Introduction

- The family Naucoridae, commonly known as saucer bugs or creeping water bugs, are predaceous aquatic insects that occur tropical and non-tropical lotic systems worldwide.
- In the family Naucoridae, Cheirochelinae is the only subfamily for which nymphal instars have not been described. • The genus *Gestroiella* Montandon in the subfamily Cheirochelinae is restricted to Southeast Asia and India and inhabits clear, rocky streams¹.
- Nanocladius asiaticus (Diptera: Chironomidae) are known to have phoretic associations with G. siamensis. For example, N. asiaticus was suggested to be associated with G. siamensis for (1) protection from predators, (2) increased mobility, (3) protection for pupation, or (4) reducing intraspecific competition for food (Boonsoong $2015)^2$.

Hypothesis

• The morphological features of the instars of *G. siamensis* are sufficiently different to distinguish each instar from conspecific instars.

Objectives

1) Quantitatively describe the nymphal instars of the naucorid species Gestroiella siamensis 2) Qualitatively describe a phoretic association between nymphs of *G. siamensis* and *Nanocladius* sp. (Diptera: Chironomidae) that was observed in the process of conducting objective 1.

Materials and Methods

- Immature specimens of *Gestroiella siamensis* used for descriptions were collected in southern Thailand in 1997. Nanocladius sp. were collected from the bodies of G. siamensis.
- For G. siamensis, 19 morphological characteristics were measured to describe each of the 5 nymphal instars. Body length is measured from the anterior margin of the head to the posterior margin of the abdomen. Body width is measured from the widest part of the body, usually the metathorax. These and other mensural characteristics are given in Table 1; all measurements are in mm (mean \pm SD).
- For *Nanocladius* sp., instar assignments were based on overall length. 1st instar: 0.56–1.12 mm; 2nd instar: 1.44–1.76 mm; 3rd instar: 2.32–2.80 mm; 4th instar: 3.12–3.76 mm.
- Images were taken using a Leica MZ16 stereo microscope coupled with the Leica Application Suite V4.10 Extended depth of Focus module and prepared by using Photoshop v 21.2.1 (Adobe Systems Inc., San Jose, California).

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R	lesults:	Naucor	Id Desci	ription	
Table 1. Descripti	ve measureme	ents (mean mr	$m \pm SD$) of ins	stars of Gestro	oiella siamensis
Character ^a	Instar 5	Instar 4	Instar 3	Instar 2	Instar 1
Body Length	11.12 ± 0.48	9.06 ± 0.30	6.85 ± 0.25	5.30 ± 0.18	3.95 ± 0.13
Body Width	8.00 ± 0.86	6.03 ± 0.19	4.67 ± 0.10	3.36 ± 0.13	2.50 ± 0.08
Head Length	2.08 ± 0.14	1.86 ± 0.15	1.44 ± 0.08	1.20 ± 0.10	0.93 ± 0.08
Head Width	4.22 ± 0.23	3.56 ± 0.12	3.21 ± 0.04	2.66 ± 0.07	2.05 ± 0.03
Synthlipsis	2.14 ± 0.05	1.79 ± 0.04	1.51 ± 0.04	1.19 ± 0.03	0.96 ± 0.02
Pronotal Length	1.66 ± 0.22	1.17 ± 0.03	0.91 ± 0.03	0.66 ± 0.02	0.47 ± 0.02
Mesonotal Length	1.61 ± 0.21	1.18 ± 0.14	0.94 ± 0.07	0.73 ± 0.07	0.50 ± 0.03
Metanotal Length	1.69 ± 0.19	1.17 ± 0.03	0.80 ± 0.03	0.62 ± 0.04	0.46 ± 0.03
Leg Lengths:					
Profemur	2.91 ± 0.14	2.43 ± 0.08	1.89 ± 0.08	1.33 ± 0.05	1.06 ± 0.04
Protibia	1.72 ± 0.10	1.34 ± 0.05	0.98 ± 0.05	0.75 ± 0.04	0.58 ± 0.03
Protarsus	0.39 ± 0.08	0.58 ± 0.07	0.52 ± 0.04	0.46 ± 0.02	1.35 ± 0.03
Mesofemur	3.19 ± 0.14	2.40 ± 0.12	1.86 ± 0.08	1.25 ± 0.07	0.93 ± 0.04
Mesotibia	2.22 ± 0.27	1.68 ± 0.14	1.32 ± 0.08	1.02 ± 0.06	0.76 ± 0.05
Mesotarsus 1	0.26 ± 0.04	0.22 ± 0.03	0.17 ± 0.02	0.13 ± 0.02	0.10 ± 0.02
Mesotarsus 2	1.08 ± 0.19	0.89 ± 0.14	0.67 ± 0.05	0.60 ± 0.04	0.46 ± 0.03
Metafemur	4.05 ± 0.12	3.12 ± 0.14	2.30 ± 0.14	$1.60\pm\ 0.07$	1.16 ± 0.07
Metatibia	3.91 ± 0.23	3.07 ± 0.08	2.36 ± 0.12	1.76 ± 0.10	1.37 ± 0.14
Metatarsus 1	0.30 ± 0.06	0.24 ± 0.06	0.20 ± 0.03	0.17 ± 0.03	0.12 ± 0.02
Metatarsus 2	1.39 ± 0.17	1.20 ± 0.15	0.95 ± 0.08	0.71 ± 0.04	0.63 ± 0.04

^aMeasurements of body, head, and notal lenghts taken at midline.

• The most notable changes between the first instar and subsequent instars, in addition to overall body size, are the anterior margin of the head becomes more convex, the lateral margins of the pronotum become less convex, and that the pigmentation becomes more pronounced, although the pattern does not change appreciably, and the relative lengths of the mesonotal wing pad compared to the exposed portion of the metanotal lateral margin increases (Table 1).

Naucorid Discussion

• The hypothesis that the nymphal instars of *G. siamensis* can be distinguished between conspecific instars using morphological features was supported by the results. G. siamensis Polhemus, Polhemus, and Sites is known only from Thailand and is the smallest of the three congeners. It was recorded from southern Thailand provisionally as G. *limnocoroides* Montandon prior to its description as G. siamensis (Sites et al. 1997)³; G. limnocoroides is more northern in distribution and the species co-occur in Kanchanaburi Province. Nymphs of Decarloa (Ludwick and Sites 2015)⁴, *Laccocoris*, and *Pogonocaudina* (Sundar et al. 2014)⁵, all in the subfamily Laccocorinae, have only single meso- and metatarsal segments. *Gestroiella siamensis*, in the subfamily Cheirochelinae, has two tarsal segments as do nymphs in the other four subfamilies (Ambrysinae, Cryphocricinae, Limnocorinae, and Naucorinae).

DESCRIPTIONS OF THE NYMPHAL INSTARS OF GESTROIELLA SIAMENSIS POLHEMUS, POLHEMUS AND SITES (HEMIPTERA: HETEROPTERA: NAUCORIDAE) AND PHORETIC ASSOCIATION WITH NANOCLADIUS KIEFFER (DIPTERA: CHIRONOMIDAE)

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Figure 1. Gestroiella siamensis. (A) adult submacropterous male, (B) 5th instar, (C) 4^{th} instar, (D) 3^{rd} instar, (E) 2^{nd} instar, (F) 1^{st} instar. Size bars = 2.0 mm.



Figure 2. Nanocladius sp. (Chironomidae) on instars 2–5 of Gestroiella siamensis (Naucoridae). (A) 1st instar chironomid on thoracic ventral midline of 2nd instar naucorid, (B) 2nd instar chironomid on abdominal sterna of 3rd instar naucorid, (C) 1st instar chironomid between pro- and mesonota of 4th instar naucorid, (D) 2nd instar and pupal chironomids on mesofemora of 5th instar naucorid.

Results: Phoretic Association

- naucorids (Table 2).
- 5 (Fig. 2, Tables 2, 3).

Table 2. Position of Nanocladius sp. (Chironomidae) on each naucorid instar.

Naucorid Body Part ^a	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5
Fem/Tr	0	0	9	19	11
AbSt	0	0	1	1	1
Fem/Tr & AbSt	0	0	0	0	1
Pro/Meso	0	0	0	2	1
Fem/Tr & Pro/Meso	0	0	0	8	9
Pro/Meso & AbSt	0	0	0	0	1
ThVentMid	0	13	18	3	0
ThVentMid & Pro/Meso	0	0	10	4	0
Fem/Tr & Fem/Tr & Pro/Meso	0	0	0	0	1
Total naucorids with chironomid	0	13	38	37	25
Total naucorids without chironomid	27	24	10	5	5
Total naucorids examined	27	37	48	42	30
^a See Results: Phoretic Association for	definitio	ns of abb	revistion	c	

Table 3. Chironomid immature stages and naucorid body parts to which they were attached.

		Chironomid Instar					
Naucorid Instar	Naucorid Body Part	1	2	3	4	Pupa	
	Fem/Tr	0	0	0	0	0	
	AbSt	0	0	0	0	0	
2	ThVentMid	2	8	3	0	0	
	Pro/Meso	0	0	0	0	0	
	Total	2	8	3	0	0	
	Fem/Tr	0	4	5	0	4	
	AbSt	0	1	0	0	0	
3	ThVentMid	2	5	5	12	0	
	Pro/Meso	8	2	0	0	0	
	Total	10	11	11	12	4	
	Fem/Tr	0	3	6	15	4	
	AbSt	0	1	0	0	0	
4	ThVentMid	0	1	1	3	0	
	Pro/Meso	10	5	0	0	0	
	Total	10	10	7	18	4	
	Fem/Tr	0	1	7	11	1	
	AbSt	0	2	0	0	0	
5	ThVentMid	0	0	0	0	0	
	Pro/Meso	13	1	0	0	0	
	Total	13	4	7	11	1	

Discussion: Phoretic Association

- be a suitable site of attachment for Nanocladius.
- phenology of the association between Gestroiella and Nanocladius.

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• Nanocladius sp. were found on the mesofemur and trochanter (Fem/Tr) (Fig. 2D), angled across the abdominal sterna (AbSt) (Fig. 2B), thoracic ventral midline between coxae 2 and 3 (ThVentMid) (Fig. 2A), and between the pronotum and mesonotum (Pro/Meso) (Fig. 2C) on naucorid instars 2–5 (Tables 2, 3). No chironomids were found on first instar

• Multiple chironomid specimens were attached to different body parts on single naucorid individuals of instars 3–5 (Table 2). Chironomid pupae were found only on the Fem/Tr and usually along with larvae on the same individuals of instars 3–

See Results. Phoretic Association for definitions of addreviations

• There does not appear to be an association between chironomid and specific naucorid instars, as each chironomid instar was found to occur on almost all naucorid instars, except naucorid instar 1. However, there does seem to be an association between naucorid instar body region and inhabitation of chironomids. More specifically, on earlier naucorid instars (2 and 3), chironomids occurred more often on the thoracic ventral midline. On later instar naucorids (4 and 5), chironomids occurred more often on the mesofemur and trochanter. This suggests that the mesofemur of early instar naucorids may not

• It is unknown whether *Nanocladius* is phoretic as Polhemus et al. (2008) and Boonsong (2015) suggested, or parasitic as in *Nanocladius* nr. *branchicolus* (Doucett et al. 1999)⁶. More research is clearly needed to address the nature and

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