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Revision of Oriental Phasmatodea: The tribe Pharnaciini Günther, 1953, including the description of the world's longest insect, and a survey of the family Phasmatidae Gray, 1835 with keys to the subfamilies and tribes (Phasmatodea: "Anareolatae": Phasmatidae)

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** Dedicated to the authors' parents Gisela & Hans-Peter Hennemann and Xenia & Matthäus Conle*

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Abstract

The family Phasmatidae Gray, 1835 is reviewed and the subfamily Phasmatinae shown to be polyphyletic. Based on features of the exosceleton of the insects, egg-morphology and copulation habits a new arrangement of Phasmatidae is proposed. The monophyly of Lanceocercata Bradler, 2001 is confirmed but this name shown to be a synonym of Phasmatidae, hence Lanceocercata is here referred to as Phasmatidae *sensu stricto*. Six subfamilies belong in Phasmatidae *sensu stricto* all of which share several common and supposedly apomorphic characters: Phasmatinae, Tropidoderinae, Extatosomatinae (**stat. nov.**), Xeroderinae, Pachymorphinae and "Platycraninae". The other two subfamilies contained in Phasmatidae sensu Bradley & Galil, 1977 (Eurycanthinae and Cladomorphinae) are not cosely related and here regarded as subfamilies of Phasmatidae *sensu lato*. The subfamily Phasmatinae sensu Bradley & Galil, 1977 is shown to be polyphyletic. The two tribes Pharnaciini and Clitumnini (= Baculini Günther, 1953) are removed from Phasmatinae and shown to be closely related to each other. They are transferred to the here established subfamily Clitumninae, a subordinate clade of Phasmatidae *sensu lato*. The subfamily Lonchodinae is closely related to Clitumninae, hence removed from Diapheromeridae and transferred to Phasmatidae *sensu lato*. The tribes Achriopterini and Stephanacridini (formerly in Phasmatinae) are shown to be not closely related to either Phasmatinae *sensu stricto*, Clitumninae or Lonchodinae, and provisionally must be treated as tribes of Phasmatidae *sensu lato* (incerte sedis).

A re-arrangement of Phasmatidae *sensu stricto* is proposed along with determinating keys to all subfamilies and their tribes. The subfamilies Phasmatinae, Tropidoderinae and Extatosomatinae **stat. nov.** are re-described and discussed in detail. Full lists of genera are provided for each tribe. Only three of seven tribes formerly in Phasmatinae remain in the subfamily, this is Phasmatini, Acanthomimini and Acanthoxylini. The subfamily Tropidoderinae contains three tribes: Tropidoderini, Monandropterini and Gigantophasmatini **trib. nov.** The tribe Extatosomatini Clark-Sellick, 1997 is removed from Tropidoderinae and raised to subfamily level (Extatosomatinae **stat. nov.**).

Several genera are transferred to other tribes or subfamilies. *Didymuria* Kirby, 1904 is removed from Tropidoderini, since it differs by having a closed internal micropylar plate in the eggs (open in all Tropidoderini). It here remains as a genus incerte sedis of Tropidoderinae and its systematic position clearly deserves further clarification. *Gigantophasma* Sharp, 1898 from the Loyalty Islands is removed from Pharnaciini, and becomes the type genus of the tribe Gigantophasmatini **trib. nov.**. *Anophelepis* Westwood, 1859 is removed from "Platycraninae" and shown to belong in Phasmatinae: Acanthomimini. The two Australian genera *Arphax* Stål, 1875, and *Vasilissa* Kirby, 1896 are removed from Acanthoxylini and provisionally transferred to Acanthomimini, but their position remains as yet debatable. *Echetlus* Stål, 1875 is misplaced in "Platycraninae" and shown to be a likely member of Phasmatinae. The two Brazilian species *Echetlus evoneobertii* Zompro & Adis, 2001 and *Echetlus fulgens* Zompro, 2004b are obviously misplaced and belong in the New World Diapheromeridae: Diapheromerinae: Diapheromerini.

The subfamily Pachymorphinae is briefly discussed and considered polyphyletic. Two genera of Pachymorphinae: Gratidiini Bragg, 1995 (*Parapachymorpha* Brunner v. Wattenwyl, 1893 and *Cnipsomorpha* Hennemann *et al.*, 2008) are transferred to Clitumninae: Medaurini **trib. nov.** The genus *Gongylopus* Brunner v. Wattenwyl, 1907 is transferred from Pachymorphinae: Gratidiini to Clitumninae: Clitumnini. The subfamily Xeroderinae is briefly discussed and shown likely to be polyphyletic, due to it contains two fundamentally different types of genitalia in the males. Only the genera *Xeroderus* Gray, 1835 and perhaps *Epicharmus* Stål, 1875 clearly belong in Phasmatidae *sensu stricto*. Both, the Pachymorphinae and Xeroderinae certainly deserve more detailed investigation to clarify their systematic positions with confirmation.

Two generic groups are recognized within Clitumnini (subfamily Clitumninae). Due to differing by genital features and egg-morphology *Medaura* Stål, 1875 and *Medauroidea* Zompro, 2000 are removed from Clitumnini and transferred to the newly described Medaurini **trib. nov.**. The new tribe furthermore contains two genera formerly included in Pachymorphinae:Gratidiini and transferred here, *Cnipsomorpha* Hennemann *et al.*, 2008 and *Parapachymorpha* Brunner v. Wattenwyl, 1893. *Phryganistria* Stål, 1875 is removed from Clitumnini and transferred to Pharnaciini. *Nesiophasma* Günther, 1934 is shown to belong in the tribe Stephanacridini.

The Australasian subfamily Lonchodinae Brunner v. Wattenwyl, 1893 has formerly been included in Diapheromeridae Zompro, 2001 (= Heteronemiidae by Bradley & Galil, 1977). However, numerous features of the genitalia and egg morphology show close relation to the Oriental subfamily Clitumninae instead. Thus, Lonchodinae is here transferred to the family Phasmatidae (*sensu lato*). Within Lonchodinae the new tribe Neohiraseini **trib. nov.** is recognized and contains the five genera formerly placed in the "*Neohirasea*-complex" of that subfamily, namely *Andropromachus* Carl, 1913, *Neohirasea* Rehn, 1904, *Pseudocentema* Chen, He & Li, 2002, *Qiongphasma* Chen, He & Li, 2002 and *Spinohirasea* Zompro, 2001. It differs from all other Lonchodinae (= tribe Lonchodini) by the well developed vomer of males and the lack of a capitulum in the eggs. The genus *Cladomimus* Carl, 1915 was previously misplaced in Clitumninae:

Pharnaciini and is here transferred to Lonchodinae: Lonchodini. It appears to be close to the Australian *Hyrtacus* Stål, 1875. *Leprocaulinus* Uvarov, 1940 and *Phenacocephalus* Werner, 1930 are removed from the subfamily Necrosciinae and transferred to Lonchodinae: Lonchodini.

Extensive research on the genera which belong to the tribe Pharnaciini Günther, 1953 and taking features of the genital exosceleton and egg-morphology into account, has shown this tribe to be polyphyletic. Based on such features two generic groups are easily recognized within Pharnaciini sensu Günther, 1953. Males of the first group have a longitudinally split anal segment, which consists of two separate, more or less elongate semi-tergites and forms a clasping apparatus, the vomer is strongly reduced or lacking, the profemora have a prominent, lamellate medioventral carina which is strongly displaced towards the anteroventral carina and the eggs have an open internal micropylar plate with a clear median line. Only the genera falling into this group remain in Pharnaciini. Males of the second group in contrast have an anal segment which is not split, but possess a clearly visible, well sclerotised, triangular or hook-like external vomer, an indistinct medioventral carina on the profemora and eggs with a closed internal micropylar plate. Most of the genera which fall into the second group are here transferred to the tribe Stephanacridini Günther, 1953, this is *Diagoras* Stål, 1877b, *Eucarcharus* Brunner v. Wattenwyl, 1907, *Phasmotaenia* Návas, 1907 and *Sadyattes* Stål, 1875. A detailed discussion of the differences between Pharnaciini and Stephanacridini is provided along with distinguishing keys, illustrations and maps showing the distinct geographic distributions. The five genera that belong in Pharnaciini are: *Baculonistria* **gen. nov.**, *Pharnacia* Stål, 1877a, *Phobaeticus* Brunner v. Wattenwyl, 1907 (= *Baculolonga* Hennemann & Conle, 1997a, = *Lobophasma* Günther, 1934b **syn. nov.** , = *Nearchus* Redtenbacher, 1908 **syn. nov.**), *Tirachoidea* Brunner v. Wattenwyl, 1893 **stat. rev.** and *Phryganistria* Stål, 1875.

Pharnacia annulata Redtenbacher, 1908 and *Pharnacia enganensis* Redtenbacher, 1908 were misplaced in *Pharnacia* Stål, 1877 (tribe Pharnaciini) and are transferred to the genus *Sadyattes* Stål, 1875 (tribe Stephanacridini, **comb. nov.**). *Phobaeticus kuehni* Brunner v. Wattenwyl, 1907 is removed from *Phobaeticus* Brunner v. Wattenwyl, 1907 (Phasmatinae: Pharnaciini) and shown to belong in *Nesiophasma* Günther, 1934c (tribe Stephanacridini, **comb. nov.**). *Phobaeticus incertus* Brunner v. Wattenwyl, 1907 (= *Nearchus grubaueri* Redtenbacher, 1908 **syn. nov.**) is unlikely to belong in Pharnaciini and here only retained in the original genus *Phobaeticus* Brunner v. Wattenwyl, 1907 with doubt, it may belong in *Nesiophasma* Günther, 1934c (tribe Stephanacridini).

Based on a total of almost 700 examined specimens, the Oriental tribe Pharnaciini Günther, 1953 is revised at the species level. The new genus *Baculonistria* **gen. nov.** (Type species *Baculonistria alba* (Chen & He, 1990) **comb. nov.**), is described to contain three species from Central and Eastern China. *Tirachoidea* Brunner v. Wattenwyl, 1893 was erroneously synonymised with *Pharnacia* Stål, 1877 and is here re-established as a valid genus (**stat. rev.**). All five genera are re-diagnosed and differentiated, their systematic position within Pharnaciini discussed, and complete synonymic and species-listings as well as distribution maps and determination keys to the insects and eggs are provided.

Detailed descriptions, diagnoses, synonymic listings, illustrations, material listings, distribution maps and measurements are provided for all 42 valid species. The type material of a further two species appears to be lost. Seven new species are described: *Pharnacia borneensis* **spec. nov.** from Borneo; *Pharnacia palawanica* **spec. nov.** from Palawan, *Phobaeticus mucrospinosus* **spec. nov.** from Sumatra, *Phobaeticus palawanensis* **spec. nov.** from Palawan, *Tirachoidea herberti* **spec. nov.** from Borneo, *Tirachoidea siamensis* **spec. nov.** from Thailand and S-Vietnam and *Phobaeticus chani* Bragg **spec. nov.** from Borneo. *Phobaeticus chani* Bragg **spec. nov.** is the world's longest known insect with a maximum body length of 357 mm and an overall length of 567 mm in the female.

Twelve new synonymies were discovered: *Bactridium grande* Rehn, 1920 = *Phobaeticus serratipes* (Gray, 1835) **syn. nov.**; *Pharnacia rigida* Redtenbacher, 1908 = *Phobaeticus sumatranus* Brunner v. Wattenwyl, 1907, **syn. nov.**; *Clitumnus irregularis* Brunner v. Wattenwyl, 1907 = *Phibalosoma tirachus* Westwood, 1859, **syn. nov.**; *Pharnacia magdiwang* Lit & Eusebio, 2008 = *Pharnacia ponderosa* Stål, 1877 **syn. nov.**; *Pharnacia spectabilis* Redtenbacher, 1908 = *Phibalosoma hypharpax* Westwood, 1859, **syn. nov**.; *Pharnacia semilunaris* Redtenbacher, 1908 = *Eucarcharus inversus* Brunner v. Wattenwyl, 1907, **syn. nov.**; *Pharnacia chiniensis* Seow-Choen, 1998c = *Pharnacia biceps* Redtenbacher, 1908, **syn. nov.**; *Nearchus grubaueri* Redtenbacher, 1908 = *Phobaeticus incertus* Brunner v. Wattenwyl, 1907, **syn. nov.**; *Phibalosoma maximum* Bates, 1865 = *Cladoxerus serratipes* Gray, 1835, **syn. nov.**; *Phobaeticus lambirica* Seow-Choen, 1998a = *Eucarcharus rex* Günther, 1928, **syn. nov.**; *Phobaeticus sichuanensis* Cai & Liu, 1993 = *Baculum album* Chen & He, 1990, **syn. nov.** and *Phobaeticus beccarianus* Brunner v. Wattenwyl, 1907 is shown to represent the previously unknown female of *Phobaeticus sobrinus* Brunner v. Wattenwyl, 1907 (**syn. nov.**)

Lectotypes are designated for: *Nearchus redtenbacheri* Dohrn, 1910, *Pharnacia biceps* Redtenbacher, 1908, *Pharnacia ingens* Redtenbacher, 1908, *Pharnacia heros* Redtenbacher, 1908, *Phibalosoma westwoodi* Wood-Mason, 1875, *Phobaeticus sinetyi* Brunner v. Wattenwyl, 1907, and *Phobaeticus sumatranus* Brunner v. Wattenwyl, 1907. A neotype is designated for *Nearchus maximus* Redtenbacher, 1908 and *Phobaeticus magnus* **nom. nov.** introduced as a replacement

name for *Nearchus maximus* Redtenbacher, which is a junior homonym of *Phibalosoma maximum* Bates, 1865.

The previously unknown males of *Pharnacia heros* Redtenbacher, 1908, *Phobaeticus ingens* (Redtenbacher, 1908), *Tirachoidea jianfenglingensis* (Bi, 1994), *Pharnacia sumatrana* (Brunner v. Wattenwyl, 1907), *Phryganistria fruhstorferi* (Brunner v. Wattenwyl, 1907) and *Tirachoidea westwoodii* (Wood-Mason, 1875) as well as the females of *Pharnacia ponderosa* Stål, 1877a and *Pharnacia tirachus* (Westwood, 1859) are described and illustrated for the first time. A brief description on the basis of colour photos of the so far unknown male of *Pharnacia kalag* Zompro, 2005 are presented.

Detailed descriptions and illustrations are provided for the eggs of 24 species. The eggs of the following 18 species are described and illustrated for the first time: *Phobaeticus magnus* **nom. nov.**, *Pharnacia borneensis* **spec. nov.**, *Pharnacia palawanica* **spec. nov.**, *Pharnacia ponderosa* Stål, 1877a, *Pharnacia sumatrana* (Brunner v. Wattenwyl, 1907), *Pharnacia tirachus* (Westwood, 1859), *Phobaeticus hypharpax* (Westwood, 1859), *Phobaeticus chani* Bragg **spec. nov.**, *Phobaeticus incertus* Brunner v. Wattenwyl, 1907, *Phobaeticus magnus* **nom. nov.**, *Phobaeticus philippinicus* (Hennemann & Conle, 1997a), *Phobaeticus sinetyi* Brunner v. Wattenwyl, 1907, *Phryganistria grandis* Rehn, 1906, *Phryganistria virgea* (Westwood, 1848), *Tirachoidea biceps* (Redtenbacher, 1908), *Tirachoidea herberti* **spec. nov.**, *Tirachoidea jianfenglingensis* (Bi, 1994) and *Tirachoidea siamensis* **spec. nov.**.

Several species were originally placed in or subsequently transferred into wrong genera by various authors. Consequently, numerous taxa are here transferred or re-transferred to other genera, which results in 22 new or revised combinations or status of genera and species (**comb. nov.** / **stat. rev.** / **stat. nov.**). A list of the taxonomic changes made in this revision is provided in the summary (9.2), which in all lists 70 nomenclatural changes.

Key words: Phasmatodea, Phasmatidae, Lanceocercata, keys, diagnoses, subfamilies, tribes, Extatosomatinae **stat. nov.**, Gigantophasmatini **trib. nov.**, Clitumninae, Medaurini **trib. nov.**, Lonchodinae, Neohiraseini **trib. nov.**, Pharnaciini, *Baculonistria* **gen. nov.**, *Pharnacia*, *Phobaeticus*, *Phryganistria*, *Tirachoidea*, classification, ootaxonomy, taxonomic revision, keys, differentiations, descriptions, new genus, new species, new synonyms, new combinations, eggs, biogeography, distribution, maps, habitats, ecology