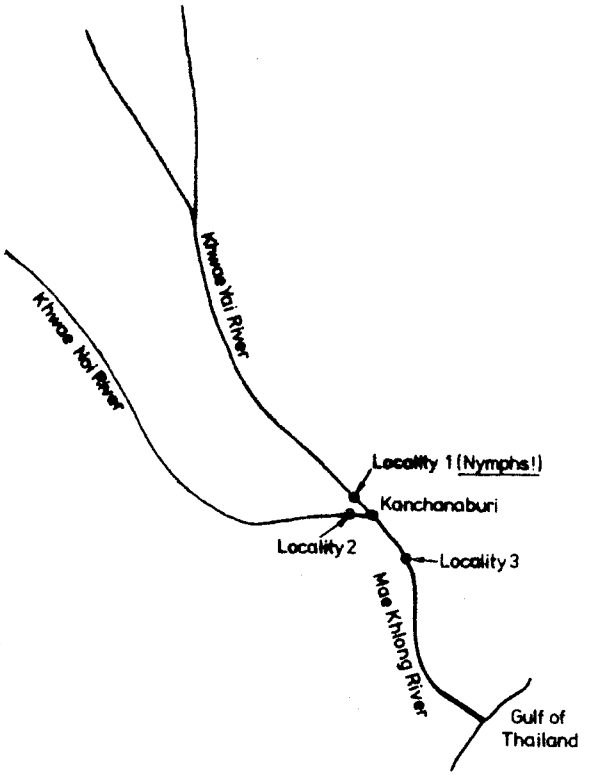


Fig. 8. Part of map Fig. 7 (after HEARD) Mae Khlong River system with localities, where *Hyriopsis myersiana* was collected

Locality 1: Khwae Yai River at Ban Nong Bua (12.3 km northwest of Kanchanaburi on Highway 323, and then 2.5 km south), Kanchanaburi Province, Thailand. (14° 03′ 30″ N Lat. × 99° 27′ E Long.)

Live clams —
Unionidae
Hyriopsis myersiana (LEA)

Dead, empty clam shells —
Unionidae
Chamberlainia hainesiana (LEA)

Locality 2: Khwae Noi River at railway bridge (= historical "Bridge on the River Kwai"), 1 km north of Kanchanaburi and then 2.5 km southeast, Kanchanaburi Province, Thailand. (14° 00′ 30″ Lat. ×99° 31′ E Long.)

Live clams —
- Unionidae
  - *Uniandra conradens tumidulus* (LEA)
- Amblemidae
  - *Indonaia caeruleus* (LEA)

Dead, empty clam shells —
- Unionidae
  - *Hyriopsis myersiana* (LEA)
  - *Physunio eximius* (LEA)
- *Amblemidae*
  - *Scabies crispata* (GOULD)

Locality 3: Mae Khlong River at Ban Tha Rua, 24.5 km east/southeast of Kanchanaburi, Kanchanaburi Province, Thailand. (13°58′ N Lat. ×99° 45′ E Long.)

Live clams —
- Unionidae
  - *Physunio superbus* (LEA)
- Amblemidae
  - *Indonania caeruleus* (LEA)

Dead, empty clam shells —
- Unionidae
  - *Uniandra contradens tumidulus* (LEA)
  - *Hyriopsis myersiana* (LEA)
- Amblemidae
  - *Ensidens ingallsianus* (LEA)

Mayfly nymphs were found only in live *Hyriopsis myersiana* (LEA) from Locality 1.

Biology and Ecology

The new genus and species, *Symbiocloeon heardi* sp.n., is the first published record of a clam mayfly association, where the nymph of a mayfly lives in association with a bivalve mollusc, and inside the shell on the surface of the clam. Six of 25 dissected clams of the species *Hyriopsis myersiana* (Fig. 10) contained mayfly nymphs, one per clam. So the frequency of nymphs in the clam is nearly 25%.

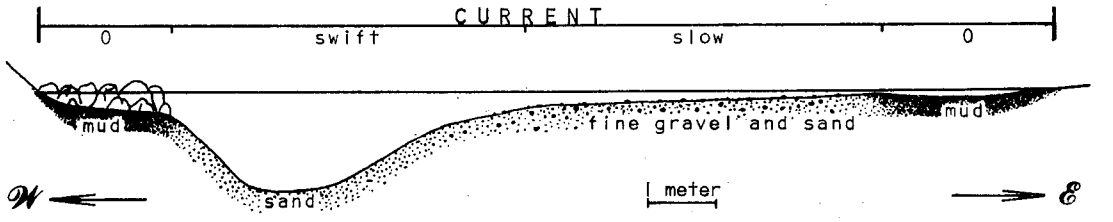


Fig. 9. Schematic cross section of habitat (Khwae Yai River at Ban Nong Bua) where *Hyriopsis myersiana* lives (JAN PETERS del.)

All 6 clams with their nymphs are from the same locality (Fig. 8). The habitat where the clams were collected, the Kwae River at Ban Nong Bua, is a medium-sized stream with "zoned" features from one side to the other. A transverse profile on the river (Fig. 9) shows the variations. W. H. HEARD was collecting when the river was very low. In this condition, it was about 15 m broad. The left bank of the river was gravel. It slowly became deeper, and at the middle it was sandy. Depth in the middle was roughly 1,3 m and current was very strong. The river then became shallower again quickly, approaching the rocks along the right bank. The clams were between the rocks in about 30 cm of water. The clams were dug in between the rocks, head (anterior end) down. The water was clean and clear, and the branchial and anal openings could be seen as long as the collector did not disturb the mud between the rocks in which the clams were burrowed.

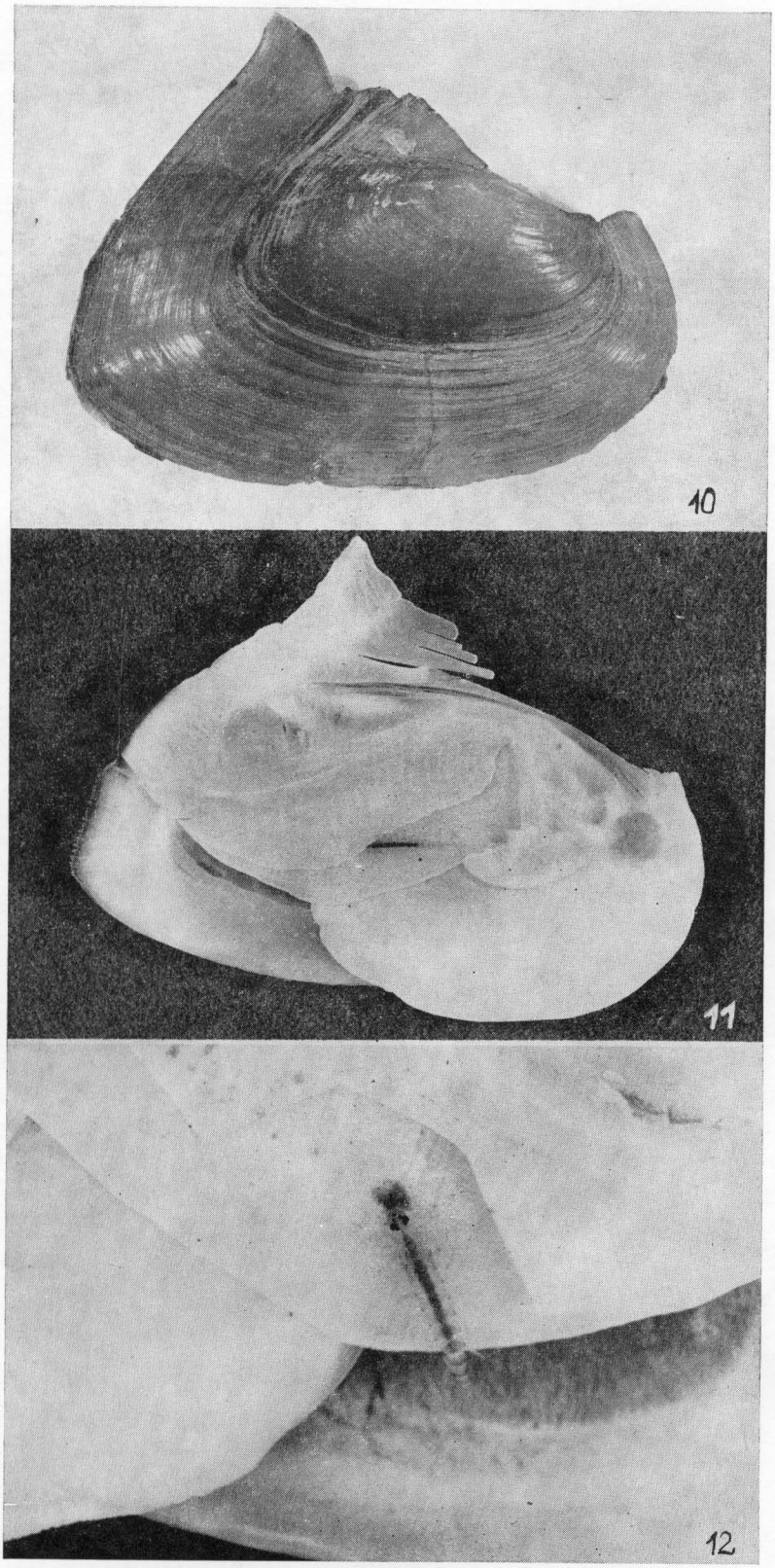
When the first two nymphs inside a clam shell were discovered by W. H. HEARD, the association was not considered as the usual way of life for a mayfly nymph, and no consideration was given to the position of the nymph. After morphological investigation of the first two nymphs, we concluded that because of some derived morphological characters this mayfly has to be more or less obligatorily associated with the clam. So in further dissections of clams more attention was given to the position of the nymph in the clam. All 4 additional nymphs had a similar position (3 were on the right side of the clam, and 1 was on the left), each on the outer surface of the inner demibranch, facing somewhat in a dorsal and then either in posterior (Fig. 11 and 12) or in anterior (Fig. 1) direction. The head and a part of the thorax are under the outer demibranch, the mouth facing the inner demibranch, the gills mostly exposed beyond the edge of the outer demibranch. The nymphal claws are embedded in the clam gill, so the nymph is firmly attached. Touching the nymph with a forceps or the like in a dish with 75% alcohol, it still remains attached to the gill and only the abdomen is movable. When the nymph is forcibly removed, tiny holes are left from the tip of the tarsal claws of the nymph, but this doesn't seem to do any serious demage to the clam gill. However the nymph is probably able to crawl between the demibranches, especially for food collecting.

Several morphological characters of the nymphs seem to be an adaption for this way of life and do lend support to the association being obligatory for the nymphs, perhaps as a commensal. Most conspicuous is the almost complete lack of bristles on the outer margins of the legs and other surface parts of the nymphs, so no bristles can irritate the sensitive surface of the demibranches of the clam. The tarsal claws do not have any teeth on the inner margin and they are much more hooked at the apex than in other baetid nymphs. As indicated, the hooked claws enable the nymph to fasten to the clam. The comparatively large gills on both sides of the body represent on the whole a large surface ensuring the oxygen supply of the nymph by the water current in the shell. The gill margins do not have any teeth, spines or bristles, which could irritate or wound the mussel. The mouthparts are in general rather similar to the well known baetid type. However, the labrum is lacking long submarginal bristles on the dorsal surface, maybe for the reason mentioned above for the legs. The mandibles are of normal type. The maxillary palpi, which generally are 2- or 3-segmented in other baetid nymphs, are only 1-segmented in *Symbiocloeon heardi* sp.n. and almost completely lack bristles. The mouthpart which is most divergent from the usual baetid type is the labium (Fig. 3 A and B). The 2nd and 3rd segments of the labial palpi are almost completely fused together, forming with the paraglossae and glossae a sort of a cup-shaped depression. The efficiency of this depression is probably increased by the relatively large maxillary palp on both sides, enlarging the depression to conduct food particles in the mouth opening. The dorsal surfaces of the paraglossae and glossae are densily covered with bristles.

Apparently the nymphs feed on the food of the clam by collecting mucous trapped detritus on the demibranches of the clam. Additionally the nymphs may be able to collect food by grazing small particles from a food groove on the outer edge of the demibranches. Beyond this perhaps the antennae assist in food collecting. In Fig. 12, in front of the nymphs head, an amount of detritus is to be seen. The antennae (not recognizable in Fig. 12) are just long enough to help in collecting and encircling the detritus within reach. One can imagine that the small particles, by movements of the different mouthparts in combined action, are transported to the mouth opening.

After investigation of the preserved material, we only can assume that the association is commensalism, in which the insect nymph profits by the food habit of the clam without seriously affecting its host. The little food which is eaten by the mayfly nymph probably is not more than the larger clam can easily be without. As far as it is possible to judge from the preserved material, both animals seem to live very well together.

Nothing is known about the life history of the newly described mayfly, i.e. mating, egg laying, hatching and further development. But considering the above described morphological characters of the nymph (mouthparts, gills, poor spination on the legs) it is obvious that already the youngest nymphal stages of this species are adapted to live in association with the clam. The mollusc is not a host for the nymphs by accident. Although all 6 nymphs here discussed are of larger size (one mature) we have to consider that also the younger and youngest individuals are living in clams.



Figs 10–12. 10 — Shell of the clam *Hyriopsis myersiana* (Lea); 11 — Clam with attached Mayfly nymph, *Symbiocloeon* n. gen., n. sp.; foot of the clam (anterior end) right; 12 — Clam with attached Mayfly nymph, *Symbiocloeon* n. gen., n. sp., part of upper demibranch cut away, so that the whole nymph is vissible; in front of the head of *Symbiocloeon heardi* n. gen., n. sp. a collection of food particles

Several species of snails were also collected at the same locality, mainly Viviparidae: *Mekongia* and *Idiopoma*, but none of them contained nymphs.

This paper draws attention to this yet unknown phenomenon of a mayfly-clam association, especially in cases, where masses of adults are swarming and not a single nymph can be found in all well known inches in the river.

Acknowledgment

The senior author, I. MÜLLER-LIEBENAU, is very thankful to Dr. W. H. HEARD, the collector of the clams, who generously gave her all his material and field notes, and to Dr. W. L. PETERS, who initiated and encouraged this paper. I. MÜLLER-LIEBENAU is also very thankful to JAN PETERS for some drawings and many dates dealing with the clam. Last but not least she has to thank Dr. W. L. PETERS for correcting this paper in English.

SUMMARY

Symbiocloeon: a new genus of Baetidae from Thailand (Insecta, Ephemeroptera)

A new genus and species of the family *Baetidae Symbiocloeon heardi* n.gen.n.sp. from Thailand is described. Only the nymphs are known, subimagos and imagos are still unknown. The material of the new baetid was collected by Dr. W. H. HEARD, Florida State University, Tallahassee, Florida, during a stay in Thailand in 1971. The nymphs live between demibranches (gills) of *Hyriopsis myersiana* (LEA) (*Bivalvia, Schizodonta, Unionidae*). The nymphs morphology shows several characters which allow the conclusion, that the nymphal stage of the new mayfly is symbiontic in a general sense with the clam. Morphological adaptation is seen in the almost complete lack of bristles on the outer margins of the legs and other surface parts of the nymph: the strongly hooked apex of the tarsal claws without teeth; the comparatively large gills, ensuring the oxygen supply of the nymph by the water current in the shell. Most conspicuous is the unique shape of the labium of the nymph (Fig. 3 A + B). The nymphs are firmly attached to the gills of the clam with the apex of the claws. This baetid apparently feeds on the food of the clam, either by filtering it from the water currents or by collecting it from the mucous of the demibranches. Nothing is known about the life cycle of this new mayfly. The clams live in the mud, in still water between the rocks (Khwae Noi River and Khwae Yai River, Prov. Kanachanaburi, Thailand). Six specimens of 25 clams contained the mayfly, one per clam, do the frequency of nymphs in the clams is nearly 25%.

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