

**Redescription of the subgenus *Rhithrogeniella* Ulmer 1939 (Ephemeroptera, Heptageniidae, genus *Ecdyonurus*) based on reared specimens from India and Thailand**

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**Abstract**

*Rhithrogeniella* Ulmer 1939 is treated here as a subgenus of the genus *Ecdyonurus* Eaton 1868 (s. l.). The subgeneric name *Rhithrogeniella* is a senior synonym of *Afghanurus* Demoulin 1964 **syn. n.**, *Paracinygmula* Bajkova 1975 **syn. n.** and *Nixe* Flowers 1980 **syn. n.** Additional description of *Ecdyonurus* (*Rhithrogeniella*) *ornatus* (Ulmer 1939) is given based on imagines and subimagines of both sexes reared from larvae in India and Thailand; lectotype of this species name is designated. Synonymy of *E. (Rh.) ornatus* and *E. (Rh.) tonkinensis* Soldán & Braasch 1986 is established (**syn. n.**). Male and female imagines and subimagines of an unnamed species of *Rhithrogeniella* are reported from India.

**Key words:** mayflies, systematics, India, Thailand

**Introduction**

The genus *Rhithrogeniella* Ulmer 1939 was originally established for a single species *Rh. ornata* Ulmer 1939 described as male and female imagines and subimagines from Java and Sumatra. Ulmer (1939: 575–576) assumed relation of this genus with *Rhithrogena* Eaton 1881. Holotype of *Rh. ornata* had not been designated; two specimens, a male imago and a female imago were reported as «Typen» (Ulmer 1939: 578), both from Bogor (former Buitenzorg). Sartori (2014) erroneously interpreted these two type specimens as «One male holotype, one female allotype». Lectotype of this species is designated below.

Soldán & Braasch (1986) described a second species of *Rhithrogeniella*, *Rh. tonkinensis* Soldán & Braasch 1986 as male subimago, female imago and larva from Vietnam. The winged stages were not reared from the larvae, and the reason for their placing in one and the same genus and species was not explained. Based on examination of the larval structure, these authors revealed closer relationship of *Rhithrogeniella* with *Ecdyonurus* Eaton 1868 and related taxa, rather than with *Rhithrogena*. Examination of eggs allowed them to assume its relationship with *Nixe* Flowers 1980. Currently (Kluge 1997), *Nixe* is regarded to be a junior synonym of *Afghanurus* Demoulin 1964, which is accepted as a subgenus in the genus *Ecdyonurus* s. l.

Braasch (1990) described male imagines from Thailand ascribed to *Rh. tonkinensis* and placed *Rhithrogeniella* in the newly established tribe Ecdyonurini.

Since association of larvae and winged stages proposed by Soldán & Braasch (1986) was not proven by rearing, Kluge (2004) reported *Rhithrogeniella* among «*Radulapalpata incertae sedis*».

Wang & McCafferty (2004) synonymized *Rhithrogeniella* with *Rhithrogena* and argued this by the single

sentence: «The type species of *Rhithrogeniella*, *R. ornata* Ulmer, possesses the essential characteristics associated with *Rhithrogena*». They did not report any concrete «essential characteristics» which allowed them to make this conclusion. With placing *Rh. ornata* in the genus *Rhithrogena*, they transferred *Rh. tonkinensis* to the genus *Ecdyonurus*, regarding these species to be non-related.

Sartori (2014) and Sartori *et al.* (2016) redescribed type specimens of *Rh. ornata* (male and female imagines and subimagines) and described larvae from Sumatra associated with this species with the help of the egg structure. They concluded that *Rh. ornata* and *Rh. tonkinensis* belong to one and the same genus *Rhithrogeniella* belonging to Ecdyonurinae (that is equal to Ecdyonurini *sensu* Braasch 1990 and Ecdyonurus/fg1 *sensu* Kluge 2004). They characterized *Rhithrogeniella* as having titillators in the subimaginal stage, but lacking them in imaginal stage. They concluded that the male imago from Thailand with well-developed titillators, identified by Braasch (1990) as *Rh. tonkinensis*, was misidentified. Three species known as larvae from Taiwan and originally described as *Nixe* (*Nixe littorosus* Kang & Yang 1994, *N. (N.) mitificus* Kang & Yang 1994 and *N. (N.) obscurus* Kang & Yang 1994, were transferred by them to the genus *Rhithrogeniella*.

Principles of the rank-free hierarchical nomenclature based on the International Code of Zoological Nomenclature, were introduced by Kluge (2004). The taxon under rank-free hierarchical name Ecdyonurus/fg1 (first published by Kluge 2004) is accepted either as the genus *Ecdyonurus* with several subgenera (Kluge 1988, 1997, 2022), or as a taxon of higher rank (either tribe Ecdyonurini *sensu* Braasch 1990, or subfamily Ecdyonurinae *sensu* Wang & McCafferty 2004) with several genera. In application to the faunas of Europe or Afrotropical Region the second approach is rather convenient, because these faunas contain few well-distinguished taxa belonging to Ecdyonurus/fg1. In contrast, in application to the Oriental Region and the East Palearctic the second approach is hardly applicable, because their faunas of Ecdyonurus/fg1 are more diverse and contain various natural groups, some of which are poorly outlined. In this situation ascribing generic ranks to natural groups smaller than Ecdyonurus/fg1, causes instability of binominal species names.

One of the taxa subordinated to Ecdyonurus/fg1, is known as subgenus or genus under the names *Afghanurus* Demoulin 1964 (*sensu* Kluge 1997, 2022), *Paracinygmula* Bajkova 1975 (*sensu* Jacob *et al.* 1996) and *Nixe* Flowers 1980. Till now (Kluge 2022), the subgenus or genus *Rhithrogeniella* was regarded as distinct from the subgenus or genus *Afghanurus* = *Paracinygmula* = *Nixe*.

Our recent examination of reared specimens from India and Thailand proves that the stage association made by Soldán & Braasch (1986) is correct, reveals failure of the characters formerly regarded as species-specific differences between *E. (Rh.) ornatus* and *E. (Rh.) tonkinensis* and reveals failure of the characters separating *Rhithrogeniella* from *Afghanurus*, *Paracinygmula* and *Nixe*.

## Material and methods

Larvae, imagines and subimagines were associated by rearing. For this purpose, subimagines were reared from larvae in cages placed in natural current water or in containers with stagnant water; imagines were reared from subimagines in wide glass tubes closed with wet cotton and protected from direct sun light. Material is preserved in ethanol. Slides are made in Canadian balsam.

Material reported in this paper, is deposited in the following institutions: (1) **ZIN**: Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia; now this material is temporarily located in the Department of Entomology of Saint Petersburg State University; (2) **AMC**: American College (Department of Zoology), Madurai, India.

In the lists of material examined, the following arbitrary signs are used: **L**—larva; **S**—subimago; **I**—imago; **L-S-I♂**—male imago reared from larva, with larval and subimaginal exuviae; **L-S-I♀/O**—female imago reared from larva, with larval and subimaginal exuviae and eggs; **L-S♂**—male subimago reared from larva, with larval exuviae; **L-S♀/O**—female subimago reared from larva, with larval exuviae and eggs; **L/S♀/O**—female subimago extracted from larva, with eggs.

The term «microlepidés» is used according to Kluge (2022); the term «protopterón» according to Kluge (2005); other terms according to Kluge (2004). The noun «blank» is used to describe an unpigmented area of cuticle. The terms «chromozone» and «achromozone» are determined in application to Leptophlebiidae by Kluge (2020), in application to *Teloganodes* by Kluge (2023). Here the term «chromozone» as applied to peculiar areas on subimaginal

mesonotum of *Ecdyonurus*, which has **anterior chromozone**, paired **lateroparapsidal chromozone** and paired ovoid **parascutellar chromozone** (Fig. 66). These chromozones have constant outlines in all *Ecdyonurus* s. l. and are variously pigmented in different species or in different individuals (Figs 66–67); areas of subimaginal cuticle between chromozones are usually colorless.

## **Genus *Ecdyonurus* Eaton 1868 s. l., or *Ecdyonurus*/fg1** (Figs 1–116)

Type species: *Ephemera venosa* Fabricius 1775 (with neotype designated by ICZN 2015: Opinion 2356).

### **Diagnosis** (according to Kluge 2004)

Metathoracic nerve ganglion greatly transferred anteriorly, nearer to mesothoracic ganglion, being connected with it by short unpaired connective; due to this, imaginal and subimaginal median impression of furcasternum parallel-sided or widened toward its anterior part (not narrowed in anterior part, in contrast to all other Heptageniidae) (Fig. 107).

Left and right mandibles have incisors dissimilar: incisor of left mandible (with mola projected distally) pointed, with a row of denticles on inner margin; incisor of right mandible (with mola projected proximally) with large denticle at some distance from apex and row of smaller denticles proximad of it; denticles on outer margins of both incisors at a distance from apex (Figs 29–30).

Superlinguae of peculiar shape uniform for all representatives, with rounded apico-lateral projection (Fig. 32).

On maxilla, ventral row of setae transformed to field of irregularly situated setae (unique apomorphy) (Figs 28, 33). Proximal dentiseta always bifurcate (Fig. 33).

Vestige of segment 3 of maxillary palp triangular, larger than in *Heptagenia*/f6=g5 (Fig. 28).

Glossae rhomboid, with inner margin convex (Fig. 31).

Tergalii are differentiated as following: tergalius I narrowed, with concave anal margin (i.e. more or less banana-like); tergali II–VII widened, with anal margin most convex (i.e. more or less roundish-triangular). Unique apomorphy.

Outer (posterior) margin of larval femur with regular row of long stout setae situated less dorsally, than similar setae in *Rhithrogena*/fg1 and *Cinygma*. (Figs 34–35).

**Composition.** The genus *Ecdyonurus* s. l. is divided into several subordinated taxa which can be treated as subgenera (Kluge 2004), with the subgenus *Rhithrogeniella* among them.

## **Subgenus *Rhithrogeniella* Ulmer 1939** (Figs 1–116)

*Rhithrogeniella* Ulmer 1939 (type species: *Rh. ornata* Ulmer 1939);

= *Afghanurus* Demoulin 1964 (type species: *A. vicinus* Demoulin 1964) **syn. n.**;

= *Paracinygmula* Bajkova 1975 (type species: *P. zhiltzovae* Bajkova 1975) **syn. n.**;

= *Nixe* Flowers 1980 (type species: *Ecdyonurus lucidipennis* Clemens 1913) **syn. n.**

= *Akkarion* Flowers 1980 (type species: *Heptagenia simplicoides* McDunnough 1924) **syn. n.**

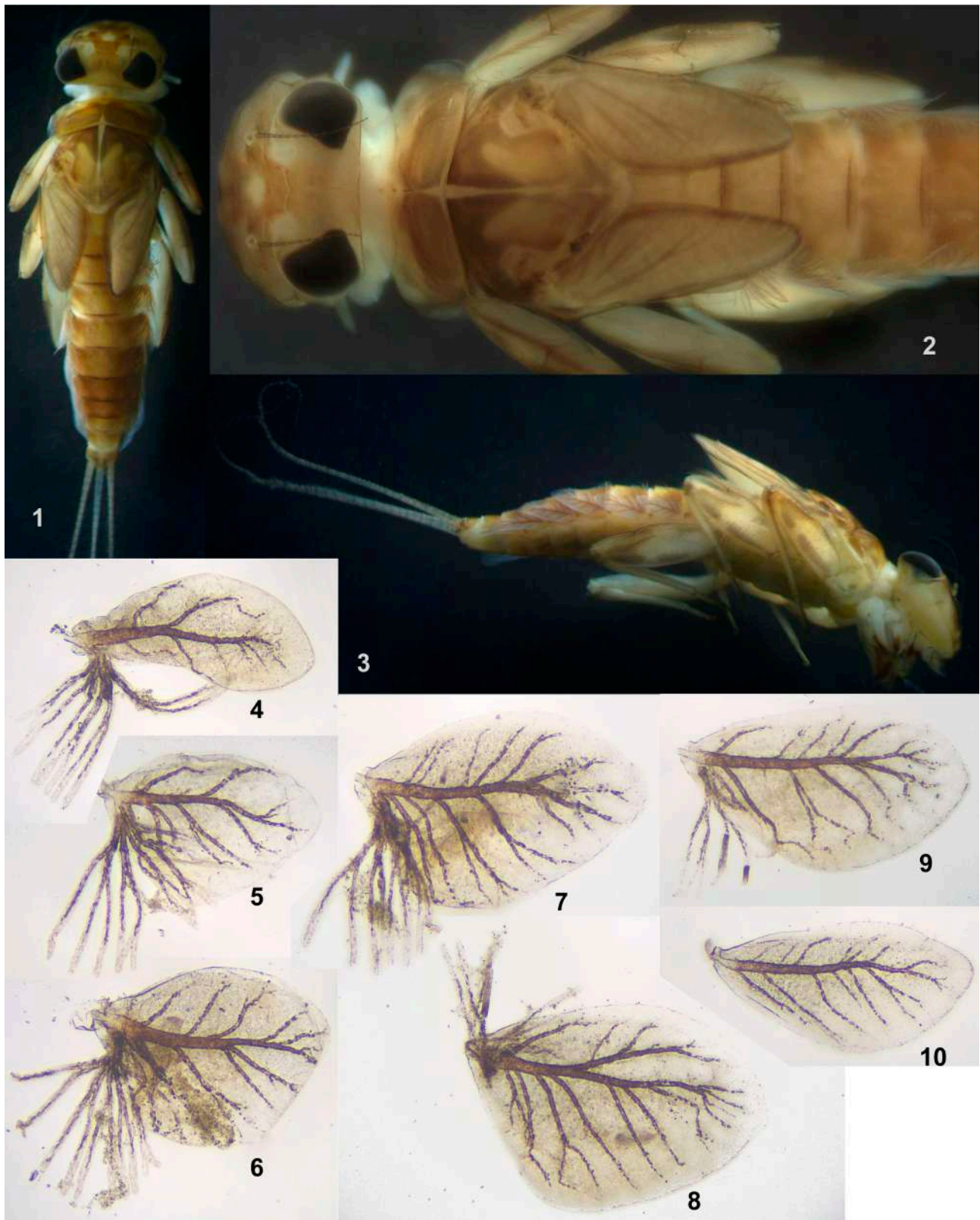
### **Diagnosis**

Maxilla with distal dentiseta simple, non-branched (Fig. 33) (the same in *Ecdyonurus*/fg2 *sensu* Kluge 2004, *Leucrocuta* Flowers 1980 and *Ecdyogymnurus* Kluge 2004; in contrast to *Atopopus*/fg1 *sensu* Kluge 2004).

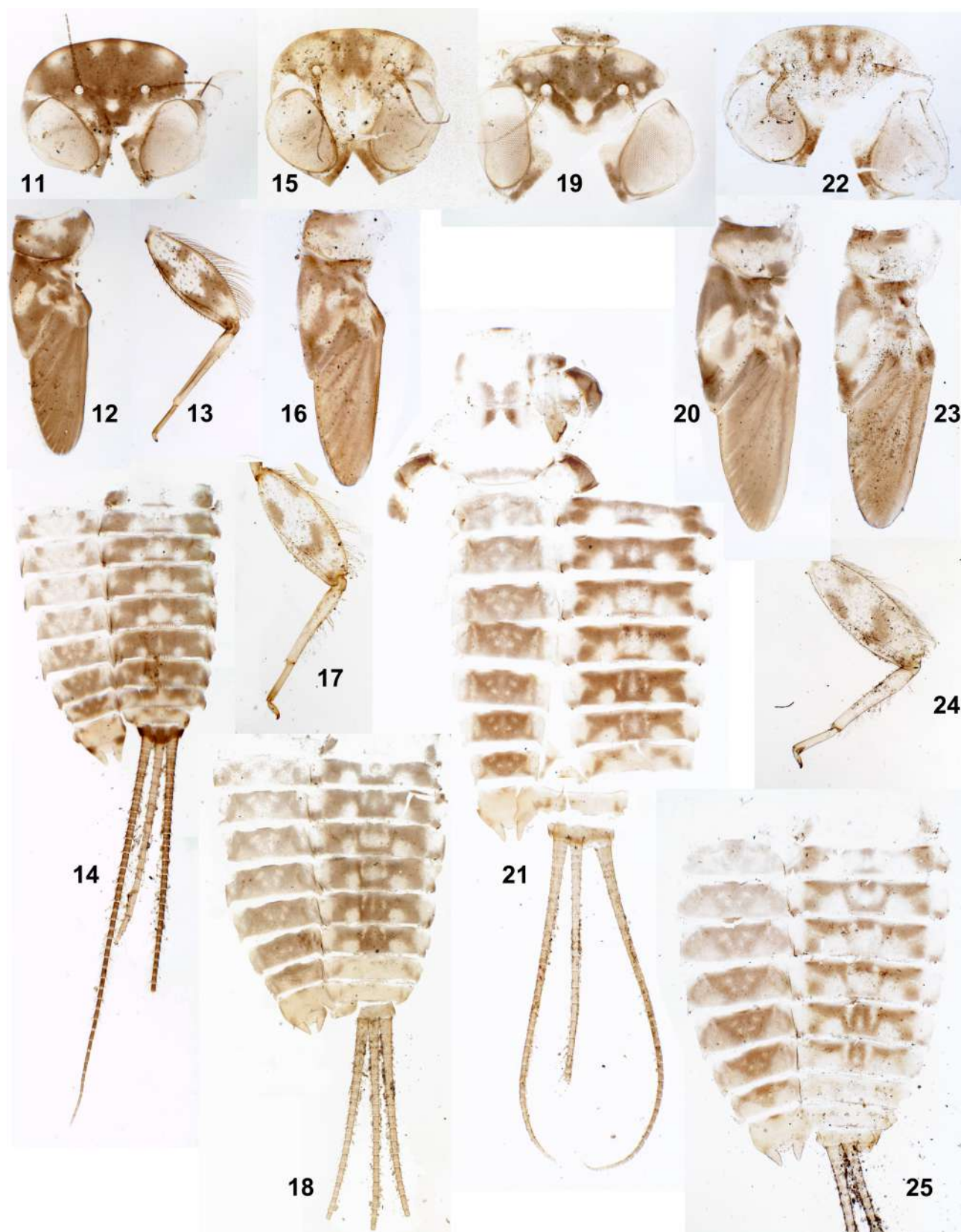
Larval pronotum without lateral projections stretched laterad of mesonotum (Figs 1–3) (in contrast to *Ecdyonurus*/fg2).

Larval caudalii with swimming setae: regular or irregular row of primary swimming setae is present at least on each lateral side of the paracercus and on median (i.e. inner) side of each cercus (Fig. 47) (the same in *Ecdyonurus*/fg2, in contrast to other taxa within *Ecdyonurus*/fg1). Similar secondary setae on lateral (i.e. outer) side of each cercus are either absent, or present: they are present in all individuals of *E. (Rh.) ornatus* (Figs 48–50) and in some individuals of *E. (Rh.) joernensis* Bengtsson 1909 (Fig. 52), but absent in other examined species.





FIGURES 1–10. *Ecdyonurus (Rhithrogeniella) ornatus* from Kodaikanal (India). 1–3, larvae; 4–10, tergalii I–VII.



**FIGURES 11–25.** *Ecdyonurus* (*Rhithrogeniella*) *ornatus*, larval exuviae. 11–14, specimen from Agumbe (India); 15–18, 19–21 and 22–25, specimens from Pai (Thailand) (11, 15, 19, 22, head; 12, 16, 20, 23, half of pronotum and mesonotum; 13, 17, 24, hind leg; 14, 18, 21, 25, abdomen).