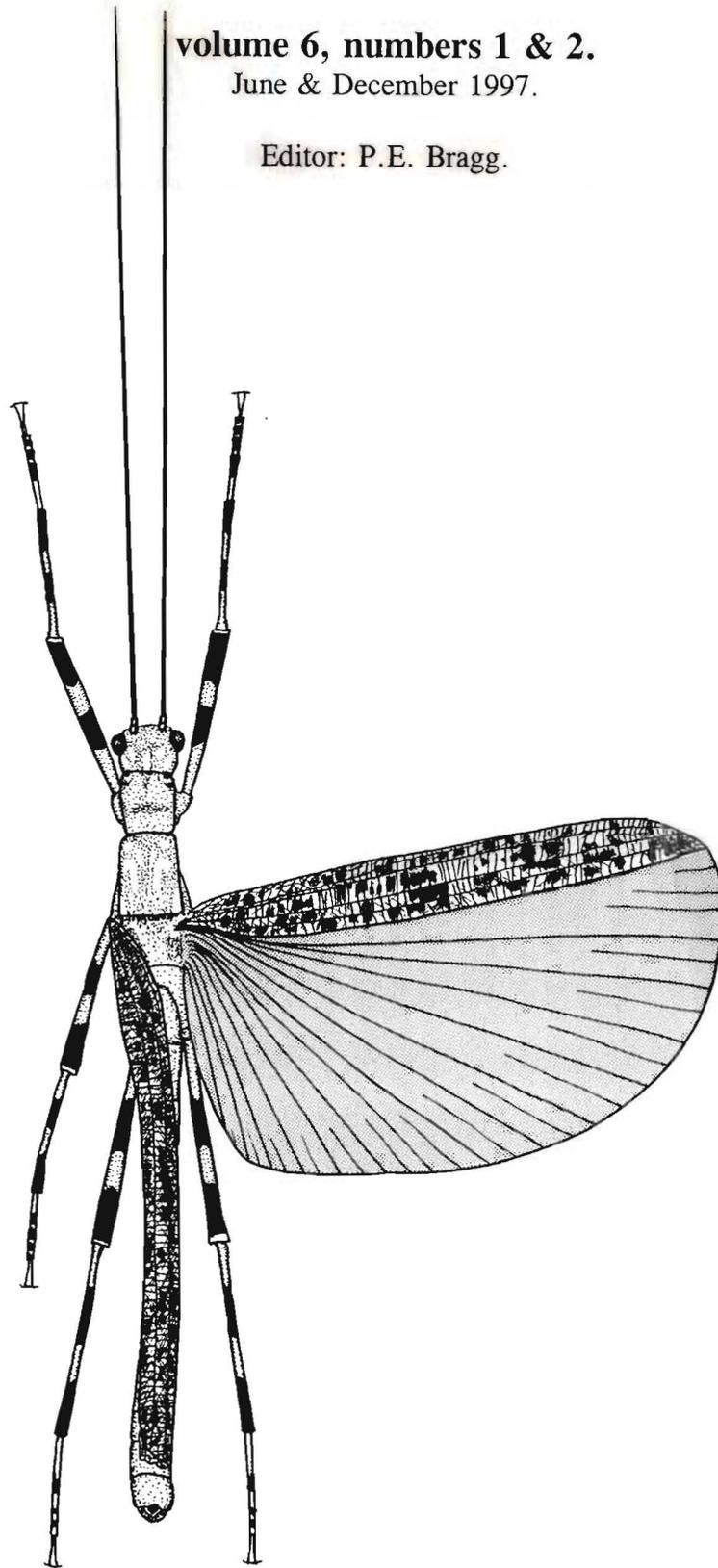


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Contents

A brief contribution to the history of the genus <i>Bacillus</i> in Sicily Simone Berni	1
An Ancient Stick Insect Murray L. Eiland	13
The "umbrella spines" and other surface projections of some phasmid eggs and some comments on phasmid taxonomy John Sellick	15
Taxonomic changes relating to New Zealand stick insects Paul D. Brock	21
A glossary of terms used to describe phasmids P.E. Bragg	24
Reviews and Abstracts Book Review	34
Phasmid Abstracts	35
The egg of <i>Baculofractum insignis</i> (Brunner) J.T.C. Sellick	41
A new species of <i>Phobaeticus</i> Brunner von Wattenwyl, from the Philippines (Phasmatidae) Paul D. Brock	43
Reviews and Abstracts Book Reviews	46
Video Review	47
Phasmid Abstracts	47

A brief contribution to the history of the genus *Bacillus* in Sicily

Simone Berni, 17 Loc. Le More di Cuna, 53014 Monteroni d'Arbia (SI), Italy.

Abstract

Some short notes on the presence of the genus *Bacillus* (Insecta, Phasmatodea, Bacillidae) in the Italian peninsula and particularly in Sicily. The present paper recounts the vicissitudes that led to the discovery of new taxa in the 1980s; provides an outline of their distribution, with notes on the relationships between the different species and a further account of their reproduction modes. Finally, excursions to the Iblean region (south-eastern Sicily) and Marettimo Island (Egadi Archipelago) are described, and future trips and study projects are suggested.

Key words

Bacillus, Sicily, Iblean region, Amphigonic, Hybrid, Parthenogenesis, Hybridogenesis, Gynogenesis, Androgenesis, Species, Endemic, Extinction, Rearing, Biodiversity.

Introduction

Up to the 1960s, only one amphigonic (sexually reproducing) population of *Bacillus rossius* (Rossi, 1788) in the Italian peninsula was recorded in the literature (Montalenti & Fratini, 1959) and was located in Campania. Italian researchers subsequently noted some further findings in Liguria and Tuscany (Marina di Pisa), where both amphigonic and parthenogenetic populations were living. With regard to *B. rossius*, some authors noted various sub-species defined on electrophoretic and ootaxonomic bases; two of these are recorded in Italy (see Figure 1). *B. rossius rossius* is located along the Tirrenic coasts (the coastlines of Liguria, Tuscany, Sardinia, Campania and Lazio), and in a small area at the river Po delta, while *B. rossius redtenbacheri* lives along the entire length of the Adriatic and Ionic basins and at the tip of the Italian peninsula (Calabria, Apulia, Basilicata), including Sicily, the Eolie Islands and a small area in southern Sardinia (see Figure 2 for a view of the Italian Districts).

Recently described taxa in Sicily

Prior to 1980 only *B. rossius* and *Clonopsis gallica* (Charpentier, 1825) were known from Italy and there was a considerable amount of confusion among dealers and breeders of insects. When the efforts of researchers concentrated on southern Italy (and in particular on Sicily) in search of bisexual stocks of *B. rossius*, they soon found themselves confronted with some new species of stick insects. Within a short time period, in the Iblean region of south-eastern Sicily, *Bacillus grandii* (Nascetti & Bullini, 1982), *Bacillus whitei* (Nascetti & Bullini, 1982) and *Bacillus lynceorum* (Bullini, Nascetti & Bianchi Bullini, 1984) were described. Holotypes of new Sicilian stick insects are kept at Natural History Museum "Giacomo Doria", Genoa, Italy. The first species immediately aroused interest because it was bisexual, in the same manner as *B. rossius*. The others two species were hybrids and the interest of the researchers was stimulated by their reproductive mechanisms, because it was clear they were genetically free from the progenitor taxa (species which have originated the hybrids).

Parthenogenesis, the embryonal development in the egg without the participation of the male, was first noted in *Bacillus* as far back as the beginning of the 1930s, thanks to observations made by a group of French researchers that included Cappe de Baillon, de Vichet and Favrelle (Benazzi, 1946). These authors carried out a series of experiments by crossing females of *B. rossius*, which in France is a parthenogenetic species only because males are very rare (de Vichet, 1944), with males of the same species collected from the Algerian coasts in bisexual populations (Favrelle & de Vichet, 1937). So-called "geographic parthenogenesis" was presumed to take place in regions with cold climates. Later, this assumption was contradicted by the discovery of parthenogenetic populations in areas, such as the Iblean region, where the climate would seem to favour amphigonic populations. From the 1960s onwards, the Italian zoologists and cytogenetists Mario Benazzi (initially) and



Figure 1. Distribution of *Bacillus rossius rossius* (vertically hatched) and *B. r. redtenbacheri* (horizontally hatched) along Italian coasts. After Tinti, Mantovani & Scali (1992: 187).

Valerio Scali (currently) have completed a series of very interesting studies on the Italian and Sicilian taxa. Their works have filled a real gap in the field of evolutionistic biology (that branch of biology concerned with the evolution of species). They have arrived at some very important and unexpected conclusions with respect to the "ecological niches" of some species and the complex genetic relationships of others.

B. grandii, apart from inhabiting the Iblean region, is also found in western Sicily and in the Egadi Archipelago, with two different sub-species situated along the coast near Trapani and in the islands of Levanzo and Marettimo: *B. grandii benazzii* and *B. grandii maretimi*. In the light of these discoveries, the range of the species was further extended. It is the Scali's opinion (1991) that this fact opens up the possibility that *B. grandii* could be the "ancestor" of the holo-Mediterranean (i.e. of the entire Mediterranean basin) forms of the genus *Bacillus*, as was believed until some years ago. This "theoretical taxon" (certainly *grandii*-like) must be located more towards the west of the Mediterranean basin or it may even be extinct.

B. grandii grandii, the Iblean sub-species, is a restricted endemic and through a series

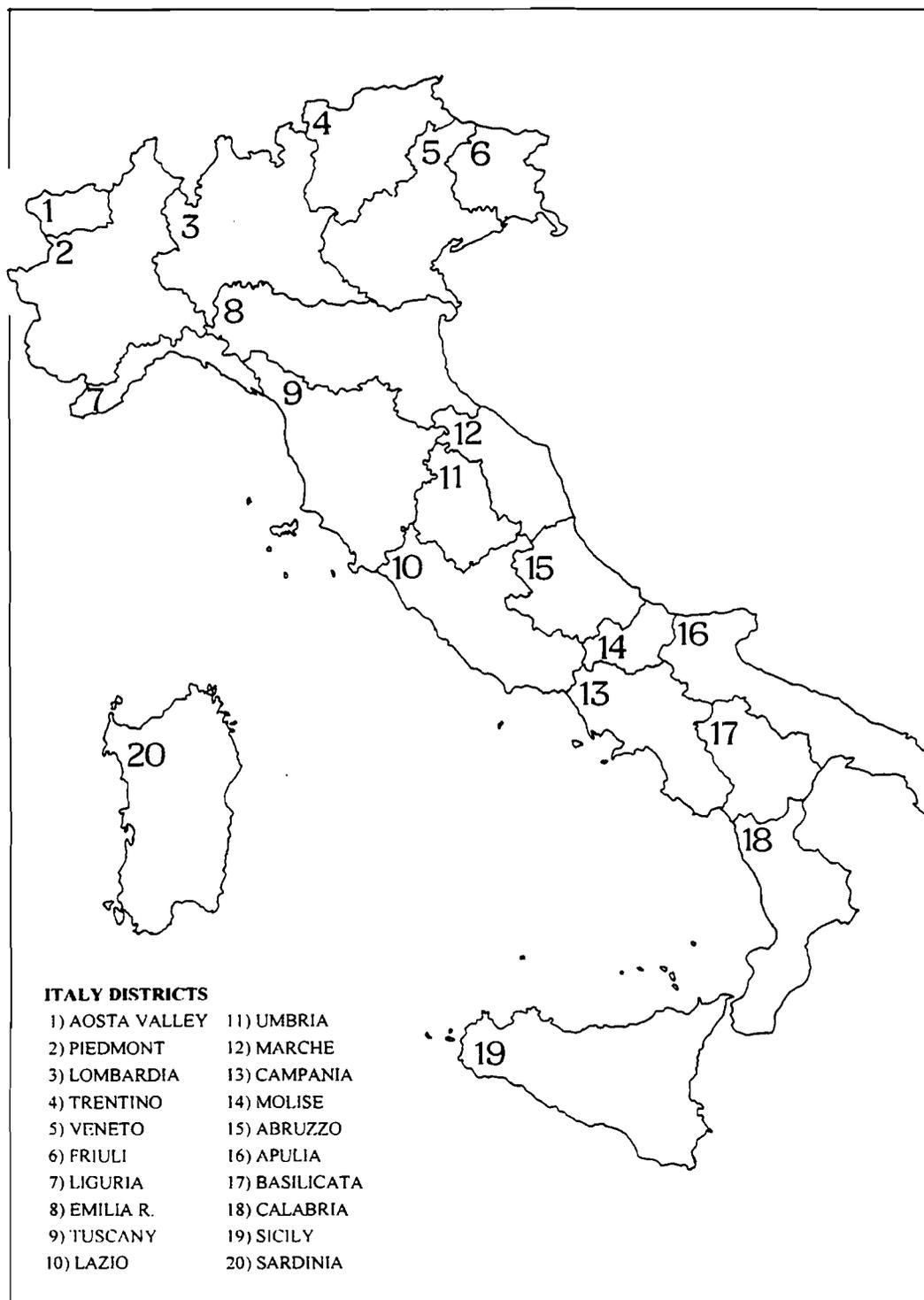


Figure 2. Districts of Italy.

of attendant circumstances is itself at risk of extinction. It is located in just a few habitats near Palazzolo Acreide, Canicattini Bagni and Floridia, in the province of Syracuse. Each of these habitats of *B. grandii grandii* harbours only a small number of specimens and the human presence represents a continuous threat, especially considering the local custom of burning or drastically trimming hedges, the only refuge for phasmids. The second major aspect creating the risk of extinction in *B. grandii grandii* is the incessant competition with

the sympatric (two or more species which live together) *B. whitei* with which it mates regularly, as confirmed by Scali, Mantovani and Tinti (1991: 104). This fact causes a substantial waste of the insects' reproductive potential, only partly balanced by the sex ratio in favour of males.

B. whitei, a hybrid of *B. rossius redtenbacheri* and *B. grandii grandii*, has lately been the subject of some interesting studies that have thrown light on its genetic characteristics. Such characteristics mean that *B. whitei* is a taxon that is unique in the whole of the animal kingdom. By means of a series of crosses with the three sub-species of *B. grandii*, researchers have found the contemporaneous presence of parthenogenesis, hybridogenesis and gynogenesis, and have also reported occasional cases of androgenesis (Scali, Mantovani &

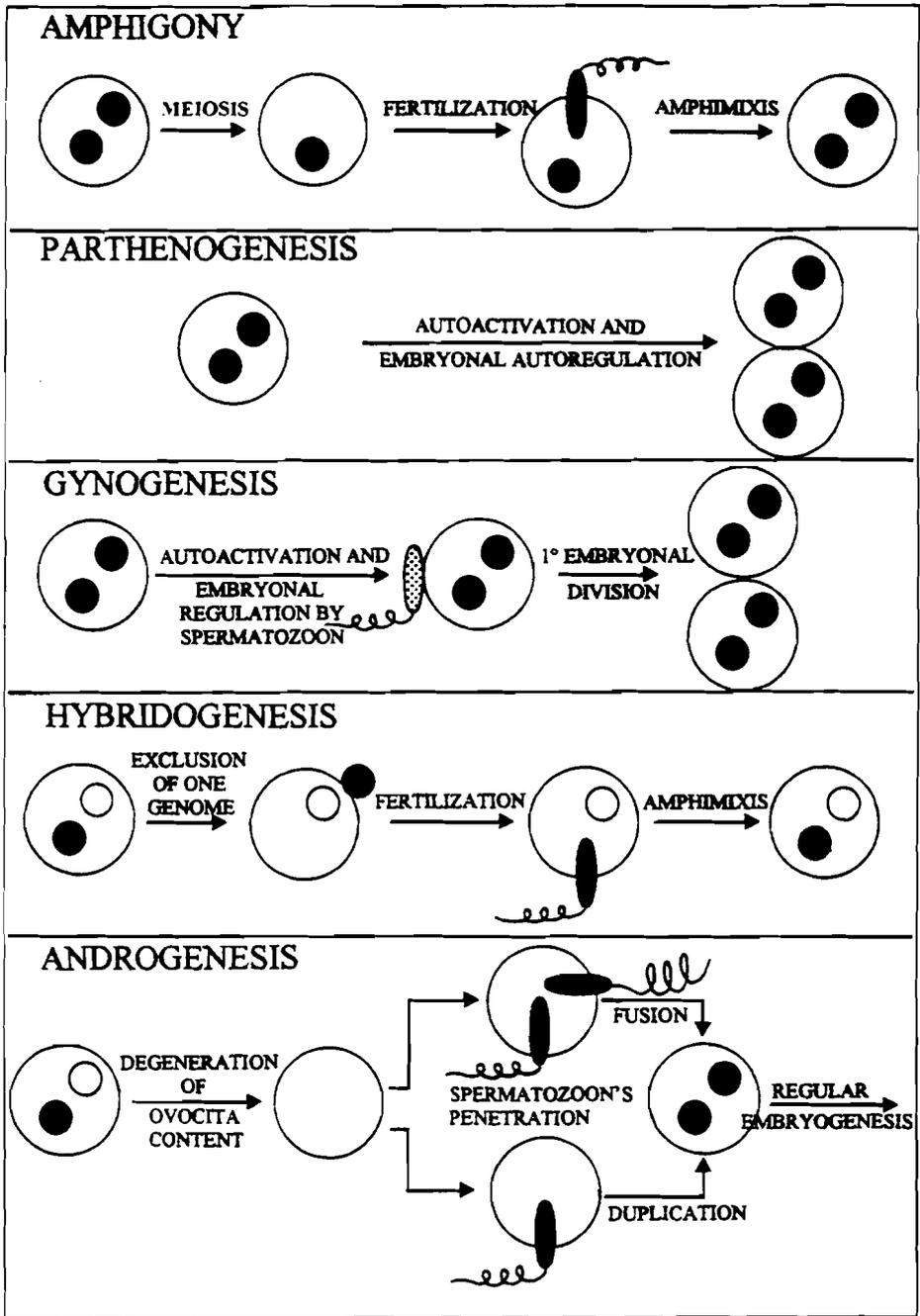


Figure 3. Reproduction modes in the genus *Bacillus*; after Tinti in Veroli (1995: 26).

Tinti, 1991) (see Table 1 and Figure 3 for a general scheme of reproduction modes in the genus *Bacillus*).

This is the first practical confirmation of the evolutionistic theory put forward by some authors on hybridogenetic organisms. For this reason, this representative of Iblean fauna takes on enormous importance, as it testifies to the genuine possibility that an amphigonic organism, evolved to the hybridogenetic stage, might select parthenogenesis as a further adaptation. This is also important because, for the first time, hybridogenesis is being considered as a vital genetic-evolutionistic adaptation. This could have highly interesting reverberations for other animal classes and call for renewed discussion of the very idea of "species" (Veroli, 1995).

B. lynceorum, the longest species in the genus, is the triploid *rossius-atticus-grandii*, probably a cross between *B. grandii grandii* and a diploid F1 hybrid *B. atticus x B. rossius redtenbacheri* which (unusually) produced fertile eggs (Brock, 1991: 20; Manaresi *et al.*, 1992).

In the 1980s, together with the discovery of new Sicilian taxa, some further locations in Italy for *Bacillus atticus* Brunner von Wattenwyl, 1882 were discovered, which was previously only recorded from Attic, Epirus and Peloponnese (in Greece) according to Nascetti and Bullini (1982), La Greca (1984, 1996a), Agostini and Scali (1989) and on the Dalmatian coasts (Müller, 1957). During the Pleistocene era (La Greca, 1996a), this taxon arrived in the Iblean region by crossing what is now Apulia and Calabria and spread throughout the whole of Sicily. In fact, the micro-plate of African origin that formed the Iblean region, during the Pliocene era, was again separated from the north of Sicily (see Figure 4). *B. atticus* on the Italian coasts displays a genetic differentiation from its counterpart in Greece and in the Dalmatian area. In 1982, the researchers Nascetti and Bullini named the Italian population as new sub-species *B. atticus caprai*. Strangely, this subspecies is not cited in Failla *et al.* (1994).

Species	Mode of reproduction
<i>Bacillus rossius</i>	amphigony (*), parthenogenesis (**)
<i>Bacillus atticus</i>	parthenogenesis
<i>Bacillus grandii</i> (***)	amphigony
<i>Bacillus whitei</i>	parthenogenesis, hybridogenesis, gynogenesis androgenesis
<i>Bacillus lynceorum</i>	parthenogenesis
<i>Bacillus rossius-grandii grandii</i>	hybridogenesis, androgenesis
<i>Bacillus rossius-grandii benazzii</i>	hybridogenesis, androgenesis, gynogenesis

Table 1. Reproduction modes in the Italian representatives of the genus *Bacillus*.

(*) Central and southern Italy; (**) Central and northern Italy; (***) All three subspecies of the taxon.

Of additional interest were the findings of specimens of the natural hybrid *Bacillus atticus-rossius*, along the coast near Alimini, in Apulia. However, these insects are completely sterile. Again, with respect to the Sicilian phasmids, it is doubtful whether the two inter-species hybrids *B. rossius-grandii grandii* of the Iblean region and *B. rossius-grandii*

benazzii of north-west Sicily should really be considered species in every respect. In accordance with the interpretation given in the recent "*Checklist delle specie della fauna italiana*" (Failla *et al.*, 1994: 19-20) - probably the most authoritative reference among those cited - authors are inclined to assign the status of species, at least temporarily (these hybrids are in course of study), although these populations seem to be unable to maintain themselves without continuous crosses with the progenitor taxa. In fact in zoology a species is the basic unit: an individual entity of a population, the members of which show the same chromosome complement; they are able to reproduce themselves, giving origin to fertile progeny; such progeny must be able to maintain themselves. (See Figure 5 for a general view of the Sicilian taxa's distribution).

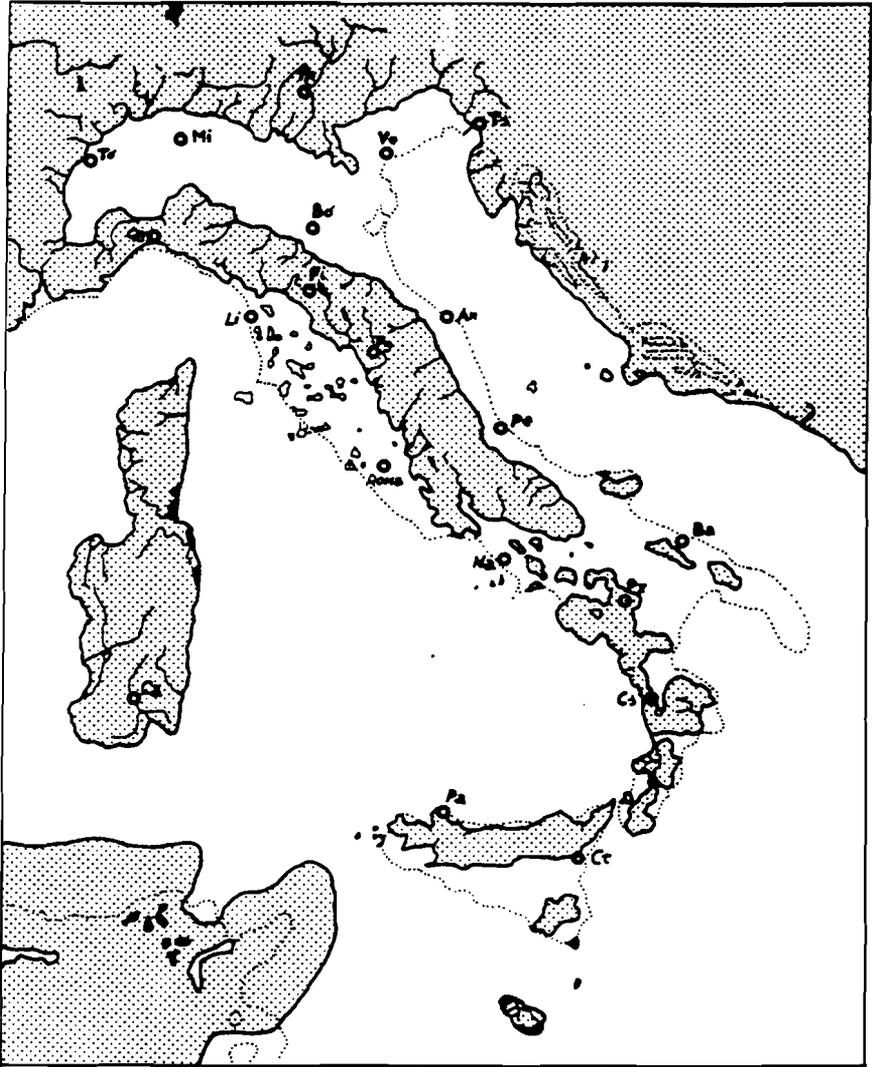


Figure 4. What is now Italy, as it was in the Pliocene era; after Blanc in La Greca (1996a: 24).

Notes on two preliminary excursions to Sicily - October 1996

In October 1996, in collaboration with the *Ente Fauna Siciliana*, some adult specimens of *B. whitei* (see Figure 6) were found, at night, near Isola Coco, alongside the old Syracuse-Vizzini-Ragusa railway, on some bramble plants (*Rubus* spp.). The plants were in the undergrowth, near the river Anapo. Although very common in the Iblean region, *B. whitei*

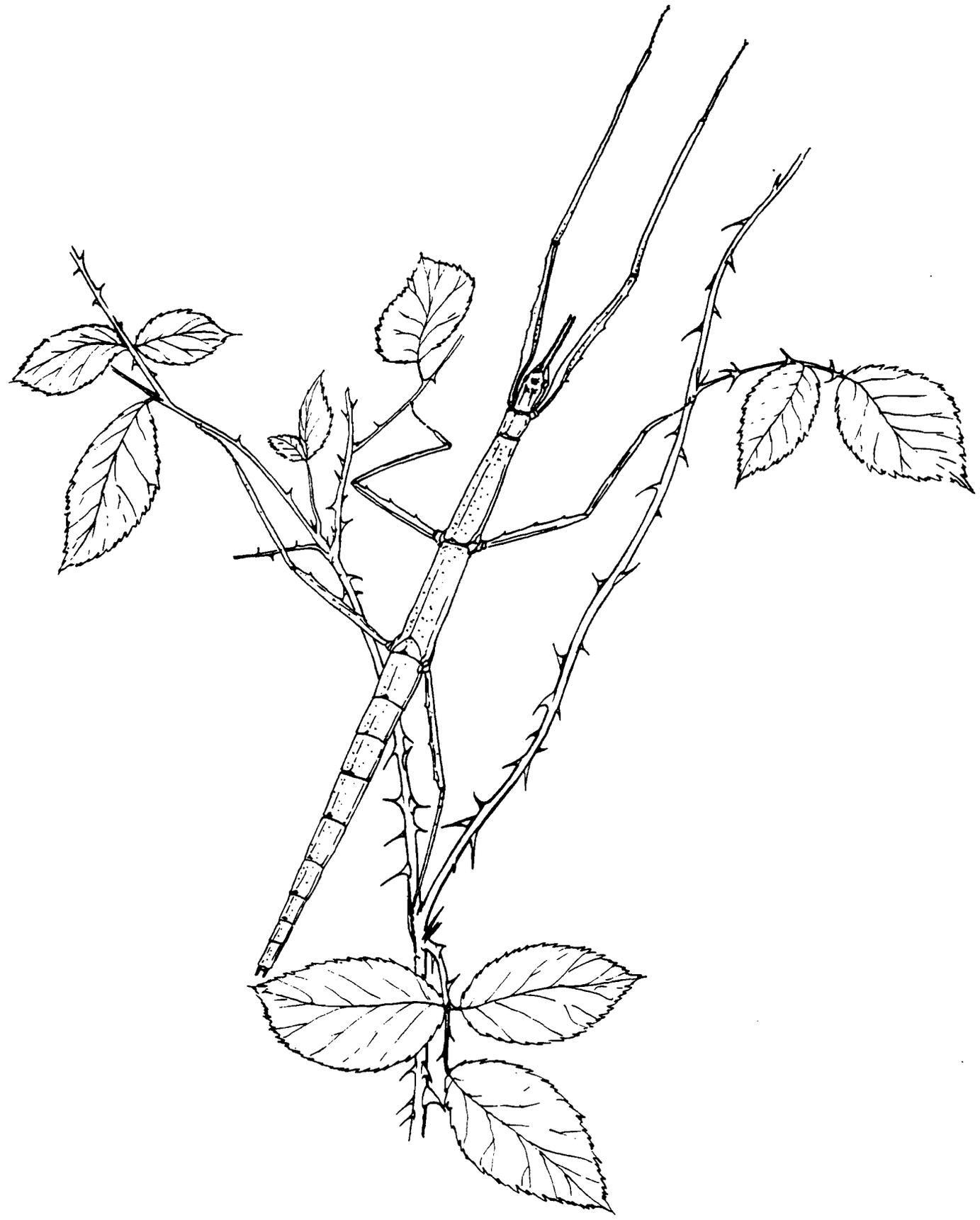


Figure 6. Female *Bacillus whitei* on bramble.

B. lynceorum and the hybrid *B. rossius-grandii grandii*. It is very difficult to recognize this hybrid because it is morphologically similar to *Bacillus whitei* (Failla *et al.*, 1994: 22). This taxon, doubted by some authors, is different from *B. whitei* in being hybridogenetic as opposed to parthenogenetic. Consequently, while *B. whitei* is completely free of males of *B. grandii grandii* for purposes of reproduction, *B. rossius-grandii grandii* requires continuous crosses with "progenitors".



Figure 7. *Bacillus grandii maretimi*, three nymphs on lentisk.

A second - and no less important - purpose concerns the conservation of the taxon *B. grandii grandii*. As previously stated, this species is in serious risk of extinction. We may assume that the best method of conservation for the taxon is the protection of its environment: hedges of bramble bushes. Unfortunately, the extensive use of fire in order to remove unwanted hedges in the Iblean territory is a cause of death for this insect. If these natural barriers were to be destroyed manually, the insect would at least have the possibility of escape during the night.

The hedge problem has already been discussed in relation to interventions aimed at protecting natural environments, with WWF Italy playing a major role. During the early 1990s, several thousand shrubs of *Prunus*, *Myrtus*, *Rubus*, *Cistus*, *Pyrus*, *Crataegus*, *Rosa*, *Pistacia*, *Erica* and other characteristic plants of the Mediterranean environment, were planted across Italy. Thus, efforts are being made to revive at least a part of a territory that has been sorely impoverished in earlier decades (Francescato, 1989).

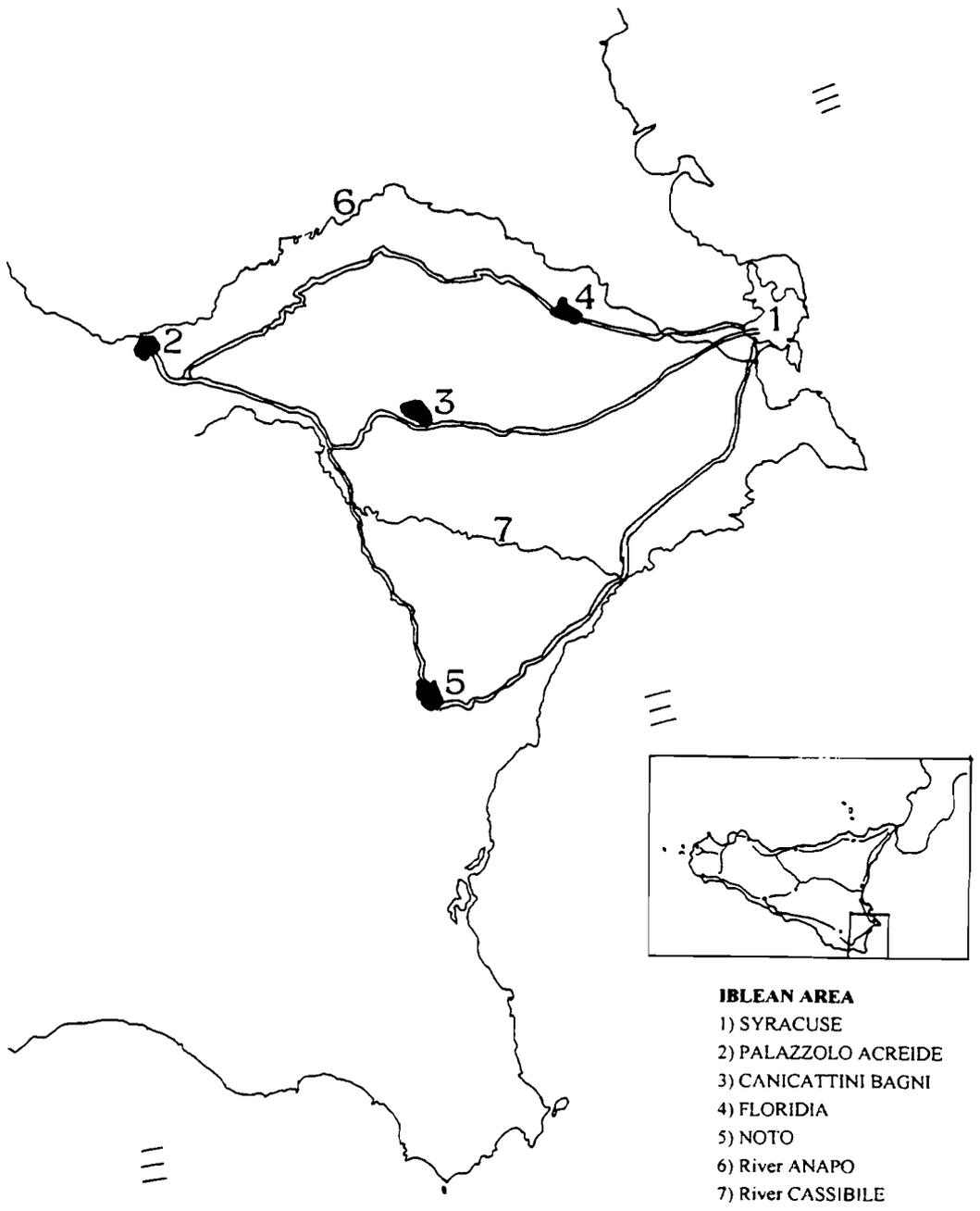


Figure 8. The Iblean area of Sicily.

Biodiversity in a natural environment is the result of a long developmental process. The most precious aspect of the resources in a natural environment is provided by the endemic species, that is, by the living creatures geographically localized and currently at risk of

extinction. It should be remembered that an incidental loss of these species would be an incalculable loss for science and utterly irredeemable (La Greca, 1993, 1996b). The situation in Marettimo is more stable, in contrast with the Iblean region; *B. grandii maretimi* is present in a large numbers and there are currently no obstacles to its survival.

Acknowledgements

I am grateful to Lorenzo Aiello for drawing figures 1 and 3-7. Thanks to: Giovanni Aliotti, Phil Bragg, Paul Brock, Marcello La Greca, Carmelo Milluzzo, Leonardo Parisi, Roberto Poggi, Bruno and Franco Ragonese, Ivor Rowan, Paolino Uccello; for support and valuable suggestions.

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An Ancient Stick Insect

Murray L. Eiland, 1110 Eagle Nest Court, Danville, CA, 94506, USA.

Abstract

This article proposes that a Chinese tree root carving of the fourth to third century BC is based on a stick insect.

Key words

Phasmida, Chinese, Antiquities.

This artifact (Figure 1) is noted today as being the oldest surviving root carving from Ancient China. The head and body of the animal is made of smoothed tree root, while the legs are rendered in bamboo, which clearly show their sectional structure. The entire creature is lacquered maroon red. The head is certainly feline, with large orange (ground) and red (pupil) eyes. Its teeth, in a formidable fence-like array, may be taken in an almost comical manner. The rest of the animal is anything but threatening. The right front leg bears a snake that wriggles up the length of the limb, while on the right hind leg a short snake bites a tailless lizard. The left front leg bears a lizard clutching the head of a (stylized) bird in its jaws, which appears on this drawing, on such a limited scale, as a floral device. The top of the left hind leg bears a small but easily identified cicada.

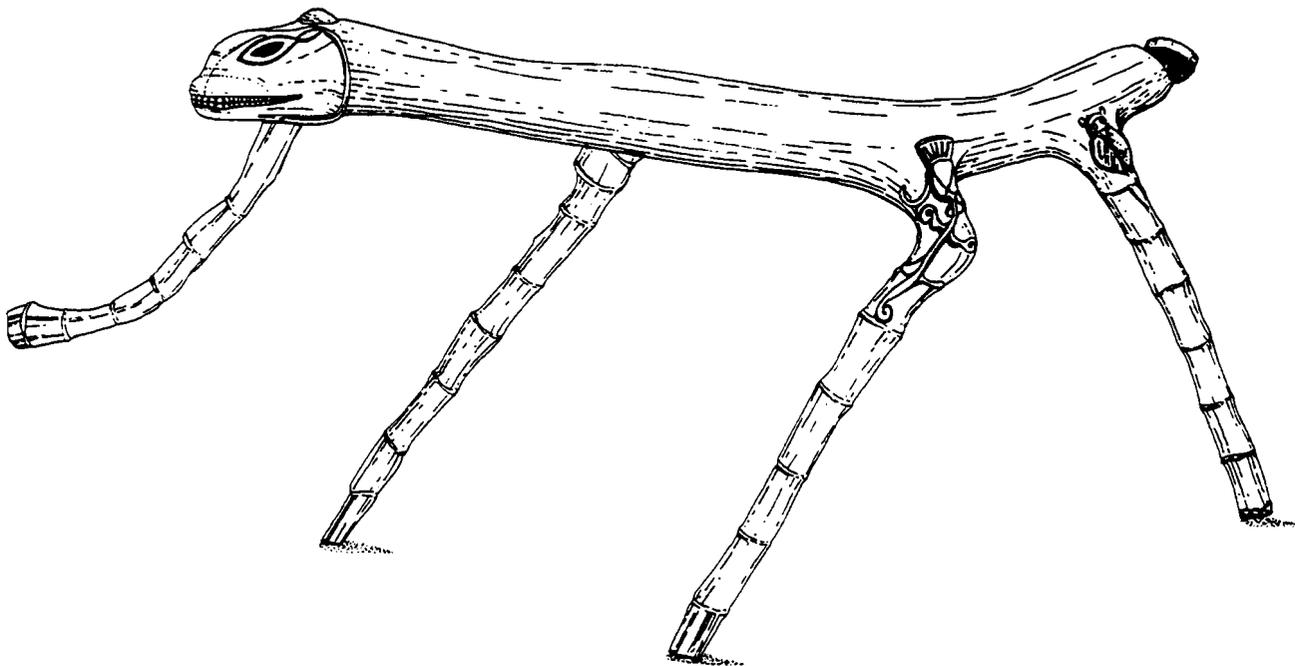


Figure 1. Tree root carving with bamboo and lacquer, height 32cm; length 69.5cm. Eastern Zhou, Warring States Period (4th-3rd century BC), Chu state. Excavated from tomb M1 at Mashan in Jiangling county, Hubei province, and now in the Jingzhou Regional Museum, Hubei province (Beijing, 1985: pl. 43:1; Goepper, 1995: no. 75).

While figures such as dragons, which have a long history in Chinese art, can be interpreted using written sources and parallels with later folklore, the nature and identity of this figure remains elusive, as do the figures that adorn its body. Were these figures common in Chu culture? When dealing with material from this period little can be taken as certain. Not only is there a dearth of textual material to aid in interpretation, but the nature of root

carvings as a group is also obscure, as very few have survived. From its position in the tomb where it was found, above the head of the female occupant, this carving could be seen as a kind of guardian, to "ward off evil" (Rawson, 1996: 143). At this period in Chinese history it is clear that there was a growing interest in "shamanism", and graves contained offerings other than bronze. At the same time the art of the Eastern Zhou is unusually rich, with a variety of motifs and geometric devices. As a result, many pieces were clearly meant to be appreciated on many levels (as this root carving contains a number of figures that are related to a greater or lesser degree). At the same time, using modern art-historical taste as a guide (which, it may be noted, is often quite different from the aesthetics of antiquity), this figure could be the favourite of the owner that shows no more than the mind-set of the occupant.

This creature has been interpreted by modern art historians as an "imaginary beast", although there is compelling evidence to suspect that it is a rendition of a stick insect, a creature that, to many museum curators, would indeed seem imaginary. While there are a number of particular features of this figure that indicate it is composed from a variety of animals, from the feline head to the smaller animals on the legs (it should be noted that there are four legs rather than six in insects), the overall morphology of this animal is clear. It has a very long thin body with long thin legs. In the case of the latter it is interesting to note that one leg is clearly projected forward into space, which is consistent with common behaviour of many phasmid species (as noted below).

The treatment of the head of the animal also deserves special consideration. While it is clear that it is based upon a feline model, one should not then quickly assume that this factors against an insect-inspired origin for the animal as a whole. It should be noted that many phasmid species have a combination of mouthparts and eyes that lead many who are unfamiliar with the habits of this order to conclude that phasmids are capable of inflicting considerable damage, and that, like mantids, they are carnivorous. As in many art objects of antiquity - and today - attention to detail is often sacrificed to capture the perceived qualities of the object of interest. Instead of depicting large compound eyes and complex mouthparts, the artist may have chosen to simplify his subject and portray a more easily conceived form.

It is from this latter point that one may pose the question, why is this root carving not of a mantis? While it is clear that the Chinese - along with many other cultures - have long venerated mantids as animals endowed with special properties due to their unique form, this carving lacks the main attribute of a praying mantis, the raptorial legs. While not venerated in modern societies today, phasmids show many features that may have inspired intrigue. Many phasmids exhibit an immobility reflex when threatened, where the animal projects its limbs forward and remains motionless for periods of time. Many species also have a swaying pattern of motion, while others stop and waft their legs in the air for anchorage if they are placed upon a surface with little opportunity for vertical movement. Also of interest are the many patterns of escape which different species display, from moving backwards to dropping and flying. Is any of this behaviour recorded in the positioning of this root carving? Without further information, this aspect may remain conjectural. However, it is with such behaviour in mind that one can appreciate why a phasmid would be portrayed in antiquity. Once we understand that this creature is a stick-insect, we can also understand why two snakes, two lizards, a bird, and a cicada are associated with this animal. These are all animals that one would expect to find in a phasmid's domain.

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The "umbrella spines" and other surface projections of some phasmid eggs and some comments on phasmid taxonomy

John Sellick, 31 Regent Street, Kettering, Northants, NN16 8QG, U.K.

Abstract

Short flat-topped spines are found in four tribes of Phasmida, widely separated in the traditional subdivision of the order. Pinnulae occur in *Phyllium siccifolium*. A survey is given of other surface projections of various types found in different families. A table of subfamilies is given, indicating some taxonomic problems.

Key words

Phasmida, egg structure, spines, hairs, pinnulae, *Bacteria*, *Baculum*, *Creoxylus*, *Datames*, *Dinophasma*, *Epidares*, *Haaniella*, *Hoploclonia*, *Paraphasma*, *Phenacephorus*, *Phyllium*, *Pseudophasma*, *Sipyloidea*, *Stratocles*.

Umbrella spines

I first noticed these structures when preparing s.e.m. images of two species of *Baculum* for my 1980 thesis. They stand around 0.15mm from the general egg capsule surface with a relatively narrow stalk and then expand into a more or less complex flattish top, the rim of which is composed of fused roughly spherical units. Reading recently Frédéric Langlois' account (1995) of the egg of *Stratocles tessulata* (Olivier) [as *Stratocles variegatus* (Stoll)] I saw there the same structures in an egg of a distinctly different group of phasmids. Langlois drew attention to the similarity of these structures in the two genera. He described them as "structures en forme de parapluie" (umbrella-like structures). Figure 1 shows the s.e.m. form of these "umbrellas".

I had noted their occurrence in *Paraphasma rufipes* (Redtenbacher), which like *Stratocles* is in the tribe Stratocleini, and in *Pseudophasma bispinosa* (Redtenbacher) in the Pseudophasmatini. Going to my reference collection I found them also in *Baculum cuniculum* (Westwood), *Baculum insignis* (Wood-Mason), *Baculum insueta* (Brunner), *Baculum* PSG 144 and *Baculum* PSG 157 in the Baculini, all of which are *Baculum* (iii), the third of the four strikingly different forms of eggs found within this "genus" (Sellick 1997). They are also in the *Creoxylus* sp. supplied to me by Oliver Zompro (his no.86) which is in the Xerosomatini. Here they are confined to the raised lines on the capsule surface, and form a ring on the operculum. I have not been able to detect them in all the species in my collection of *Baculum* (iii) or of *Creoxylus*. Stratocleini, Pseudophasmatini and Xerosomatini are closely related tribes (subfamily Bacunculinae), but in the traditional classification the Baculini are far separated from them (subfamily Phasmatinae). The first two tribes are Areolatae, whilst the Baculini is in the Anareolatae. Where else are these to be found? Similar structures occur in *Phyllium celebicum* (de Haan). These have shorter stalks (about 0.07mm) and complex heads (fig. 2A). The curious crusty surface of the egg of *Bacteria* PSG 152 (Subfamily Bacteriinae) is composed of the tessellated top plates of large umbrella spines (fig. 3). Like the others they stand around 0.15mm above the surface, their top plates being up to 0.35mm across, compared with 0.15 - 0.25mm in those species in other tribes where they do not form a full surface layer. The top plates are particularly large in a single layer surrounding the micropylar plate and along the opercular collar, where they form a series of open scales. Whilst the spines of Stratocleini, Xerosomatini and Baculini are so similar that they seem to indicate a close relationship, it is possible that those of Bacteriinae and Phylliidae with different dimensions are an accidental similarity of different origin.

The surface of the egg of *Phenacephorus cornucervi* (Brunner) (Lonchodinae) appears to be a pattern of rings with central depressions. Sectioning shows that these rings are produced by surface extensions with some similarity to umbrella spines in that they have stalks and an expanded head. They surround a thickening of the translucent compact layer of the capsule (fig. 5B). All the heads are however united into the ring formations, leaving

irregular openings which mark the circumferences of the rings (fig. 5A).

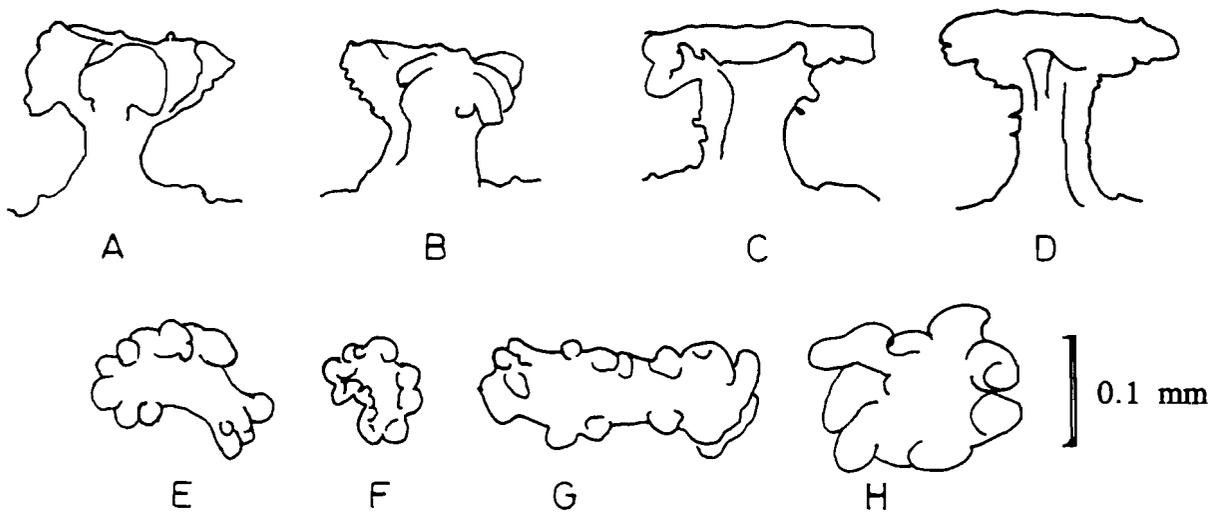


Figure 1. Umbrella spines.

A-D Side views: A. *Baculum thaii*. B. *Baculum cuniculum*. C & D. *Stratocles variegatus*.

E-H Surface views of *B. thaii*.

All traced from s.e.m. images (A-B, E-H Sellick 1980; C-D Langlois 1995).

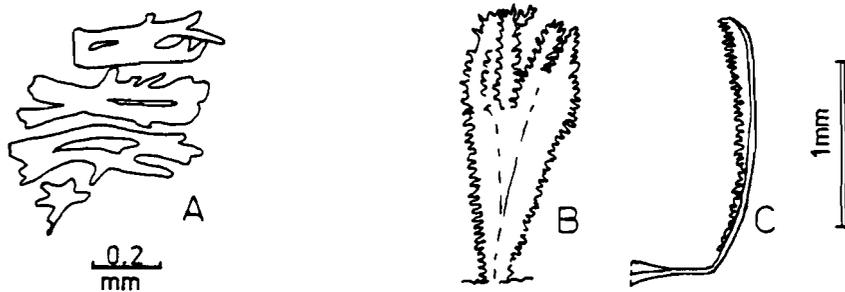


Figure 2. *Phyllium*.

A. Flat-headed spines in *P. celebicum* showing variety in shape and size of heads.

B & C. Pinnulae of *P. siccifolium*: B. side view of projecting portion. C. view showing base.

Pinnulae

I used this term in Sellick 1978 to describe the feather-like extension of the capsule and

operculum surface characteristic of *Phyllium siccifolium* (Linnaeus), but not so far found in any other species. These (figs. 2B & 2C) originate in a base some 0.5mm long which runs along the surface of the egg tapering from a broad origin almost to a point; it then extends outwards as a one- or two-branched flattened structure up to 1.6mm long and around 0.5mm wide which curves somewhat back in the direction of the base.

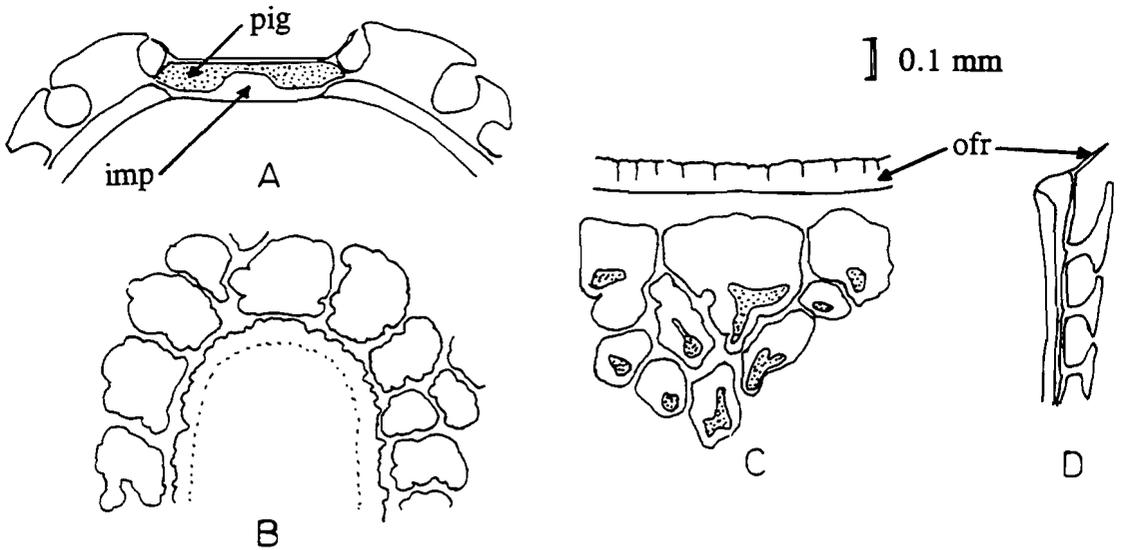


Figure 3. Umbrella spines forming the surface of the egg of *Bacteria* PSG 152.

A. Section through the micropylar plate.

B. Surface view of the area at the front of the micropylar plate.

C. Scale-like plates of the opercular collar seen in transparency, stalks of the plates are shaded.

D. Section of this region.

Drawings using a light microscope. pig = sunken pigmented surface layer over the plate, imp = internal micropylar plate, ofr = opercular fringe.

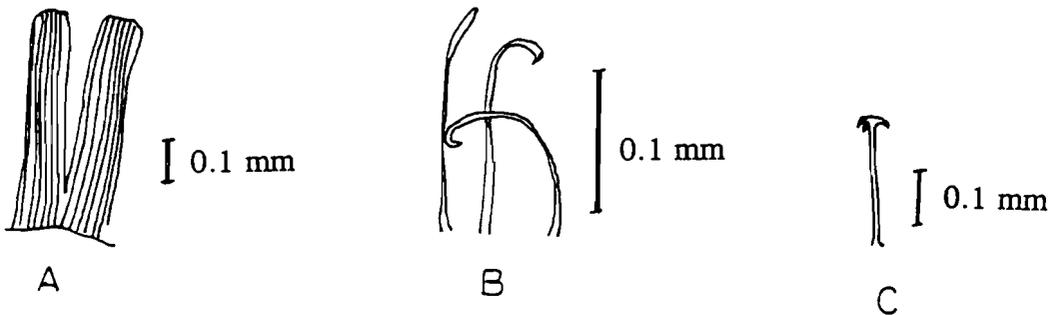


Figure 4.

A. Formation of collar fringes in *Diesbachia*.

B & C. Hairs of *Datamini*. B. *Epidares*. C. *Datames*.

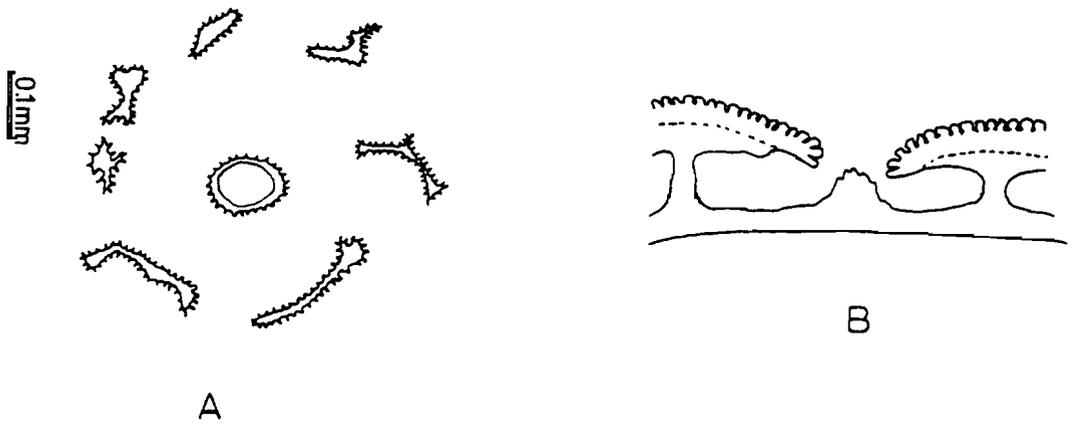


Figure 5. The surface of *Phenacephorus cornucervi*.
 A. Surface view showing "pit" and "ring".
 B. section through a pit and ring system.

Fringes of the capsule collar

A number of genera of the Necrosciidae possess fringes on the collar which surrounds the operculum. These are of various lengths, ranging from 0.3mm in *Orxines macklottii* (de Haan), through 0.5mm in *Acacus sarawacus* (Westwood) and 0.6mm in *Diesbachia tamyris* (Westwood), to 0.65mm in *Centrophasma hadrillus* (Westwood). The fringe material is traversed by some sixty thickened struts, each about 0.2mm wide and it then splits into separate fringes, each fringe containing usually two or three of these struts (fig. 4A). These are all true capsule outgrowths, and must not be confused with the fringe of *Trachythorax maculicollis* (Westwood), which is produced by a splitting away of the surface capsule layer. What appears to be a collar fringe in various species of *Baculum*, particularly PSG 157, is produced by variously developed umbrella spines and is opercular and not capsular.

Egg capsule hairs

Hairs of various types occur sporadically throughout the groups of phasmids. In *Orobia* sp. (from Madagascar) [Pygirhynchinae] there are short fine hairs ca. 0.03mm long. Three species of *Haaniella* [Heteropteryginae, Heteropterygini] show fine hairs of different lengths: 0.02mm in *H. echinata* (Redtenbacher), 0.07 mm in *H. grayii* (Westwood) and 0.13mm in Zompro's no.30. Similar fine hairs, 0.08mm long, are found in *Hoploclonia gecko* (Westwood) [Heteropteryginae, Obrimini]. Longer hairs, 0.18mm long, are found over the capsule and operculum surface of *Sipyloidea ?sipylus* PSG 4. In the Heteropteryginae, Datamini three species show forms of hooked hairs. In *Datames oileus* (Westwood) these are sparse and 0.22mm long, expanded at the tip to form a three- (possibly four-) pronged top (fig. 4C). *Epidares nolimetangere* (de Haan) has a dense covering of long (0.4 - 0.45mm) hairs each with a single hook at the tip (fig. 4B). *Dinophasma guttigera* (Westwood) [Aschiphasmatinae, Aschiphasmatini] has a dense fine covering of 0.2mm hairs.

Comments on phasmid taxonomy

The division of the Phasmida into two on the basis of the presence or absence of triangular areas (the "area apicalis") on the mid- and hind-tibiae has been brought into question by a number of authors (e.g. Kristensen 1975, Key 1974, Roberts 1974), although retained by Kevan (1982) who, after the removal of *Timema* as the suborder Timematodea, divided his other suborder, the Phasmatodea, on conventional lines. Kristensen merely criticised the value of the area apicalis as a taxonomic criterion, pointing out that it may be sclerotised or not, elevated or depressed, and delimited by carinae, rows of spines, or have neither of these. He made no suggestion for regrouping within the order. Key suggested that the criterion for membership of the "Areolatae" should be the presence of a male vomer, on which basis he would transfer the Necrosiidae into that suborder. Roberts found vomers in Lonchodinae and Bacteriinae, both traditionally Anareolatae. These latter three groups are themselves at present in the two different superfamilies of the Anareolatae.

As an illustration of the chaos of phasmid classification, table 1 shows the 23 subfamilies of the Kevan classification, with some of their characteristics. Some of the names have been corrected following Bragg (1997), as they also have been in the above account. In no case is it to be taken that any of these characteristics is found throughout the subfamily in question.

Infraorder	Superfamily	Family	Subfamily	1	2	3	4	5
Timematodea	Timematoidea	Timematidae	---	+	-	-	X	ab
Bacillidea	Bacilloidea	Bacillidae	Bacillinae	+	+	-	O/C	+
			Pygirhynchinae	+	+	-	C	ab
			Heteropteryginae	+	+	-	O	+/ab
		Pseudophasmatidae	Aschiphasmatinae	+	+	-	C	ab
			Korinninae	+	+	-	O	+
			Pseudophasmatinae	+	+	+	O	+/ab
	Phyllioidea	Phylliidae	---	+	+	+	C	ab
Phasmatidea	Heteronemioidea	Necrosiidae	---	ab	+	-	O/C	+/ab
		Heteronemiidae	Heteronemiinae	ab	-	-	O/C	+
			Libethrinae	ab	-	-	O	+
		Lonchodidae	Lonchodinae	ab	+	+?	O	+
			Menexeninae	ab	-	-	O/C	+/ab
		Pachymorphidae	Gratidiinae	ab	-	-	O/C	+/ab
			Pachymorphinae	ab	-	-	C	ab
		Palophidae	---	ab	-	-	O	ab
	Phasmatoidea	Bacteriidae	Cladoxerinae	ab	-	-	-	-
			Bacteriinae	ab	+	+	O	+/ab
		Phasmatidae	Platycraninae	ab	-	-	O/C	+/ab
			Xeroderinae	ab	-	-	-	-
			Eurycanthinae	ab	-	-	O	+
			Tropidoderinae	ab	-	-	C	ab
			Phasmatinae	ab	-	+	O/C	+/ab

Table 1. Phasmid subfamilies.

- 1 Area apicalis on tibiae
- 2 Male vomer
- 3 Egg umbrella spines
- 4 Internal micropylar plate type; X = no gap; O = open gap; C = closed gap
- 5 Median line: + = present in at least some genera; - = presence not known; ab = definitely absent in genera examined.

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Taxonomic changes relating to New Zealand stick insects

Paul D. Brock, "Papillon", 40 Thorndike Road, Slough, SL2 1SR, U.K.

Abstract

Following research on New Zealand stick-insect type specimens four new synonyms have been identified, as follows: *Pachymorpha finitima* Brunner von Wattenwyl, 1907 and *Tectarchus diversus* Salmon, 1954 are synonyms of *Tectarchus huttoni* (Brunner von Wattenwyl, 1907) (which has been transferred from the genus *Pachymorpha* Gray). *Pachymorpha bouvieri* Brunner von Wattenwyl, 1907 is a synonym of *Mimarchus annulatus* (Hutton, 1898); and *Clitarchus interruptelineatus* Brunner von Wattenwyl, 1907 is a synonym of *Clitarchus hookeri* (White, 1846).

Key words

New Zealand, Salmon, Brunner von Wattenwyl, Naturhistorisches Museum Wien, synonym, Phasmida.

Introduction

Whilst revisiting the Naturhistorisches Museum Wien (NHMW) in 1996, I took the opportunity of examining Brunner von Wattenwyl's New Zealand taxa unfortunately overlooked in Salmon's excellent book (1991). I had already seen type material in Paris (MNHN) and believed that the *Pachymorpha* species described by Brunner von Wattenwyl in 1907 had been incorrectly placed in that genus.

My research has made certain taxonomic changes necessary, as listed in the following section. Listings of species include only the most important references or a change of genus made by a later author. Museum codens are also given below:

BMNH	The Natural History Museum, London, England.
CMNZ	Canterbury Museum, Christchurch, New Zealand.
MNHN	Museum National d'Histoire Naturelle, Paris, France.
MONZ	Museum of New Zealand, Wellington, New Zealand.
NHMW	Naturhistorisches Museum Wien, Wien, Austria.
ZMUH	Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Hamburg, Germany.

Tectarchus Salmon, 1954

Tectarchus Salmon, 1954: 161. Type species: *Tectarchus diversus* Salmon, 1954: 163, designated by Salmon, 1954: 162 [= *Tectarchus huttoni* (Brunner von Wattenwyl), 1907: 213; see below].

Tectarchus huttoni (Brunner von Wattenwyl) comb.n.

Pachymorpha huttoni Brunner von Wattenwyl, 1907: 213. Syntype series: ♂, 2♀♀, New Zealand (NHMW, No. 383); ♂, ♀, New Zealand: Nelson (MNHN).

Pachymorpha finitima Brunner von Wattenwyl, 1907: 215. Holotype ♀, New Zealand, [18]48-52, leg. Petit, "Mus. Paris" (NHMW, No. 380). **syn.n.** [No types of this species were found in MNHN].

Tectarchus diversus Salmon, 1954: 163, pl. 7: 1-2, pl. 8: 1,2,4,8, pl. 9: 1 & 5. Holotype & paratypes ♂♂ & ♀♀, New Zealand (several localities) (MONZ, including coll. Salmon; also in coll. G. Ramsey). **syn.n.**

Mimarchus Carl, 1913

Mimarchus Carl, 1913: 22. Type species: *Mimarchus tarsatus* Carl, 1913: 23, by monotypy.

Mimarchus annulatus (Hutton)

Pachymorpha annulata Hutton, 1898: 162. Holotype ♀, New Zealand: Dunedin (CMNZ).

Mimarchus annulatus Hutton; Salmon, 1991: 96.

Pachymorpha bouvieri Brunner von Wattenwyl, 1907: 214. Syntype series: 3♂♂, 3♀♀, New Zealand: Invercargill, leg. Burr; ♂, 2♀♀, New Zealand: Nelson, 1876, leg. Filhol, "Mus. Paris"; ♂, no locality (NHMW, No. 378); ♂♂ & ♀♀, New Zealand (MNHN). **syn.n.**

Three further females in NHMW, without identification labels, are not regarded as part of the type series.

Clitarchus Stål, 1875

Clitarchus Stål, 1875: 34, 82. Type species *Clitarchus laeviusculus* Stål, 1875: 82, by designation of Kirby, 1904: 339 [= *Clitarchus hookeri* (White), 1846].

Clitarchus hookeri (White)

Phasma hookeri White, 1846: 24, pl. 6: 6. Holotype ♀, New Zealand (BMNH).

Bacillus hookeri (White); Westwood, 1859: 14.

Clitarchus hookeri (White); Stål, 1875: 83.

Clitarchus laeviusculus Stål, 1875: 82. Syntype series: 4♀♀, New Zealand, leg. Boucard (NHMW, No. 443). (synonymised by Ragge, 1965: 39).

Bacillus coloreus Colenso, 1885: 151. ♀, New Zealand: Pourerere, near Blackhead, 1884, leg. W. Scott. (synonymised by Brunner von Wattenwyl, 1907: 237).

Bacillus minimus Colenso, 1885: 153. New Zealand: Norsewood. (synonymised by Salmon, 1991: 82).

Clitarchus reductus Hutton, 1899: 55. ♀, New Zealand: Canterbury (CMNZ). (synonymised by Salmon, 1991: 82).

Clitarchus interruptelineatus Brunner von Wattenwyl, 1907: 236, pl. 10: 4a-d. Syntype series: ♂, 2♀♀, New Zealand (NHMW, No. 445); ♂, New Zealand: Great Barrier Island (ZMUH). **syn.n.**

Summary

Apart from noting new synonyms, there is only one significant change to make to Salmon's book, i.e. references to *Tectarchus diversus* should read *Tectarchus huttoni* (for main section on this species, see pages 101-105 of Salmon, 1991).

Whilst a number of species described by Brunner von Wattenwyl (1907) and Redtenbacher (1906; 1908) have been synonymised, I consider that once detailed studies are made on the phasmid fauna from other geographical regions, numerous further unpublished synonyms will be identified. A detailed background on the Brunner von Wattenwyl collection in Vienna is included in Brock (in press).

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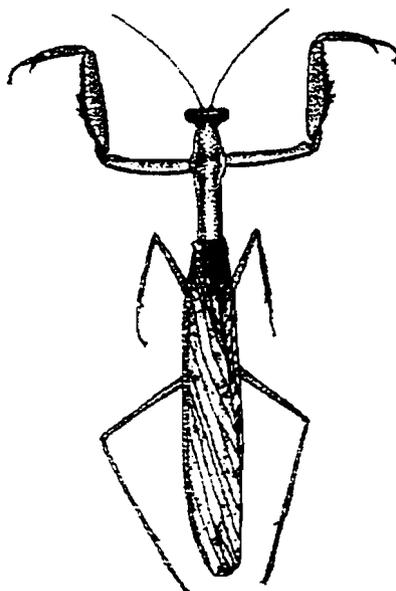
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Shustoke,
Coleshill,
Birmingham,
B46 2AU,
U.K.



A glossary of terms used to describe phasmids

P.E. Bragg, 51 Longfield Lane, Ilkeston, Derbyshire, DE7 4DX, U.K.

Abstract

A brief glossary of descriptive terms used for external morphology of phasmids, including synonyms. Particular attention is paid to terms which are specific to phasmids or are used in a restricted sense when applied to phasmids. Some features are illustrated.

Key words

Phasmida, Glossary, Terminology, Morphology.

Introduction

I have received several requests for an article explaining the terminology that is used in descriptions of phasmids. For those without access to a good entomological dictionary, or a morphological textbook, the terminology can be confusing. In the past, authors have used terminology from various sources when describing phasmids, and although many terms have a meaning which applies equally to any insect, some terms have a specific or restricted meaning when applied to phasmids. Generally authors have used terminology which is usually applied to Orthoptera, but the structures may differ from those in Phasmida. Some terms are used differently by different authors (e.g. use of the word *wing* is often restricted to the hindwing, with *elytron* being used for the forewing, but some people use *wing* for both hindwing and forewing. To avoid confusion in this particular case it is best if *elytron* and *hindwing* are used, and the term *wing* avoided whenever possible). Some terms are hyphenated by some authors and not by others, it is best to avoid using unnecessary hyphens: i.e. use *hindwing* or *hind wing* and *mid leg* or *midleg*, but not *hind-wing* or *mid-leg*.

An English language glossary of phasmid terminology has never been published, and some of the terms used in the past have been inadequately defined, or usage has changed. It should be recognised that this article is intended only as a brief guide for those without easy access to more thorough texts. Two of the most widely available texts on morphology are Snodgrass (1935) and Chapman (1982); a very widely available book containing a section on morphology is *A general textbook of entomology* by Imms (various editions, 1925-1994). An illustrated glossary was recently published in French (Lelong, 1996a, 1996b, 1996c).

A number of entomological dictionaries have been published but they are generally not widely available. I have three entomological dictionaries and offer the following comments on them:

The Dictionary of Entomology by N.K. Jardine (1913), Janson & Sons, London; 259 pages.

Very useful, particularly when working with old descriptions, but obviously lacking modern terms. Occasionally available second hand.

A Dictionary of Entomology by A.W. Leftwich (1976), Constable & Company, London; 360 pages; ISBN 0-09-460070-8. This is not a dictionary: it is an entomological encyclopedia which contains many family, generic and common names of insects, and very few descriptive terms. I do not recall ever having used it as a dictionary. Occasionally available second hand.

The Torre-Bueno Glossary of Entomology by S.W. Nichols (1989) New York Entomological Society; 840 pages; ISBN 0-913424-13-7. This is a completely revised edition of *A Glossary of Entomology* by J.R. de la Torre-Bueno (1937); 50 people are credited as editorial contributors. It is invaluable, not only does it clearly define about 16000 terms but it also refers to alternatives and gives the source of the term. This book should still be available from the publishers.

Glossary of morphological terms

The following glossary is intended to include only those terms likely to be used in species descriptions, it excludes most terms which are likely to be found in a general dictionary. Some basic features not in the glossary are illustrated in figure 1. Most of the terms apply to adult insects but a few apply to eggs, for further egg terminology see Sellick (1992). In many cases I have included some explanation with a basic definition. Where alternatives exist they are indicated in square brackets following the definition; I have indicated reasons for my personal preferences. Many terms are of Latin origin: some of these are commonly made plural by the addition of the English endings *s* or *es*, others are used with the Latin plural; where the Latin plural is usually used this is given in brackets.

Terms used for the carinae of the legs, body surfaces, genitalia and the wing venation are discussed in more detail following the alphabetical list.

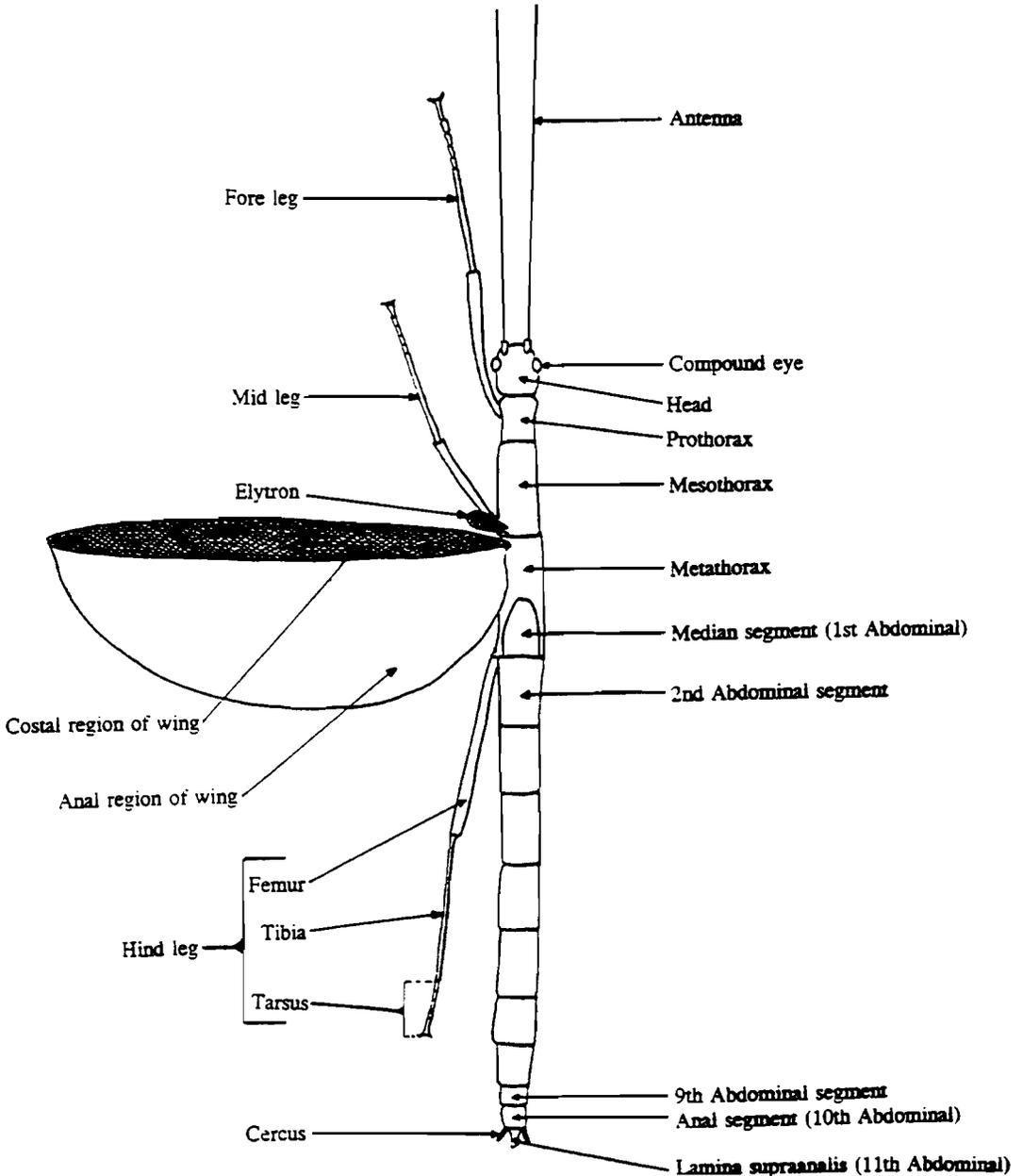


Figure 1. Basic features of a typical phasmid.

- Abdominal segments:** The segments making up the abdomen are numbered from front to back. Traditionally Roman numerals have been used but the use of Arabic numerals is becoming common. The first, tenth and eleventh segments have specific names: Median segment, Anal segment, and Lamina supraanalis.
- Acanthotaxy:** The naming of spines on the body and head. This is particularly useful for members of the Heteropteryginae; spines have been described and illustrated by Rehn & Rehn (1938).
- Ala (Alae):** The hindwing. It is attached to the anterior of the metanotum and is divided into the leathery costal region and the folding anal region. [see Wing]
- Anal process:** A process projecting from, and part of, the anal segment; the processes are usually paired although the two may be of unequal size (e.g. in *Presbistus* spp.).
- Anal region:** The folding part of a phasmid's hindwing. This is often transparent or translucent, and only rarely opaque.
- Anal segment:** The tenth abdominal segment. In most species this is the last full-sized segment, but in females of some species the 11th segment may be large.
- Appendicular ovipositor:** An ovipositor formed by elongated ovipositor valves, it projects beyond the end of the abdomen.
- Archedictyon:** A network of non-directional veins in the costal region of the wing or in the elytron. It is these veins which make the elytron and costal region of the hindwing thicker and stiffer than the anal region of the hindwing.
- Areola:** A sunken area on the ventral surface of the apex of the tibiae. This depression is roughly triangular. This feature is used to split phasmids into two groups: the Areolatae which have the sunken area, and the Anareolatae which do not.
- Arolium (Arolia):** A pad between the claws (ungues) of the pretarsus.
- Binnenkörper:** A hard sclerotization found in the genitalia of some female Asciphasmatinae; may protrude from the left side of the operculum; the function is unknown.
- Body length:** The combined length of head, thorax and abdomen, including the operculum. Some authors seem to have excluded the operculum from the body length, so where the operculum extends beyond the end of the anal segment it is preferable to state clearly whether the operculum is included in the body length.
- Capitulum:** A raised structure on the operculum of the egg (not present in all species).
- Carina (Carinae):** A ridge or raised line, typically along the leg, or centre line of the body.
- Cercus (Cerci):** Paired appendages attached to the anal segment. They may project beyond the end of the abdomen or be hidden underneath; in a few cases they are enlarged leaf-like structures.
- Collar:** The part of the capsule of an egg which surrounds the operculum; this is often a narrowing, and occasionally an elongation, of the capsule.
- Costal region:** The anterior portion of the hindwing. This is thickened, opaque, and does not fold; it is the part of the hindwing which is uppermost when the wings are folded.
- Dentate:** See toothed.
- Dorso-anterior carina (carinae):** A carina on the front, upper corner of the femur or tibia.
- Dorso-posterior carina (carinae):** A carina on the back, upper corner of the femur or tibia.
- Elytron (Elytra):** The fore wing. Attached to the posterior of the mesonotum. [Tegmen].
- Foramen:** see Pronotal foramen.
- Gonapophysis (Gonapophyses):** Appendages on the female's abdomen which are usually hidden by the operculum, but in some species they form part of an appendicular ovipositor and are clearly visible (see fig. 5). [Ovipositor valves].
- Granular:** See Granulose.
- Granulose:** Covered in small granules; generally circular, and height is less than the diameter. [Granular].

- Hindwing:** Attached to the anterior of the metanotum. The term hindwing (or hind wing, or hind-wing) is usually used, the alternative, *ala*, is rarely used. [See Wing, Costal region, Anal region].
- Lamella (Lamellae):** A thin sheet. Often used to refer to a thin sheet or lobe along the carina of a leg, typically running the whole length of the femur or tibia (frequently found in Lonchodinae).
- Lamina subgenitalis:** The plate covering the genital opening. Rather an out-dated term. [Subgenital plate; Operculum of female; Poculum of male].
- Lamina supraanalis:** The 11th tergite (11th dorsal abdominal segment); absent in males but can be seen in some females, it may be quite long but is more often minute or absent. [Supra-anal plate].
- Median segment:** The first abdominal segment. This is fused with the metanotum to varying degrees, in some instances it is indistinguishable.
- Median sternite:** The sternite of the median segment (indistinguishably fused with the metasternum in most cases).
- Median transverse groove:** A indentation running across the pronotum, usually more or less in the middle; it is particularly noticeable in some groups, e.g. *Dares*, but in many groups can only be seen with magnification. It marks the position of the sulcus, the joint between the two plates which make up the pronotum. Sometimes just referred to as the sulcus.
- Medio-ventral carina (carinae):** A carina in the middle of the ventral face of the femur or tibia.
- Mesonotum:** The upper surface of the mesothorax.
- Mesothorax:** The second section of the thorax. The middle legs and elytra are attached to the posterior of this segment.
- Metanotum:** The upper surface of the metathorax.
- Metathorax:** The third section of the thorax. The hindwings are attached to the anterior, and the hind legs to the posterior of this segment.
- Notum:** A tergum of a thoracic segment, i.e. a dorsal plate of the thorax (see pronotum, mesonotum, metanotum).
- Opercular angle:** The angle the operculum of an egg makes with the longitudinal axis. This may be either negative or positive.
- Operculum (Opercula):** Used in two distinct contexts:
- a) The lid of the egg.
 - b) Covering of genital opening of the females (the term has also been used for males by some authors but should be restricted to females; poculum should be used for males). [Lamina subgenitalis; Subgenital plate].
- Ovipositor:** A device for egg laying, found in many species which push eggs into soil, cracks or plant tissues. It is formed by either an elongated lamina supraanalis and elongated operculum (an oviscapt); or by elongated valves and the operculum (an appendicular ovipositor).
- Oviscapt:** An ovipositor which is formed by elongation of the operculum (8th sternite) and lamina supraanalis (11th tergite); examples occur in Heteropterygini, Obrimini, some Eurycanthinae, and some Necrosiinae. It is analogous to that found in several Dipteran groups where the oviscapt is formed by a modified 7th sternite and 7th tergite.
- Pectinate:** Comb-like; the term is used to refer to the serrated ungues of Aschiphasmatinae.
- Pleurite(s):** A pleural sclerite, i.e. a lateral plate: one on the side of the body, between the tergum and sternum. They are most commonly seen on the thorax and may be very large and distinct in some groups, e.g. on the thorax of Heteropteryginae.

- Poculum (Pocula):** The covering of the male genital opening; the 9th sternum. Often referred to as the male operculum, but the use of poculum is preferable since it cannot be confused with the female operculum. [Lamina subgenitalis; Subgenital plate].
- Polar body:** A mound on the egg at the opposite end to the operculum.
- Praeopercular organ:** An organ on the 7th sternite of females, used during copulation. It is usually composed of one or more bumps, ridges or flaps. It is not present in all species. [Preopercular organ].
- Preopercular organ:** See praeopercular organ.
- Pretarsus:** The distal segment of the tarsus, i.e. the claws (ungues) and arolium at the end of the 5th tarsomere (3rd tarsomere in *Timema*).
- Pronotal foramen:** A distinctive opening on the anterior of the pronotum, used as a diagnostic character of the tribes of Heteropteryginae (Rehn & Rehn, 1938).
- Pronotum:** The upper surface of the prothorax.
- Prothorax:** The first segment of the thorax. The fore legs are attached to this segment.
- Punctate:** Covered with many small pits (used in description of the surface structure of eggs).
- Rugose:** Wrinkled; covered in small ridges.
- Rugulose:** Minutely rugose; finely wrinkled.
- Scabrous (or Scabrose):** Rough; irregularly and roughly rugose; possessing short sharp projections or wrinkles.
- Sclerite:** A hard plate of the body. These may be given more precise names depending on where they are on the body, i.e. tergite, sternite.
- Setose:** Covered in setae; covered in stiff hairs.
- Sternite:** A ventral plate; a hardened plate which makes up part (or all) of a sternum.
- Sternopleurite:** A lateral plate on the ventral surface of the body, these are rarely evident externally.
- Sternum (Sterna):** The ventral part of a segment, including sternites and sternopleurites. Often sternopleurites are not evident, in which case the sternum may consist of a single sternite.
- Subgenital plate:** A plate covering the genital area. [Lamina subgenitalis; Operculum, Poculum].
- Supra-anal plate:** The 11th abdominal segment. [Lamina supraanalis].
- Tarsomere:** A segment of the tarsus. There are five segments in all phasmids except *Timema* which have only three.
- Tegmen (Tegmina):** The fore wing. Use of this term appears to have decreased, with a corresponding increase in the term elytron in recent years.
- Tergite:** A dorsal sclerite; a hardened plate on the dorsal surface of the body which makes up part (or all) of a tergum.
- Tergum (Terga):** The dorsal part of any segment. Although the term applies to all segments, notum is often used to refer to the thoracic terga.
- Tooth:** A tubercle in which the height is greater than the diameter; a short blunt spine.
- Toothed:** Bearing numerous teeth. [Dentate].
- Tuberculate:** Covered in tubercles. Finely tuberculate is generally considered the next stage after granulose i.e. more strongly projecting than granulose.
- Tubercule:** A blunt or irregularly topped structure, not pointed like a spine; usually small but the term is also used to refer to large wart-like structures; often of an irregular shape. (See also Tooth and Verrucose).
- Ungues:** The claws of the pretarsus.

Ventro-anterior carina (carinae): A carina on the front, underside corner of the femur or tibia.

Ventro-posterior carina (carinae): A carina on the back, underside corner of the femur or tibia.

Verrucose: Covered in irregularly shaped lobes or wart-like protuberances.

Vomer: A moveable sclerotization on the 10th abdominal sternum of the male, usually more or less triangular in shape; used during copulation. [Vomer subanalis].

Vomer subanalis: See Vomer.

Wing: The terms elytron or tegmen are almost always used when referring to the forewing of a phasmid. The term hindwing is usually used in preference to ala. If the term *wing* is used on its own it usually refers to the hindwing since in most phasmids the forewing is relatively insignificant. [See Elytron, Tegmen, Ala, Hindwing]

The carinae of the legs

The surfaces and carinae of the legs are named on the following basis: with the leg extended at right angles to the body, the upper surface is *dorsal*, lower surface is *ventral*, forward facing surface is *anterior*, backward facing surface is *posterior*. Thus the four main carinae are named: *dorso-anterior*, *ventro-anterior*, *dorso-posterior*, and *ventro-posterior*. A carina between any of these carinae is termed a *median* carina and named according to the face on which it is located, e.g. *medio-ventral*.

Some authors have used *outer* for dorsal, and *inner* for ventral: based on the flexed leg. Since inner and outer could also be confused with inner meaning towards the body and outer away from the body, it is best to avoid these terms.

Descriptions of surfaces

Surfaces are described using the following terms (in order of ascending roughness): *Smooth*, *Rugulose*, *Rugose*, *Scabrous*, *Verrucose*; these terms are used when the whole surface is more or less uniform. The terms *Granulose* and *Tuberculate* are also used to describe surfaces, with *granulose* indicating an even covering of rounded granules, and *tuberculate* indicating a surface with some rough projections which may range from sharp granules to isolated verrucose structures; there is an overlap between tuberculate and scabrous and verrucose but the latter two terms are used only if the whole surface is covered in irregularities, a tuberculate surface clearly has flat areas between the individual tubercles.

Individual projections are referred to using the terms *Granule*, *Tubercule*, *Tooth*, *Spine*. Sizes of spines present a problem because what one person considers small another may consider large. Generally spine sizes are given relative to the other spines on the body. The general nature of the genus, tribe or family group under consideration will influence the terms used: a spine termed minute in the very spinose Heteropteryginae may be rated medium in a species of a relatively spineless group such as Aschiphasmatinae. To try to be consistent, I use the following as a rough guide for my own descriptions: *minute* (microscopic); *small* (just visible to the naked eye); *medium* (clearly visible); *large* (very obvious); *very large*, and *extremely large* (usually at least as high as the body).

Wing venation

Ragge (1955) surveyed the wing venation of the Phasmida, and applied the Comstock-Needham terminology to the veins. Hamilton, in his study of insect wing venation (Hamilton, 1971; 1972a; 1972b; 1972c) states that the radial and sector are fused and that Ragge had been unaware of this and had therefore used the wrong terms for a number of the veins. Table 1 gives the equivalent terms used by Ragge and Hamilton.

The areas of the wing are named after the vein immediately anterior to the area, i.e. the area behind the subcostal vein is the subcostal area, that behind the radial vein is the radial area, etc. The main use of wing venation in phasmid descriptions is to name areas of the wing for the purpose of describing the wing coloration.

The elytron of phasmids is usually reduced to a rudimentary flap, or is absent. In species which have reduced wings, the wings and elytra may be of similar size and the elytron may be much wider than the costal region of the wing.

The hind wings are divided into two distinct regions, the costal region and the anal region. The costal region extends from the costal vein to about the empusal vein, and is thickened and usually coloured. The radial vein is usually very obvious as the main vein of the costal region. The anal region is thin, folding, and usually either colourless or translucent, but in some species the anal region is strongly coloured. The anal veins arise from two distinct points and form two sets, A_{1-6} , and A_7 onwards; the exact number of anal veins in a species is difficult to assess without fully spreading the wing which usually necessitates removing it.

The Phylliidae are atypical phasmids: in females the elytra are large while the wings are absent; in males the wings and elytra are similar to typical phasmids except that the costal region of the wing is not coloured.

Ragge (1955)		Hamilton (1971-72)	
Costa	C	Costa	C
Subcosta	Sc	Subcosta	Sc
Radial	R	Radial	R
		Sector (fused to R)	S
Radial sector	Rs	Media	M
Media (anterior)	M_A	Cubitus	Cu_1
Media (posterior)	M_p	Cubitus	Cu_2
Cubitus	Cu	Plical	P
First anal	A_1	Empusal	E
Anal	A_{2-7}	Anal	A_{1-6}

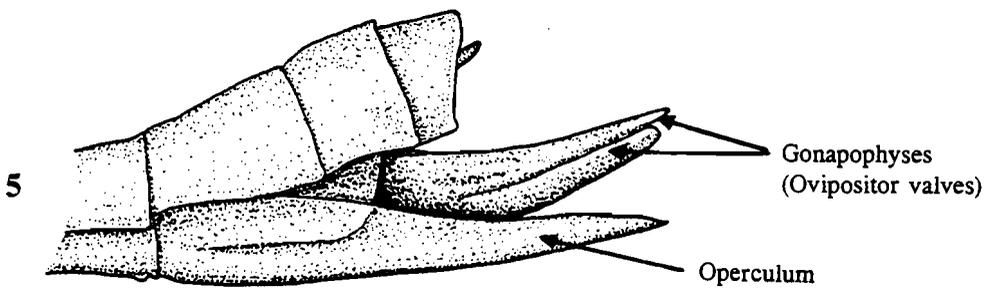
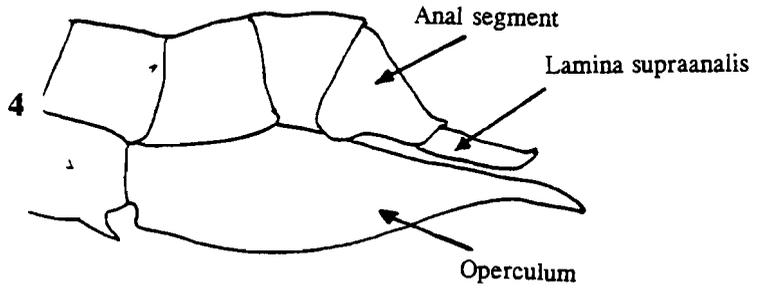
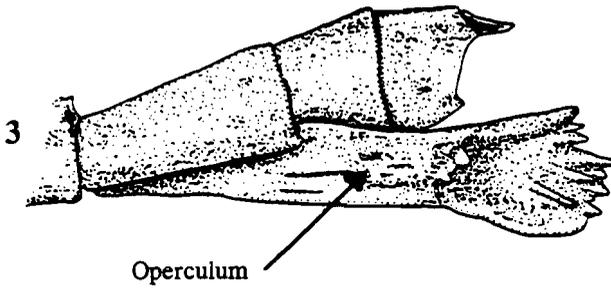
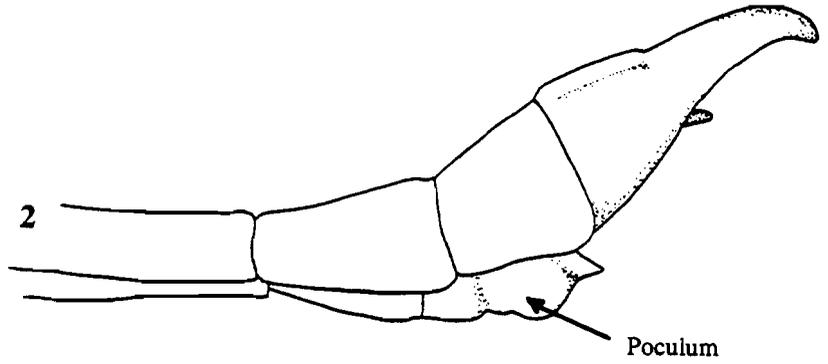
Table 1 Equivalent names used for veins by Ragge and Hamilton.

External genitalia of phasmids

Two features of the genitalia: the praeopercular organ of females, and the vomer of males, are unique to Phasmida, although they are not found throughout the order. The male genitalia was discussed by Snodgrass in his review of the genitalia of Orthopteroid insects (Snodgrass, 1937), but phasmids were not mentioned by Scudder in his paper on the comparative morphology of the insect ovipositor (Scudder, 1961). Günther (1970) in Tuxon's *Taxonomist's glossary of genitalia in insects* makes only a fairly brief mention of the male and female genital anatomy and does not distinguish between the three distinct types of ovipositor.

The anal segment bears a pair of cerci which are typically cylindrical or slightly

conical. The cerci may be straight or incurving and the apex may be smoothly rounded or may bear a small spine. In some species the cerci have a complex shape; leaf-like cerci occur in some groups.



Figures 2-5.

- 2. Poculum.
- 3. Scoop-shaped ovipositor with deep keel.
- 4. Oviscapt.
- 5. Appendicular ovipositor.

Male genitalia

The male genitalia are covered ventrally, and usually also laterally, by the 9th sternum (fig. 2) which has been variously termed the lamina subgenitalis, operculum, and poculum; the 9th sternum is usually divided into two sternites, the posterior of which has been termed the subgenital lobe (Snodgrass, 1937). The term poculum was apparently first used by Key (1970) for just the posterior sternite, but in Nichols (1989), for which Key was an editorial contributor, it refers to the whole of the 9th sternum and I have followed that interpretation here (and elsewhere). Poculum should be used in preference to the alternatives in order to avoid possible confusion with the operculum (8th sternum) of the female.

In some species there is a large sclerotized organ, the vomer, which is pushed into the praeopercular organ of the female. In some species, particularly in Lonchodinae the anal segment is deeply cleft, forming a pair of claspers which are used to grip the female.

Female genitalia

The female genitalia are covered ventrally and laterally by the 8th sternum which has been termed the *lamina subgenitalis* or *subgenital plate*, or *operculum*; the term operculum is now almost invariably used. In some groups e.g. Heteropteryginae, Phasmatidae and Lonchodinae, there is often a structure on the posterior of the 7th sternum which is termed the praeopercular organ and varies from a small hollow, a rounded bump, a spine, to a pair of large leaf-like structures. The praeopercular organ is gripped by the male during copulation and appears to serve as a guide to positioning of the male's genitalia. The internal organs which may be visible externally comprise three pairs of valvulae, or gonapophyses. In some species of the genus *Presbistus* Kirby (Aschiphasmatinae) there is a shiny black sclerotized organ, termed the binnenkörper by Günther (1933; 1970), which may protrude from the right side of the genital opening; the function of this organ is unknown.

There are three distinct forms of ovipositor in Phasmida. The typical form is a scoop-shaped operculum varying in depth from an almost flat plate in some Necrosiinae and Aschiphasmatinae to a deep scoop such as that found in most Lonchodinae; the deep forms often have a distinct ventral or apical keel (fig. 3). The operculum usually reaches almost to the end of the abdomen but in some genera or species it projects well beyond the end.

The second form of ovipositor is the *oviscapt*, formed by elongation of the operculum and the 11th tergite (fig. 4); it is analogous with the structure found in several Dipteran groups formed by a modified 7th sternite and 7th tergite. An oviscapt occurs in some Heteropteryginae, some Eurycanthinae, some Necrosiinae, and in at least one "undescribed" South American genus of Heteronemiinae (Günther, 1970: 60).

The third form, termed an *appendicular ovipositor*, is formed by an elongated and laterally compressed operculum and elongated gonapophyses; it is not homologous with the typical orthopteran appendicular ovipositor which is formed from the gonapophyses alone. An appendicular ovipositor is distinguished by the gonapophyses clearly projecting beyond the anal segment (fig. 5). To be strictly correct the structure found in these phasmids should be termed a semi-appendicular ovipositor because the operculum is not an appendage, but since there are no known phasmids with a truly appendicular form the more convenient term appendicular can be safely applied. An appendicular ovipositor is found in a group of closely related genera of Necrosiinae: *Centrophasma*, *Diardia*, *Diesbachia*, *Galactea*, *Orxines*, *Parastheneboea*.

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Reviews and Abstracts.

Book Review

A guide to the stick and leaf insects of Singapore by Francis Seow-Choen (1997), with foreword by David Rentz. Published by The Singapore Science Centre, Singapore. Softback, 160 pages, 122 colour illustrations, 5 black and white figures (10cm x 15cm). Price S\$5.15. ISBN 981-00-8628-8. Reviewed by Paul D. Brock.

This is an excellent little colour pocket book with an attractive leaf-insect design on the cover, part of a popular, inexpensive series of nature books published by the Singapore Science Centre. Several years ago little was known about phasmids from Singapore, apart from mainly historic records. The author has succeeded in making a thorough survey of the Singapore phasmid fauna, collecting widely and listing previously unrecorded foodplants; no-one has done more to popularise the study of phasmids in Asia.

The book amply succeeds in its aim of educating the public of Singapore, by using some general introductory sections on these fascinating insects e.g. anatomy, functions, defence and reproduction. The main section gives a brief description and notes on each species found in Singapore, with many colour photographs of the adults and eggs (where known), or occasionally sketches. Common names have been used, which should prove popular with non-specialists. All but one of the 40 species included are illustrated (including three species being described in my forthcoming book on the phasmids of Peninsular Malaysia and Singapore).

This book is well printed, with good quality photographic reproductions, which often show insects on their foodplants in nature, at night; rarely featured in previous publications on phasmids. A very short glossary of some terms is included, in addition to notes on phasmid groups and selected references.

To sum up, this excellent, accurate pocket book will be a must for every phasmid enthusiast and should considerably raise interest in phasmids in S.E. Asia, especially as many of the species are also found in Peninsular Malaysia. Individuals living in a warm climate, may even be tempted to build a 'hut' in their garden to keep live insects (as illustrated), alternatively they might venture out at night with torchlight to look for these insects! With so much crammed into this book, the fact that information on the wider distribution of species is not always mentioned is not unreasonable, however, the mention of a number of non-Singaporean species, sometimes without any reference to their distribution, may be confusing to the non specialist. For the benefit of the specialist, there are a few name variations, ignoring those currently in press: *Lonchodes geniculatus* Gray, should not have the author's name in brackets; in the case of *Bacteria ridleyi*, the generic name should read *Bactricia*; *Gargantuoidea phaetusa* (Westwood) is the valid name, rather than *G. gargantua*; *Datames mouhotii* should be spelt as shown, with an extra 'i'; the male of *Planispectrum bengalensis* was described in 1995, and *Presbistus flavicornis* is associated with Singapore from a historic record, but not mentioned.

PSG members interested in obtaining this book, please send s.a.e. for details of price and ordering arrangements to P.D. Brock, "Papillon", 40 Thorndike Road, Slough, SL2 1SR, or await details in the September *PSG Newsletter*. A bulk order will reduce costs considerably.

Phasmid Abstracts

The following abstracts briefly summarise articles which have recently appeared in other publications; also included are publications published since 1992 (the first issue of *Phasmid studies*) which have only recently come to the attention of the editor. Some of these may be available from local libraries. Others will be available in university or college libraries, many of these libraries allow non-members to use their facilities for reference purposes free of charge. In the UK libraries can usually obtain publications which they do not hold by using the inter-library loan system; there is usually a charge for this service. A similar inter-library loan system operates in many other countries.

The editor of *Phasmid Studies* would welcome recent abstracts from authors so that they may be included in forthcoming issues. In the case of publications specialising in phasids, *Phasma* and *Le Monde des Phasmes*, only the longer papers are summarised.

Ali, D.W. & Orchard, I. (1996) Immunohistochemical localization of tyrosine hydroxylase in the ventral nerve cord of the stick insect, *Carausius morosus*, including neurons innervating the salivary glands. *Cell & Tissue Research*, **285**(3): 453-462.

The distribution of tyrosine hydroxylase-like immunoreactive neurons is mapped in the ventral nerve cord of the stick insect, *Carausius morosus*. This study also examines the tyrosine hydroxylase- and serotonin-like immunoreactive elements in the salivary glands of *Carausius morosus*. Tyrosine hydroxylase is the first and rate-limiting enzyme in the pathway for the production of catecholamines; therefore, tyrosine hydroxylase-like immunoreactive neurons are likely to contain catecholamines. Approximately 225 tyrosine hydroxylase-like immunoreactive neurons are present in the ventral nerve cord. The majority of these neurons appear to be interneurons. The suboesophageal ganglion contains the only unpaired neuron and the only pair of peripherally projecting tyrosine hydroxylase-like immunoreactive neurons in the ventral nerve cord. The peripherally projecting neurons project to the salivary glands via the salivary nerve. Each neuron in this pair is termed the salivary neuron 1. The remaining tyrosine hydroxylase-like immunoreactive neurons in the ventral nerve cord are interneurons and exhibit a characteristic distribution within the thoracic and the abdominal ganglia. Serotonin-like immunoreactivity is also present in the salivary glands. Positive staining of the suboesophageal ganglion for serotonin-like immunoreactivity indicates the presence of several neuron pairs including a large pair along the ventral posterior midline that project to the salivary glands via the salivary nerve. Each neuron in this pair is termed the salivary neuron 2. Backfilling of the salivary nerve with cobalt chloride reveals the presence of only two neurons within the suboesophageal ganglion that project to the salivary glands; these neurons are the salivary neurons 1 and 2. Reverse-phase high-performance liquid chromatography coupled with electrochemical detection of ventral nerve cord and salivary gland homogenates confirms the presence of dopamine and serotonin.

Ansorge J. (1996) On the systematic position of *Schesslitzziella haupti* Kuhn 1952 (Insecta: Phasmatodea) from the Upper Liassic of northern Franconia (Germany). *Palaeontologische Zeitschrift*, **70**(3-4): 475-479.

The holotype of *Schesslitzziella haupti* Kuhn, 1952 from the Upper Liassic of northern Franconia is redescribed. The species is considered a representative of the *Chresmodellinae* (Phasmatodea: Aerophasmatidae). *Chresmodella* Bode, 1953 is a younger synonym of *Schesslitzziella* Kuhn, 1952. [In German]

Baessler, D., Bueschges, A., Meditz, S. & Baessler, U. (1996) Correlation between muscle structure and filter characteristics of the muscle-joint system in three orthopteran insect species. *Journal of Experimental Biology*, **199**(10): 2169-2183.

In orthopteran insects, neural networks for joint control exhibit different characteristics due to behavioural specializations. We investigated whether these differences are generated purely by the neuronal networks, or whether characteristics of the muscles or joint architecture (muscle-joint system) are also involved in these behavioural specializations. We compared the properties of the muscle system moving the femur-tibia joint of the middle and hind leg of three species, *Carausius morosus*, *Cuniculina impigra* and *Locusta migratoria*. Four aspects were analyzed for the tibial extensor muscle: (i) the frequency-dependence of motoneuronal activity in response to sinusoidal stimulation of the femoral chordotonal organ (fCO), (ii) the muscle structure, (iii) the innervation pattern of the muscle and (iv) the histochemical properties of the muscle fibres. These aspects were compared with the filter characteristics of the open-loop femur-tibia control system and of the muscle-joint system involved. Whereas in both phasmid species (*Carausius morosus* and *Cuniculina impigra*) the motoneuronal activity steadily increases with sinusoidal stimulation of the fCO in the frequency range 0.01-5Hz, in *Locusta migratoria* there is a decrease in motoneuronal activity between 0.01 and 0.3Hz. The muscle structure is basically similar in all three species, as the number of singly innervated muscle fibres (supplied by the fast extensor tibiae motor neurone, FETi) decreases from proximal to distal. The number of triply innervated fibres supplied by the FETi, the slow extensor tibiae (SETi) and the common inhibitor 1 (CI-1) is maximal in the middle of the muscle, and the number of dually innervated fibres (supplied by SETi, CI-1) increases from proximal to distal. Differences between the locust and the two phasmid species exist in the distal portion of the muscle. The phasmid extensor tibiae muscle contains a morphologically distinct bundle of muscle fibres, not present in the locust, which is mostly dually innervated and which is larger in *Cuniculina impigra*. Similar results were obtained for the histochemical characterization of the muscle fibres as revealed from their staining for myofibrillar ATPase activity. The number of histochemically identified fast fibres decreased from proximal to distal, while the number of slow fibres increased. In *Carausius morosus* and *Locusta migratoria*, the percentage of slow fibres increased by up to 60-70% at the distal end, while this increase was to almost 100% in *Cuniculina impigra*. Apparently, the larger this distal region and the higher the percentage of slow, dually innervated fibres in it, the lower is the upper corner frequency (the stimulus frequency at which the joint control system produces a movement with 70% of its maximal response amplitude) of the muscle-joint system. In summary, it appears that the upper corner frequency of the open-loop system in *Locusta migratoria* (lt 0.05Hz) results at least in part from properties of the neuronal joint control network, but in *Carausius morosus* (0.5-1.0Hz) and *Cuniculina impigra* (0.1-0.2Hz) it results from the upper corner frequency of the muscle-joint system.

Baessler, U. & Stein, W. (1996) Contributions of structure and innervation pattern of the stick insect extensor tibiae muscle to the filter characteristics of the muscle-joint system. *Journal of Experimental Biology*, **199**(10): 2185-2198.

It is shown that the low-pass filter characteristics of the muscle-joint system of the femur-tibia joint of the stick insect *Cuniculina impigra* result from co-contraction of the extensor and flexor tibiae muscles. The most distal region of the extensor muscle, which contains a high percentage of slow muscle fibres, is involved in this co-contraction. This conclusion results from the following evidence. (1) Inertial and friction forces do not affect the characteristics of the low-pass filter of the muscle-joint system. (2) There is some co-contraction of the extensor and flexor muscles during sinusoidal stimulation of the femoral

chordotonal organ at high stimulus frequencies. Both muscles generate tonic forces that increase with increasing stimulus frequency and also increase with time from the beginning of stimulation until a plateau is reached. (3) For the extensor muscle, this tonic force is produced by its most distal portion only. (4) Electrical stimulation of the common inhibitory motoneurone (CI-1) reduces the tonic force generated in this most distal portion of the extensor muscle. Therefore, CI-1 stimulation reduces the amplitude of tibial movement in response to sinusoidal stimulation of the femoral chordotonal organ at stimulus frequencies below 0.5Hz (over this frequency range, the tibial movement amplitude is a function of the force amplitude produced by the whole extensor muscle and there is no co-contraction), but at chordotonal organ stimulus frequencies of 1Hz and above, CI-1 stimulation increases the tibial movement amplitude (in this case, movement amplitude is limited by the degree of cocontraction of the extensor and flexor muscles). With repeated chordotonal organ stimulation at higher stimulus frequencies, the tibial movement amplitude steadily decreases. This must be a consequence of increasing levels of co-contraction of the extensor and flexor muscles, since at low stimulus frequencies (no cocontraction) there is no reduction in movement amplitude during repeated stimulations. It is concluded that co-contraction of the extensor and flexor tibiae muscles prevents instability in the reflex loop in spite of the high gain necessary for the generation of catalepsy. Therefore, the mechanism described can be considered to be an adaptation to the ecological niche occupied by this animal. The contribution of the distal part of the extensor muscle to this system can be switched off by the CI-1 during active movements.

Báez, M. (1996) Nuevas citas de insectos en las Islas Canarias (Phasmatodea, Lepidoptera, Embioptera). *Boletín de la Asociación Española de Entomología*, 20(1-2): 252-253.

In 1926 Bolívar included the Canary Islands in the distribution of *Clonopsis gallica* (Charpentier) but no specific records were published. In 1982 Báez recorded a female phasmid from La Metanza on the island of Tenerife but it was not certain that it was from an established colony, the possibility of it being a casual introduction could not be discounted. In 1994 the author collected two more female specimens from the same locality, confirming this species does occur on Tenerife.

Bland, R.G., Gangwere, S.K. & Morales Martin, M. (1996) An annotated list of the Orthoptera (*sens. lat.*) of the Canary Islands. *Journal of Orthoptera Research*, 5: 159-173.

The distribution of 117 Canary Island orthopteroid species belonging to Orders Blattaria, Mantodea, Orthoptera, and Phasmida are presented based on the authors' collections, museum specimens, and literature since the last list in 1954. The number of species in each order and the percentage endemic to the archipelago are: Blattaria 24 (50%); Mantodea 9 (67%); Orthoptera 83 (37%), and Phasmida 1 (0%). The same for families of Orthoptera follows: Acrididae 41 (41%); Gryllidae 18 (17%); Gryllotalpidae 2 (0%); Pamphagidae 4 (100%); Pyrgomorphidae 1 (0%); Tetrigidae 1 (0%); and Tettigoniidae 16 (44%). *Orthopteroid species diversity and the number of endemics were greatest on Tenerife* (82 species, 24 endemics), followed by Gran Canaria (64 species, 17 endemics), and La Gomera (49 species, 14 endemics); Fuerteventura had the fewest number of species (28) and the lowest number of endemics (5). Tenerife supported the highest number of single-island endemics (8) and La Palma had the lowest (1). The highest percentages of endemics, 27% to 29%, occurred on Tenerife, La Gomera, La Palma, Lanzarote, and Gran Canaria; Fuerteventura had 18% and El Hierro 17%.

New species, changes in nomenclature, and unconfirmed records are discussed, as are taxonomic problems encountered in taxa of the acridid genera *Sphingonotus* and *Acrotylus*.

Chen, S.C. & He, Y.H. (1996) A new species of *Cnipsus* from Yunnan, China (Phasmida: Phasmatidae). *Acta Entomologica Sinica*, **39**(3): 286-288.

This paper describes a new species of the genus *Cnipsus* from Yunnan Province. The type specimen of *Cnipsus colorantis* n.sp. is deposited in the Institute of Zoology, Academia Sinica. All the measurements in descriptions are in millimetres. [In Chinese]

Chen, S.C. & He Y.H. (1996) Description of two species of males of *Parasipyoidea* and *Trachythorax* (Phasmatoidea: Heteronemiidae) unknown before. *Forest Research*, **9**(6): 664-665.

In this paper two new species *Parasipyoidea emeiensis* Chen & He and *Trachythorax fuscocarيناتus* Chen & He are described from males. The specimens are kept in the Insect Collection of Beijing Forestry University. All measurements in descriptions are in mm. [In Chinese]

Doerr, H., Hess, D. & Gramoll, S. (1996) Interstitial voltage and potassium concentration in the mesothoracic ganglion of a stick insect at rest and during neuronal activation. *Journal of Insect Physiology*, **42**(10): 967-974.

In the mesothoracic ganglion of the stick insect *Cuniculina impigra* the interstitial voltage and potassium concentration were measured. The interstitial voltage was measured using conventional glass microelectrodes and had a mean value of +17.6mV (\pm 4.7mV, N = 14 animals). The potassium concentration in the interstitium was measured using ion-selective microelectrodes and had a mean value of 4.3mM (\pm 1.1mM, N = 13 animals). The interstitial voltage and the interstitial potassium concentration changed when the ganglion was superfused with solutions containing different potassium concentrations: in bath solutions containing, e.g. high potassium concentrations, the interstitial voltage increased and the interstitial potassium concentration increased. The interstitial voltage decreased by 1-5mV when neuronal activity was evoked by stimulating a nerve electrically. When an animal was activated by stimulation with a paintbrush, the interstitial voltage decreased by 2.7mV (\pm 1.1mV, N = 3 animals) and the interstitial potassium concentration increased by 0.4mM (\pm 0.2mM, N = 3 animals).

Frantsevich, L.I. (1997) Artfactual motility of the subcoxal axis in a model insect leg with skew joint axes. *Journal of Theoretical Biology*, **184**(3): 271-277.

Kinematic reconstructions of joint angles during walking in stick insects revealed that the subcoxal axis (SCA) was neither firm during the step (it was movable), nor was its position matched to the line between articulation condyles. It has been demonstrated on kinematic models of a leg that the application of a simplified leg model for reconstruction caused an artfactual result: apparent movement of the SCA and its drift from the real firm position. Simplified models assume that the plane where leg segments lie rotates about the SCA or at least the axis of joint rotation is perpendicular to the leg segment. Real legs have joints with non-parallel or non-orthogonal axes. Models considered in this article had an oblique arrangement of joint axes. Real or artfactual motility of SCA is discussed.

Hennemann, F.H. & Conle, O.V. (1996) *Symetriophasma brevitarsa* n.gen., n.sp. - eine neue Phasmide aus Neuguinea (Phasmatoidea: Eurycanthinae). *Entomologische Zeitschrift*, **106**(11): 457-460.

Symetriophasma brevitarsa n.gen. n.sp., a new genus and species of Phasmatoidea from New Guinea, belonging to the subfamily Eurycanthinae, is described and figured. The systematic position of the genus within the subfamily is briefly discussed. A second species,

Trapezaspis echinata Günther, 1936, is also transferred to the new genus.

Hennemann, F.H., Conle, O.V. & Brückner, M. (1996) *Dajaca nigrolineata* n.sp. - eine neue Phasmide aus Myanmar (=Burma), mit Bemerkungen zu dem Genus *Dajaca* Brunner 1893 (Phasmatodea: Phasmatidae: Aschiphasmatinae). *Entomologische Zeitschrift*, **106**(8): 329-335.

A new species of Phasmida - *Dajaca nigrolineata* n.sp. - from Myanmar is described. It is the first non-Bornean representative of the genus *Dajaca* Brunner, 1893. A review of the genus is given, with a key to its species. The new species differs from *D. monilicornis* Redtenbacher in the males being completely wingless. It is nearly related to *D. filiformis* Bragg. The eggs of *D. monilicornis* are described and illustrated for the first time.

Hennemann, F.H. & Conle, O.V. (1997) Die Gattung *Thaumatobactron* Günther, 1929 mit der Beschreibung zwei neuer Arten aus Papua Neuguinea (Phasmatodea, Eurycanthinae). *Mitteilungen aus dem Zoologischen Museum in Berlin*, **73**(1): 175-182.

Two new species of the genus *Thaumatobactron* Günther, 1929 (*T. granulosa* n.sp. and *T. guentheri* n.sp.) from Papua New Guinea are described and figured. A review of the genus and a key to the males is given. Some information on the biology of the species is included.

Hennemann, F.H. & Conle, O.V. (1997) Intraspezifische Variabilität bei *Lonchodes femoratus* (Stoll, 1787) nebst einigen Bemerkungen zu ihrer Synonymie (Phasmatodea: Phasmatidae: Lonchodinae). *Entomologische Zeitschrift*, **107**(1): 30-37.

In this paper the intraspecific variation of the phasmid *Lonchodes femoratus* (Stoll) is discussed and illustrated. The material examined originates in a phasmid collection made by P. Kibler in 1912 from the Key Islands, which is now housed in the collection of the Naturkunde-Museum in Stuttgart (SMNS) and includes 158 females, 7 males and two large female nymphs. The synonymy of the species is discussed and one new synonym (*Prisomera expulsus* Brunner v. W., 1907) is listed, which is said to differ from *L. femoratus* by having a struma on the mesonotum. The eggs are described and illustrated. [Editor's note: The correct name for *L. femoratus* is *Lonchodes foliopeda* (Olivier, 1792) - see *Phasmid Studies*, 4(1): 24 for details.]

Kittmann R., Schmitz J. & Bueschges A. (1996) Premotor interneurons in generation of adaptive leg reflexes and voluntary movements in stick insects. *Journal of Neurobiology*, **31**(4): 512-531.

We investigated the role of local nonspiking interneurons involved in motor control of legs in the stick insect, *Carausius morosus*. In a preparation that allowed the animals to perform active leg movements such as adaptive tactile reflexes, proprioceptive reflexes, and walking, we gathered the following results. Almost all tested nonspiking interneurons that provide synaptic drive onto motoneurons of the proximal leg muscles contribute to all of the motor programs underlying tactile reflexes and voluntary leg movements such as walking, searching, and rocking. Most of them are also involved in the generation of proprioceptive reflexes. All motor programs for coactivation, avoidance reflexes, resistance reflexes, and voluntary leg movements result from parallel pathways including nonspiking interneurons that support and others that oppose the motoneuronal activity. The contribution of a single interneuron to the different motor programs is specific: it can be supporting for one motor program but opposing for the other. Even for the same motor program, for example, coactivation, the contribution of an individual interneuron can depend on the stimulus site

from where the response is elicited. Our results support the idea that the different motor patterns for adaptive tactile reflexes, resistance reflexes, and voluntary leg movements emerge from a multifunctional neuronal circuit that is reorganized corresponding to the motor behaviour performed. The actual motor pattern is then shaped by distributed information processing in parallel supporting and opposing pathways.

Mantovani, B., Tinti, F. Barilani, M. & Scali, V. (1996) Current reproductive isolation between ancestors of natural hybrids in *Bacillus* stick insects (Insecta: Phasmatodea). *Heredity*, **77**(3): 261-268.

Interspecific hybrids raise a variety of developmental, reproductive, and evolutionary issues. In Sicily, geographically and chronologically distinct hybridizations between the highly differentiated *Bacillus rossius* and *B. grandii* have produced hybridogenetic strains and clonal parthenogenetic species. In northern Sicily, all-female populations of facultatively parthenogenetic *B. rossius* and bisexual *B. grandii benazzii* co-occur and we could test their current hybridization through electrophoretic marker analyses; control crosses with allopatric males were also carried out. Hybrid female progeny percentages ranged from 0-74 being fewer in egg batches laid by parthenogenetic mothers than in those of amphimictic females; no difference was noticed between sympatric and allopatric pairs. F2 hybrids of both sexes proved sterile; although some eggs started cleaving, no hemiclinal or clonal progeny hatched, only rare androgenetics being obtained. In currently produced hybrids a complete disruption of gametogenesis occurs, so that genetic constraints between parental taxa appear stronger now than in the past, most likely the result of ancestor evolution.

Seow-Choen, F. (1996) The leaf insects of peninsular Malaysia. *Nature Malaysiana*, **21**(3): 68-73.

A magazine article which briefly reviews the leaf insects known from West Malaysia. The article includes 13 colour photographs of *Phyllium* and one photograph of an egg.

Seow-Choen, F. (1996) A colourful stick insect from Sarawak. *Nature Malaysiana*, **21**(4): 116-119.

A magazine article discussing the brightly coloured stick insect *Dajaca monilicornis* Redtenbacher, 1906; with seven colour photographs. The native foodplant is *Tristania* sp. but *Eucalyptus robusta* is eaten in captivity.

Seow-Choen, F. (1997) The joy of stick-insects. *Singapore Scientist*, **81**: 10-14.

A magazine article with 18 colour photographs of South East Asian phasmids.

Zompro, O. (1997) *Hermarchus leytensis* n.sp., eine neue Phasmide von den Philippinen. *Entomologische Zeitschrift*, **107**(1): 38-40.

A new phasmid (Phasmatodea: Phasmatidae: Phasmatinae: Hermarchini [= Pharnaciini]) from the Philippine island of Leyte and its egg is described and figured. *Hermarchus leytensis* n.sp. is the first member of the genus *Hermarchus* Stål, 1875 recorded from the Philippine islands.

The egg of *Baculofractum insignis* (Brunner)

J.T.C. Sellick, "Montemassi", 31 Regent Street, Kettering, Northants, NN16 8QG, UK.

Abstract

The capitulum of the egg of *Baculofractum insignis* described, and the egg illustrated. The unusual features of the egg are discussed.

Key words

Baculofractum insignis, egg structure.

The genus *Baculofractum* Zompro, 1995 was erected for what was previously *Carausius insignis*. The significant reason for this was the discovery that the male of this species was winged, whereas in *Carausius*, and indeed in the whole of the Lonchodinae in which it was placed, males are apterous. As a consequence the new genus was placed in Necroschiinae.

Zompro (1995) described both the male and the egg of this species for the first time. However the egg was illustrated only by a lateral black-and-white photograph. Both description and photograph lack the capitulum of this egg. Zompro's description (translated from the German) is:— "Dimensions (average of five eggs): length 4.4mm, width 2.95mm, height 3.75mm. Dark brown; round, laterally bevelled, surface with more or less round depressions that are enclosed by very short-bristly raised areas. Micropylar plate darker, raised above the egg surface, laterally widened at the level of the micropyle. Operculum flat, with a conical projection."

It can be seen from Fig. 1 that this is accurate, as far as it goes. The bristles are indeed very short (around 0.01mm long) and difficult to detect. Zompro suspects that these may be lost in older eggs. I have recently been sent a number of eggs of this species by Wim Potvin, one of which retains its capitulum. Zompro (personal communication, 1997) saw several hundred eggs of this species without finding a single one which retained its capitulum. However the position of the capitulum stalk is clearly visible in those opercula which have

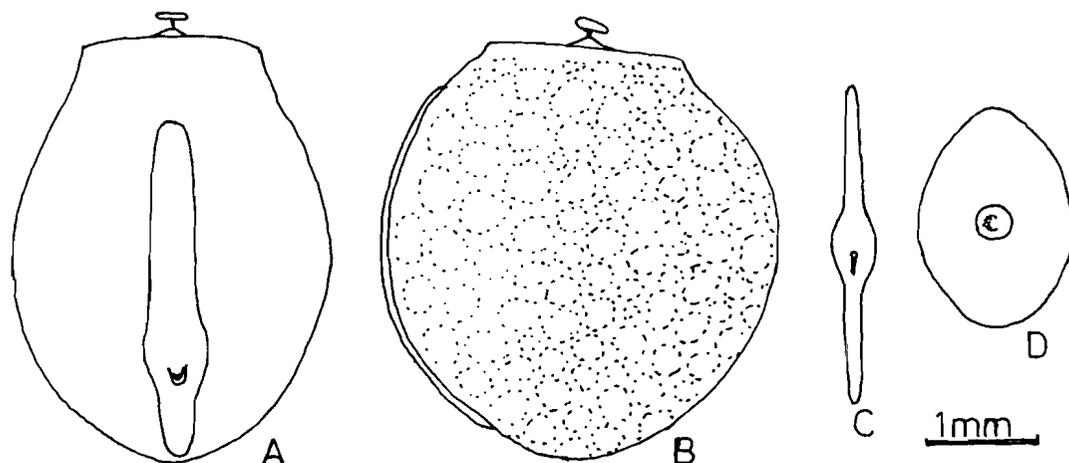


Figure 1. Egg of *Baculofractum insignis*.

A. dorsal; B. lateral; C. internal micropylar plate; D. operculum.
Surface patterning shown on lateral view only.

lost the actual capitulum. Whatever the function of a stalked capitulum, this species shows more than most the fragility of its attachment to the operculum. This capitulum is so far unique in its minute size (0.2mm diameter) and very fine stalk (0.06mm thick). It is pale yellowish-brown and button-shaped with a central depression, very much like a capitulum of a genuine *Carausius*.

The internal micropylar plate follows roughly the outline of the external plate, though narrower, and it is closed. This is the first egg with this type of capitulum that I have found with a closed internal plate. This egg therefore shows a combination of characters from the two subfamilies and is a further indication for the need to reexamine relationships within this family. Stalked button capitula have only previously been found in the Lonchodinae (all of which have open plates with median lines) whilst the closed internal plate most closely resembles that of *Phaenopharos* Kirby, 1904 of the Necrosciinae, though the capitulum of this genus is not stalked.

References

Zompro, O. (1995) *Baculofractum* n.gen. — ein neues Genus der Phasmida. *Entomologische Zeitung*, **105**(24): 488-491.

Phasmid Studies, **6**(2): 41-42. Published January 1998.

A new species of *Phobaeticus* Brunner von Wattenwyl, from the Philippines (Phasmatidae)

Paul D. Brock, "Papillon", 40 Thorndike Road, Slough, SL2 1SR, UK.

Abstract

Phobaeticus lumawigi n.sp. is described from a single female collected from Luzon, Philippines and deposited in the Natural History Museum, London. This species is distinguished from others in the genus by its unusual leg serration. *Pharnacia rigida* Redtenbacher, 1908 is returned to the genus *Pharnacia* Stål, 1877 (from *Phobaeticus* Brunner von Wattenwyl, 1907).

Key words

Phasmida, *Phobaeticus lumawigi* n.sp., Philippines.

Introduction

Mr Ismael Lumawig (Manila, Philippines) recently made an interesting collection of stick-insects from various parts of the Philippines, which have been sent to me for identification; they include several large stick-insects from Mountain Province, North Luzon, all except one identified as *Pharnacia ponderosa* Stål, 1877, type species of *Pharnacia* Stål, 1877. This single female is described as the first *Phobaeticus* Brunner von Wattenwyl, 1907, species to be recorded from the Philippines; other Asian representatives of this genus include the longest known insects. The taxonomy follows that of Brock (1996), which corrected various errors in the literature relating to 'giant' stick-insects, designated a type species for *Phobaeticus* and, in particular, pointed out that *Phobaeticus* includes species with either winged or wingless males; females are always wingless. The genus belongs to the family Phasmatidae, subfamily Phasmatinae.

Phobaeticus Brunner von Wattenwyl, 1907

Phobaeticus Brunner von Wattenwyl, 1907: 194. Type species: *Phobaeticus sobrinus* Brunner von Wattenwyl, 1907: 184, pl. 7.1a (♂), 1b (♀); designated by Brock, 1996: 30 (type locality - Sumatra, Si-Rambé).

Phobaeticus lumawigi n.sp.

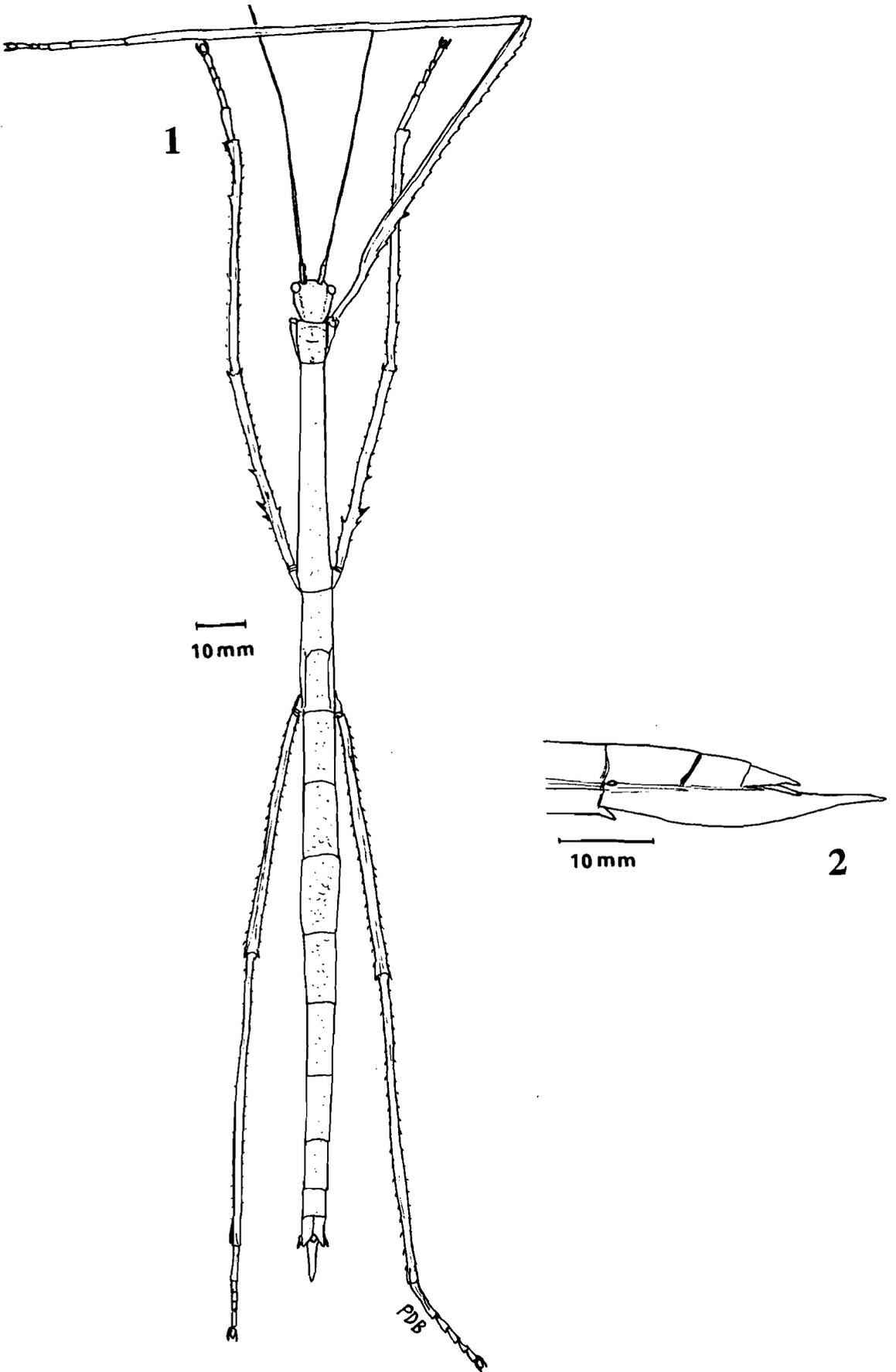
Holotype ♀: Philippines, Mountain Province, North Luzon, VII.1996, leg. I. Lumawig (BMNH, London).

Female: Elongate, completely brown, largely smooth, with serrate legs, including a few larger dentations on upper third of all femora; end of anal segment sharply triangularly incised.

Head: Segment marginally longer than wide, with indistinct dark lines from eyes to back of head. Eyes large, brown. Antennae same shade as body, basal segment long and thin, 2.5 times length of next segment; tips broken off (believed to exceed length of fore femora originally).

Thorax: Pronotum shorter and narrower than head, with a central indentation; viewed laterally, front and hind part of segment are slightly raised. Mesonotum long and slender, almost 6.5 times length of pronotum, and tapered gently towards hind part of segment. Metanotum much shorter than mesonotum.

Abdomen: About same width as thorax; ninth segment only half the length of eighth. Anal segment slightly longer than ninth; with a bold triangular incision, although the extreme margins are rounded and covered with small hairs; a central, rounded extension (the lamina supraanalis) protrudes beneath the incision. Minute hairs present on abdomen, which is otherwise smooth. Cerci medium sized, slender, tapering sharply to an almost pointed tip.



Figures 1 & 2. *Phobaeticus lumawigi* n.sp.
1. Dorsal view. 2. End of abdomen, lateral view.

Operculum long, projecting beyond end of anal segment; rather tapered to a narrow tip. Distal end of underside of seventh segment split into two central, stout pointed extensions.

Legs: Numerous small serrations on femora and tibiae, typical of the genus (but sometimes larger in other species). Ventro-anterior carina of fore femur with a medium sized triangular spine-like lobe four-tenths from base, beneath the regular serrations which are more tooth-like than those on mid and hind femora. Mid and hind femora with large black sub-basal triangular spine-like lobe on dorso-anterior carina, followed by a smaller lobe after a gap of approximately 6mm; a pair of large spine-like lobes are present on the ventral carinae beneath the largest spine (left hind leg has been regenerated and is slightly shorter than normal). Mid tibiae also with a few larger lobes, both apically and basally, and an apical broadened crest at base of dorsal surface; features also present to a lesser degree on hind tibiae. Tarsi long.

Measurements (left fore leg is missing; measurements of hind leg are taken from the right leg): Body length 202mm, head 9mm, antennae 62mm, pronotum 7.5mm, mesonotum 48.5mm, metanotum 14mm (25mm, including first abdominal or median segment). Femora: fore 62mm, mid 46mm, hind 55mm. Tibiae: fore 83mm, mid 50mm, hind 65mm. Operculum 30mm, cerci 3mm.

Etymology: Named after the collector Ismael Lumawig, in recognition of his considerable recent efforts and enthusiasm in collecting stick-insects, despite the presence of venomous snakes in some localities!

Discussion

This insect, the first *Phobaeticus* species recorded from the Philippines, may be distinguished from other taxa by the unusual spine formation on its legs. In the absence of a male, it is not clear with which "group" within the genus this species is closely linked i.e. those with winged or wingless males. The egg is not known, but the adult morphology is sufficient to readily distinguish *Pharnacia* from *Phobaeticus*. I am aware of a current study placing considerable importance on eggs in *Phobaeticus* and related taxa; however, whilst the study of eggs may assist in distinguishing closely related taxa, variation of eggs within a genus can sometimes be striking and until the eggs of a number of species are known, it does not appear practical to draw meaningful conclusions.

Since publication of my 1996 paper (which includes listings of *Pharnacia* and *Phobaeticus* species), I have been able to examine type material in the Naturhistorisches Museum Wien; as a result, I here reinstate *Pharnacia rigida* Redtenbacher, 1908: 453 (holotype locality - Sumatra: Mt Battak) in the genus *Pharnacia* (automatically transferred to *Phobaeticus* in my 1996 paper). It will undoubtedly be necessary to make further changes, following Brunner von Wattenwyl and Redtenbacher's difficulty in distinguishing between the genera. However, this will require critical examination of all relevant taxa, comparing specimens alongside each other to establish the correct synonymy.

Acknowledgement

I would like to thank Mr Ismael Lumawig for sending the specimen described.

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 Brunner von Wattenwyl, K. (1907) *Die Insektenfamilie der Phasmiden*, 2: 181-338. Verlag Engelmann, Leipzig.
 Redtenbacher, J. (1908) *Die Insektenfamilie der Phasmiden*, 3: 339-576. Verlag Engelmann, Leipzig.
 Stål, C. (1877) Orthoptera nova ex Insulis Philippinis descriptis. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar*, 34(10): 33-58.

Reviews and Abstracts.

Book Reviews

Your First Stick Insect by David Alderton (1997), with photographs by the author, Nick Baker and Paul Brock. Published by TFH Kingdom Books, Waterlooville. Paperback, 33 pages, 28 colour photographs and front cover painting. 21.5cm x 14cm. Price £1.45. ISBN 1-85279-079-2. - Reviewed by Paul D. Brock.

This book is part of a Your First series by TFH/Kingdom Books, which are designed to provide clear, practical information, with full colour illustrations throughout; incredible bargains at £1.45 each.

David Alderton will be known to many phasmid rearers for his *Step by Step Guide to Stick Insects*, also published by TFH in 1992 - in fact, many of our members joined after learning of the PSG from his book; they would probably otherwise have been unaware of our existence. This new book contains similar sound advice on culturing species. The colour photographs of several species do not, unfortunately, include *Sipyloidea sipyilus* or the male of *Extatosoma tiaratum* (both feature in Alderton's 1992 book). A strikingly beautiful insect is the gynandromorph (part male, part female) *Oreophoetes peruana* on page 17 - my photograph of PSG member Gordon Ramel's insect.

Any phasmid enthusiast will want a copy of this book, which should amply succeed in its aim of helping the beginner. Buy it and wonder how the publishers can produce a book at such an attractive price!

The Ecology of Java and Bali by Tony Whitten, Roehayat Emon Soeriaatmadja & Suraya A. Afiff (1996). Published by Periplus Editions (HK) Ltd. 983 pages, plus 28 pages of colour plates. 16cm x 23.5cm. Price £50.00. ISBN 962-593-072-8. - Reviewed by Phil Bragg.

This excellent book is volume two of *The Ecology of Indonesia Series*. In addition to the colour plates, there are many black and white plates, drawings, maps and diagrams. The book covers all aspects of the ecology of Java and Bali although the coverage of particular groups of fauna, in chapter five, varies greatly because of difficulties obtaining reliable information. This book will undoubtedly provide an essential guide for anyone interested in the ecology of the area. I make no attempt to review the book in detail, except for the section on phasmids.

Stick insects and leaf insects are covered in more detail than most insect groups: on pages 273-277, and there is one colour plate of *Orxines macklottii* at the end of the book. The section on phasmids provides a useful checklist of the 125 species recorded from these two islands and indicates which species are endemic.

Atlas of grasshoppers, crickets and allied insects in Britain and Ireland by E.C.M. Haes & P.T. Harding. (1997) The Stationery Office, London. 61 pages, 295mm x 210mm. Price £15.50. ISBN 0-11-702117-2. - Reviewed by Phil Bragg.

This book gives distribution maps for all the native and naturalised orthopteroid insects in Britain and Ireland. The phasmid section (pages 52-53) gives one map but does not distinguish between the species; the distribution of the different species is discussed on the facing page. The book has an attractive colour cover with photographs of six species of Orthoptera. The price seems excessive for what is little more than an up-date of the maps in *Grasshoppers and allied insects of Great Britain and Ireland* (Marshall & Haes, 1988).

Video Review

Stick & Leaf Insects - A Novice's Guide to Keeping Phasmids. GK Video, price £11.99.
- Reviewed by Paul D. Brock.

PSG members can benefit by ordering direct from GK Video, PO Box 213, Grimsby, DN36 5ZG for a special mail order price of £10, inclusive of postage and packing; please quote your PSG membership number when ordering. Foreign orders will be sent by surface mail.

At last! A well filmed, practical video for the enthusiast, with some beautiful film dealing with phasmid behaviour. This 32 minute film has a commentary by Keith Stiff, who relays an incredible range of information.

I like the practical advice included in sections on moulting, housing, feeding, general care and breeding. The feeding section even includes outdoor filming of obtaining bramble. There is an excellent sequence dealing with the moulting of a male *Extatosoma tiaratum*. My only criticism is that there are so many sequences of species early on that novices may be confused as to which species is being shown, although some insects are named. However, the 'star' performers' particulars are given in more detail at the end of the video.

The Phasmid Study Group is recommended and indeed the 'stars' have been obtained from members, with Roger Reeve and Peter Vice given particular mentions. This video is a must for individuals and schools starting, or thinking of starting, cultures. PSG members will wish to obtain a video even if they are experienced in breeding phasmids; it is worth it just for the footage of *Heteropteryx dilatata*, *Extatosoma tiaratum*, *Orxines macklottii*, and others.

Readers may be interested to know that this video is the second in a series: the first is on tarantulas and the third (in production) will cover mantids.

Phasmid Abstracts

The following abstracts briefly summarise articles which have recently appeared in other publications; also included are publications published since 1992 (the first issue of *Phasmid studies*) which have only recently come to the attention of the editor. Some of these may be available from local libraries. Others will be available in university or college libraries, many of these libraries allow non-members to use their facilities for reference purposes free of charge. In the UK libraries can usually obtain publications which they do not hold by using the inter-library loan system; there is usually a charge for this service. A similar inter-library loan system operates in many other countries.

The editor of *Phasmid Studies* would welcome recent abstracts from authors so that they may be included in forthcoming issues. In the case of publications specialising in phasmids, *Phasma* and *Le Monde des Phasmes*, only the longer papers are summarised.

Arillo, A., Ortuno, V.M. & Nel, A. (1997) Description of an enigmatic insect from Baltic amber. *Bulletin de la Société Entomologique de France*, **102**(1): 11-14.

In this paper an interesting orthopteroid-like insect preserved in Baltic amber is described. The specimen has such peculiar features that the attribution to an order is difficult. A comparison with other amber orthopteroid-like insects is also made.

Bouchard, P., Hsiung, C.C. & Yaylayan, V.A. (1997) Chemical analysis of defense secretions of *Sipyloidea sipyilus* and their potential use as repellents against rats. *Journal of Chemical Ecology*, **23**(8): 2049-2057.

The defensive secretion of *Sipyloidea sipyilus* was analyzed using a GC-MS technique. Five chemicals were identified (diethyl ether, acetic acid, benzaldehyde, limonene, and benzothiazole) and mixed in about the same ratio as detected in the secretion to determine the potential effectiveness of such a mixture as a repellent against lab rats.

Brock, P.D. (1997) The jungle nymph, *Heteropteryx dilatata* (Parkinson). *Bulletin of the Amateur Entomologists' Society*, **56**(412): 109-112, plates 97K & 97L.

Some general notes on *Heteropteryx dilatata*, with four colour photographs.

Brock, P.D. (1997) Magnificent Malaysian insects. *Bulletin of the Amateur Entomologists' Society*, **56**(413): 135-136, plates 97M & 97N.

The author briefly discusses various insects found on a trip to Sarawak and Peninsular Malaysia. There are colour photographs of three phasmids: a female *Lonchodes strumosus* (Brunner), a female *Acacus sarawacus* (Westwood), and a male of a new species of *Anarchodes* from Fraser's Hill, Peninsular Malaysia. The article includes photographs of other insects and a general view of Fraser's Hill.

Brock, P.D. (1997) Breeding the stick-insect *Phasma gigas* (L.) from Papua, New Guinea. *Bulletin of the Amateur Entomologists' Society*, **56**(414): 181-184, plates 1-4.

Brief comments on rearing *Phasma gigas*, with some historical notes. Figure 1 shows lateral and dorsal views of the egg [with labels transposed]. The plates are black and white photographs of the adults.

Clark Sellick, J.T. (1997) Descriptive terminology of the phasmid egg capsule, with an extended key to the phasmid genera based on egg structure. *Systematic Entomology*, **22**: 97-122.

An attempt is made to standardize further the descriptive terminology of the phasmid egg capsule by introducing stricter definitions and standard abbreviations. In addition, the various forms of the internal micropylar plate are categorized. *Eophasma* Sellick is replaced by *Eophasmodes* nov.n. A key to 131 generic forms of these eggs is provided. Where more than one egg form is associated with a genus, a diagnosis of the subgroups is provided.

Fausto, A.M., Mazzini, M., Cecchetti, A. & Giorgi, F. (1997) The yolk sac in late embryonic development of the stick insect *Carausius morosus* (Br.). *Tissue & Cell*, **29**(3): 257-266.

Differentiation of the yolk sac was examined ultrastructurally and cytochemically in late embryonic development of the stick insect *Carausius morosus*. During migration along the yolk sac, endodermal cells form a discontinuous cell epithelium, leaving wide intercellular channels between neighbouring cell clusters. Within the same cell cluster, cells are all joined by septate junctions. In the proximity of the proctodeum region, intercellular channels are filled with numerous cell debris which are shown to derive from vitellophages undergoing cell lysis. Yolk sacs resolved by gel electrophoresis are shown to release a number of vitellin polypeptides into the culture medium. These are equivalent in molecular weight to those present in the vitellophage yolk granules. This observation is consistent with the evidence that the basement lamina may act as a coarse physical filter, retaining particles larger than colloidal thorium dioxide and allowing free percolation of peroxidase. Differentiating

endodermal cells form a microvillar striated border along the apical plasma membrane. A number of vesicular criptae were frequently seen in these differentiating endodermal cells. Electron dense granules released by endodermal cells are suggested to play a role in vitellophage lysis and vitellin release from the enclosed yolk granules.

Frantsevich, L. & Cruse, H. (1997) The stick insect, *Obrimus asperrimus* (Phasmida, Bacillidae) walking on different surfaces. *Journal of Insect Physiology*, **43**(5): 447-455.

Unrestrained adult stick insects (*Obrimus asperrimus*) walked below a tread wheel 4 or 30 mm wide in the upside-down position or above a 'bridge' 30 or 60 cm wide in the upright position. They were recorded on video and the positions of reference points on the legs and on the body were measured on still frames. Step parameters such as step amplitude, step duration, swing duration, body height and ground width are given for broad and narrow footing as well as for leg trajectories and the course of leg joint angles. Joint angles were calculated directly between the leg segment vectors. Walking with a narrow footing, the stick insect used the same slow metachronal gait as on a broad footing. Adjustment to the narrow footing was accomplished by narrowing the ground base, raising the body distance, depressing the femora (by 40-45°) and flexing the tibiae (20-25° in the front and middle legs). The upper turning-point of the swing movement seems to be determined by a constant amplitude of the vertical movement component rather than a given position in a body-fixed coordinate system. Walking on a horizontal rod of circular cross-section, the insects preferred to walk upside down below the rod for small diameters, but preferred to walk upright above the rod if its diameter was great enough.

[Editor's note: The species used in this experiment belongs in the genus *Aretaon* Rehn & Rehn, as *Aretaon asperrimus* (Redtenbacher)]

Gade, G., Lorenz, M.W. & Hoffmann, K.H. (1997) Stick insect (*Carausius morosus*; Phasmatodea: Lonchodidae) brain extract contains multiple fractions with allatostatic activity. *European Journal of Entomology*, **94**(3): 361-368.

A first attempt to purify inhibitors of juvenile hormone biosynthesis from extracts of brains of the Indian stick insect, *Carausius morosus*, is reported here. A heterologous bioassay in the cricket, *Gryllus bimaculatus*, was used throughout the study. Separation of a prepurified extract using C-18 reversed phase high performance liquid chromatography (RP-HPLC) resulted in a broad zone with biological activity. Upon re-chromatography of each of six active regions on a wide-pore C-18 column, the material separated in distinct peaks of biologically active fractions. Introducing a third purification step (C-8 column) resulted in a total of 18 absorbency peaks with allatostatic activity. It remains to be seen whether all these fractions contain authentic allatostatins which are active in stick insects, or whether other functions can be attributed to them.

Gorkom, J. van (1997) PSG 174 *Lopaphus caesius* (Redtenbacher). *Phasma*, **7**(26): 18-20.

A report on rearing *Lopaphus caesius* from Vietnam. Measurements and colour photographs are included for both the male and female; the egg is illustrated by a drawing.

Kittmann, R. (1997) Neural mechanisms of adaptive gain control in a joint control loop: Muscle force and motoneuronal activity. *Journal of Experimental Biology*, **200**(9): 1383-1402.

An adaptive gain control system of a proprioceptive feedback system, the femur-tibia control loop, is investigated. It enables the joint control loop to work with a high gain but it prevents instability oscillations. In the inactive stick insect, the realization of specific changes in gain is described for tibial torque, for extensor tibiae muscle force and for

motoneuronal activity. In open-loop experiments, sinusoidal stimuli are applied to the femoral chordotonal organ (fCO). Changes in gain that depend on fCO stimulus parameters (such as amplitude, frequency and repetition rate), are investigated. Furthermore, spontaneous and touch-induced changes in gain that resemble the behavioural state of the animal are described. Changes in gain in motoneurons are always realised as changes in the amplitude of modulation of their discharge frequency. Nevertheless, depending on the stimulus situation, two different mechanisms underlie gain changes in motoneurons. (i) Changes in gain can be based on changes in the strength of the sensorimotor pathways that transmit stimulus-modulated information from the fCO to the motoneurons. (ii) Changes in gain can be based on changes in the mean activity of a motoneuron by means of its spike threshold: when, during the modulation, the discharge of a motoneuron is inhibited for part of the stimulus cycle, then a change in mean activity subsequently causes a change in modulation amplitude and gain. A new neuronal mechanism is described that helps to compensate the low-pass filter characteristics of the muscles by an increased activation, especially by a sharper distribution of spikes in the stimulus cycle at high fCO stimulus frequencies. The work was done with *Carausius morosus*.

Marescalchi, O. & Scali, V. (1997) Chromosomal and NOR patterns in the polyclonal stick insect *Bacillus atticus atticus* (Insecta; Phasmatodea). *Genome*, **40**(2): 261-270.

Bacillus atticus atticus is a complex of thelytokous parthenogens, related to the bisexual *Bacillus grandii*, that ranges from Sardinia to Near Eastern countries. Karyotypic and cytogenetic differentiation of the *B. atticus atticus* diploid unisexual "isolates" is really higher than expected. Its standard karyotype has $2n = 34$ chromosomes, but several instances of repatterned or even aneuploid complements have been found. The number and location of silver-stained NORs are particularly intriguing, since in addition to homozygous NOR patterns, simple or double hemizygous strains are found spread over specific and wide regions. The odd patterns are not due to Ag-NOR staining technique artifacts, since the FISH method, using rDNA probes, apparently labels the same ribosomal clusters. Transpositions and translocations have been suggested to account for some NOR patterns, but hybridizations between different NOR-bearing races are also a possible cause. This chromosomal survey clearly contributes to a better understanding of *B. atticus* phylogeny.

Miksýs, S., Lange, A.B., Orchard, I. & Wong, V. (1997) Localization and neurohemal release of FMRFamide-related peptides in the stick insect *Carausius morosus*. *Peptides (Tarrytown)*, **18**(1): 27-40.

FMRFamide-like immunoreactivity was localized immunohistochemically in the central and stomatogastric nervous systems, visceral tissues, and the neurohaemal corpora cardiaca, transverse, and segmental nerves. Each of these neurohaemal areas contains one morphologically distinct type of immunoreactive neurosecretory granule. The haemolymph level of FMRFamide-like peptides, quantified by RIA, is higher in animals sampled 2 h into the dark cycle, relative to those sampled at mid-light cycle or 9 h into the dark cycle. High potassium depolarization evokes the calcium-dependent release of FMRFamide-like peptides from neurohaemal areas in vitro and HPLC fractionation of haemolymph, corpora cardiaca, and their bathing medium suggests that these organs contribute a single peptide to the FMRFamide-related peptides circulating in the haemolymph of active animals.

Potvin, J. (1997) Eieren van wandelende takken. *Phasma*, **7**(26): 1-9.

Illustrations of the eggs of 104 species of phasmids; showing dorsal views only.

Scapigliati, G., Pecci, M., Piermatei, A. & Mazzini, M. (1997) Characterization of a monoclonal antibody against a 180 kDa hemocyte polypeptide involved in cellular defence reactions of the stick insect *Bacillus rossius*. *Journal of Insect Physiology*, **43**(4): 345-353.

Defence properties of haemocytes were investigated using the anti-haemocyte monoclonal antibody BrH1 obtained by immunizing mice with 2% paraformaldehyde-fixed haemocytes of the stick insect *Bacillus rossius*. In Western blot analysis, the antibody recognized a 180kDa antigen in haemocyte cell lysates, whereas fat body lysates and cell-free haemolymph were negative. In immunofluorescence analysis of cultured or freshly collected haemocytes, BrH1 stained intracellular antigen(s) in detergent-treated cells. Transverse cryosections of adult stick insects probed by immunofluorescence with BrH1 showed in situ the scattered distribution of haemocytes inside the haemocoel. The antigen(s) recognized by BrH1 appears to be involved in cell defence haemocyte-mediated mechanisms, as evidenced by the fact that cryosections of insects challenged in vivo with yeast cells, bacteria, or polystyrene latex particles and probed with BrH1 showed an accumulation of antigen surrounding the injected stimuli.

Sellick, J. (1997) The range of egg capsule morphology within the Phasmatodea and its relevance to the taxonomy of the order. *Italian Journal of Zoology*, **64**: 97-104.

Within the order Phasmatodea there is a basic egg capsule morphology which defines the order. This shows extensive variation in detailed form. Some of this is aberration, which can be recognised and excluded from taxonomic considerations. Much is adaptation to egg-laying techniques and egg survival. Nevertheless the range of egg capsule form both externally and internally is a valuable aid to the classification at sub-ordinal level and below of this group of insects. In particular this confirms the Timematodea as members of the order, confirms the distinct status of Phylliidae and shows some so far undivided groups such as Necroschiidae to be taxonomically very diverse. A new tribe Extatosomatini is proposed for *Extatosoma* Gray on the basis of both egg and adult morphology. A survey of internal micropylar plate types within the order is given.

Viscuso, R., Narcisi, L., Sottile, L. & Giuffrida, A. (1997) Secretory product of the lateral oviducts of *Baculum thaii* Haus. (Phasmida: Phasmatidae) and its change during egg transit. *International Journal of Insect Morphology and Embryology*, **25**(4): 369-379.

The secretory product elaborated by the epithelium of the lateral oviducts of *Baculum thaii* (Phasmida: Phasmatidae) gives rise, in the oviduct lumen, to 2 main structural types: fibrils and granules. The ultrastructural characteristics of the fibrils are uniform throughout the various oviductal zones in both the virgin and mated females. However, the organization of the granules is characteristic of a particular zone, and sometimes different in the same zone, when virgins are compared with mated females. The fibrils accumulate on the chorion of newly ovulated eggs to form a thick, compact sheath outside which the granules converge, undergo rapid and multiple fragmentation, and overlay the fibrillar sheath in an orderly arrangement. The fibrillar and granular components give rise, in both virgin and mated females, to the formation of a sclerotized sheath called extrachorion that is still present in newly laid eggs. The probable role played by these 2 extrachorionic components in relation to the egg is discussed.

Zompro, O. (1996) Beiträge zur Kenntnis philippinischer Phasmiden II. Bemerkungen über philippinische Obriminen, mit einer Neubeschreibung (Phasmatodea: Heteropterygidae: Obriminae). *Entomologische Zeitschrift*, **106**(11): 450-456. [In German]

A new genus and species of Phasmatodea, *Sungaya inexpectata* n.gen., n.sp. and its egg

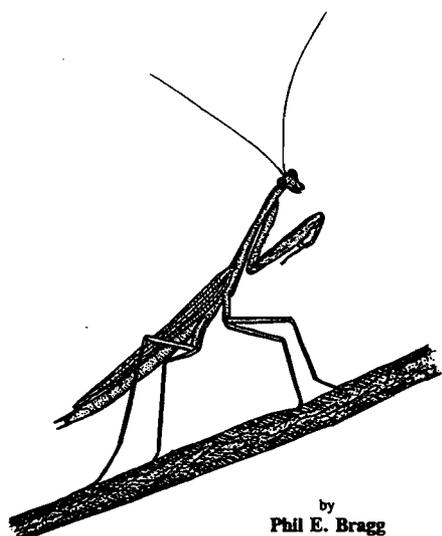
are described from the Philippine island of Luzon. The form of the egg appears to be new for the Obrimini. The male of *Aretaon echinatus* (Stål, 1877) is described for the first time. It is similar to that of *Aretaon asperimus* (Redtenbacher, 1906). Ecological notes on *Stenobrimus bolivari* Redtenbacher, 1906 are included.

Publications noted

The following paper has been noted, but no abstract has been received.

Knutelski, S. & Royaud, A. (1997) *Liparus dirus* Herbst (Coleoptera: Curculionidae) and *Clonopsis gallica* (Charpentier) (Phasmatodea: Bacillidae), two interesting species for the entomofauna of the Pyrenees-Atlantiques Department (France). *Entomologiste*, 53(3): 97-98.

An Introduction to Rearing Praying Mantids



An introduction to Rearing Praying Mantids

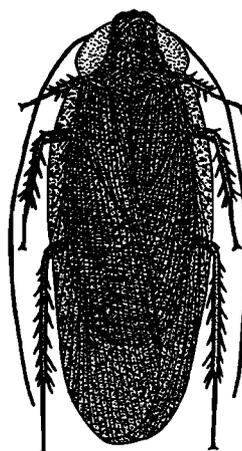
A5 softback, 16 pages, 10 figs. ISBN 0-9531195-0-5. This book describes methods of rearing and breeding praying mantids. The headings include: An introduction to praying mantids, Types of mantids, Structure of mantids, Mantids in captivity, Cages, Feeding, Breeding, Sexing, Mating, Egg laying, Identification, Preserving mantids, Obtaining mantids, Distributing mantids, and Sources of further information.

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An Introduction to Rearing Cockroaches



An introduction to Rearing Cockroaches

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There is a general introduction to cockroaches with information on the structure and different types. The commonly available species are grouped according to general type and their suitability for culturing. Cages, feeding, sexing and preserving are all discussed. There are suggestions on obtaining and distributing cockroaches, and there is a list of books offering further information.