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# Johann Jakob Kaup as the founder of phasmatodean ootaxonomy

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## Abstract

The ootaxonomy has become an important feature for any research in the systematic arrangement of the insect order Phasmatodea. The idea to use the eggs for this purpose originated from Johann Jakob Kaup (1803–1873), but unfortunately it took more than a century until authors followed his idea again. In this publication, the importance of Kaup's idea is discussed and the eggs and taxa of Phasmatodea described by him are listed.

## Kurzfassung

Die Ootaxonomie hat sich zu einem bedeutenden Hilfsmittel für die Systematik der Phasmatodea entwickelt. Die Idee, die Eier hierfür zu verwenden, stammt ursprünglich von Johann Jakob Kaup (1803–1873), doch leider hat es mehr als ein Jahrhundert gedauert bis weitere Autoren dieser Idee gefolgt sind. In dieser Arbeit wird die Bedeutung von Kaups Idee erörtert, und die von ihm beschriebenen Eier und Arten der Phasmatodea werden aufgelistet.

## Introduction

The first Phasmatodean egg figured in the literature was that of *Heteropteryx dilatata* (PARKINSON, 1798), presented in an excellent colour picture in its natural size and also magnified. It was followed by a detailed description of an egg by MÜLLER (1825). The first scientist that discussed the variety of and differences between the eggs was Johann Jakob Kaup (1803–1873) who worked on several groups of insects. He is the author of several new taxa of Odonata (SCHNEIDER, this volume) and wrote a famous monograph (KAUP 1871c) on bess beetles (Coleoptera: Passalidae), and he also studied the stick insects. He described two species of Phasmatodea from New Zealand (KAUP 1867), followed by two papers within the same journal issue. In the first of these (KAUP 1871a), he described the eggs of 28 species of stick insects and figured 27 of them (Fig.1). The eggs of the species newly described in the second paper (KAUP 1871b) are part of the type-series of these species. Unfortunately, several of the species described by other authors have been misidentified by KAUP (l.c.).

In the introduction (KAUP 1871a: 17), Kaup reflects on the possibility that the eggs of closely related species are similar to each other and that major differences in the structure of the eggs would justify their systematic separation. He supposed that one day it might become easier to distinguish species rather by the structure of the eggs than by the adult insects, although he had only the possibility to compare three eggs of species which were indeed closely related, belonging to the Aschiphasmatidae. All other eggs he examined belonged to species of various higher taxa of the order.

In the second paper (KAUP 1871b), two genera and 21 species of Phasmatodea were described. For the first time in the history of phasmatodean taxonomy, the description of new taxa, the two genera *Ophicrania* Kaup, 1871 and *Megacrania* Kaup, 1871, was mainly based on the differences of the eggs of their type species.

Of the 23 nominal species of Phasmatodea described by J. J. Kaup, the type specimens of 16 are deposited in the Hessisches Landesmuseum Darmstadt, Germany (HLMD) and four in the Senckenberg-Museum in Frankfurt am Main, Germany (SMF), three are obviously lost. The material has been described by ZOMPRO (2001b). In that publication, all original data presented by KAUP (1871b) are included and the type label data are recorded. Furthermore, 19 species are figured. The taxa are listed in alphabetical order of species names. Usually Kaup is cited as sole author of all species listed below, but for several species Kaup explicitly names von Heyden as coauthor (ZOMPRO 1998). The type specimens in the holdings of the HLMD were labelled and rearranged by the present author in a single drawer kept now apart from the rest of the collection, while the specimens at SMF are included in the main collection.

Unfortunately, it took more than 100 years until subsequent authors considered the value of stick insect eggs for their taxonomy again. J.T. Clark (later publishing under the names J.T. Clark-Sellick or J.T. C. Sellick) standardized the terminology for egg descriptions and subsequently published several papers on the different structures of the eggs (CLARK 1976a, 1976b, 1979; CLARK-SELLICK 1987; SELLICK 1997), but rarely based changes in phasmatodean taxonomy on egg morphology. Nevertheless, this was the first step towards a phylogeny of the Phasmatodea based on egg structure.

The first work that consistently based the phylogeny on the egg structures was ZOMPRO's (2001a) revision of the Diapheromerinae. A shortcoming of this paper was that only a small group of the whole order could be revised which resulted in two different egg structures within the taxon Diapheromerinae. The problem was solved in a subsequent paper (ZOMPRO 2004), in which all genera of the suborder »Areolatae« were revised. A ground pattern of the Phasmatodea, including that of the eggs, was worked out, and J. J. Kaup's idea was confirmed: Closely related taxa possess similar eggs, and more widely separated taxa exhibit different egg structures. Kaup's merits have been honored by Caspar Stål by the dedication of the Phasmatodean name *Myronides kaupii* Stål, 1875. The type of this species is housed in the Naturhistorisches Museum in Vienna, Austria, which holds at present the most important collection of Phasmatodea.

## The eggs of the Phasmatodea

The eggs of stick insects are famous for their similarity to seeds of plants or droppings of insects (Fig. 2). The length ranges from 2 to about 20 millimeters, and some eggs have the size of a peanut. The number laid by a single female varies considerably between the different tribes. Females of *Dares* Stål, 1875 produce only a few dozen eggs, those of *Bacillus* St. Fargeau & Audinet-Serville, 1825 up to 1500.
The usual way to lay the eggs is just to drop them, but some species bury them into the ground, press them into the bark of trees, glue them to a substrate or even pin them through a leaf.
The eggs feature some structures that make them unique among those of all insects. The capsule is very hard and bears an internal and an external micropylar plate; the latter contains the micropylar cup. On one end, the capsule bears an operculum which is thrown off when the nymph is hatching (Fig. 3).

The capsule may be smooth and shiny or glossy and matt or rough and covered with pits, ridges, hairs, tubercles or hooks. The ventral surface can be modified to a smooth and flat area when the egg is glued to a substrate. The most striking character of the capsule is often the micropylar plate, which marks the dorsal surface of the capsule. It consists of an external and an internal plate, which are connected by the micropylar stalk. Rarely it surrounds the capsule completely (Aschiphasmatidae). The posterior part of the external micropylar plate contains the

micropyle, which is situated within the micropylar cup, a u-shaped prominence, which is easily visible by the raised dorsal margin of the cup. Often this margin is connected with a raised line, which runs to the posterior pole of the egg, the polar area (Fig. 4). The anterior end of the capsule contains the operculum, which is usually oval in shape in dorsal aspect. The angle of the operculum is defined as positive if it is tilted towards the micropylar plate and negative if it is tilted ventrad. Often the operculum bears striking structures. These structures are distinguished into two different forms, a pseudocapitulum and a capitulum. A pseudocapitulum is a structure which is part of the capitulum and which cannot be separated from it without damage. A capitulum is detachable and swells if cooked in sodium hydroxide solution.

The length of the egg is defined as the length from the centre of the operculum to the mid-point of the posterior end, the height is measured from the micropylar plate to the mid-point of the ventral surface of the capsule. The width is measured right-angled to length and height (Fig. 4).

## The profit of ootaxonomy for phylogenetical studies in the Phasmatodea

Stick insects survive because of their perfect camouflage. This camouflage is subject to considerable variation. Specimens found under humid conditions usually bear more and larger spines and feature more colouration than those found under dry conditions. This was also confirmed by thousands of cultured specimens.

The egg is a product of the complete oviproducing and ovipositioning apparatus, and therefore a result of complex phylogenetic changes. So with high probability the eggs conserve more primitive characters than the insects themselves.

When examining the ground patterns of the eggs of various higher taxa of Phasmatodea (ZOMPRO 2004), the author was able to trace characters of the insects which supported the phylogeny indicated by the eggs. At a later stage of this work it became obvious that the striking similarity between several taxa was just based on convergence, and distinguishing characters could be detected.

The egg structures revealed that several taxa can no longer be included in the families to which they had been assigned previously. Members of the newly established family Anisacanthidae (ZOMPRO 2004) have been assigned to three different families before, and an examination of the type material of the species and genera concerned revealed, that apomorphies present in all of them have not only been overlooked, but explicitly been denied by authors concerned. As a result, in many cases the taxonomic position of taxa can be determined much faster by the examination of the eggs than by examining the insects.

Saving a considerable amount of time is not the only advantage in studying the eggs. In the last decades stick insects have often been identified as pests, and the introduction of egg parasites has proven to be a successful tool in their control. More than a century after Kaup had the idea to use eggs in the taxonomy of Phasmatodea, his idea might also become useful in the field of pest control.

## Phasmatodean eggs described by J. J. Kaup

The species are listed under the combination used by Kaup and their spelling corrected when necessary.

***Bacillus abdul*** Westwood, 1859 (KAUP 1871a: 18, pl. 1: 1). Not traced in HLMD or SMF. The egg figured belongs to an unidentified species of *Ramulus* de Saussure, 1861.

***Bacillus cuniculus*** Westwood, 1859 (KAUP 1871a: 18, pl. 1: 2). Not traced in HLMD or SMF. The egg figured belongs to an unidentified species of *Ramulus* de Saussure, 1861.

***Bacillus hyphereon*** (Westwood, 1859) (KAUP 1871a: 18, pl. 1: 3). Not traced in HLMD or SMF. The egg figured belongs to an unidentified species of *Cuniculina* Brunner von Wattenwyl, 1907.

***Pachymorpha novaeguineae*** Kaup, 1871 (KAUP 1871a: 18, pl. 1: 4). Not traced in HLMD or SMF. The egg figured belongs to *Dimorphodes novaeguineae* (Kaup, 1871).

***Bacteria sartoriana*** Kaup & von Heyden, 1871 (KAUP 1871a: 18, pl. 1: 5). Not traced in HLMD or SMF. This is a synonym of *Phanocles burkartii* (de Saussure, 1868), and the egg belongs to this species.

***Bacteria cacica*** Kaup, 1871 (KAUP 1871a: 19, pl. 1: 6). Not traced in HLMD or SMF. The egg figured belongs to *Clonistria cacica* (Kaup, 1871).

***Lonchodes duivenbodei*** Kaup, 1871 (KAUP 1871a: 19, pl. 1: 7). Not traced in HLMD or SMF. The egg figured belongs to this species, which is a synonym of *Periphetes forcipatus* (Bates, 1865).

***Acanthoderus hystrix*** Kaup, 1871 (KAUP 1871a: 19, pl. 1: 8). Not traced in HLMD or SMF. The egg belongs to this species, which is a synonym of *Neopromachus hispa* (Bates, 1865).

***Acanthoderus occipitalis*** Kaup, 1871 (KAUP 1871a: 19, pl. 1: 9). Not traced in HLMD or SMF. The egg belongs to this species, which is a synonym of *Pylaemenes coronatus* (de Haan, 1842).

***Anophelepis xiphias*** Westwood, 1859 (KAUP 1871a: 19, pl. 1: 10). Not traced in HLMD or SMF. The egg figured belongs to *Orxines xiphias* (Westwood, 1859).

***Cladoxerus hypharpax*** (Gray, 1835) (KAUP 1871a: 19, pl. 1: 11). Not traced in HLMD or SMF.

***Phibalosoma lepelletieri*** (Gray, 1835) (KAUP 1871a: 20, pl. 1: 11a). Not traced in HLMD or SMF. The valid name of the species is *Cladomorphus phyllinus* Gray, 1835.

***Heteropteryx rosenbergii*** Kaup, 1871 (KAUP 1871a: 20, pl. 1: 12). Not traced in HLMD or SMF. The egg belongs to *Haaniella muelleri rosenbergii* (Kaup, 1871).

***Eurycantha rosenbergii*** Kaup, 1871 (KAUP 1871a: 20). Not traced in HLMD or SMF. The figure 12a, to which the author refers in the text, is not included in the plate.

***Aplopus grayi*** Kaup, 1871 (KAUP 1871a: 20, pl. 1: 13). Three eggs are present in HLMD. The species belongs to the genus *Diapherodes* Gray, 1835.

***Aschiphasma catadromus*** (Westwood, 1859) (KAUP 1871a: 21, pl. 1: 14). Seven eggs which might belong to *Orthomeria catadromus* (Westwood, 1859) are present in HLMD.

***Aschiphasma annulipes*** (Westwood, 1834) (KAUP 1871a: 21, pl. 1: 15). Not traced in HLMD or SMF. The egg figured might belong to this species.

***Abrosoma nebulosum*** (Westwood, 1859) (KAUP 1871a: 21, pl. 1: 16). Three eggs are present in SMF, which might belong to this species.

***Cyphocrania gigas*** (Gray, 1835) (KAUP 1871a: 21, pl. 1: 17). Four eggs which belong to this species are present in HLMD.

***Platycrania edulis*** (Gray, 1835) (KAUP 1871a: 21, pl. 1: 18). Six eggs which belong to this species are present in HLMD.

***Ophicrania striatocollis*** Kaup, 1871 (KAUP 1871a: 21, pl. 1: 19). Five eggs of this species are present in HLMD.

***Acrophylla chronus*** (Gray, 1835) (KAUP 1871a: 22, pl. 1: 20). Not traced in HLMD or SMF. The egg figured belongs to this species.

***Necroscia pallescens*** Kaup & von Heyden, 1871 (KAUP 1871a: 22, pl. 1: 21). Not traced in HLMD or SMF. It is not clear to which genus the egg figured belongs.

***Necroscia westermanni*** (Westwood, 1859) (KAUP 1871a: 22, pl. 1: 22, 22a). Five eggs which belong to *Calvisia westermanni* (Westwood, 1859) are present in HLMD.

***Dinelytron neptunus*** Kaup, 1871 (KAUP 1871a: 23, pl. 1: 23). Not traced in HLMD or SMF. The egg figured belongs to this species, which is a synonym of *Xerosoma canaliculatum* Audinet-Serville, 1838.

***Prisopus spiniceps*** (Burmeister, 1838) (KAUP 1871a: 23, pl. 1: 24). Two eggs of this species are present in SMF.

***Extatosoma tiaratum*** (MacLeay, 1827) (KAUP 1871a: 23, pl. 1: 25). Not traced in HLMD or SMF. The egg figured belongs to this species.

***Phyllium siccifolium*** (Linnaeus, 1758) (KAUP 1871a: 24, pl. 1: 26). Not traced in HLMD or SMF. The egg figured belongs to this species.

## List of the Phasmatodean taxa described by J. J. Kaup

Taxa are listed in alphabetical order of the species name under the combinations used by Kaup. When possible the valid name currently in use is added. Type specimens are listed and type data provided for the species present at HLMD.

***Bacteria arampes*** Kaup & von Heyden, 1871 (KAUP 1871b: 30) [SMF; not traced].

***Diapheromera beckeri*** Kaup, 1871 (KAUP 1871b: 27) [HLMD]. Valid name: *Diapheromera* (*Rhabdoceratites*) *beckeri* Kaup, 1871.
Specimen: Holotype, ♂, »*Diapheromera - Beckeri* Kp. - Mexiko / *Diapheromera beckeri* ♂ - Kaup, 1871 - Holotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-4-HT.

***Diapheromera bidens*** Kaup, 1871 (KAUP 1871b: 28) [HLMD]. Valid name: *Sermyle bidens* (Kaup, 1871).
Specimen: Holotype, ♂, »*Diapheromera - bidens* Kp: - Puebla Becker - [not decipherable] / *Diapheromera bidens* ♂ - Kaup, 1871 - Holotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-6-HT.

***Bacteria cacica*** Kaup, 1871 (KAUP 1871b: 28) [HLMD]. Valid name: *Clonistria cacica* (Kaup, 1871). ZOMPRO (2001c: 134) designated a lectotype for this species.
Specimens: Lectotype, ♀, »*Bacteria - cacica*, Kp - Puebla - Becker [not decipherable] / *Bacteria cacica* ♀ - Kaup, 1871 - Lectotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-7-LT; paralectotype, ♀ nymph, no original label, HLMD-Phas-7-PLT.

***Ceroys capreolus*** Kaup, 1871 (KAUP 1871b: 34) [HLMD]. Synonymized with *Sermyle mexicana* Stål, 1875 by ZOMPRO (2001c: 134).
Specimens: Lectotype, ♀ nymph (4th instar), »*Ceroyis - capreolus* Kp. - Mexiko Leuth / *Ceroys capreolus* ♀ - Kaup, 1871 - Lectotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-11-LT; paralectotype, ♂ nymph (3rd instar), no original label, HLMD-Phas-11-PLT.

***Lonchodes duivenbodei*** Kaup, 1871 (KAUP 1871b: 30, pl. 2: 3) [HLMD]. Synonymized with *Periphetes forcipatus* (Bates, 1865) by ZOMPRO (2001c: 134).
Specimens: Lectotype, ♂, no original label, »Syntypus ♂ - *Lonchodes duiven- - bodei* Kaup, 1871 - det. W. Schneider 1997 / *Lonchodes duivenbodei* ♂ - Kaup, 1871 - Lectotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-8-LT; paralectotype, ♀, no original label, HLMD-Phas-8-PLT.

***Bacillus geisovii*** Kaup, 1867 (KAUP 1867: 578) [HLMD]. Valid name: *Acanthoxyla prasina geisovii* (Kaup, 1867).
Specimen: Holotype, ♀ nymph, »*Bacillus - Geisovii* Kp - N.seeland / *Bacillus geisovii* ♀ n3 - Kaup, 1866 - Holotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-2-HT.

***Bacillus gerhardii*** Kaup, 1867 (KAUP 1867: 577) [HLMD]. Synonymized with *Argosarchus horridus* (White, 1846) by SALMON (1991: 48).
Specimen: Holotype, ♀, »*Bacillus - Gerhardii* - Kp - N.seeland. / *Bacillus gerhardii* ♀ - Kaup, 1866 - Holotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-1-HT.

***Aplopus grayi*** Kaup, 1871 (KAUP 1871b: 36, pl. 2: 1) [HLMD]. Valid name: *Diapherodes grayi* (Kaup, 1871). The origin »Molukken« is definitely wrong, the species of *Diapherodes* Gray, 1835 are restricted to the Caribbean Islands.
Specimen: Holotype, ♀, »*Haplopus - Grayi.* Kaup - Mol. v. Rosenberg / *Haplopus grayi* ♀ - Kaup, 1871 - Holotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-14-HT.

***Acanthoderus hystrix*** Kaup, 1871 (KAUP 1871b: 32, pl. 2: 4) [HLMD]. Synonymized with *Neopromachus hispa* (Bates, 1865) by BRUNNER VON WATTENWYL (1907: 296). ZOMPRO (2001c: 138) designated a lectotype for this species.
Specimens: Lectotype, ♂, »*Acanthoderus - histrix* Kp - N.Guinea v. R / *Acanthoderus hystrix* ♂ - Kaup, 1871 - Lectotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-10-LT; paralectotypes, 2 ♂♂, 5 ♀♀, 3 of the latter with original label »NG«, HLMD-Phas-10-PLT1 to -PLT7.

***Cladoxerus insignis*** Kaup & von Heyden, 1871 (KAUP 1871b: 39) [SMF]. Valid name: *Hermarchus insignis* (Kaup & von Heyden, 1871).

***Dinelytron neptunus*** Kaup, 1871 (KAUP 1871b: 41) [SMF]. Synonymized with *Xerosoma canaliculatum* Audinet-Serville, 1838 by ZOMPRO (2004).

***Pachymorpha novaeguineae*** Kaup, 1871 (Kaup 1871b: 26) [HLMD]. Valid name: *Dimorphodes novaeguineae* (Kaup, 1871). ZOMPRO (2001c: 138) designated a lectotype for this species.
Specimens: Lectotype, ♀, »*Pachymorpha* - spec.? - Neu Guinea / *Pachymorpha novaeguineae*? - Kaup, 1871 - Lectotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-3-LT; paralectotype, ♀, no original label, HLMD-Phas-3-PLT.

***Acanthoderus occipitalis*** Kaup, 1871 (KAUP 1871b: 31) [HLMD]. Synonymized with *Pylaemenes coronatus* (de Haan, 1842) by HENNEMANN (1998). ZOMPRO (2001c: 138) designated a lectotype for this species.
Specimens: Lectotype, ♂, »*Acanthoderus - occipitalis* Kp - Celebes N.Guin R / *Acanthoderus occipitalis* ♂ - Kaup, 1871 - Lectotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-9-LT; paralectotypes, 1 ♂, 4 ♀♀, one of the latter with original label »♀ - alle von Celebes - durch Duivenbod«, HLMD-Phas-9-PLT1 to -PLT5.

***Necroscia pallescens*** Kaup & von Heyden, 1871 (KAUP 1871b: 41) [SMF; not traced].

***Eurycantha rosenbergii*** Kaup, 1871 (KAUP 1871b: 34) [HLMD]. ZOMPRO (2001c: 138) designated a lectotype for this species. It is a male, but KAUP (1871a) described also the egg of this species. He there refers also to a figure of the egg, but figure 12a is in fact not included in the plate. It could not be determined from which specimen KAUP (1871a) gained the egg for his description. For further comments see ZOMPRO (2001c).
Specimen: Lectotype, ♂, no original label, »*Eurycantha rosenbergi* ♂ - Kaup, 1871 - Holotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-12-LT.

***Heteropteryx rosenbergii*** Kaup, 1871 (KAUP 1871b: 35, pl. 2: 2) [HLMD]. Valid name: *Haaniella muelleri rosenbergii* (Kaup, 1871).
Specimen: Holotype, ♀, no original label, »*Heteropteryx rosenbergi* ♀ - Kaup, 1871 - Holotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-13-HT.

***Necroscia rosenbergii*** Kaup, 1871 (KAUP 1871b: 40) [HLMD; not traced]. This species was supposed to be represented by one female at HLMD which could not be found.

***Bacteria sartoriana*** Kaup & von Heyden, 1871 (KAUP 1871b: 29) [SMF]. Synonymized with *Phanocles burkartii* (de Saussure, 1868) by ZOMPRO (2001a: 197).

***Acanthoderus scops*** Kaup, 1871 (KAUP 1871b: 32) [SMF]. Valid name: *Ocnophila scops* (Kaup, 1871).

***Ophicrania striatocollis*** Kaup, 1871 (KAUP 1871b: 38) [HLMD]. ZOMPRO (2001c: 138) designated a lectotype for this species.
Specimens: Lectotype, ♂, »*Ophicrania - striaticollis* ♂ - Mol. v. Ros. / *Ophicrania striatocollis* ♂ - Kaup, 1871 - Lectotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-15-LT; paralectotype, ♀, with original label »*Ophicrania - striaticollis* - ♀ - Mol. v. Rosenb«, HLMD-Phas-15-PLT.

***Diapheromera strigiceps*** Kaup, 1871 (KAUP 1871b: 28) [HLMD]. Valid name: *Pseudosermyle strigiceps* (Kaup, 1871).
Specimen: Holotype, ♂, »*Diapheromera - strigiceps* Kp - Puebla Becker / *Diapheromera strigiceps* ♂ - Kaup, 1871 - Holotypus - det. O. Zompro XI. 1999 (HLDH)«, HLMD-Phas-5-HT.

***Necroscia vipera*** Kaup, 1871 (KAUP 1871b: 39) [HLMD]. Valid name: *Leprocaulinus vipera* (Kaup, 1871). ZOMPRO (2001c: 144) designated a lectotype for this species.
Specimen: Lectotype, ♂, »*Necroscia - vipera.* Kp - Celebes Rosenb. / *Necroscia vipera* ♂ - Kaup, 1871 - Lectotypus - det. O. Zompro XI.1999 (HLDH)«, HLMD-Phas-16-LT.

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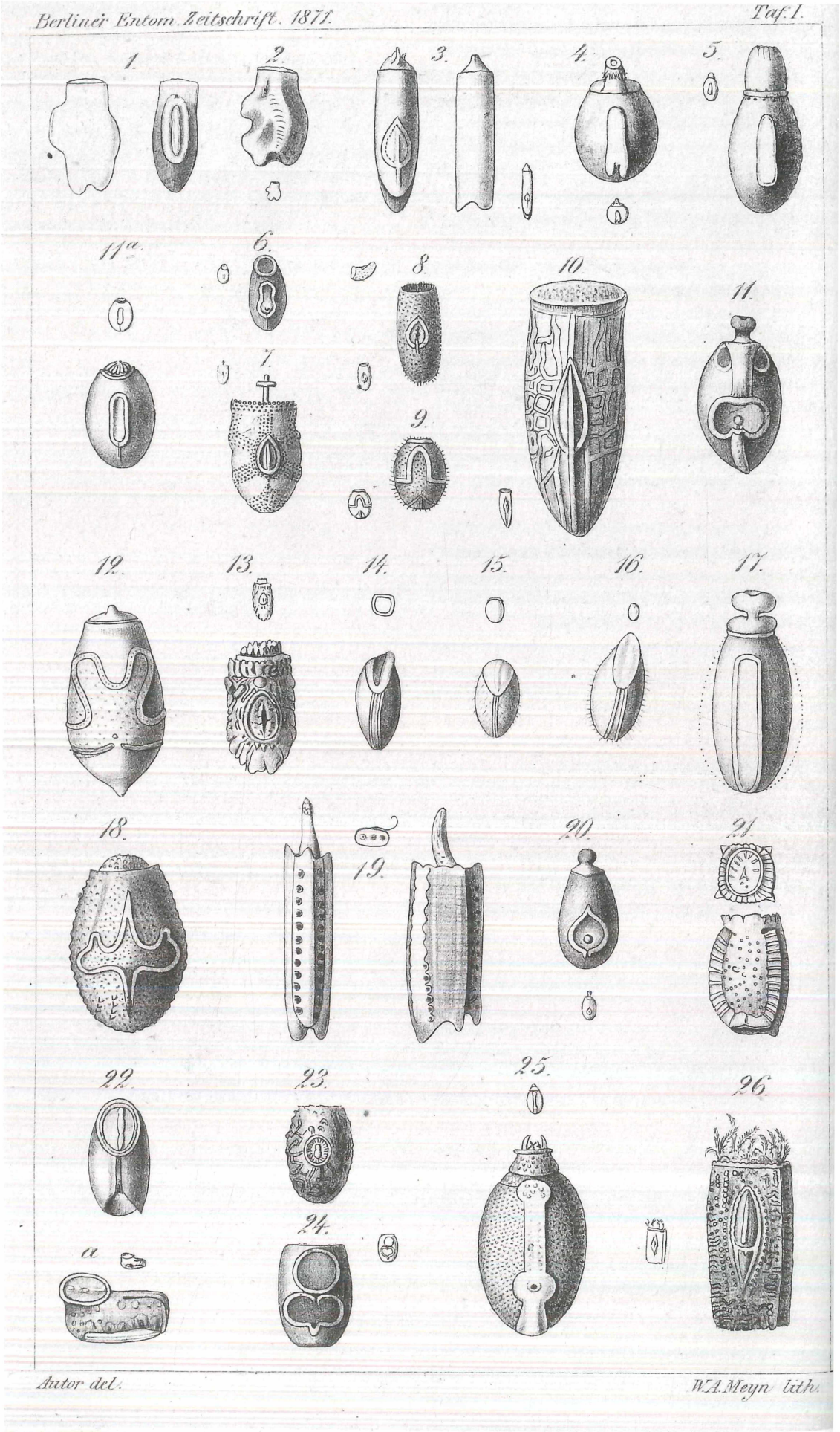
**Fig.1: Plate1 from KAUP (1871 a), showing the eggs described by him.**



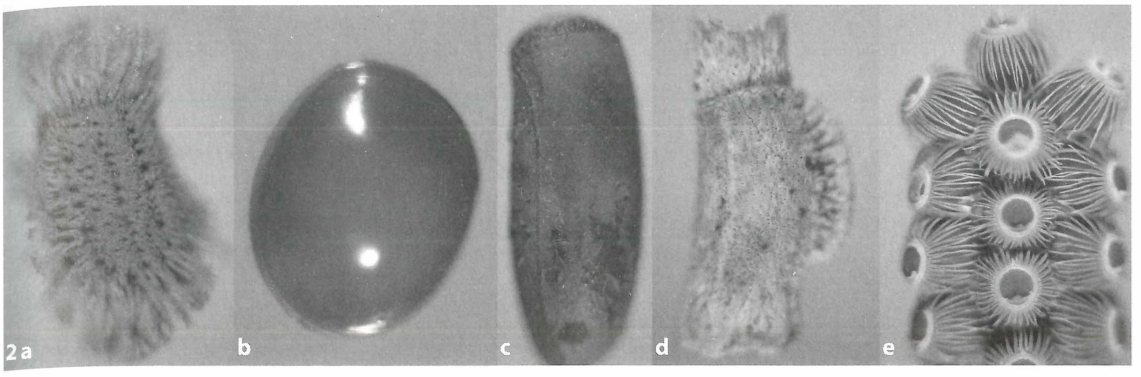



Fig. 2: Eggs of Phasmatodea, lateral aspect.
a. *Phyllium siccifolium* (Linnaeus, 1758).
b. *Xylobistus braggi* Zompro, 2003.
c. *Theramenes olivaceus* (Westwood, 1859).
d. *Achrioptera punctipes* (Audinet-Serville, 1838).
e. Eggs of *Trachythorax maculicollis* (Westwood, 1848), dorsal aspect.

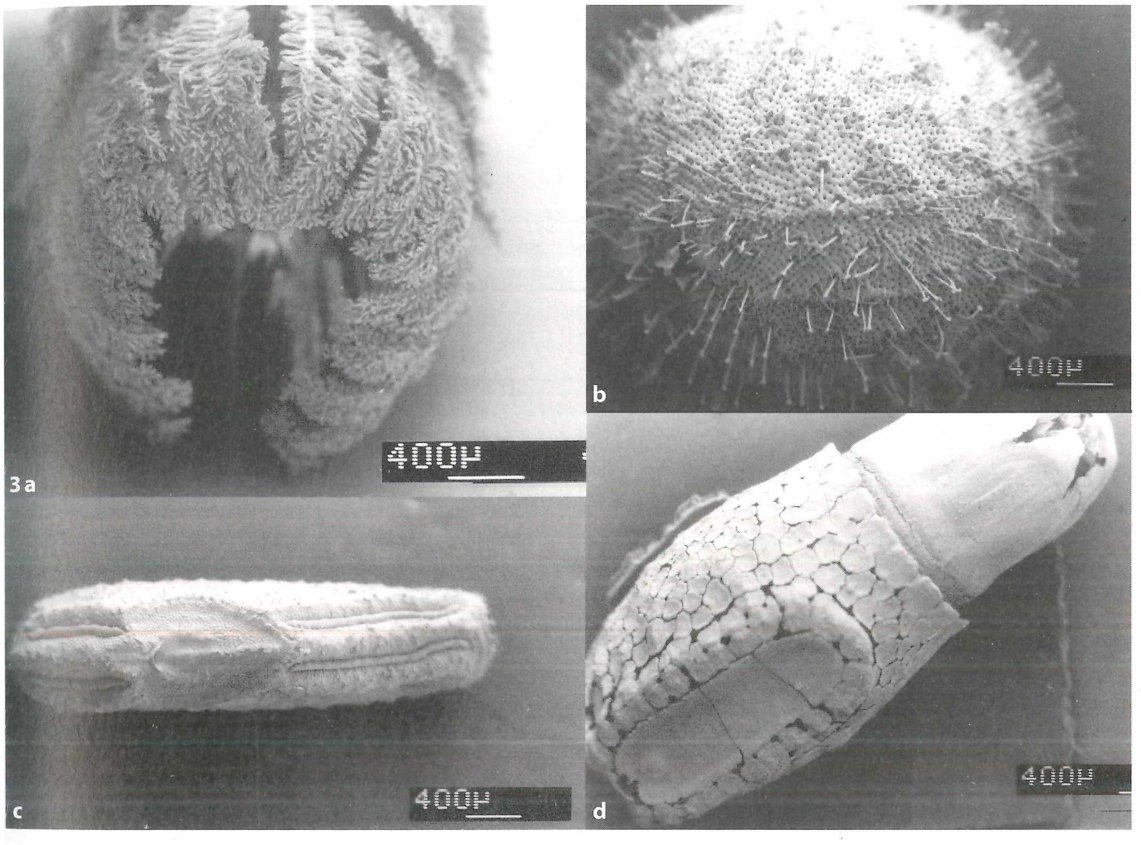



Fig. 3: Details of eggs of Phasmatodea, SEM-micrographs.
a. *Phyllium siccifolium* (Linnaeus, 1758). Operculum, dorsolateral aspect.
b. *Dares ziegleri* (Zompro & Fritzsche, 1999). Egg capsule, dorsal aspect.
c. *Ramulus thaii* (Hausleithner, 1987). Egg capsule, dorsal aspect.
d. *Phanocloidea nodulosa* (Redtenbacher, 1908). Egg capsule, dorsolateral aspect.

Fig. 4: Descriptive terminology of the Phasmatodean egg (after ZOMPRO 2003)