

Notes on 5th instar nymphs of two species of *Phaenacantha* Horváth (Heteroptera: Colobathristidae)

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Fifth-instar nymphs of two species of colobathristid genus *Phaenacantha* from China are described, and the diagnosis of nymphal Colobathristidae and its significance in phylogenetic study are discussed.

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1. Introduction

Colobathristidae is a small family of Heteroptera, with a total of 83 species in 23 genera described (Schuh & Slater 1995). It is difficult to place Colobathristidae in a phylogenetic context properly, because they possess certain conflicting characters. Štys (1965, 1966a, 1967) thought that Colobathristidae belonged to his malcid evolution line (that also includes Berytidae, Malcidae, and the lygaeid subfamily Cyminae) and shared the same ancestral group of precymines. Some other authors have discussed its relationship to other groups of Pentatomomorpha based on different characters. For example, Ashlock (1957) indicated that the phallus of Colobathristidae showed strong affinities to those found in Heterogastrinae and Pachygronthinae of Lygaeidae. Kumar (1968) compared the salivary glands and gastric caeca, discussed its close relationship to the Lygaeidae and believed that Colobathristidae might well be included in the Lygaeidae as a subfamily. Cobben (1968) indicated that

the eggs of Colobathristidae mostly resembled those in the Coreoidea. Based on the trichobothrial numbers of abdomen, Schaefer (1975) suggested that the Colobathristidae may be an early offshoot from the line (malcid line) ancestor.

Sweet & Schaefer (1985) mentioned that the eggs of Colobathristidae have a pseudoperculum shared with Ischnorhynchinae, Chauliopininae and some Rhyparochrominae among the Lygaeid groups. From the cladograms of Henry (1997) and Dong & Zheng (1997), Colobathristidae and Berytidae are sister taxa, and then united as the sister group to Malcinae plus Chauliopininae. These results basically agree (though not completely) with Štys (1967) opinion (e.g. Berytidae and Malcidae are sister groups), and also somewhat support the malcid evolution line viewpoint.

None of the immature stages of Colobathristidae have been described in detail in the literature, besides the diagram of Cobben (1978) and simple notes of Schuh & Slater (1995). In ad-

dition, Colobathristidae never occurs in any keys to families of Heteropteran nymphs and was not mentioned by Yonke (1991) in his monograph of nymphal Heteroptera. In this paper, 5th instar nymphs of two species of genus *Phaenacantha* Horváth are described for the first time in detail. This contribution to the diagnosis of nymphal Colobathristidae and the significance of some characters in a phylogenetic context are discussed. The present paper further increases our knowledge on this family.

2. Material and methods

Up to now, only two genera (*Symphylax* Horváth and *Phaenacantha* Horváth) have been known from China (Hsiao *et al.* 1977). In Jiangxi Province, where the nymphal material involved in this study was collected, only *Phaenacantha* spp. have been found (the *Symphylax* was recorded from southern Yunnan). *Symphylax* and *Phaenacantha* can readily be distinguished by the comparative length of 3rd and 4th labial segments. Based on both the geographical and morphological aspects listed above and the adult specimens collected along with the nymphs, the identifications of the nymphal material in the study were justified.

Phaenacantha sp. 1: 1 (5th instar) nymph and 1 adult male, Xihe, Guanshan Nature Reserve, Yifeng County (28 N, 115 E), Jiangxi Prov., China, 2.VIII.2002, Xue Huai-jun leg..

The nymphal specimen was collected among tall unidentified grass (Poaceae) with an adult brachypterous specimen of *Phaenacantha trilineata* Horváth. Thus, possibly the nymphal specimen is also *P. trilineata*, as the very short mesothoracic wing pads and the dark brown ring-shaped patches near the terminal part of femora support such a tentative identification. In addition, the emergence of ocellar traces validates it as a 5th instar nymph (in some heteropteran taxa, ocellar traces can be seen in 5th instar nymphs).

Phaenacantha sp. 2: 1 (5th instar) nymph, 2 adult females, Pingkeng, Juliashan Nature Reserve (24 N, 114 E), Jiangxi Prov., China, 15.VII.2002, Xue Huai-jun leg.

The nymphal specimen was collected among tall Gramineae together with two adult specimens

of *Phaenacantha bicolor* Distant (which is the only species of Colobathristidae collected at this locality during that collecting trip).

The material is preserved in 75% alcohol and deposited in Institute of Entomology, College of Life Sciences, Nankai University, Tianjin, China.

3. Species descriptions, and discussion

3.1. Body form

Body elongate, slender. Abdomen constricted at base in *Phaenacantha* sp. 2; while in the brachypterous *P.* sp. 1, the abdominal base is not obviously constricted.

3.2. Coloration

The ground color of head, pronotum and wing-pads yellowish brown with several black patches at base of head, postero-lateral side of eyes, epicranium, callosity and postero-lateral angle of pronotum. Eye and ocellar traces all reddish. Bases of eyes, labium (except tip), most part of legs, 1st, 2nd and basal part of 3rd segments of antennae yellow or pale yellow. Antennal sclerite, distal part of 3rd segment and 4th segment of antennae, tip of labium, 2nd segment of each tarsus and a ring-shaped patch near terminal part of each femur (only *Phaenacantha* sp. 1) dark brown. Lines closely lateral to pale ecdysial suture on pronotum black. Scutellum brownish-black with tip milky white. A patch on 8th abdominal sternum black (*Phaenacantha* sp. 2). Undeveloped genital segment dark brown.

3.3. Hairs

Head, pronotum and mesothoracic wing-pads covered with short and pale soft hairs. Antennae, femora and tibiae also covered with some fine and sub-adpressed setose hairs. Glandular hairs or scale-like hairs are not found in these two species.

Among the groups of the malcid evolution line, Malcinae (Štys 1967, Zheng & Liu 1998), Chauliopinae (Chopra & Rustagi 1982, Sweet & Schaefer 1985, Zheng & Liu 1998), Berytidae

(Péricart 1984, Schuh & Slater 1995, Zheng & Liu 1998), and Cyminae (Hamid 1975 did not mention nymphal glandular hairs in his Cyminae monograph; however, hairs thickened apically in our study in nymphs of *Cymus* sp. were observed) all have glandular hairs in nymphal stages, at least in some of the instars. Thus, in malcid evolution line the Colobathristidae is the only group in which the glandular hairs have not been found up to now.

3.4. Head

Eye large, stalk developed, diameter slightly narrower than eye and seems shorter than in adult. Head short, transverse, wider than pronotum, anterior margin of head straight and clypeus undetectable in dorsal view; vertex flat, upper margin of eyes higher than vertex slightly in lateral view. In Berytidae, head is more elongate and more or less narrowed basally; eyes are sessile and small; anterior part of head (clypeus) usually clearly visible and somewhat tapered in dorsal view; in lateral view, upper margin of eyes lower than vertex, the neck flat and vertex convex, the anterior part of head (clypeus) declivent.

Ocellar traces visible in 5th instar nymph of *Phaenacantha* sp. 1 but not in *Phaenacantha* sp. 2, near to each other, the location similar to that in adults.

Antenna four segmented, longer than body length; general shape, structure and length proportions similar to that in adults but slightly thicker. Antennal sclerite ring-shaped, situated on frontal face of head (Figs. 1a–b, 2a–b). The first antennal segment relatively stout, cylindrical; 2nd and 3rd segments slender and thin, stick-shaped; 4th segment slender, the tip somewhat pointed.

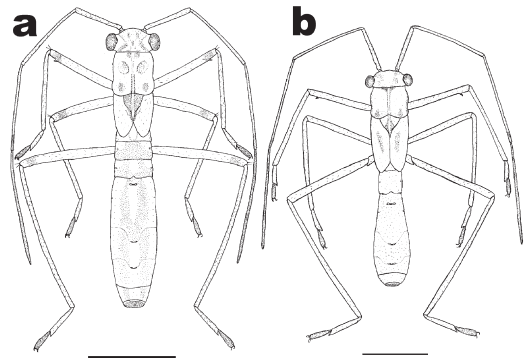


Fig. 1. The 5th instar nymphs, dorsal view. a. *Phaenacantha* Horv h sp. 1. b. *Phaenacantha* Horv h, sp. 2. Scale bars 2.0 mm.

Segments 2–4 almost equal in thickness. Fourth segment is the longest, 1st segment the shortest. In Berytidae nymphs (*Yemmatropis* & *Metacanthus*), antennae are much longer than body length, 1st antennal segment is the longest and very slender; 4th one comparatively short and somewhat fusiform; 3rd segment much longer than 4th one in general, sometimes longer slightly (e.g. in *Metacanthus*, 3rd segment: 4th segment = 1.25:1).

The diameter of antennal segments (especially 2nd and 3rd segments) in 5th instar nymphs often wider than that in adults. Furthermore, in some groups (Berytidae, Malcinae, Chauliopininae and Cyminae (Cymini), their fourth antennal segment fusiform), diameter proportion of 4th and 3rd antennal segments is very different in 5th instar nymphs and in adults. For example, in adults of Berytidae, the diameter of 4th antennal segment is 3–5 times that of the 3rd segment, but in 5th instar nymphs, the proportion is 2 times or less. So 4th antennal segments are more spindle-like in 5th instar nymphs than that in adults. But such changes in diameter proportions are not found in

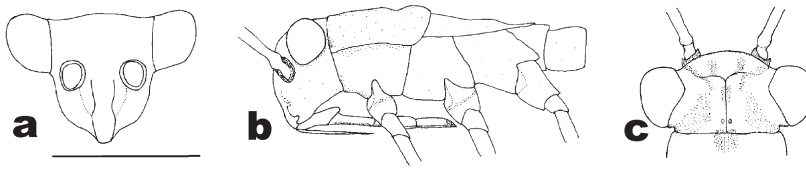


Fig. 2. a. Head of *Phaenacantha* sp. 1, frontal view. b. Head and thorax of *Phaenacantha* sp. 1, lateral view. c. Head of *Phaenacantha* sp. 1, dorsal view, showing epicranial sulcus. Scale bars 1.0 mm.

Colobathristidae (4th antennal segment not obviously fusiform).

In adult Berytidae, apex of 1st antennal segment and femur are thickened, but in nymphs, the apices are not notably thickened; so this character would be useless in distinguishing the nymphs of Colobathristidae and Berytidae.

Bucculae very small, posteriorly free. In Malcidae, the bucculae are relatively large in adults but undeveloped in nymphs; bucculae undeveloped in both nymphs and adults of Colobathristidae, Cyminae and Berytidae. Labium 4 segmented, reaching bases of medial coxae.

Based on the nymphal specimens we observed, the epicranial sulcus is present. But only its stem and basal part of arms are relatively clear, the distal part of arms is hardly visible (Fig. 2c).

3.5. Thorax

Thorax with broad median pale ecdysial suture along entire dorsum. Pronotum with unobvious collar, subquadrate. Anterior margin of pronotum straight and posterior margin concave; anterior lobe of pronotum longer than posterior one (about 2:1), but in adult, the ratio is about 1:1. The lateral margins of anterior lobe slightly elbowed.

Scutellum subtriangular with acute and spear-tip like apex (In adult, scutellum shorter but with an acute and oblique dorsal spine). In adults of Colobathristidae and some Berytidae the dorsal spines on scutellum are inclined or perpendicular to the body surface, but in nymphs the undeveloped spine is horizontal and caudally directed.

For *Phaenacantha* sp. 1, the brachypterous individual, mesothoracic wing pads very short, not reaching the posterior margin of 1st abdominal segment; for *P.* sp. 2, mesothoracic wing pads reaching posterior margin of 2nd abdominal segment.

The three pairs of legs similar, thin, very long, with setiform hairs (shorter or longer). Femora stick-shaped, equally in thickness in whole length. Terminal part of anterior femur ventrally with a black acute spine [in adult *Dayakiella* Horváth, two spines present on terminal part of anterior femur according to Štys (1965)]; a pair of spiculiform hairs on dorsal side of each femur



Fig. 3. Hind- and pretarsus of 5th instar nymphs of *Phaenacantha* sp. 1, dorsal view. Scale bar 0.5 mm.

apex (only found in *Phaenacantha* sp. 1). Tibiae stick-shaped, covered with some fine setiform hairs, longer than those on femora. Tarsi with two joints, 1st tarsal segment much longer than the 2nd (anterior leg 1.5:1; intermediate leg 1.5:1; posterior leg 1.9:1). In Berytidae (*Yemmatropis* & *Metacanthus*), two segments are almost equal in length. The character that 1st tarsal segment much longer than 2nd segment only occur in Colobathristidae among malcid evolution line.

Pretarsus as in Fig. 3.

3.6. Abdomen

Abdomen narrow, the lateral part of the abdomen thin, the central part of abdomen strongly convex ventrally (such a situation is only found in Colobathristidae among malcid evolution line groups).

According to the diagram and illustrative notes of Cobben (1978), dorsal abdominal scent glands of Colobathristidae are small, first two glands reduced and/or displaced posteriad within the tergite. Schuh & Slater (1995) mentioned that the scent-gland openings between 3–4 and 4–5 are reduced.

Through the observation to 5th instar nymph of the two species of *Phaenacantha* Horváth, we found the following. (1) Three dorsal abdominal scent glands present, sclerite-rings around the scent-gland openings relatively small, and the three pairs of scent-gland openings are not reduced. (2) The first pair of openings present on tergum 4 behind the suture between abdominal terga 3–4 (that the scent-gland pores are not situated on the suture itself is somewhat extraordinary among the Lygaeoidea to our knowledge); 2nd and 3rd pairs of openings present between abdominal terga 4–5 and 5–6. (3) Glands have no dark areas surrounding their openings.

Štys (1966b) stated that the hind margin of 3–5 mediotergite of *Phaenacantha australiae* Kirk.

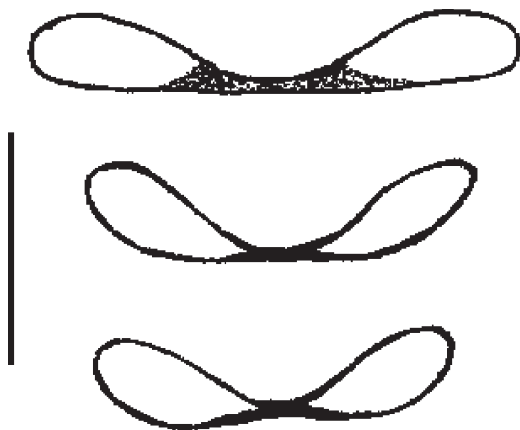


Fig. 4. Dorsal abdominal scent-gland orifices of *Phaenacantha* sp. 1. Scale bar 0.2 mm.

is produced posteriorly and provided with unpaired orifices of dorsal abdominal scent glands in the adult. But, the situation in the congeneric nymphs we observed is different (Fig. 4; it is hard to say if one or a pair of orifices are present from the traces in adult specimens we observed): Each dorsal abdominal scent gland has a pair of scent-gland pores, and sclerite-rings of glands are narrow. The suture between abdominal tergites 3–4 is not very distinct, its medial part somewhat protrudes forward. In nymphs, the sutures between abdominal terga 4–5, 5–6 are very obscure, apparently the tergites 4, 5 and 6 are fused. The sutures between abdominal sterna 4–5, 5–6 are clearly visible. In adults, both *P. trilineata* Horváth and *P. bicolor* Distant, the tergites 3–6 are fused [not tergites 3–5, as Štys (1967) stated].

The medial part of sutures between abdominal terga 4–5, 5–6 (both in nymphs and adults) is curved posteriorly. Štys (1967) thought this was a primitive character in his Coreoidea (in adults) [He said that the straight intersegmental sulci between the medial tergites represent probably a derivative condition in his Coreoidea (including Coreoidea+Lygaoidea+Pyrrhocoroidea in a conventional sense)]. However, Henry (1997) regarded it as a derived character in Pentatomomorpha, and stated that the curved sutures occur in Geocorinae, Henestarinae and Bledionotinae among the Pentatomomorpha (in nymphs). Based on our observation and other published data [e.g. figures in Putshkov (1958) and Péricart (1998a–

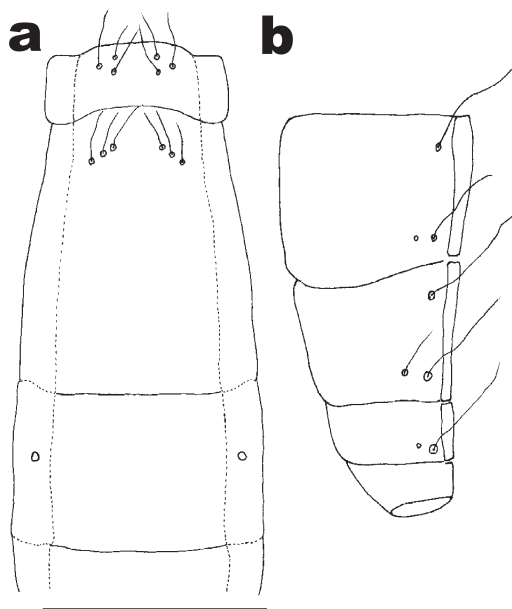


Fig. 5. The abdominal segments of 5th instar nymphs, showing abdominal trichobothrial pattern. a. *Phaenacantha* sp. 1, segments 3–5, ventral view. b. *Phaenacantha* sp. 1, segments 5–9, lateral view. Scale bars 1.0 mm.

c)], the curved sutures in fact also occur in many other groups in nymphal Lygaeidae. It is obvious that this character has appeared and disappeared more than once. Štys (1967) also mentioned that this character is often variable at generic level.

Abdominal spiracles 2–4 dorsal and 5–7 ventral, relatively small.

The abdominal trichobothrial pattern in nymph (Fig. 5a–b) is similar to that in adult. According to our specimens, the trichobothrial setae of posteromedial trichobothria on 5th and medial one on 7th sternum are hardly distinguished (only a small raised tubercle is visible). Based on our observation, both adult *P. trilineata* Horváth and *P. bicolor* Distant have the same abdominal trichobothrial pattern as in *P. australiae* Kirkaldy (Štys 1966b, Schaefer 1975). It seems that the abdominal trichobothrial pattern (in adults) is rather constant in this genus. As the posteromedial trichobothria on 5th, 6th and the medial one on 7th sterna are thin and short, they are sometimes difficult to observe.

The sex can be distinguished from the undeveloped genital segment of 5th instar nymphs.

Table 1. Nymphal characters of Colobathristidae compared with the related groups.

Group	Colobathristidae (<i>Phaenacantha</i>)	Berytidae (<i>Yemmatropis</i> & <i>Metacanthus</i>)	Malcinae (<i>Malcus</i>)	Chauliopinae (<i>Chauliops</i>)	Cyminae (<i>Cymus</i> & <i>Cymodema</i>)
Body form	Elongate	Elongate	Oval	Oval	Fusiform
Head	Short, transverse; anterior margin straight and clypeus undetectable in dorsal view; vertex flat	Elongate; anterior part tapered in dorsal view; base flat and vertex convex	Anterior part arc-shaped in dorsal view; vertex comparatively flat; anterior part of head heavily declivent	Declivent smoothly	Declivent slightly, almost horizontal
Eyes	Large, stalk developed; upper higher than vertex	Sessile, small; upper margin lower than vertex	Sessile, small; upper margin slightly higher than vertex or in a same plane	Protruding; upper margin higher than vertex	Sessile, small; upper margin lower than vertex
Antennae	Longer than Body; 1st segment stout and Shortest; 4th segment longest but not fusiform	Much longer than body, 1st segment longest and very slender; 4th segment short and fusiform	Longer than body; 1st segment cylindrical; 4th segment short and fusiform	Shorter than body; 1st segment cylindrical; 4th segment short and fusiform	Shorter than body; 1st segment stout, 4th segment fusiform
Glandular hair	None	Elongate and pale, sparse	Sclerotized spinose process; dense	Sclerotized spinose process and/or nail-like	Tiny, sparse
Spine on anterior femur	Present	None	None	None	None
Length of tarsal segment I-II	1.4~1.9 : 1	1 : 1	1 : 1.5~2	1 : 1.4~1.6	1 : 1.5~2
No. dorsal abdominal scent gland openings	3	1-2	3	2	1-3
Situation of dorsal abdominal scent gland openings	1st pair of openings on tergum 4 (not on suture)	On sutures between abdominal segments	On sutures between abdominal segments	On sutures between abdominal segments	On sutures between abdominal segments
Orifices of dorsal abdominal scent glands	Paired	Unpaired	Paired	Paired	Paired
Sutures between abdominal terga 4-5 and 5-6	Medial part curved posteriorly	Straight	Straight	Straight	Straight
Position of abdominal spiracles	2-4 dorsal and 5-7 ventral	All dorsal	All dorsal	All dorsal	2-6 dorsal and 7 ventral or 2-7 ventral

3.7. Measurements (in mm)

Phaenacantha sp. 1 Body length 6.30, Head length 0.49, width across eyes 1.30; interocular space 0.57; length of antennal segments I 1.05, II 1.80, III 2.00, IV 2.60; length of labial segments I 0.30, II 0.36, III 0.37, IV 0.40; pronotum length 0.90, pronotum width 0.78; width of scent gland sclerites I 0.20, II 0.15, III 0.14.

Phaenacantha sp. 2 Measurements: Body length 6.72, Head length 0.52, width across eyes 1.35; interocular space 0.75; length of antennal segments I 1.35, II 2.25, III 2.70, IV 3.19; length of labial segments I 0.36, II 0.30, III 0.36, IV 0.42; Pronotum length 0.97, pronotum width 1.12. width of scent gland sclerites I 0.29, II 0.22, III 0.20.

3.8. Contribution to the diagnosis of nymphal Colobathristidae

Based on the 5th instar nymphs of genus *Phaenacantha* Horváth we have described, we consider the following characters to be useful in diagnosing the nymphal Colobathristidae.

Body elongate, slender. Base of abdomen constricted or not. Head short, transverse, wider than pronotum, anterior part of head strongly declivous to vertical, vertex flat, upper margin of eyes slightly higher than vertex. Eye large, more or less stalked; ocellar traces near to each other. Antennae 4 segmented, 1st segment relatively stout, cylindrical; 2nd–4th segments slender and thin, stick-shaped; almost equal in thickness; 4th segment slender with tip somewhat pointed; 1st segment is the shortest, then 2nd segment, 4th the longest. Legs long and thin, with an acute spine near ventral side of terminal part of the anterior femur; tarsi with two joints, 1st segment much longer than 2nd segment. Scutellum with a spear-tip shaped apex. Three pair of dorsal abdominal scent gland openings and without dark areas surrounding them. The first pair of openings present on tergum 4 behind the suture between abdominal terga 3–4; 2nd and 3rd pair of openings present between abdominal terga 4–5 and 5–6. The sutures between abdominal terga 4–5, 5–6 very obscure and the medial part of them curved posteriorly.

The nymphs of Colobathristidae can be dis-

tinguished from the related groups as summarized in Table 1.

3.9. Family position

Several phylogenetic analysis of family groups within Lygaeoidea (or Pentatomomorpha), mainly based on adult features (Henry 1997, Dong & Zheng 1997, Xue 2004), all showed that Colobathristidae is the sister group of Berytidae. Armature on scutellum, postero-laterally directing articulation of metacoxae, elongate body, antennae and legs, impunctate clavus and corium, and some other synapomorphies support the relationship. In nymphal stages, some characters can also provide support for the above suggestion: (1) the acute and spear-tip like apex of scutellum; (2) elongate body, antennae and legs; (3) no dark areas surrounding the dorsal abdominal scent gland openings (possibly a symplesiomorphy). On the other hand, the following characteristic autapomorphies found in nymphal stages (i. e. the position of 1st pair of dorsal abdominal scent gland openings; the tarsomere I much longer than II, and the position of abdominal spiracles) strongly indicate that the Colobathristidae is somewhat far separated from its sister group Berytidae.

We conclude that the nymphal characters revealed in this study support the conventional opinion on the family position of Colobathristidae: a lygaeoid family situated at the tip of familial cladogram with Berytidae as its sister group.

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