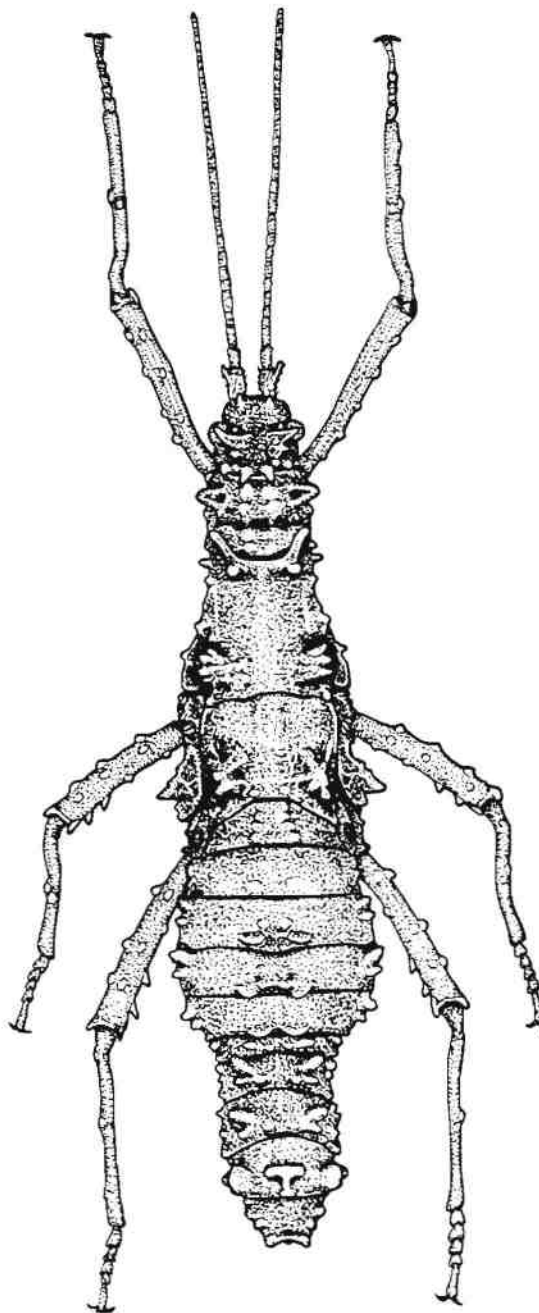
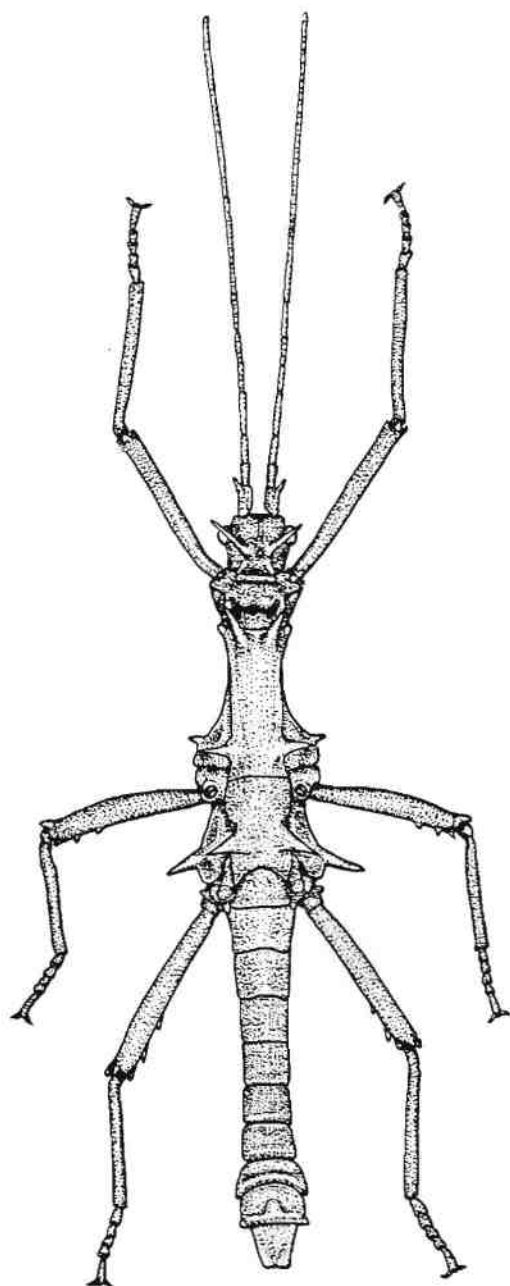


PHASMID STUDIES.

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Phasmids in the Western Australia Museum.

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Key words

Phasmida, Western Australia Museum.

During a visit to Australia in October 1993, I visited the Western Australia Museum in Perth. While I was in the museum I carried out a brief survey of the phasmids in the collection. To put things into perspective it is useful to know a few facts about Western Australia. The area is 2.5 million square kilometres, ie almost the size of western Europe (i.e. excluding the former USSR); the population is 1.59 million, less than most capital cities in Europe. This huge area is served by the Western Australia Museum which has only one entomologist! The Entomology Department consists of Dr. Terry Houston (a bee specialist), with one technician to assist him. The earliest date of any insects in the collection is about 1900, the first entomologist was appointed in the 1950s. The museum relies mainly on material donated by local amateurs, the staff are too busy with other duties to have time to make general collections.

The phasmids are stored in an air conditioned room, in metal cabinets, which contain glass topped metal drawers. The drawers are not very satisfactory, it is difficult to open them. Inside the drawers the insects are housed in unit trays. A total of 15 drawers are occupied by the phasmids. There are no type specimens in the collection, this is not surprising, very very few phasmids have ever been described by people working in Australia; most have been described by foreigners working in Europe.

A quick survey showed a total of 337 specimens which included a number of nymphs. All the material was Australian except for: 3 *Phyllium* sp., 1 *Prisomera* sp., and one unidentified specimen all from Sri Lanka, and one male *Eurycantha horrida* from New Britain. The commonest phasmid in the collection was a species of *Podacanthus*, represented by 41 specimens, adults and nymphs; a quick look showed adults collected in both June and December. A close second was *Tropidoderus* sp., a total of 39 specimens; third was *Eurycnema goliath* (16 specimens); fourth *Onchestrus* sp.; the remaining 226 specimens were unidentified. I was not very surprised when the only phasmids I found in an hour and a half hunt around the cultivated area outside the house in which I was staying were three nymphs, two green and one brown, of *Podacanthus* sp.; as expected they were feeding on eucalyptus.

In the past parts of Australia have suffered serious pest problems with phasmids defoliating eucalyptus forests. However such outbreaks are rare and have not been reported from Western Australia. With only one entomologist for the whole of Western Australia, and a low population, it is not very surprising that the collection is relatively small. Neither is it particularly surprising that so little has been identified, there is no publication available for identification of Australian phasmids except for Brunner (1907) & Redtenbacher's (1906; 1908) joint monograph. There are undoubtedly many undescribed phasmids in Australia, indeed it is likely that there is a larger proportion of undescribed material there than anywhere else in the world, few other places have been so under studied in this respect. Before going to Australia I did a quick survey: in the last 70 years only three new species of phasmids have been described from Australia.

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Redtenbacher, J. (1906) *Die Insektenfamilie der Phasmiden*, volume 1, Leipzig.
Redtenbacher, J. (1908) *Die Insektenfamilie der Phasmiden*, volume 3, Leipzig.

A new (hot) method of collecting stick insects in Australia.

Lyn Lowe & Paul Brock.

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Key words

Phasmida, Collecting, Bush-fire.

Various techniques may be used to locate and collect stick insects in the wild, and to some extent this depends on knowledge of the species of foodplants. It is generally easy to locate stick insects on, or near their foodplants during the day in Europe. This is also possible in Australia. A joint paper on stick insects collected during the day in Kakadu National Park, Northern Territory, Australia, is in progress.

In Peninsular Malaysia, Singapore, and many other tropical countries, finding stick insects in the daytime is uncommon, but they are easily observed by torchlight at night, when they are active. However, collectors such as Michael Yeh (Ipoh, Malaysia), are successful in locating mainly winged species by knocking them from the tree tops, using a net with an extended handle (for further details see Brock, 1992).

Langlois and Lelong (1992) reported blowing air or cigarette smoke over insects, or using a fine humidifying spray in suitable habitats, to reveal the whereabouts of well concealed stick insects. This method was used for all three species found in France.

A new method is reported here.

On the afternoon of 26th May 1994, Graham Brown (Museum and Art Gallery of the Northern Territory, Darwin, Australia) and the authors were collecting in Litchfield National Park, Northern Territory. Graham very kindly arranged the 4WD vehicle and chauffeured the party around. The second author was specifically looking for twig like, grass feeding stick insects known to occur in the area. He, his mother and sister had failed to find a single specimen, despite hours spent in a thorough examination of the vegetation. While returning to Darwin, the first author suggested a search ahead of a scrub fire may be rewarding. Approximately 15km southwest of the Territory Wildlife Park, Berry Springs (which displays a few live grass feeding stick insects), on the gravel section of Wagait Road, just such a roadside fire awaited the party.

The smoke was spreading rapidly through ground cover and mid level vegetation, and numerous insects were moving ahead of the fire front, towards the entomologists. Within minutes it was hotting up and numerous grass feeding stick insect nymphs were walking rapidly towards the road nearby to escape the fire. All individuals collected were of the same species, belonging to the subfamily Lonchodinae, probably of the genus *Hyrtacus*, and common in the Northern Territory.

In addition to stick insects, other insects, winged and brachypterous, were rapidly making their escape. The first author, who has previously used this technique for collecting, found several interesting species of tettigoniid.

To avoid the rapidly approaching flames, the entomologists made a hasty retreat. A photograph of the authors searching for insects, and Graham Brown facing the camera in his "Exterminate" T-shirt, was published in *Myrmecia* (anon, 1994), prompting the editor of the news bulletin to comment that Graham's T-shirt "explained the technique".

Bush fires are a frequent occurrence in many parts of Australia, especially in the monsoonal tropics of northern Australia. Many local volunteer fire brigades burn off dense vegetation, following heavy growth in the wet season, along property boundaries and roadsides to prevent or reduce damage to people and property by uncontrolled fires during the dry season. Other fires may be the result of lighted cigarettes thrown from passing cars.

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The distribution of *Aretaon* in Borneo.

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Key words

Phasmida, *Aretaon*, Distribution, Sarawak, Sabah, Brunei, Borneo.

The distribution of the tribe Obrimini is quite limited; most of the known species are restricted to the Philippines, while some are native to New Guinea, Fiji or Borneo. The only bornean members are a few species of *Hoploclonia* Stål and *Aretaon* Rehn & Rehn. Members of the Obrimini are easily distinguished from other member of the Heteropteryginae which occur in Borneo by the presence of an operculum and the absence of wings. Members of the genus *Aretaon* can be easily distinguished on the basis of size; *Hoploclonia* do not exceed 40mm for males and 55mm for females, *Aretaon* are clearly larger with males at least 45mm and females at least 65mm.

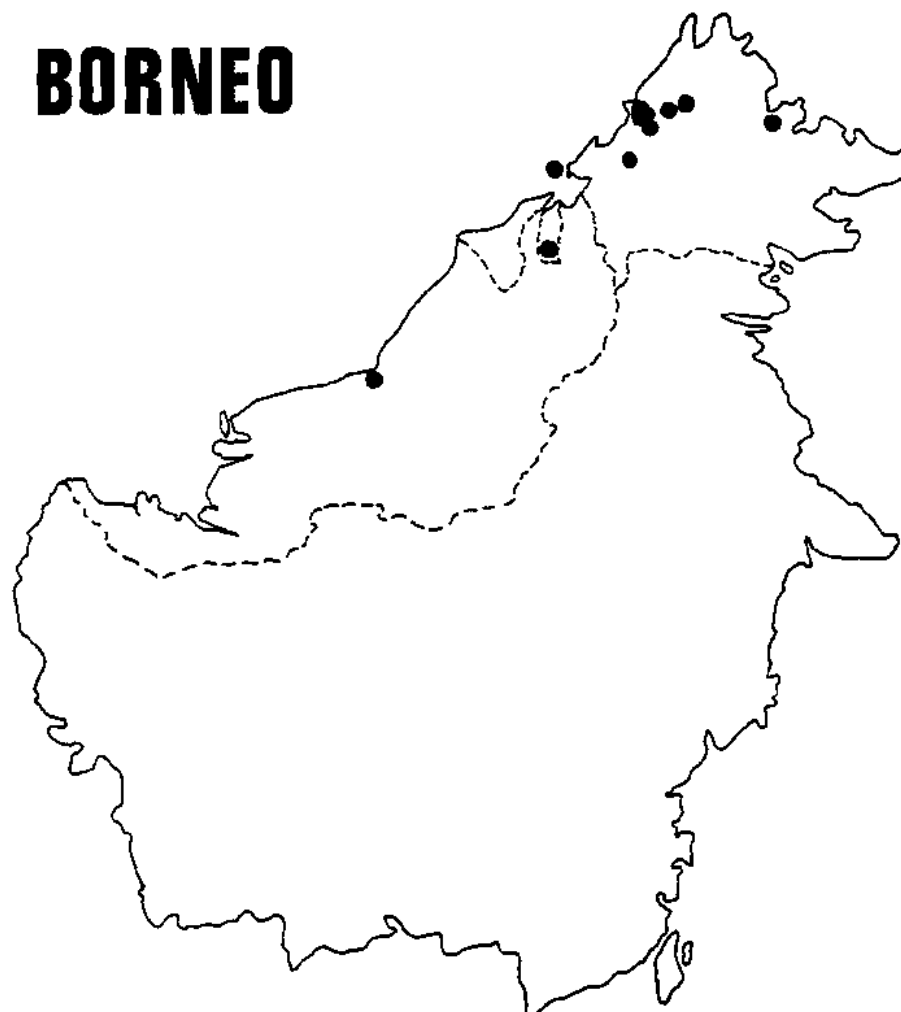


Figure 1. Distribution of *Aretaon* spp. in Borneo.

There are two species of *Aretaon* recorded from Borneo: *A. asperrimus* and *A. muscosus*, whether these are distinct species is doubtful as I have previously discussed (Bragg in Jennings, 1992: 26). The distribution of this genus is of particular interest to me; I have found several thousands of phasmids in Borneo during the past few years, many of them Heteropteryginae, but I have never seen *Aretaon* in Sarawak. Most of my collecting has been done in western Sarawak, about 60 nights ranging from two to ten hours per night. I have spent relatively little time in Brunei and

Sabah but have encountered *Aretaon* in both countries. The only specimen in the Sarawak Museum is from Sabah and a specimen in the Sarawak Forestry Department's collection is from Bintulu in the eastern half of Sarawak. The previously published records from Borneo are for Mt Kinabalu and the island of Labuan (Günther, 1935: 123), both are in the north east. These facts suggested that *Aretaon* may be restricted to the north east of the island.

During a recent visit to Borneo I had the opportunity to examine C.L. Chan's extensive collection of phasmids which are mainly from Sabah. I was interested to see the number of *Aretaon* from different localities, eight in Sabah and one in Brunei. My own records of this species overlap those of Chan's so including the Sarawak F.D. specimen there are eleven known localities, these are indicated on the map (Fig. 1); a number in the region around Kota Kinabalu overlap.

The distribution map emphasises the restricted nature of this genus. The recorded localities are as follows - BRUNEI: Kuala Belalong; SARAWAK: Bintulu Similanjau Forest Reserve; LABUAN; SABAH: Poring Springs, Babaggon, Ulu Dusun, Inanam, Bundu Tuhan, Kampung Madziang, Ulu Mayog, Kimanis logging road in the Crocker Range. The type locality of Mt Kinabalu has been ignored as it is not very specific, the mountain and its foothills covers a large area which includes Poring Springs, a locality which is included.

Another interesting aspect of Chan's collection was the variation in the size and number of spines on specimens, further evidence, although not conclusive, that *A. asperrimus* and *A. muscosus* may be a single species.

References

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A survey of the phasmids held in the collection of the National Museum of Wales, Cathays Park, Cardiff.

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Key words

Phasmida, National Museum of Wales.

The National Museum of Wales was founded in 1907 in order to give Wales the same facilities that had already been granted to Scotland and Ireland. Much of the insect collection is not on display and is housed in the basement. The following list is intended to give a brief overview of the collection to assist students of phasmids to decide whether they need to make use of the collection and to let everyone know what is there.

The insect collection is divided into two sections; British insects and non British insects. In the British insects collection there are 13 specimens of phasmids, 11 of which are identified. As this is not intended to be a comprehensive catalogue and to save space I shall give only the following information: the species (where known), the place and year of collection and the National Museum of Wales accession data. The accession number is created as follows - the name of the donor, NMW (National Museum of Wales), the number of the donation, which starts at zero each year, and for more recent acquisitions a Z is included to denote the item is in the Department of Zoology.

- 1 *Acanthoxyla geisovii*, Tresco, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 2 *Acanthoxyla geisovii*, Tresco, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 3 *Acanthoxyla geisovii*, Tresco, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 4 *Clitarchus hookeri*, Tresco, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 5 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 6 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 7 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 8 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 9 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 10 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 11 *Carausius morosus*, 1940, P.M. Miles Coll. NMW 1989 092 Z
- 12 undetermined. A.F. Amsden Coll. NMW 1980 130 Z
- 13 undetermined. no data

The undetermined specimens appear to be nymphs of *C. morosus*. The *C. morosus* in the P.M. Miles collection have extra data - they were all killed by frost in January 1940.

The non British collection consists of 151 specimens of which 111 are identified at least to genus.

- 1 *Phryganistria sarmentosa*, Northern India, A.E. Gardner Coll. NMW 1976 9 Z
- 2 *Orexines macklottii*, captive bred, London Zoo, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 3 *Staelonchodes* sp. Mt. Kinabalu, Borneo, A.E. Gardner Coll. NMW 1976 9 Z
- 4 *Acanthoxyla prasina*, Rotorua, New Zealand, 1971, A.E. Wade Coll. NMW 1971 38 Z
- 5 *Acanthoxyla prasina*, Rotorua, New Zealand, 1971, A.E. Wade Coll. NMW 1971 38 Z
- 6 *Ctenomorpha tessellata*, Brisbane, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 7 *Ctenomorpha tessellata*, Brisbane, 1955, A.E. Gardner Coll. NMW 1976 9 Z
- 8 *Ctenomorpha tessellata*, Brisbane, 1955, A.E. Gardner Coll. NMW 1976 9 Z
- 9 *Carausius morosus*, captive bred, 1959, A.E. Gardner Coll. NMW 1976 9 Z
- 10 *Carausius morosus*, no data, A.E. Gardner Coll. NMW 1976 9 Z

- 11 *Carausius morosus*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 12 *Acrophylla tessellata*, Cairns, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 13 *Acrophylla tessellata*, Cairns, 1965, A.E. Gardner Coll. NMW 1976 9 Z
- 14 *Acrophylla tessellata*, Cairns, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 15 *Phyllium siccifolium*, no data.
- 16 *Phyllium siccifolium*, no data, R.H.F. Rippon Coll. NMW 1918 93
- 17 *Anisomorpha paromalus*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 18 *Anisomorpha paromalus*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 19 *Anisomorpha paromalus*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 20 *Podacanthus typhon*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 21 undetermined, North Queensland, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 22 undetermined, North Queensland, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 23 undetermined, Botswana, 1969, A.E. Gardner Coll. NMW 1976 9 Z
- 24 undetermined, captive bred, 1972, A.E. Gardner Coll. NMW 1976 9 Z
- 25 undetermined, S. Queensland, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 26 undetermined, S. Queensland, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 27 *Paraphasma rufipes*, captive bred, 1994, S. Clark Coll. NMW Z 1994 073
- 28 *Orexines macklottii*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 29 *Orexines macklottii*, no data, A.E. Gardner Coll. NMW 1976 9 Z
- 30 undetermined, Melbourne, 1958, A.E. Gardner Coll. NMW 1976 9 Z
- 31 undetermined, New South Wales, 1959, A.E. Gardner Coll. NMW 1976 9 Z
- 32 *Echinoclonia exotica*, Sabah, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 33 *Haaniella scabra*, Sabah, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 34 *Ctenomorphodes* sp., Brisbane, 1955, A.E. Gardner Coll. NMW 1976 9 Z
- 35 *Ctenomorphodes* sp., Brisbane, 1955, A.E. Gardner Coll. NMW 1976 9 Z
- 36 Undetermined, no data, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 37 *Ctenomorphodes* sp., Cairns, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 38 *Baculum extradentatum* captive bred, 1969, A.E. Gardner Coll. NMW 1976 9 Z
- 39 *Extatasoma tiaratum*, Cairns, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 40 *Extatasoma tiaratum*, N. Queensland, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 41 *Extatasoma tiaratum*, Cairns, 1968, A.E. Gardner Coll. NMW 1976 9 Z
- 42 *Extatasoma tiaratum*, New Guinea, 1949, A.E. Gardner Coll. NMW 1976 9 Z
- 43 *Extatasoma tiaratum*, Cairns, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 44 *Extatasoma tiaratum*, Brisbane, 1955, A.E. Gardner Coll. NMW 1976 9 Z
- 45 *Extatasoma tiaratum*, N. Queensland, 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 46 *Extatasoma tiaratum*, captive bred, 1981, C. Scurr Coll. NMW Z 1987 029
- 47 *Eurycantha horrida*, New Guinea, A.E. Gardner Coll. NMW 1976 9 Z
- 48 *Eurycantha horrida*, New Guinea, A.E. Gardner Coll. NMW 1976 9 Z
- 49 *Phyllium scythe*, Philippines 1966, A.E. Gardner Coll. NMW 1976 9 Z
- 50 *Phyllium* sp., no data
- 51 *Aplopus jamaicensis*, Jamaica, R.H.F. Rippon Coll. NMW 1918 93
- 52 *Aplopus jamaicensis*, Jamaica, R.H.F. Rippon Coll. NMW 1918 93
- 53 *Damasippus westwoodi*, Costa Rica, R.H.F. Rippon Coll. NMW 1918 93
- 54 undetermined, Brazil, R.H.F. Rippon Coll. NMW 1918 93
- 55 *Carausius morosus*, no data, P.H. Holland Coll. NMW 1921 373
- 56 *Carausius morosus*, no data, P.H. Holland Coll. NMW 1921 373
- 57 *Carausius morosus*, no data, P.H. Holland Coll. NMW 1921 373
- 58 undetermined, Labuan, R.H.F. Rippon Coll. NMW 1918 93
- 59 *Prisopus* sp, Rio San, R.H.F. Rippon Coll. NMW 1918 93

- 60 *Prebistus pilosipes*, Danum Valley, Sabah, 1987, A.H. Kirk-Spriggs NMW Sabah, Borneo) expedition NMW Z 1987 094
- 61 undetermined, Queensland, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 62 undetermined, Cairns, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 63 undetermined, Botswana, 1972, A.E. Gardner Coll. NMW 1976 9 Z
- 64 undetermined, Cairns, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 65 undetermined, Cairns, 1967, A.E. Gardner Coll. NMW 1976 9 Z
- 66 *Kalocorinnis pulchella*, Danum Valley, Sabah, 1987, A.H. Kirk-Spriggs NMW Sabah (Borneo) expedition NMW Z 1987 094
- 67 undetermined, Labuan, Borneo, Rippon Coll. NMW 1918 93
- 68 undetermined, Jamaica, R.H.F. Rippon Coll. NMW 1918 93
- 69 undetermined, Calabar, R.H.F. Rippon Coll. NMW 1918 93
- 70 *Diacanthoidea* sp., Labuan, Borneo, R.H.F. Rippon Coll. NMW 1918 93
- 71 *Neoclides simyra*, East Java, R.H.F. Rippon Coll. NMW 1918 93
- 72 undetermined, Labuan, Borneo, R.H.F. Rippon Coll. NMW 1918 93
- 73 undetermined, Sumatra, R.H.F. Rippon Coll. NMW 1918 93
- 74 undetermined, Costa Rica, R.H.F. Rippon Coll. NMW 1918 93
- 75 undetermined, Ceylon, R.H.F. Rippon Coll. NMW 1918 93
- 76 undetermined, Espirito Santo, Brazil, R.H.F. Rippon Coll. NMW 1918 93
- 77 undetermined, Costa Rica, T.W. Proger Coll. NMW 1932 504
- 78 undetermined, Labuan, Borneo, R.H.F. Rippon Coll. NMW 1918 93
- 79 undetermined, Costa Rica, R.H.F. Rippon Coll. NMW 1918 93
- 80 *Paradiacantha acanthocephala*, Labuan, R.H.F. Rippon Coll. NMW 1918 93
- 81 undetermined, Bahia, R.H.F. Rippon Coll. NMW 1918 93
- 82 undetermined, Bahia, R.H.F. Rippon Coll. NMW 1918 93
- 83 *Diaphemora femorata*, Canada, R.H.F. Rippon Coll. NMW 1918 93
- 84 *Diaphemora femorata*, Calgary, R.H.F. Rippon Coll. NMW 1918 93
- 85 *Diaphemora femorata*, Calgary, R.H.F. Rippon Coll. NMW 1918 93
- 86 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 87 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 88 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 89 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 90 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 91 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 92 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 93 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 94 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 95 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 96 undetermined, no data, R.H.F. Rippon Coll. NMW 1918 93
- 97 undetermined, Jamaica, R.H.F. Rippon Coll. NMW 1918 93
- 98 *Diaphemora femorata*, Toronto, R.H.F. Rippon Coll. NMW 1918 93
- 99 undetermined, no data, R.H.F. Rippon Coll. NMW 1918 93
- 100 undetermined, Labuan, R.H.F. Rippon Coll. NMW 1918 93
- 101 undetermined, Costa Rica, R.H.F. Rippon Coll. NMW 1918 93
- 102 *Sipylodea sipylus*, captive bred 1969, Ay.E. Gardner Coll. NMW 1976 9 Z
- 103 undetermined, Kassia Hills, Assam, R.H.F. Rippon Coll. NMW 1918 93
- 104 undetermined, no data, Viscount Bollingbroke Coll. NMW 1974 62 Z
- 105 undetermined, Hong Kong, M.L. Williams Coll. NMW 1979 152
- 106 undetermined, Hong Kong, M.L. Williams Coll. NMW 1979 152

- 107 undetermined, Hong Kong, M.L. Williams Coll. NMW 1979 152
- 108 undetermined, Malaysia, May Coll. NMW 68 499
- 109 *Sosibia peninsularis*, Malaysia, May Coll. NMW 68 499
- 110 *Calynda* sp., captive bred, 1994, S. Clark Coll. NMW Z 1994 073
- 111 *Lonchodes haematopus*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 112 *Oreophoetes peruana*, captive bred 1994, S. Clark Coll. NMW Z 1994 073
- 113 *Oreophoetes peruana*, captive bred 1994, S. Clark Coll. NMW Z 1994 073
- 114 *Ramulus* sp., captive bred 1994, S. Clark Coll. NMW Z 1994 073
- 115 *Anisomorpha buprestoides*, captive bred 1992, S. Clark Coll. NMW Z 1994 073
- 116 *Aretaon asperrimus*, captive bred 1994, S. Clark Coll. NMW Z 1994 073
- 117 *Eurycantha calcarata*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 118 *Eurycantha calcarata*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 119 *Eurycantha calcarata*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 120 *Eurycantha calcarata*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 121 *Lamponius guerini*, captive bred 1992, S. Clark Coll. NMW Z 1994 073
- 122 *Heteropteryx dilitata*, captive bred 1991, S. Clark Coll. NMW Z 1994 073
- 123 *Heteropteryx dilitata*, captive bred 1993, S. Clark Coll. NMW Z 1994 073
- 124 undetermined, New Zealand 1991, S. Clark Coll. NMW Z 1994 073
- 125 *Paramyronides perakensis*, captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 126 *Paramyronides perakensis*, captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 127 *Paramyronides perakensis*, captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 128 *Phaenopharos* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 129 *Phaenopharos* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 130 *Pharnacia serratipes*, captive bred 1989, P. Bragg Coll. NMW Z 1994 074
- 131 *Sipyloidea* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 132 *Sipyloidea* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 133 *Sipyloidea* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 134 *Sipyloidea sipylus*, captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 135 *Paramyronides* sp., captive bred 1991, P. Bragg Coll. NMW Z 1994 074
- 136 Ova of *Paramyronides* sp., captive bred 1991, P. Bragg Coll. NMW Z 1994 0741
- 137 *Staelonchodes* sp., captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 138 *Carausius sanguineoligatus*, captive bred 1992, P. Bragg Coll. NMW Z 1994 0741
- 139 *Eurycantha* sp., captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 140 *Eurycantha* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 141 *Eurycantha coriacea*, captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 142 *Eurycantha coriacea*, captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 143 *Extatosoma tiaratum*, captive bred 1991, P. Bragg Coll. NMW Z 1994 074
- 144 *Extatosoma tiaratum*, captive bred 1991, P. Bragg Coll. NMW Z 1994 074
- 145 *Ramulus* sp., captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 146 *Oreophoetes peruana*, captive bred 1990, P. Bragg Coll. NMW Z 1994 074
- 147 *Aretaon asperrimus*, captive bred 1992, P. Bragg Coll. NMW Z 1994 074
- 148 *Rhaphiderus scabrosus*, captive bred 1989, P. Bragg Coll. NMW Z 1994 074
- 149 *Rhaphiderus scabrosus*, captive bred 1989, P. Bragg Coll. NMW Z 1994 074
- 150 *Haaniella grayi grayi*, Mt Serapi, Sarawak, Aug. 1991, P. Bragg Coll. NMW Z 1994 074
- 151 *Haaniella grayi grayi*, Mt Serapi, Sarawak, Aug. 1991, P. Bragg Coll. NMW Z 1994 074

There have been four main contributors to the foreign collection, H.F. Rippon, A.E. Gardner, P.E. Bragg and myself. My own contributions, and those of P.E. Bragg, are mainly captive bred stock.

The bulk of the museum's collection was assembled by Gardner and Rippon and left to the museum as bequests in 1976 and 1918 respectively. Both Gardner and Rippon were keen amateur entomologists and the phasmids are only a very small part of their collections. Neither Gardner or Rippon appear to have collected their own phasmids; when specimen data labels are present and complete, a range of collectors are mentioned. Due to old age many of the undetermined specimens from the Rippon collection have deteriorated and may not be identifiable to species with any accuracy.

The collection, although small, shows a wide range of species and most of the common species in culture are well represented. The British collection is missing one species (*Acanthoxyla inermis*). A few undetermined species are on display in a case of mixed insects in the main museum - these have not been included on this list. Access to the collection is via the Department of Zoology at the National Museum of Wales. Telephone 01222 397951.

Type species of phasmid genera with particular reference to the status of *Baculum* Saussure, 1861, *Ramulus* Saussure, 1862, and *Gratidia* Stål, 1875.

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Key words

Phasmida, *Baculum*, *Clitumnus*, *Cuniculina*, *Gratidia*, *Ramulus*, Synonymy, Type species.

Some information which I had previously been unable to check due to difficulties obtaining copies of papers, and a few errors, have come to light concerning my recent check list of type species (Bragg, 1995a). Most are quite straight forward changes and are listed at the end of this paper. However while checking the synonymies of various species for the Phasmid Database, I discovered that both *Ramulus* and *Baculum* had been described earlier than recognised by most authors. The consequences are significant as in both cases the type species are different from those quoted by Kirby (1904) and myself (1995a). In the case of *Ramulus* the current use of the name is incorrect.

Baculum Saussure, 1861

The genus *Baculum* is one of the largest genera in the Phasmida. One of the reasons for this is the accidental synonymising of several genera, this has been partly due to authors being unaware of, or disregarding the type species.

In my recent check list of type species (Bragg, 1995a: 32) *Baculum cunicularis* (Westwood) was given as the type species of *Baculum* Saussure, 1870. The spelling of the specific name was an error (copied from Saussure, 1869), it should have read *B. cuniculus* (Westwood). The publication date for the paper has usually been quoted as 1870, however checking has revealed that the journal was published in two parts, part one in 1869 and part two in 1870; Saussure's paper was in part one so the date on my list should have read 1869. However I have also found that *Baculum* was described before 1869.

In 1861 Saussure (p. 127) described *Baculum* as a subgenus of *Bacillus* Latreille, 1825. He included only one species, *ramosum*, which he described as new; *Baculum ramosum* Saussure is therefore the type species of *Baculum* Saussure, 1861, by monotypy.

In 1869 Saussure (p. 292) again described *Baculum* (still as a subgenus of *Bacillus*) and included *Bacillus cunicularis* Westwood (specific name misspelt) and *Bacillus (Baculum) ramosus* Saussure. In 1904 Kirby selected *Baculum cuniculus* (Westwood) as the type species of "*Baculum* Saussure 1870" (Kirby, 1904: 327). This is a strange selection for Kirby to make, his catalogue clearly shows by the inclusion of the name and reference (Kirby 1904: 329) that he was aware of the earlier publication by Saussure of the name *Baculum ramosum*. All subsequent authors have treated *Baculum cuniculus* (Westwood) as the type species.

In 1875 Stål described many new genera and produced a detailed key to the genera, however he did not include either *Ramulus* or *Baculum*. Stål (1875: 67) included *cuniculus* (Westwood) in his new genus *Clitumnus*, this clearly would have synonymised the genera if *cuniculus* was the type species of *Baculum*. Kirby selected *Phasma (Bacteria) nematodes* de Haan as the type species of *Clitumnus*. Kirby listed the two genera as synonyms (1904: 327) because he mistakenly considered *cuniculus* and *nematodes* to be the type species. However Kirby did synonymise the genera (although not quite as he thought) by including *nematodes* and *ramosus* in the same genus.

Brunner von Wattenwyl (1907) omitted *ramosum* from his monograph. However he included *nematodes* in his new genus *Cuniculina*. Brunner thus synonymised *Cuniculina* with *Clitumnus* Stål; Brunner's use of the name *Clitumnus* was incorrect.

In Saussure's descriptions of *ramosum* both the male (1861: 128) and the female (1869: 294) clearly lack horns on the head. According to Brunner's key (1907: 181) this would place *ramosum* in *Clitumnus* of Brunner (not *Clitumnus* Stål).

Currently *Baculum*, *Cuniculina* and *Clitumnus* are treated as synonymus because this is the way that they were treated by Karny (1923: 235) when he published some corrections to Brunner's work. Although I am not at present disputing this decision by Karny, some of his statements regarding the genera are incorrect. Karny stated that if Brunner's two genera were treated as distinct, a new name would be required for *Clitumnus* of Brunner (not Stål), since Karny was mistaken about the type species involved, this is not the case. *Clitumnus* of Brunner, 1907 should have been referred to as *Baculum* Saussure, 1861. *Cuniculina* of Brunner, 1907 should have been referred to as *Clitumnus* Stål, 1875.

***Ramulus* Saussure, 1862 and *Gratidia* Stål, 1875**

Ramulus Saussure 1862 (p. 471) was originally established as a subgenus of *Bacillus* Latreille, 1825, with *Bacillus (Ramulus) humberti* Saussure 1862 as the type species, by monotypy.

Bacillus (Ramulus) humberti was subsequently synonymised with *Lonchodes pseudoporus* Westwood, 1859 by Saussure (1869: 300). In the same paper Saussure (1869: 291) used the name *Ramulus*, again as a subgenus of *Bacillus*, and included only one species: *Bacillus carinulatus* Saussure, 1868. *Bacillus (Ramulus) carinulatus* (Saussure, 1868) is thus the type species of *Ramulus* Saussure, 1869 (not *Ramulus* Saussure, 1862), by monotypy.

All subsequent authors have treated *Bacillus carinulatus* Saussure as the type species of *Ramulus* Saussure 1869, most seemingly unaware of the earlier usage, examples include: Kirby (1904: 329), Karny (1923: 236), Bragg (1995a: 36). Brock & Shlagman (1994: 104) were aware of the earlier usage, but discounted it dealing with "*Ramulus* Saussure, 1870 [sic]: 291. Type species: *Bacillus carinulatus* Saussure 1868: 63". Subsequent treatments of *B. carinulatus* have placed it in *Baculum* Saussure 1869 (Kirby, 1904: 328), or *Clitumnus* Stål, 1875 (Brunner von Wattenwyl, 1907: 192); *Clitumnus* is a junior synonym of *Baculum* Saussure (Karny, 1923: 235). Thus *Ramulus* Saussure, 1862 (not *Ramulus* Saussure, 1869) is a junior synonym of *Baculum* Saussure, 1861.

Ramulus Saussure, 1869 is not an available name, however *Gratidia* Stål, 1875 is an available synonym, so no replacement name is necessary. In future all species currently regarded as belonging to *Ramulus* 1869 should be referred to *Gratidia*. The tribal name Ramulini should be changed to Gratidiini.

Changes to the list of type species

The following corrections and additions should be made to the list of type species (Bragg 1995a) and to version 1.5 of The Phasmid Database (Bragg, 1995b). For convenience I am including changes caused by the corrections to *Baculum* and *Ramulus* which are explained above.

A. Changes to existing entries:

1. **Cyphocrania* was described by St. Fargeau & Audinet Serville, not just Audinet-Serville, and the date was 1827 (not 1825), the type species was by subsequent designation.
2. **Gratidia* becomes *Gratidia*.
3. The type species of *Aplopus* was described by St. Fargeau & Audinet Serville.
4. *Cladoxerus* was described by St. Fargeau & Audinet-Serville in 1827, with *gracilis* St. Fargeau & Audinet-Serville as the type species, by monotypy.

5. *Epibacillus* becomes **Epibacillus* (synonymised with *Bacillus*).
 6. The type species of *Otraleus* was described by Günther.
 7. The type species of *Parabrosoma* is *bigibbum*, by original designation (not by monotypy).
 8. *Parastheneboea* becomes **Parastheneboea*.
 9. The type species of *Phasma* is *empusa*, by subsequent designation.
 10. *Prisopus* was described by St. Fargeau & Serville in 1827 (not by Latreille in 1825), the type species is *P. sacrata* (Olivier), by subsequent designation.
 10. *Ramulus* Saussure 1870 becomes **Ramulus* Saussure 1869 (a preoccupied name).
 11. *Baculum* Saussure 1870 etc. becomes *Baculum* Saussure, 1861, type species *ramosum* Saussure, by monotypy.
- B. Additional entries to be added to the list:
1. **Hermagoras* Stål, 1875, type species *personatus* (Bates), by subsequent designation (synonymised with *Lonchodes*).
 2. **Ramulus* Saussure, 1862, type species *humberti* Saussure, by monotypy (synonymised with *Baculum*).
 3. **Tisamenus* Stål, 1875, type species *serratorius* Stål, by subsequent designation (synonymised with *Hoplocloia*).
 4. **Xylodus* Saussure, 1859, type species *adumbratus* Saussure, by monotypy (synonymised with *Phibalosoma*).
 5. *Denhama* Werner, 1912, type species *aussa* Werner, by monotypy.

Spellings of generic names

Some of the minor changes above were kindly brought to my attention by Philippe Lelong. He also queried several generic names in species.dbf of The Phasmid Database; although there were a few typing errors and spelling errors on my part, many of queries were cases of spelling errors by the original authors, or in some cases incorrect emendations. These are not listed in the genera.dbf as they were not described as new genera, they are incorrect spellings. The most variable name is *Aschipasma* or *Ascepasma* or *Acepasma* or *Ascephasma* being used for *Aschiphasma*. Perhaps the most potentially confusing incorrect spelling is Kirby's (1896: 457) use of *Hermagenes* instead of *Hermogoras*. Generally spelling errors are quite easy to recognise, however if the error occurs in the first few letters it can be confusing if one is trying to check it on an alphabetical list, as with the use of *Acepasma* for *Aschiphasma*, or *Alopus* for *Aplopus*. The potential problems are greater when using a computer database because the similar spellings will not necessarily appear, depending on the method of searching which is being used. This should be borne in mind when doing searches with The Phasmid Database. Generally a search for the first three or four letters of a name is better than a more specific search as it will display similar names or variations in the spellings.

Publication dates

The date of publication of papers is often difficult to check although it may be essential for identifying the valid name of a species or genus. Journals may produce one volume over a period of several years, this is usually obvious from the volume numbers and the dates. What is less obvious is that journals produced annually are not always numbered so that one volume refers to a calendar year. For example, *Annales de la Société entomologique de France*, series four, volume one is sometimes quoted as 1861, however although the earlier parts were published in 1861, the later parts of this volume which include the pages describing *Ramulus* were actually published on January 22nd 1862. This journal was by no means the only one; also involved in the confusion surrounding *Ramulus* is *Mémoires de la Société de Physique et d'Histoire naturelle de Genève*,

volume 20 was produced in two parts, the first in 1869 and the second in 1870. Saussure described *Ramulus* for the second time in "Mélanges Orthoptérologiques" which was the last paper in the first part of volume 20. As libraries usually have journals bound as complete volumes it is important to check the dates of each part, if possible.

Often more difficult to detect, are cases where for some reason the issue was produced late and therefore not at the time stated on the cover (such as occurred with the last issue of *Phasmid Studies*). Some type species have not yet been included in The Phasmid Database or on the list in the last issue of *Phasmid Studies* because I have been unable to obtain copies of the original publications of old publications, or because I need to check on the dates of publication.

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A survey into the distribution of the stick insects of Britain.

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Key words

Phasmida, *Acanthoxyla geisovii*, *Acanthoxyla inermis*, *Clitarchus hookeri*, Distribution, United Kingdom, Eire.

There are no native stick insects in Britain, but no less than three alien species are now thriving here: The Prickly Stick Insect, *Acanthoxyla geisovii* (Kaup), The Unarmed Stick Insect, *Acanthoxyla inermis* Salmon, and the Smooth Stick Insect, *Clitarchus hookeri* (White). Coincidentally, all are from New Zealand. The principal colonies are found in Cornwall, but there are also a few sites in South Devon, and in South West Ireland.

In 1992, after finding a stick insect in my garden, I undertook a survey into the local population of the Unarmed Stick Insect, the results of which were published in *Phasmid Studies* (Lee, 1993). The following year, I set myself the task of researching into stick insect populations further afield. Initially, the survey was restricted to Cornwall, but, thanks to some national publicity, it covered all the UK, and even a report from Eire.

As anyone who has ever undertaken field research will readily attest, looking for these masters of camouflage in the wild can be extremely frustrating. A far easier way to locate them is to contact those lucky people who have found them in their garden, and this was my approach. Starting with articles requesting sightings in local Cornish newspapers, interest was raised at the West Country daily paper, the *Western Morning News*, which ran a front page story with picture. This led to an article in *BBC Wildlife* magazine, and then national radio, on Radio 4's *Natural History Programme*. The most recent features have been on Westcountry TV's *Wild West Country*, and my local radio station, Radio Cornwall. All this publicity was remarkably successful, with over 80 sightings. These confirmed the recent occurrence at nearly all known locations, identified many new sites, and more than doubled the number of existing UK stick insect reports.

The story of the "British" stick insects is fascinating. The first insect to be recorded was the Prickly Stick Insect, located in Paignton, Devon in 1908, and Tresco, Isles of Scilly in 1943. The Scilly colony may be as old as the Paignton one, since a consignment of New Zealand plants was imported onto Tresco in 1907, and some of these were sent to Paignton the same year. The next species to arrive was the Unarmed Stick Insect which was certainly in Treseder's Truro Nursery in the 1920s, and may have been there somewhat earlier. The Smooth Stick Insect was first recorded on Tresco in the 1940s.

They arrived here on New Zealand plants, most likely as eggs in the soil. There were probably several importations. Apart from those at Tresco and Treseder's, Falmouth insects were traced to an import by Scott's at Merriot, Somerset in the 1970s, where insects were later seen in the nursery. Since those early arrivals, they have now spread throughout the west country, but are still very localised, often restricted to just a few adjacent gardens or streets.

How have flightless insects managed to spread so far? In almost every case, this has been with human help. Their original mode of transport from New Zealand to England by hitching a lift on plants works equally well within the UK. The Victorian founders of Treseder's were responsible for many new plant introductions, particularly from Australasia. Until its closure in the 1980s, this was one of Cornwall's premier nurseries and their plants are found in many west country gardens, both large and small. Several of the colonies seem to have originated via plants from Treseder's nursery. There are undoubtedly others awaiting discovery.

Children are fascinated by these insects and any encountered in the wild are often taken home, which can readily lead to new colonies. This may explain several small colonies near to known sites, and the discrete colonies found in different parts of large towns.

1982 saw a further boost to the Unarmed Stick Insect population, as large numbers of nymphs were distributed to schools and other interested parties throughout the county. These nymphs were raised by a butterfly breeder in Penryn from insects collected in Falmouth. Discarded school insects and eggs have led to many new colonies. My local insects originated this way, and several other colonies date from this time. The only species not to have spread is the Smooth Stick Insect, which is still known only on Tresco, the only colony outside New Zealand.

One unexpected result of the survey has shown that the colour forms exhibited by our insects differ from those in their native New Zealand. All stick insects can be either green or brown, with hatchling nymphs seeming to be all green, and a varying percentage turning brown at moulting. In my local survey, there was an unexpectedly wide variety of brown colour forms, light straw, mahogany red, brown with purple blotches, and all shades in between. After sending colour photos to Professor John Salmon, the New Zealand authority on stick insects, I was very surprised when he confirmed the brown form in New Zealand is always light straw. Further, our mahogany red forms can exhibit rapid colour change, varying from red to pale in half an hour. Professor Salmon has never recorded this in over 40 years of research.

Why the translocation has led to this variation is not certain. Research by the French insect physiologist Marie Raabe on the Laboratory Stick Insect showed that variations in humidity and light levels on early instar nymphs affect the percentages of brown colour forms in adults (Raabe, 1983). Perhaps our moister climate is causing the variation. The differing foodplants may also be working on the insect's hormones. In Port Isaac I have only found mahogany red forms on roses, where they were a perfect match for the autumn stems, and dark straw on bramble where they were almost invisible on the old stems.

The survey results

The following comprehensive list of sites includes both those for which survey reports were received, and those sites appearing in literature, but for which no reports were received. For each site, I have stated the species present, where confirmed (or the most likely, if not), and the earliest record for the location. Where the origin of the colony is not known, I have suggested the most likely source.

The methodology used to get these records is an essentially random process, with the response depending, amongst other things, on the circulation area of the media used to request sightings, the number of gardens within that area which hold stick insects, and the likelihood of a finder bothering to act on the request. To increase the last factor, no locations were mentioned in any of the articles, so people at known sites would be as likely to respond as others. In most locations the reports were clustered within a small area, typically only a few hundred metres across. In view of this random process, such clustering is indicative of a very localised population. In only a few sites were reports spread out, suggesting a more widespread colony.

Many sightings were received of stick insects outside their normal range. In most reports, they spoke of once only sightings. In the absence of any suggestion of insects seen over a period of some years, or several reports from one location, I have treated them as discarded Laboratory Sticks, or other sticks in culture. In some of these cases the species was confirmed, and showed

they were undoubtedly discarded insects from local collectors. Other knowledge may come to light for these one-off reports, so I have listed these separately.

(a) Cornwall

ANGARRACK (SW5838): One report in 1993, confirming *A. geisovii* present in just one garden. Also present in 1994, and into 1995. They originated from a spillage of eggs obtained from St Mawes in 1989. It is possible that a further New Zealand species, *Acanthoxyla prasina* (Westwood), is also present, as the spillage may have contained eggs obtained from a culture kept by a St Mawes enthusiast. One previous report for 1992 (Haes, 1993).

BLISLAND SCHOOL (SX1072): No survey reports. One previous report in 1992, from the school grounds (Lee, 1993). Species present not confirmed, but if, as seems likely, it is *A. inermis*, this undoubtedly came from the Penryn distribution to Cornish schools.

BUDOCK VEAN (SW7527): One survey report in 1993. Two previous reports, the earliest one, in 1990, was recorded by Brock (1991), and the other also by Brock (pers. comm.). All reports are only a few hundred metres apart. In Brock (1991) the species is reported as *A. geisovii*, as advised to Paul Brock by the Cornish Biological Records Unit (CBRU) in a letter received shortly before publication. The record held at CBRU however states it was *A. inermis*. The one survey report was from that same garden, but the owners did not look closely at the insects and were unable to confirm the species. The other Budock Vean report spoke of a nymph of *A. inermis*. In my opinion, all the insects are likely to be *A. inermis*. This location is very close to Helford Passage (q.v.) and the insects could well have originated by natural spread from there.

FALMOUTH (SW7832, SW7931, SW7933, SW8032, SW8033): Insects are widespread in Falmouth, with twelve survey reports throughout the town in 1993 and 1994. The earliest report, in 1981, was in the *West Briton* newspaper (West Briton, 1981b), and there are seven other records in print up to 1992. The species present was confirmed as *A. inermis* by Paul Brock in 1985 (Brock, 1987). A CBRU report in 1992 is shown as *A. geisovii*, but this seems in error. There is likely to have been more than one introduction. A Banksian Rose on which the 1981 insects were found was traced to an import by a Somerset nursery in the mid 1970s, and insects were subsequently found at that nursery (Brock, 1987). Insects have also been found in the Falmouth garden of Neil Treseder, the 84 year old director of the former Truro nursery. He remembers seeing stick insects in the nursery when he was a lad in the 1920s, and his garden, not surprisingly, has plants from the nursery.

There are several discrete colonies in Falmouth. Half of the Falmouth reports are from an area around the 1981 colony, five from north Falmouth, three from a close in west Falmouth, and two others. These separate colonies could well have originated by children finding insects at the known sites and taking them home for subsequent release.

FEOCK (SW8238): Two survey reports in 1993, at one of which the insects had been seen on a patch of Dahlias for "many years", and in the other they were first seen about 15 years ago. Both reports were only a few hundred metres apart. There is one previous report from 1987 (West Briton, 1987). Regarding the species present, the photo in the 1987 newspaper article is clearly *A. geisovii*. However, in one of the survey report gardens, after comparing an actual insect with photographs of the three "British" species, the gardener confirmed it was *A. inermis*, a new location for this species. The origin of *A. inermis* may well have come via Treseder's nursery, as it was reported that the garden was laid out 20-25 years ago, principally with Treseder's plants.

The origin of *A. geisovii* is much more of a mystery, as *A. geisovii* has only been confirmed in Cornwall at Tresco, St Mawes, and at nearby St Just-in-Roseland and Veryan. The newspaper photo is totally convincing, and, from the report, was clearly of the insects found there. After local research, no trace could be found of the owner of that 1987 garden, who may have moved away. Perhaps the colony originated from plants transferred from St Mawes, or another known location. It is to be hoped that this *A. geisovii* colony still persists in small numbers.

GLENDURGAN (SW7727): A new location. One August 1994 report. The species present is confirmed as *A. inermis* from a clear photo supplied with the report. As with the Budock Vean (*q.v.*) site, this colony may have originated by natural spread from the Helford Passage (*q.v.*) colony, although Glendurgan was itself laid out with many New Zealand plants a very long time ago, and some came from Treseder's nursery. As the gardeners have never reported insects before, the likelihood of an early colony remaining undetected does seem remote, but not impossible.

GREAT WORK (SW5930): One 1993 report via Paul Brock, and also recorded in PSG Newsletter (Harman, 1993) as "Helston". Both *A. geisovii* and *A. inermis* have been present in one garden since about 1985, having originated from a spillage of eggs some years ago.

HELFORD PASSAGE (SW7527, SW7626, SW7627): Two survey reports in 1993 and 1994. Three previous reports, the earliest in 1969 (West Briton, 1969). The five reports are well spaced out, and the colony is probably widespread in this sparsely populated area. The presence of *A. inermis* was confirmed by field research in 1987 (Brock 1991). Although this location has been recorded as a site for *A. geisovii* since 1981 (West Briton, 1981a), and in subsequent literature, I think this is in error. The suggestion of *A. geisovii* stems from a clear photo in West Briton (1969). That newspaper report went on to give an explanation from Victor Heath of Riviera Garden, St Mawes (*q.v.*) as to how the insects may have turned up there on plants supplied by him to a customer in Helford Passage. The actual sighting of the 1969 insect was in the previous week's paper, and the photo may have been of one of Mr Heath's own *A. geisovii* insects. In 1969, no records of any Cornish mainland colonies of insects had appeared in print, so Mr Heath may have reasonably concluded that the insect came from his St Mawes stock. The sale of some of his plants to a client in Helford Passage would have made his conclusion seem the more tenable. It is now known that the *A. inermis* colony may well have been present since the 1920s, originating from plants supplied by Treseders (Brock 1991).

MAWNAN SMITH (SW7728, SW7729): Three survey reports in 1993 and 1994, well spaced out within this large village. Two previous reports, the earliest in 1981 appears in Turk (1985). The species present is confirmed as *A. inermis* from a clear photograph accompanying one report. The origin of the colony is uncertain, and, as the earliest report predates the 1982 countywide distribution, may have come from Treseder's plants. One possibility which merits some attention is the proximity of this site to Budock Vean, Glendurgan, and Helford Passage (*q.v.*). Although most stick insect colonies are generally very localised, this whole area may prove to be one widespread colony. Field research in the local countryside will be needed to verify this.

MEVAGISSEY (SX0144, SX0145): Another new location. Six survey reports in 1993 and 1994 show this colony to be widespread in the village. The species present is confirmed as *A. inermis* from a clear photo supplied with one report. The origin of the colony is unclear. The first reports were centred around the school, where the headmistress confirmed that insects have regularly been brought to the school over the last 10 years. This suggested the 1982 countywide distribution as the source. However, the latest report confirms the species was present in 1981, and in a

neighbouring garden from 1977. In this case, they probably originated from Treseder's plants introduced into a local garden.

PENRYN (SX7734, SX7735): Another new location. Four survey reports in 1993 and 1994. The origin of this colony goes back to 1981, when *A. inermis* insects found on a Banksian rose in a Falmouth (*q.v.*) garden were removed and given to a Penryn butterfly breeder. She bred them successfully, and distributed many insects countywide in 1982. Those she could not give away, she released in her garden; although Turk (1985) records that in March 1984 she had no evidence they survived, they clearly did. Three of the reports are clustered around this garden, and one from near the school. This latter report probably came from discarded school insects, undoubtedly from the 1982 distribution. The species present is definitely *A. inermis*.

PORT ISAAC & PORT GAVERNE (SW9980, SX0080): Many survey reports in 1993 and 1994 show this colony is widespread throughout the two adjacent villages. There are two previous reports (Brock, 1991 and Lee, 1993). The Port Isaac colony originated from discarded school insects from the 1982 distribution. Although Port Gaverne is only about 500 metres from the Port Isaac colony, it was puzzling that, despite intensive searching, no insects could be located on the bramble covered slope between the two villages. Further, Port Gaverne has a tiny resident population with no children, so the most common mode of spread by children seemed unlikely. Since my 1993 report, I have confirmed that the colony in Port Gaverne pre-dates that in Port Isaac by at least 10 years. One gardener recently reported to me that he has seen stick insects since the early 1970s. As his garden has many plants acquired from Treseder's nursery over the years, this is undoubtedly the source of Port Gaverne's insect colony, and another incidence of more than one introduction at virtually the same site. The species present in both locations was confirmed as *A. inermis* (see Lee, 1993).

PROBUS (SW9047): Another new colony. Five survey reports in 1993 and 1994, all clustered together. The species was reliably confirmed as *A. inermis* by John Humphreys. The origin of the site was clearly from plants supplied by Treseder's, as they laid out a large garden here in 1969, and insects have been seen there for "many years".

St IVES: No survey reports, but one inconclusive 1990 report of small juvenile stick insects (Haes, 1991). My experience has shown that when people find stick insects, they invariably take them to local schools for the children to see. Having contacted the head teachers of both the infants and junior school, they have put up information on our insects, and asked the children to report any sightings. Although two children said they had seen stick insects, none were forthcoming, and nothing further has been heard in the last 15 months. In these circumstances, I conclude that the 1990 report was discarded Laboratory sticks.

St JUST-IN-ROSELAND (SW8535): Another new location. One 1994 survey report, where insects have been seen for about five years in the garden. From the owners description, the species was *A. geisovii*. This site is only a few miles from St Mawes (*q.v.*), where *A. geisovii* is widespread, and they were probably brought back from St Mawes by local children who go to school there.

St MAWES (SW8432, SW8433, SW8532, SW8533): Eleven survey reports throughout the town in 1993, 1994 and into 1995. Ten previous reports, the earliest in *West Briton* (1969). The species present is certainly *A. geisovii*, and *A. inermis* may be present in one garden at least. Several reports spoke of insects without spines, in one garden such insects have been seen since 1960 when the owner first moved in, but these may just be *A. geisovii* with few spines. Certainly when Eve

Bysouth did her St Mawes survey (Bysouth, 1990), she never found *A. inermis*, and several of her *A. geisovii* reports came from gardens in the same road as this 1960 report. Two other alien species *Acanthoxyla prasina*, and *Bacillus rossius* (Rossi) are also present in small numbers at one garden site, having survived outdoors for at least one winter. *A. geisovii* was deliberately introduced into the Riviera Gardens c.1959 using insects obtained from Tresco (q.v.). Incidentally, this was on the other side of town from the 1960 report - were there two introductions? *A. inermis* was introduced into the one garden by accidental spillage of eggs, as were the two other species.

TRESCO (SV8914, SV8915): One survey report in 1993. Many previous reports, both for *A. geisovii*, and *C. hookeri*. The earliest report for *A. geisovii* is from 1943 (Uvarov, 1944), although this colony was certainly pre-war, and may go back to 1907 when a consignment of New Zealand plants was imported onto the island. Some of these plants were sent to Paignton, Devon (q.v.), where *A. geisovii* was recorded the following year (Kirby, 1910), the first British record. The earliest for *C. hookeri* is autumn 1949 (Uvarov, 1950). Non-prickly stick insects had been seen previously, so *C. hookeri* was present in earlier years, perhaps contemporaneous with *A. geisovii*. Reports of *A. geisovii* have come from several sites, and it is probably quite widespread on the island. *C. hookeri* is found in just one location, the only site outside New Zealand. For both *A. geisovii* and *C. hookeri*, the origin is undoubtedly plants imported direct from New Zealand.

TRURO (SW8044, SW8244, SW8245, SW8345): 10 survey reports from several parts of the town in 1993, 1994 and into 1995. There are two previous reports, the earliest in 1979 in *West Briton* (1981a), although it is now known that this was one of the earliest UK locations with insects being present since the 1920s, and probably earlier. Species present is undoubtedly *A. inermis*, although this has not actually been confirmed. The origin of the main colony of insects was from plants imported from New Zealand by Treseder's to their Truro nursery. Three of the survey reports were actually from the new houses built on the nursery site, and nine out of all twelve reports were within a few hundred metres of this site. The other three reports were from separate parts of Truro, and probably originated by children taking them home from the main site.

TYWARDREATH (SX0754, SX0854): Another new location. Three survey reports in 1994, with one person having seen them since 1991. Species not confirmed, but most likely *A. inermis*. All three reports are within a few hundred metres of the local primary school, and I expect this was the source, probably via discarded insects from the 1982 distribution.

VERYAN (SW9139): Two survey reports in 1993 and 1994 from the same close. There are two previous reports, the earliest from 1985 (Bysouth, 1985). Species present is confirmed as *A. geisovii* from a clear photo supplied with one report. This location is only a few miles from St Mawes (q.v.), and the origin of the colony is most likely from local children attending school in St Mawes and bringing them back.

VERYAN GREEN (SW9139, SW9239): Another new location. Three survey reports in 1993 and 1994, all within a hundred metres of each other. The species present is confirmed as *A. inermis* from a clear photo sent with one report. This small hamlet is only a few hundred metres from Veryan, but we find a separate colony of a different species, yet another incidence of more than one introduction at adjacent sites.

(b) Devon

ERMINGTON (SX6353): Another new location. Two survey reports in 1994, a few hundred metres apart. First found in one garden in 1993, and again in 1994. The second garden has had them for about 10 years. Species not confirmed, but on the basis of the owners description of small spines on thorax, most likely *A. geisovii*. This site is only two miles south of Ivybridge (q.v.), and the insects probably arrived here via local children attending school in Ivybridge and bringing them back.

GALMPTON (SX8856, SX8956): Three survey reports in 1994, spread around the village. The teacher at the local school confirmed that they get large numbers brought in every year. The earliest previous record (Marshall & Haes, 1988) states they have been known here since the early 1970s. Species confirmed as *A. geisovii* by a clear photo with one report. The site is only a few miles south of Paignton (q.v.), and this colony probably originated via local children attending school in Paignton and bringing them back.

IVYBRIDGE (SX6356): No survey reports. There is very little information on this location, with Brock 1991 stating "Ivybridge - also noted in the 1980s". Chris Haes (pers. comm.) advised me that the record was from a gardener in Ivybridge, who sent a specimen he found to the British Museum (Natural History) in about 1985. The species was confirmed as *A. geisovii*. Despite the absence of any survey reports, there is no reason to doubt a small colony is still surviving, particularly as a report was received from Ermington (q.v.) only a few miles south of Ivybridge. With so little information on the Ivybridge colony, it is difficult to be certain how the colony originated, but transfer as eggs or insects on plants from one of the Torbay colonies must be the most likely source.

PAIGNTON (SX8859): One 1994 survey report only, from a garden backing onto the Botanical Gardens, where there has been a long established colony. This location was the earliest UK stick insect site, with insects being first recorded here in 1908 (Kirby, 1910). C.F. Rivers (1953), who felt that Kirby's report was originally thought to be the outcome of some practical joke, rediscovered the species in 1952 at the very same house where they were living on a large Japanese Cedar (*Cryptomeria japonica*). Interestingly, when Colin Bath, Curator Paignton Zoo, undertook a survey of these insects in 1985, he received a letter from the family who used to live at that house, but had moved to London some years earlier. They remembered Mr Rivers' 1952 visit, and became quite fond of their "tenants at the bottom of the garden" (Brock, personal communication). The species has been confirmed as *A. geisovii*. The colony originated from a consignment of New Zealand plants imported direct onto Tresco, Cornwall (q.v.) in 1907, part of which was transshipped to Paignton Botanical Gardens the same year.

TORQUAY (SX9064): No survey reports. A report in the *Paignton Observer* on 2nd January 1947 of an unusual blue-green specimen found at Torbay Mill is probably the earliest record at this site. That record was confirmed as *A. geisovii* (then *Macracantha geisovii*) by Herbert Whitley, who owned the Paignton Zoological and Botanical Gardens - the original UK stick insect location. Brock (1991) also records the species as frequent in Torquay Palm House in the 1960s until it was exterminated by insecticide, but a stock was found in a nearby garden in 1985. The origin of the Palm House colony was probably from insects or eggs on plants from Paignton Botanical Gardens. Despite the absence of survey reports, there is no reason to doubt a small colony still survives here.

(c) Eire

BAY OF KENMARE, COUNTY KERRY: One 1994 survey report from Claddanure. This location is some 15 miles from the Island of Rossdohan, Viscount Mersey's Estate opposite the island, and nearby Kilmakillage Harbour, where stick insects have been known since the 1960s. The species here was long thought to be *C. hookeri* (as were most British "smooth" stick insects until 1985), but Michael Kemp confirmed the species was *A. inermis* in 1993. Michael's own survey (in prep.) of the area suggests the insects are widely distributed in the Bay of Kenmare. The origin of this colony, surprisingly, seems to go back to Treseder's Truro (q.v.) nursery in Cornwall. Neil Treseder stated that his Victorian grandfather supplied many New Zealand plants, not only to the large Cornish gardens, but also to estates in western Ireland and the west coast of Scotland. (Stick insects have never been recorded from Scotland, and correspondence with the head gardener at Inverewe, one garden supplied by Treseder's, confirms they have never been recorded there.)

(d) Other stick insect reports

BASINGSTOKE, HANTS: A stick insect seen in a garden some years ago.

BODMIN, CORNWALL: March 1995, single 3" (7.5cm) brown insect in garden, identified as *Carausius morosus* (Sinéty).

CAMELFORD, CORNWALL: Large numbers of nymphs seen in one garden by a biologist about 10 years ago.

COVENTRY, WARCS: One person reported that he used to catch them regularly before the war in hedgerows.

FARNHAM, SURREY: Four nymphs of Macleay's Spectre [*Extatosoma tiaratum* (Macleay)] and Jungle Nymph [*Heteropteryx dilatata* (Parkinson)] found on a rose bush in July 1994. Identified by Paul Brock.

GREAT MISSENDEN, BUCKS: Several found on a rose bush c. 1940.

HUDDERSFIELD, YORKS: 2½-3" (6.5-7.5cm) long insects seen over several years, last seen c. 1988.

IPSWICH, SUFFOLK: Two reports of many stick insects on roses in an ornamental garden during August 1994. Confirmed as *Carausius morosus* by Howard Mendel, Curator Ipswich Museum, who also reported several other sightings in the town during the hot summer.

KESWICK, CUMBRIA: 1½-2" (4-5cm) green stick insect fell onto garden path in August 1994.

LLANTWIT MAJOR, SOUTH WALES: Single insect found in garden in 1985.

PLYMPTON, DEVON: Several 1" (2.5cm) nymphs found on a bramble patch in Autumn 1994. The finder, a former Exotic Entomology Group member, reared them to adulthood, and to nymphs of the next generation. Nymphs confirmed as *Bacillus rossius* by Paul Brock. A further report of *B. rossius* from this location was also received by Chris Haes. As this species is widespread in culture, these were almost certainly discarded stock, rather than an established colony, although this species may survive as a short lived colony in favoured sites (see St Mawes).

PRESTON, LANCS: A small "stick-like" insect found in garden July 1994.

RAYLEIGH, ESSEX: Two stick insects 2½-3" (6.5-7.5cm) long found on cotoneaster in summer 1992.

SAMPFORD COURTNEY, DEVON: Saw stick insects in her elderly neighbour's garden in May 1993, and had been seen there previously. There is a possibility that this may be a New Zealand species, but in the absence of confirmation it is treated as discards.

SOLIHULL, WARCS: 1½" (4cm) stick insect seen on a Basil plant in summer 1994.

WEMBLEY, MIDDX: Stick insects frequently found in the garden, mainly on roses, about 20 years ago, before moving to Sheffield. Usually 1-1½" (2.5-4cm) long only.

WEST GRAFTON, WILTS: One person reported finding them in the 1950s on a bramble patch.

A search by Paul Brock at the exact location revealed nothing.

All those people who made these one off reports have been asked to keep an eye out in future years, so more information may come to light for a few of the locations, but most will be discarded Lab-sticks.

Footnote

In Professor Salmon's excellent book *The Stick Insects of New Zealand* (1992), he downgrades various *Acanthoxyla* species, including *A. geisovii* and *A. inermis*, to subspecies of *A. prasina* (Westwood), so the "British" species would be *A. prasina geisovii* and *A. prasina inermis*.

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Comments on the species of Phasmida described by Stoll in 1788 and named by Olivier in 1792.

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Key words

Phasmida, Objective synonyms, Olivier, Stoll, Lichtenstein.

In 1788 Stoll produced the first part (pages 1-56 and plates 1-18) of his superbly illustrated book on phasmids, mantids etc. He did not use latinized binomial names in the descriptions, so he was describing the species without scientific names. Stoll died in 1795 and the remainder of this work was published posthumously in 1813, with an index containing latinized binomial names. The second part was obviously edited by someone because some of the names in the index are ones which were used for his species by other authors after he died. However there is no direct evidence to suggest that Stoll did not propose the new specific names which were used in 1813, these are therefore attributed to him.

Between 1788 and 1813 other authors proposed scientific names for the species described by Stoll in 1788. As these names are clearly linked to Stoll's descriptions and plates, they are valid names, and, as they predate Stoll's names, they have priority. The first person to propose names for Stoll's species was Olivier in the *Encyclopédie Méthodique, Histoire Naturelle, Insectes*, in 1792. Lichtenstein, in his publications of 1796 and 1802, proposed different names for almost all of these species, presumably unaware of most of Olivier's names. Olivier's names have priority over both Lichtenstein's and Stoll's; however Stoll's, and occasionally Lichtenstein's, names have been used by various authors over the years. Kirby's *Synonymic Catalogue of Orthoptera*, published in 1904, clearly listed the correct names and the synonyms; this should have ensured that the correct names were used subsequently. However Brunner (1907) and Redtenbacher (1906, 1908) used Stoll's names in most cases, and, as their work forms the basis for most identification, some subsequent authors have similarly used incorrect names.

Objective synonyms are different names based on the identical description or illustration (and hence the same specimen). They are relatively rare, yet between 1792 and 1813 there were 17 junior objective synonyms produced, during the same period only 18 new species were described (excluding those described by Stoll in 1813). There has never been any other occasion when so many objective synonyms have been produced for phasmids; these may constitute the majority of all the objective synonyms. The following list gives the synonyms for Olivier's names.

***Mantis baculis* Olivier, 1792.** - Stoll, 1788: 41, pl. 13.51

Phasma arumatia Stoll, 1813.

***Mantis keratoskeleton* Olivier, 1792.** - Stoll, 1788: 46, pl. 15.57, 15.57A.

Phasma cornutum Lichtenstein, 1796.

Phasma bicornis Stoll, 1813.

***Mantis foliopeda* Olivier, 1792.** - Stoll, 1788: 44, pl. 14.54.

Phasma latipes Lichtenstein, 1796.

Phasma femorata Stoll, 1813.

***Mantis sacrata* Olivier, 1792.** - Stoll, 1788: 53, pl. 18.65, 18.65A.

Phasma dracunculus Lichtenstein, 1796.

Phasma flabelliformis Stoll, 1813.

Mantis xanthomela Olivier, 1792. - Stoll, 1788: 31, pl. 10.36, 10.37.

Mantis erythroptera Olivier, 1792. - Stoll, 1788: 13, pl. 5.6.

Mantis draco Olivier, 1792. - Stoll, 1788: 13, pl. 5.18.

Phasma dracunculus Lichtenstein, 1796.

Phasma nympha Stoll, 1813.

Mantis skeleton Olivier, 1792. - Stoll, 1788: 45, pl. 14.55.

Phasma sceleton Lichtenstein, 1796.

Phasma simplex Stoll, 1813.

Mantis inflexipes Olivier, 1792. - Stoll, 1788: 43, pl. 13.52.

Phasma valgum Lichtenstein, 1896.

Phasma curvipes Stoll, 1813.

Mantis tessulatus Olivier, 1792. - Stoll, 1788: 4, pl. 8.26.

Phasma variegatum Lichtenstein, 1896.

Mantis bimaculata Olivier, 1792. - Stoll, 1788: 26, pl. 8.29.

Mantis viridana Olivier, 1792. - Stoll, 1788: 15, pl. 6.20.

Phasma edule Lichtenstein, 1796.

Mantis maculata Olivier, 1792. - Stoll, 1788: 8 & 10, pl. 3.8 & 4.11.

Phasma naevium Lichtenstein, 1802.

Mantis cinerea Olivier, 1792. - Stoll, 1788: 45, pl. 14.56.

Mantis chloropus Lichtenstein, 1796.

Although I have not included them in the above list, some subjective synonyms have been published. The situation with regard to subjective synonyms is more difficult to resolve. With such old species the original specimens are often untraceable and thus unavailable for comparison; I know type specimens of four of Stoll's species still exist, the rest may or may not still exist. In most cases the brevity of the early descriptions makes certain identification impossible unless the type specimens are available.

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Reviews and Abstracts.

Book Reviews

Belalong: A Tropical Rainforest [Edited] by Earl of Cranbrook & David Edwards. Published by Sun Tree Publishing, Singapore. Hardback, 389 pages (16cm x 23cm). ISBN 981-00-4519-0. Price £18.00 (hardback), £15.00 (softback). - Reviewed by P.E. Bragg.

This book is actually edited by, rather than written by Cranbrook & Edwards; near the back of the book there is a list of the 75 authors and the sections which they contributed. The book is a summary of some of the findings of the Royal Geographical Society and University of Brunei Rainforest Expedition of 1991/92. The book is nicely produced, with about 400-500 colour photographs. After an introductory chapter there are three chapters dealing with climate, geography and soil, then eleven chapters dealing with various aspects of natural history. The text is written in a style aimed at the general reader and is easy reading. The section on phasmids is a general introduction and a brief summary of the phasmids found by Phil Bragg and Ian Abercrombie. The book includes colour photographs of *Acacus sarawacus* (Westwood), *Anarchoides lyratus* Redtenbacher, *Carausius everetti* (Kirby), *Dares validispinus* Stål. There are drawings of a female *Hoploclonia cuspidata* Redtenbacher, and a male *Hoploclonia abercrombiei* Bragg; the latter species (labelled as *H. cuspidata*) was not collected on the expedition. Material submitted by the contributors was edited but never returned to the contributors for checking; contributors did not know which of their material would be in the book until it had been published. Presumably the number of contributors, and the integration of the text, made the editors decide that proof reading by the individual contributors was not practicable; it is unfortunate that so many errors have resulted from this decision. Within the few pages on phasmids, there is the incorrect caption mentioned above, the now classic mistake of showing phasmids upside down has been made with the photograph of *A. sarawacus* (despite very clear marking on the original transparency), and there are minor points in the text which could have been corrected. Having listed all the faults, I should make it clear: it is a very readable book, which should appeal to anyone with an interest in natural history, the photographs are colourful and often spectacular.

The book is not available in bookshops but may be ordered from: The Royal Geographical Society, 1 Kensington Gore, London, SW7 2AR.

A Walk through the Lowland Rain Forest of Sabah by Elaine J.F. Campbell. Published by Natural History Publications (Borneo) Sdn. Bhd., Kota Kinabalu. Hardback, 85 pages, ISBN 983-812-004-9. Price RM39.00 (hardback), RM29.00 (softback). - Reviewed by P.E. Bragg.

This general interest book deserves a mention here because two of its pages are devoted to photographs of phasmids: a leaf female insect, a mating pair of *Haaniella echinata* and a female *Lonchodes haematomus* are shown in the section on Night Insects. The book contains numerous colour photographs of a wide variety of animals and plants. The text is written in an informative but easy to read style and covers a wide range of topics which will be of interest to anyone contemplating a visit to Borneo, or anyone with an interest in rain forests.

The book is not available through any European dealers at present but may be ordered from the publishers: Natural History Publications (Borneo) Sdn. Bhd., A913 Wisma Merdeka, P.O. Box 13908, 88846 Kota Kinabalu, Sabah, Malaysia.

Phasmid Abstracts

The following abstracts briefly summarise articles which have recently appeared in other publications. 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.

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.

Baessler, U. & Nothof, U. (1994) Gain control in a proprioceptive feedback loop as a prerequisite for working close to instability. *Journal of Comparative Physiology, A Sensory Neural and Behavioral Physiology*, 175(1): 23-33.

In the artificially closed femur-tibia control system of stick insects oscillations were induced in 3 different ways: Increasing the phase-shift by introducing an electronic delay, afference sign reversal and coupling the tibia to an inert mass. In all 3 cases the oscillations stopped after some time. The gain of the open-loop system was significantly smaller after the oscillations. Afference sign reversal by surgically crossing of the receptor apodeme of the femoral chordotonal organ for 25-85 days does not lead to altered characteristics of the control loop. When sinusoidal passive movements are forced upon the intact femur-tibia joint the forces resisting these movements do not decrease with time. In contrast to direct stimulation of the femoral chordotonal organ, these passive movements also influence the contralateral leg. The experiments show that the gain-control system of the femur-tibia control loop of stick insects consists of at least two components: A sensitization system (with inputs from many kinds of stimuli indicating some kind of disturbance) increases the gain of all reflex loops. A specific habituation-like system decreases the gain with repetitive stimulation only of one control system. Work was done on *Carausius morosus*, *Cuniculina impigra*, and *Acrophylla wulfingii*.

Bi, D.Y. (1993) *Phasmatodea of Longqishan, Fujian Province*. In: Huang, C.M. (Editor). *The Series of the Bioresources Expedition to the Longqi Mountain Nature Reserve: Animals of Longqi Mountain*. pp. 35-40?. China Forestry Publishing House: Beijing, China. [in Chinese, with English summary]

The chapter describes five new species from China: *Entoria bituberculata*, *Entoria gracilis*, *Entoria humilis*, *Phraortes curvicaudatus*, *Paramyrionides biconiferus*.

Bragg, P.E. (1994) A review and key to the genus *Phenacephorus* Brunner (Insecta: Phasmida: Heteronemiidae: Lonchodinae), including the description of two new species. *Zoologische Mededelingen*, 68(22): 231-248.

The genus *Phenacephorus* Brunner 1907 is reviewed. Keys are provided for both males and females. Two new species from Borneo (*P. nieuwenhuisi* and *P. sepilokensis*) are described and illustrated. Eggs of three species are formally described for the first time. All five known species are partly illustrated and the synonymy of all species is given. The paper includes 25 illustrations.

Bragg, P.E. (1995) The longest stick insect in the world, *Pharnacia kirbyi* (Brunner). *Entomologist*, 114(1): 26-30.

The longest insect in the world was originally recorded from Borneo under the name *P. serratipes* (Gray), subsequent corrections to the name were overlooked and this name continued to be used for 95 years. The specimen is in fact the holotype of *Pharnacia kirbyi* (Brunner).

Pharnacia kirbyi is the senior synonym of both *P. sagitta* Redtenbacher and *P. pilicornis* Redtenbacher. The egg is described and illustrated for the first time.

Bragg, P.E. (1995) The phasmid genus *Hoploclonia* Stål from Borneo, including the description of two new species. *Entomologist's Monthly Magazine*, 131: 25-39.

A key and complete synonymy is provided to the Bornean members of the genus *Hoploclonia*. Lectotypes are designated for *H. draconia* (Westwood) and *H. gecko* (Westwood). The male and egg of *H. cuspidata* (Redtenbacher) are described for the first time. Both sexes and the egg are illustrated. Two new species, *H. apiensis* and *H. abercrombiei* are described and illustrated. A map is provided to show the distribution of the genus in Borneo.

Brock, P.D. & Shlagman, A. (1994) The Stick-insects (Phasmatodea) of Israel, Including the Description of a New Species. *Israel Journal of Entomology*, 28: 101-117.

Three species of stick-insects occurring in Israel are described and figured, including *Ramulus eitami* n.sp. Notes on distribution, biology, habitat, and eggs are presented, in addition to keys to adults and eggs. Electron microscope photographs of the eggs of the three species are included.

Brunn, D.E. & Dean, J. (1994) Intersegmental and local interneurons in the metathorax of the stick insect *Carausius morosus* that monitor middle leg position. *Journal of Neurophysiology (Bethesda)*, 72(3): 1208-1219.

Keywords: *Carausius morosus*, movement, walking, leg coordination, motoneuron.

Bueschges, A., Kittmann, R. & Schmitz, J. (1994) Identified nonspiking interneurons in leg reflexes and during walking in the stick insect. *Journal of Comparative Physiology A Sensory Neural and Behavioral Physiology*, 174(6): 685-700.

In the stick insect *Carausius morosus* identified nonspiking interneurons (type E4) were investigated in the mesothoracic ganglion during intra- and intersegmental reflexes and during searching and walking. In the standing and in the actively moving animal interneurons of type E4 drive the excitatory extensor tibiae motoneurons, up to four excitatory protractor coxae motoneurons, and the common inhibitor 1 motoneuron (Figs. 1-4). In the standing animal a depolarization of this type of interneuron is induced by tactile stimuli to the tarsi of the ipsilateral front, middle and hind legs (Fig. 5). This response precedes and accompanies the observed activation of the affected middle leg motoneurons. The same is true when compensatory leg placement reflexes are elicited by tactile stimuli given to the tarsi of the legs (Fig. 6). During forward walking the membrane potential of interneurons of type E4 is strongly modulated in the step-cycle (Figs. 8-10). The peak depolarization occurs at the transition from stance to swing. The oscillations in membrane potential are correlated with the activity profile of the extensor motoneurons and the common inhibitor 1 (Fig. 9). The described properties of interneuron type E4 in the actively behaving animal show that these interneurons are involved in the organization and coordination of the motor output of the proximal leg joints during reflex movements and during walking.

Carlberg, U. (1994) Bibliography of Phasmida (Insecta). VII. 1985-1989. *Spixiana*, 17(2): 179-191.

The literature on the stick- and leaf-insects (order Phasmida) published during the period 1985-1989 has been reviewed. A total of 261 scientific papers, chapters in books, theses etc. are listed. A systematic index is included covering some 70 species.

Chan, C.L. & Lee, S.W. (1994) The thorny tree-nymph stick insect, *Heteropteryx dilatata* of Peninsular Malaysia. *Malayan Naturalist*, **48**: 5-6.

General information on *Heteropteryx dilatata*, two colour photographs are included.

Chen, S.C. & He, Y.H. (1994) Two new species of the genus *Baculum* from China (Phasmida: Phasmatidae). *Acta Entomologica Sinica*, **37**(2): 196-198. [In Chinese, with English summary]

In this paper are described two new species of *Baculum* Saussure, collected from Zhejiang and Liaoning Provinces. The type specimens are deposited in Beijing Forestry University. All measurements are in mm. 1. *Baculum apicalis* sp. nov. (figs. 1-2). This new species is allied to *B. trilineatum* (Brunner), but differs in the median segment rather short, a row of denticles on the front femora distinct. Body 86-87; pronotum 3-3.2; mesonotum 19-19.4; metanotum + median segment 15-15.2; median segment 3; front femora 32; middle femora 17; hind femora 23; ninth tergite 3.0; operculum 8.8-9.0. Male: unknown. Holotype female, Zhejiang Province: Anji Co. Oct. 24, 1984, the Chinese Academy of Forestry. Paratypes 2 female female, Zhejiang: Yuhang Co. Oct. 10, 1988. Xu Tiansen. 2. *Baculum minutidentatum* sp. nov. (figs. 3-4). This new species is similar to *B. pingliense* Chen & He, but differs in the body rather small, legs rather short, and without any denticles on the basal portions of the four posterior tibiae. Body 78; pronotum 2.4; mesonotum 14; metanotum + median segment 12.4; median segment 2.4; front femora 23; middle femora 14, hind femora 16.5; ninth tergite 2.8; operculum 10.8. Male: unknown Holotype female, Liaoning Province: Huanren Co. Sept. 11, 1983, Song Youwen. Paratype: 1 female, same as Holotype.

Chen, S.C. & He, Y.H. (1994) A new species of the genus *Baculum* from Sichuan, China (Phasmida: Phasmatidae). *Forest Research*, **7**(3): 311-312. [In Chinese, with English summary]

This paper deals with a new species of the genus *Baculum* Saussure from Sichuan Province of China. All measurements are in mm. The type specimen is kept in Beijing Forestry University. *Baculum paulum* sp. nov. (Fig. 1). This new species is similar to *Baculum capitatum* (Brunner), but differs from the latter in the following characters: size smaller; four posterior femora without any teeth on the apical portion of the inferior median carina; Supraanal plate distinct. Male: unknown. Holotype female, Leshan, Sichuan. VIII, 1991, collected by Li Changan. Body 61.4; pronotum 2.2; mesonotum 12.4; metanotum (with median segment) 11; median segment 2.2; abdomen 32.2; operculum 4.4; front femora 20; middle femora 12; hind femora 14.2.

Fausto, A.M., Carcupino, M., Mazzini, M., & Giorgi, F. (1994) An ultrastructural investigation on vitellophage invasion of the yolk mass during and after germ band formation in embryos of the stick insect *Carausius morosus* Br. *Development Growth & Differentiation*, **36**(2): 197-207.

Developing embryos of the stick insect *Carausius morosus* were examined ultrastructurally with a view to studying vitellophage invasion of the yolk mass during and after germ band formation. Newly laid eggs in *C. morosus* have a unique yolk fluid compartment surrounded by a narrow fringe of cytoplasm comprising several small yolk granules. Vitellophages originate mainly from a thin layer of stem cells, the so-called yolk cell membrane, interposed between the germ band and the yolk mass. Throughout development, a thin basal lamina separates the yolk cell membrane from the overlying embryo. Vitellophages extend from the yolk cell membrane with long cytoplasmic processes or filopodia to invade the central yolk mass. Along their route of entrance, filopodia engulf portions of the yolk mass and sequester it into membrane-bounded granules. As this process continues, the yolk mass is gradually partitioned into a number of yolk granules inside the vitellophages. Later in development, the yolk cell membrane is gradually replaced by the endodermal cells that emerge from the anterior and posterior embryonic rudiments. From this stage of development onwards, vitellophages remain attached to the basal lamina through long filopodia

extending between the endodermal cells. Yolk confined in different vitellophagic cells appears heterogeneous both in density and texture, suggesting that yolk degradation may be spatially differentiated.

Liu, S.L. & Cai, B.L. (1994) Descriptions of three new species of *Micadina* from China (Phasmatodea: Heteronemiidae). *Acta Entomologica Sinica*, 37(1): 87-90. [In Chinese, with English summary]

The genus *Micadina* was erected by Redtenbacher in 1908, when two species were recorded. It is presently known by six valid species distributed in China and Japan. Three new species are described here. The types are preserved in the Department of Biology, Nankai University. All measurements are in millimeters. *Micadina brachyptera* sp. nov. (fig. 1, fig. 2:9-10), the female of this species is similar to *Micadina yasumatsui* Shiraki 1935, but its hind wings very short, merely exceeding half length of 3rd tergite; the apex of operculum narrow; and with median longitudinal carina on 10th tergite conspicuous. *Micadina bilobata* sp. nov. (fig. 2:1-4) It resembles to *Micadina rotundata* Shiraki 1935, but apex of female 10th tergite bilobed, wide emarginate in the middle; operculum long, exceeding abdominal apex and cerci. *Micadina fujianensis* sp. nov. (fig. 2:5-8). The present species is distinguished from *Micadina sonani* Shiraki 1935 by shape of cercus and posterior margin of 10th tergite of male. Female with abdominal apex obtuse and supra-anal plate indistinct.

Pashley, D.P., McPherson, B.A. & Zimmer, E.A. (1994) Systematics of holometabolous insect orders based on 18S ribosomal RNA. *Molecular Phylogenetics and Evolution*, 2(2): 132-142.

Phylogenetic relationships of 19 species representing nine holometabolous insect orders and three outgroup orders were examined using sequence data from two-thirds of the 18S nuclear ribosomal RNA molecule. Of 1330 aligned nucleotide sites in 19 taxa, 460 were variable and used for phylogenetic analysis. Parsimony analyses resolved relationships in a few groups but left the most controversial questions regarding relationships among major lineages unresolved. All analyses supported a clade with Lepidoptera and Trichoptera as sister taxa most closely related to Diptera. Mecoptera and Siphonaptera were most often linked basally to this group, supporting the existence of the Mecopterida superorder. Phylogenetic affinities of this superorder and remaining lineages, Coleoptera, Hymenoptera, and neuropterids, were ambiguous. In contrast, distance analysis produced a tree supporting one of three morphologically based hypotheses. Neuroptera and Hymenoptera were placed as sister taxa ancestral to Mecopterida, with Coleoptera basal to all orders. The inability of the 18S molecule to resolve ancient divergence events may be due to the rapid divergence of holometabolous orders, resulting in few synapomorphies. Includes work with *Anisomorpha buprestoides*.

Pike, E.M. (1994) Historical changes in insect community structure as indicated by hexapods of Upper Cretaceous Alberta (Grassy Lake) amber. *Canadian Entomologist*, 126(3): 695-702.

Species richness and relative abundance of arthropod taxa from an Upper Cretaceous (Campanian: 75 Mya) amber deposit in Alberta are described. About 130 hexapod species have been recognized to date from this deposit, making it the most diverse Cretaceous insect assemblage so far known. Taxa present, in order of abundance, are Hemiptera (66 specimens per kg), Diptera (28), Acari (21), Hymenoptera (13), Aranea (12), Psocoptera (4), Coleoptera (2), Blattodea (1), Thysanoptera (1), and Trichoptera (0.6). Representatives of Lepidoptera, Collembola, Dermaptera, Mantodea, Phasmatodea, and Ephemeroptera are also present. In the total of 65 identified families, 15 are extinct. Only one of about 77 genera identified in this deposit is extant. All recognized species are extinct. In comparison, virtually all families reported from Baltic and Dominican Republic ambers are extant, as are the majority of the genera. Morphology and feeding

structures are well within the variation seen in modern insects. It is hypothesized that the taxonomic structure of modern insect communities was well established before the end of the Cretaceous and that the structure and interrelationships of insect guilds were also very similar to those of today.

Ratti, E. (1994) Stick insect: *Bacillus rossius redtenbacheri* Padewieth, 1899 in Lido Venice (Insecta, Phasmida, Bacillidae). *Societa Veneziana di Scienze Naturali Lavori*, 19: 219. [In Italian]
Discusses morphology, genetics and distribution of *Bacillus rossius redtenbacheri*.

Sellick, J.T.C. (1994) Phasmida (stick insects) eggs from the Eocene of Oregon. *Palaeontology*, 37(4): 913-921.

Three new taxa of fossil stick insects *Eophasma oregonense*, *E. minor* and *Eophasmina manchesteri*, are named from eggs found in the Eocene of Oregon. They are allocated to the tribe Anisomorphini and are the oldest known members of an extant family of the Phasmida. The eggs are illustrated by drawings and SEM photographs.

Seow-Choen, F. (1994) Moulting in the Giant Prickly Stick Insect. *Singapore Scientist*, 73: 10-14.

This article consists of a general introduction, and a series of twelve colour photographs of a male *Extatosoma tiaratum* shedding undergoing its final ecdysis.

Seow-Choen, F. (1995) Walking leaves. *Nature Watch*, 3(1): 16-19.

A general interest article on *Phyllium*. Includes several colour photographs.

Seow-Choen, F., Brock, P.D. & Seow-En, I. (1994) An Introduction to the Stick and Leaf-insects of Singapore. *Malayan Naturalist*, 48(1): 7-11.

This paper includes material from West Malaysia as well as Singapore. Three colour photographs are included, one showing the unusual yellow form of *Heteropteryx dilatata* (not material from Singapore). Three new synonyms are given (a fourth, although indicated as a new synonym, has previously been published elsewhere). Several species are recorded from Singapore for the first time.

The authors of this paper and also of "The Stick Insects of Singapore" [*Singapore Scientist*, 70: 10-14] wish to clarify comments made by the Editor of *Phasmid Studies* [3(2): 47] in the abstract of this article. All species included in that paper have been found in Singapore. For the record, *Datames mouhoti* (Bates) was the only species photographed in Peninsular Malaysia, all the others were photographed in Singapore. As specimens from Peninsular Malaysia and Singapore are identical the authors did not consider it necessary to make reference to this point. The Editor of *Phasmid Studies* would like to apologise for any confusion caused; it appears that comments made by one of the authors about the inclusion of non-Singaporean material were intended to refer to the paper "An Introduction to the Stick and Leaf-insects of Singapore".

Seow-Choen, F., Brock, P.D. & Seow-En, I. (1994) Notes on the Stick-insect *Prisomera malaya* (Stål) (Phasmida) in Singapore with a description of the Male and Egg. *Malayan Nature Journal*, 48: 59-65.

Prisomera malaya (Stål) (Heteronemiidae, subfamily Lonchodinae) is a common stick insect in Singapore, although previously known only from the type specimen from Malaysia. The male of *P. malaya* and eggs are described for the first time. Details of two colour forms are also recorded.

Publications noted

The following publications have been noted but no abstracts have been received.

Basset, Y. & Hoefft, R. (1993) Can apparent leaf damage in tropical trees be predicted by herbivore load or host-related variables?: A case study in Papua New Guinea. *Proceedings of the Biological Society of New Guinea annual meeting 1993. Wau, Papua New Guinea, August 31-September 1, 1993.* Pages 93-95.

Obituary

Ulrich Ziegler, after a long battle against cancer, died at the age of 52 in the evening of 1st June 1994. Born in Berlin on 6th April 1942, he had a lifelong interest in animals. He was a keen self-educated entomologist whose field work was concentrated on phasmids and cockroaches. His interest in phasmids began 25 years ago when he started using them to feed to his spiders. The biology of Phasmida fascinated him so much that at times he kept over 30 different species. He built up a large photographic collection showing interesting situations from various stages of their lives. He was particularly interested in egg laying strategies. Because of his world wide connections with other people interested in phasmids, and his collecting trips throughout Europe and elsewhere, he managed to build up a remarkable collection of phasmids. Ulrich was a member of the PSG for ten years and was also a member of the Groupe d'Etude des Phasmes, Phasma, and the Blattodea Culture Group.

At the beginning of 1990, Ulrich, with others, launched the periodical *Arthropoda* which has become an important publication for anyone interested in rearing terrestrial arthropods. Through publications, he communicated his broad knowledge which he gained over many years. Unfortunately his untimely death interrupted his work and much of his knowledge has not been put into print. His publications included the following:

- 1989 Ein Gynandromorphes Exemplar von *Phyllium bioculatum* (Gray) (Phasmida). *Entomologische Zeitschrift*, **99**(3): 30-32.
- 1992 The green cockroach, *Panchlora nivea* Linnaeus, husbandry and breeding as a food-insect. *Sauria [E]*, Kempton Park, **1**(4): 13-14.
- 1993 Schaben, Mantiden, Phasmiden (Haltung und Zucht) 1. Teil: Schaben (Blattodea). *ZAG Rundschreiben* **14**: 2-6. [Reprinted in 1993: *Arthropoda*, **1**(4): 14-17]
- Schaben, Mantiden, Phasmiden (Haltung und Zucht) 2. Teil: Stab-Gespensschrecken, Wandelnde Blätter (Phasmida) (Verbreitung, Taxonomie u. Determination). *Arthropoda*, **1**(1): 15-19.
- Schaben, Mantiden, Phasmiden (Haltung und Zucht) 3. Teil: Haltung und Zucht von Phasmiden, sowie Bau von Terrarien. *Arthropoda*, **1**(2): 7-11.
- Die Grüne Schabe, *Panchlora nivea* Linné, Haltung und Zucht als Futtertier. *Arthropoda*, **1**(3): 14-15.
- Einige Bemerkungen zu *Phyllium siccifolium* (Linné, 1758). *Arthropoda*, **1**(4): 18-20.
- 1994 Über die Haltung von *Pricisia vanwaerebeki* (van Herreweghe, 1973) (Blaberoida: Oxyhaloidae). *Arthropoda*, **2**(2): 31-33.

Food plants for *Phyllium bioculatum* Gray in Sri Lanka.

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Key words

Phasmida, *Phyllium bioculatum*, Foodplants, Sri Lanka.

A search through such literature as we have been able to lay our hands on says precious little about the food plants of leaf insects other than that they can be reared on Guava (*Psidium guajava* - Myrtaceae). Alain Deschandol (1990) gave an account of food plants for *Phyllium* spp. gleaned from the literature and Pat Matyot (1990) gave his views on food plants of *Phyllium bioculatum* in the Seychelles.

The genus *Psidium* belongs to tropical America and the W. Indies, while the leaf insects are from the Australasian region. It stands to reason that guava as such cannot be the "original" food plant, despite the fact that the guava leaf is so perfectly mimicked by leaf insects. The family Myrtaceae itself, however, is more widely distributed in the tropics and there are genera within it which are native to Sri Lanka e.g. *Eugenia* and *Syzigium*.

Despite the fact that guava is introduced, there is more than a superficial association between the two. For instance, in Sri Lanka the vernacular name for a leaf insect is "pera kolaya" (guava leaf) and *P. bioculatum* certainly occurs on guava here. Our guess is that *P. bioculatum* has certain tall forest trees (perhaps in the Myrtaceae) as the natural food plant here in Sri Lanka, and that, when the guava was introduced, the species spread on to the newcomer. People would rarely "bump into" a leaf insect (and to see them you have to practically bump into them) on a tall tree. One would be more likely to find them on the (rather small) guava tree however, especially when picking fruit.

In support of this hypothesis we would offer two rather anecdotal stories. Firstly, Green (1909) stated that leaf insects could be found in the Kandy district. He said that the locals would locate them by waiting under trees they were known to live in and watching for falling pieces of green leaves dropped by the feeding insects. The implication from this is that at that time they were associated with forest trees rather than the guava.

The second such story concerns a conversation with Nimal, our contact in Ekneligoda village where we are making a long-term study. It seems that leaf insects are rarely found on guava in the village and we chanced to ask what the local name was. Did they still call them "guava leaves"? In reply we were told that it depended what they were feeding on. They were "dehi kolaya" (lime leaves) when they were found on dehi, "etamba kolaya" (Ceylon mango leaves) on etamba, "kottamba kolaya" (Indian almond leaves) on kottamba and so forth. It seemed that leaf insects were associated with leaves of a whole range of fruit bearing plants. Maybe they are polyphagous and it is human behaviour (i.e. whether we get up amongst the leaves and branches to pluck fruit) that determines where we find them. Never the less, this may not be the whole story. In captivity they seem to accept some food plants much more readily than others.

As we are finding leaf insects in Ekneligoda, you would think that the food plant would be obvious by now. Unfortunately this is not the case. The specimens we have found have mostly been newly hatched nymphs. Given that they may not feed for the first day or two, one has to assume that they are "in transit". The trees overhanging the place where they are found are perhaps more likely to be the true food plants.

In the end we have four lines of evidence on trying to pin down food plants:

- 1) The plants on which we find them;
- 2) The trees associated with sites where they are found;
- 3) Plants on which the villagers say they have found them;
- 4) Plants that they have been raised on in captivity.

It should be made clear at the outset that none of these lines of "evidence" is anything more than tenuous. Only when we find second instar and above specimens feeding on native trees are we sure of our facts. Bearing this in mind, so far we have indications that they may feed on twelve plant species from seven different families. To this tally, further species and families may be added from other authors as follows:

Myrtaceae

We have found adult females on *Psidium guajava*, guava. We also have trustworthy reports of leaf insects on *P. cattleianum*, strawberry guava. There is also "jambu" (rose apple, *Eugenia jambos* [= *Syzigium jambos*]); Mr Wijayasiri, a local insect breeder, says that they can be raised on this although they do not take to it readily. Pat Matyot collected a nymph from it (Matyot, 1990).

One villager recently claimed to have found leaf insects on "Dun" (*Eugenia corymbosa*). Pat Matyot also describes females picked up underneath trees of *Eugenia malaccensis* [= *Syzigium samarangense*]. This mode of discovery tallies exactly with our experience in relation to mango (see below).

Anacardiaceae

If pressed as to main food plant for leaf insects, "etamba" (*Mangifera zelanica*) is the one that Nimal chooses. In addition, he has more than once found mature (senescent?) adults that have fallen out of a particular etamba tree. He recently provided us with two well grown specimens from this tree. Pat Matyot states that some collectors in the Seychelles reported finding leaf insects on mango. I have raised leaf insects on Indian mango (*Mangifera indica*) at home, and Nimal has found a mature female under a *M. indica* tree. *Mangifera* is a genus which is native to the area. It is likely to be one of the true "original" food plants. "Kadju" (Cashew, *Anacardium occidentale*) is also said to be a food plant.

The Anacardiaceae contains 55 genera, and 500 species (6 genera and 18 species in Sri Lanka). It includes some widely distributed forest trees and would be a good family to investigate for potential food plants.

Rutaceae

After the "etamba", the "dehi" (lime, *Citrus aurantifolia*) is considered the next most common food plant in the village (though not any other citrus species). It is native to the area and a likely food plant, though we have yet to confirm it. Alain Deschandol (1990) quotes three references to *Citrus* species, as food plants for leaf insects.

Leguminosae

Nearly all the nymphs that we have collected from Ekneligoda have been found on "karanda" (*Pongamia glabra*). Virtually all of them have been the bright scarlet colour of a freshly hatched nymph (the exception was of a colour that suggested an age about three days from hatching, still very young). Despite the caveat about young nymphs not giving much indication of food plants, there is such a consistent association that one does begin to wonder! Two further caveats should

be added, however. One is that the karanda form a large proportion of the undergrowth in this particular location. Another is that once you have success in one spot you cannot help but be drawn back to it. Both these factors may create a bias in the data. Where the kavanda grows there is also a large tree called naimbul (*Harpulia imbricata*, a member of the Sapindaceae) which Nimal has successfully used as a foodplant for caged leaf insects.

Elaeocarpaceae

The Ceylon olive or Veralu, *Elaeocarpus serratus* has been mentioned as a probable foodplant by several people. Most recently a villager whose statements can be taken as reliable affirmed that he had found leaf insects on this plant.

Combretaceae

The villagers say that Indian almond (*Terminalia catappa*) is a food plant. Interestingly, Pat Matyot (1988) quotes Guerard as giving Indian almond as a food plant for leaf insects.

In June 1995 we visited the Botanic Gardens in Kandy and talked to the gardeners; there was one in particular who was very informative. He said that the time to look for them is just before the rains when *Terminalia belerica* loses its leaves and "all the leaflets fall to the ground, then you often find leaf insects under the trees". I have often wondered about Green's (1906) description as it would imply too high a population density of leaf insects, it would attract predators. Could it be that there was a little bit of mis-communication and that really they were finding insects under trees that had shed their leaves?

After talking to the gardener we went on into the park. We soon came to a nice big tree labelled *Terminalia belerica*. Its branches and leaves were high up and inaccessible so we searched the ground. Within the first couple of minutes we found a leaf insect egg! This confirmed the gardener's statements in relation to *T. belerica* and makes us inclined to believe that his statement about another foodplant is reliable.

Bignoniaceae

The same gardener said that they had found a leaf insect just a few days earlier on bulu (*Tabebuia serratifolia*). *Tabebuia* is an introduced genus so it is not a native foodplant.

Other families

Alain Deschandol (1990) adds two tropical plants not mentioned above, *Theobroma kakao* (Cocoa, Sterculaceae) and *Thea sinensis* (Tea, Theaceae) both records are attributed to Linnaeus (although Deschandol does not state which species of *Phyllium* was involved, it is unlikely to have been *P. bioculatum* because this species was not known to Linnaeus). The latter plant was also mentioned in the village as one on which nymphs may sometimes be found. As the village is a part of a tea plantation, however, I did not give much credence to the suggestion - just about everything must end up on tea at some time in Ekneligoda!

Pat Matyot (1990) also states that specimens were found either under or on *Anona reticulata* (Bullock's heart, Anonaceae), *Artocarpus heterophyllus* (Jack fruit, Moraceae) and on *Sandoricum* spp. (Meliaceae).

What conclusions can we draw from the above? The finding of adult females where they have

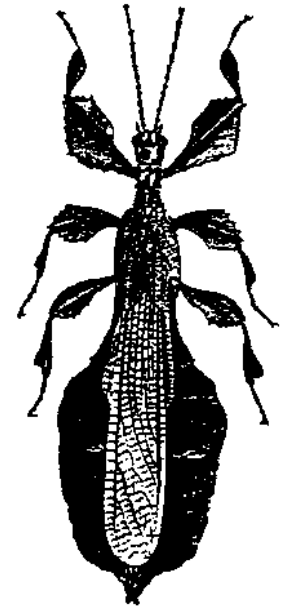


Figure 1. The original illustration of Gray's male *Phyllium bioculatum*.

fallen from a tree provides fairly good evidence that the plant families Anacardiaceae and Myrtaceae provide "natural" food plants for *P. bioculatum*. Beyond that there is very weak support for as many as ten other families (taking our findings along with those of Alain Deschandol and Pat Matyot). Even if only a few of these are eventually substantiated it would imply that *P. bioculatum* is polyphagous.

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A short description of some deformed eggs of *Bacillus lynceorum*.

Ingo Fritzsche, Huberstrasse 1, 38855 Wernigerode, Germany.

With illustrations by Beatrice Ochs.

Key words

Phasmida, *Bacillus lynceorum*, Deformed eggs, Micropylar plate.

In 1993 I received some eggs of *Bacillus lynceorum* Bullini, Nascetti & Bullini from a French phasmid breeder. Some of these eggs were deformed and none of these hatched. In the next generation I have found a lot of deformed eggs. I will now describe four.

Figure 1 shows a normal egg. The micropylar plate is a narrow stripe running from the operculum to the polar end. The micropylar cup is at the polar end of the dorsal surface. The surface of the capsule is irregularly covered with tubercles.

The first deformed egg (figs 2 & 3) has a micropylar plate as a transverse ring around the egg, but the micropylar cup is in a separate part of the capsule at the polar end of the egg. The second deformed egg is similar to the first but the transverse ring is just below the operculum; the micropylar cup is shown in figure 3a.

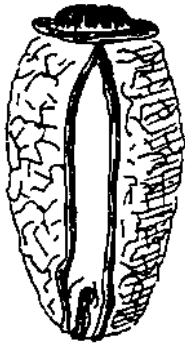


Figure 1.



Figure 2.

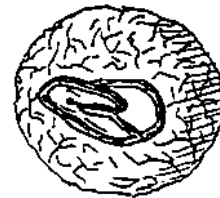


Figure 3.

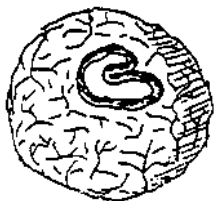


Figure 3a.

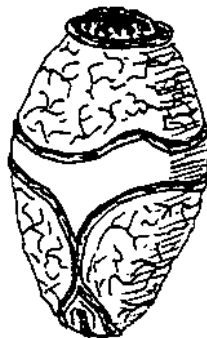


Figure 4.



Figure 5.

Figure 4 shows another form of the ring and micropylar cup, these two parts are connected by a small strip between the cup plate and the ring. Figure 5 shows the deformed micropylar cup of this egg.

Figures 6-9 show another deformed egg with a ring around the egg and two spiral arms. The ring is around the middle of the egg with two spiral arms running to the operculum. As with the other

deformed eggs, the micropylar cup is also on its own plate at the polar end.



Figure 6.

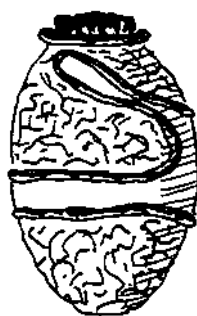


Figure 7.

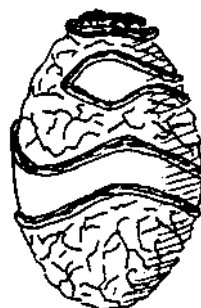


Figure 8.



Figure 9.

All eggs have a normal micropylar cup but I do not know if nymphs hatch from these eggs.

Sizes (mm)*	length	width	height
Normal egg	3.0	2.0	2.1
Egg No. 1	2.5	2.1	2.1
Egg No. 2	3.1	2.2	2.1
Egg No. 3	2.9	2.1	2.0
Egg No. 4	2.9	1.8	1.9

The table above gives the measurements of the eggs; the surface with the micropylar cup is treated as the dorsal surface for eggs 1-3, for egg 4 the dorsal surface could not be identified so height and width were selected at random.

***Baculum* sp. from Chiang Mai (PSG 153).**

Wim Potvin, Brusselbaan 7, 1600 St-Pieters-Leeuw, Belgium.

Note on classification by P.E. Bragg.

Key words

Phasmida, *Baculum*, colour variation, housing, rearing.

Classification

This species seems to belong to the genus *Baculum*, in the section which Brunner von Wattenwyl (1907) treated as the genus *Clitumnus*. His key to *Clitumnus* refers the female to *C. siamensis* Brunner and the description seems in agreement. However the male does not agree with Brunner's description, the fore femora in particular are much shorter (about 25% shorter) than indicated by Brunner. Assuming that Brunner has correctly associated his specimens, this species cannot be *C. siamensis*. Apart from using Brunner's key I have made no other attempt to identify this species. Almost 100 species of *Baculum* have been described (including 14 since 1907); many appear similar, particularly to general collectors, so there are likely to be many uncollected and undescribed species. This species may be undescribed.

Culture history

This *Baculum* sp. is to be found in the northern part of Thailand. Our culture stock originally came from the area around Chiang Mai. Some years ago a dealer imported specimens and eggs into Europe (van Gorkom, 1995). Unfortunately details like quantity, year, names, etc. are not known. Ulrich Ziegler distributed this species widely, he gave some eggs to me too.

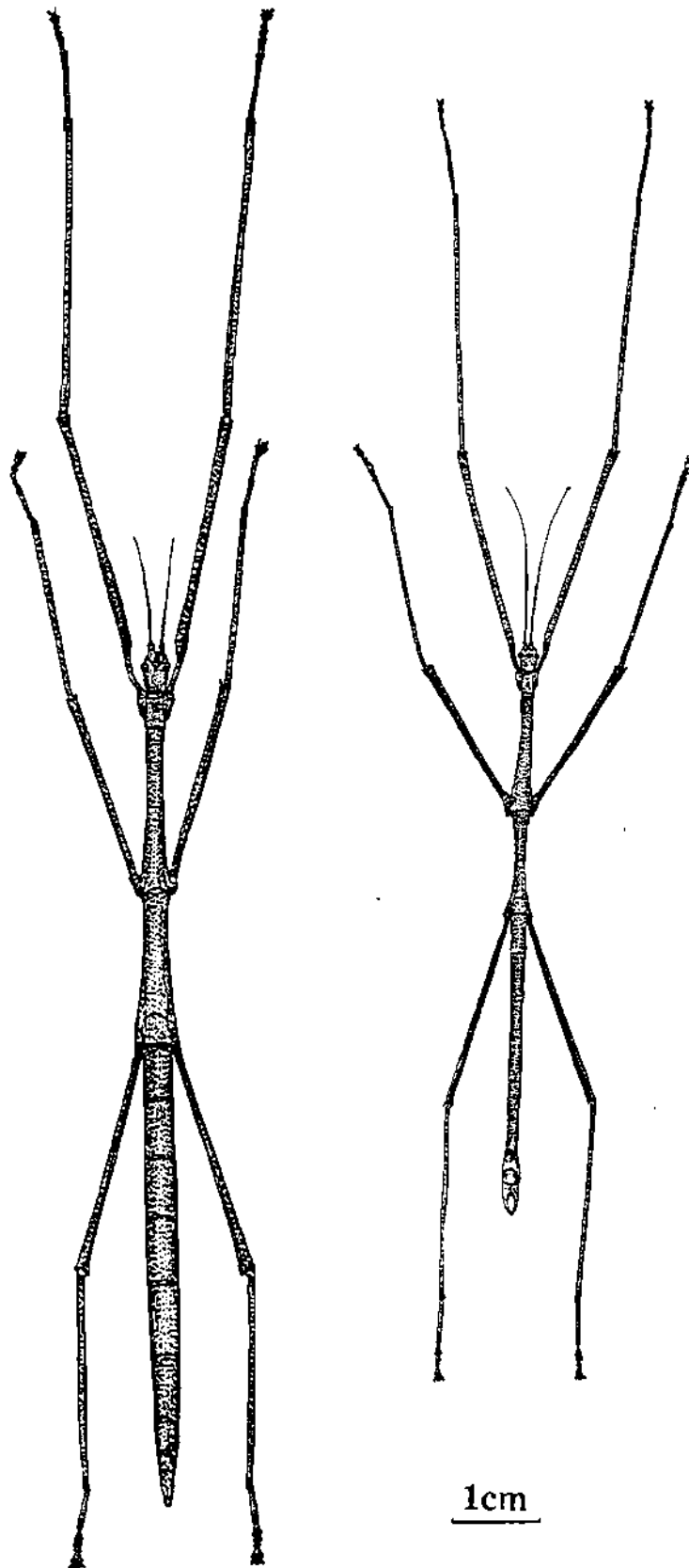
Females

The female has a smooth surface throughout. There are no spines or any other protuberances on the head, body or legs. The female has an ordinary cylindrical abdomen which ends in a point and is as wide as the thorax. Only the mesothorax becomes a bit thinner towards the middle. The cerci are small (figure 6). None of the legs have spines (except for a few on the underside of the apices of the middle and hind femora). Even the front femora are smooth. The antennae are about half as long as the front femora. The front femora have an indentation in which the head fits when the forelegs are folded against each other.

The table below gives the typical sizes of the adults.

Lengths (mm)	Male	Female
Body	85	120
Overall	200	225
Antennae	21	15
Front legs	92	97
Middle legs	58	59
Hind legs	70	75

The coloration can vary according to the rearing conditions. As explained by Bragg (1995: 4), the females are light brown dorsally and reddish ventrally when they are kept very dry and well ventilated. Under humid conditions the body colour is dark green dorsally and creamy-brown ventrally. The legs are always green. However, I have always had both colour variations together, so my conditions must have been between dry and humid. When this happens some choose the



Figures 1 & 2 Female and male PSG 153, *Baculum* sp.

"dry colours" while the others prefer the "humid colours". Almost two weeks after their final moult the females start laying eggs at an average rate of about two eggs a day. The female simply drops the eggs.

Males

The male also does not have any spines or other protuberances on the body or legs. The whole of the thorax and abdomen are smooth and are of uniform width except for the last three abdominal segments which are a bit thicker than the rest. The tenth abdominal segment is split into two large "claws" (claspers) which are pointed towards each other. The cerci are small and hidden under the claspers. The legs of the male are very smooth, thin, and long. The antennae are longer than those of the female but still shorter than the front femora.

Whatever the breeding conditions, the male is always between bronze and golden in colour, only the middle and hind femora are coloured differently, being green. The antennae are black. Males are very slender with very long legs (figure 2), so the shape is similar to the males of *B. thaili*. The male cerci are longer than those of the female, and hidden under the claw-shaped tenth abdominal segment (figure 7).

Copulation is not often seen, and usually does not take much time. Mating only takes place at night. The adults do not form permanent pairs.

Nymphs

The nymphs are very slender and fragile. Again they are very similar to *B. thaili*, although they are reddish in colour when they hatch (figure 3); after the first moult they become green. The nymphs easily lose legs. At normal room temperature they become adult within 4 or 5 months.

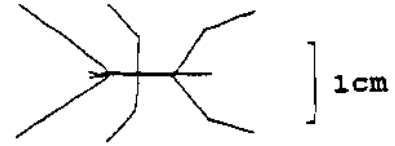


Figure 3 1st instar nymph.



Figures 4 & 5 Eggs: lateral and dorsal views.

Eggs

The eggs (figures 4 & 5) are similar to those of *B. thaili*, but smaller and with more markings. The egg is flat and has a very irregular surface, the whole surface is marked with small pits. On each side there are two larger pits near the micropylar plate. The micropylar plate is relatively small and oval, it ends indistinctly towards the operculum. The operculum is flat and there is no capitulum. The surface of the operculum is like the rest of the egg: irregular with many small pits. The colour is dark brown. The egg shell is relatively thin, so that they easily break when they are picked up. There is no capitulum on the operculum. The typical sizes are: length 3.5mm, height 1.7mm and width 1.0mm.

They are best incubated in a plastic box on a humid layer of peat, soil, sand or vermiculite (or a mixture of these). When kept this way at room temperature the nymphs hatch in 2-4 months. The percentage hatching is very high, being 90% or even more. When the eggs are kept dry (for some weeks or until they hatch), this percentage is a bit lower and the incubation period is longer. But when the time for hatching has come it is better to keep the eggs humid, otherwise some nymphs might fail to get all their legs out of the egg.

Foodplants

Both nymphs and adults are best fed on bramble and/or rose (they prefer wild rose), depending on your personal food supply. They also eat raspberry and pyracantha (Bragg, personal communication) although I have not tried these plants. I once tried to feed them oak, privet and ivy, but they refused to eat these three plants.

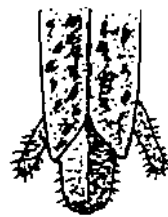


Figure 6
Apex of ♀ abdomen.



Figure 7
Apex of ♂ abdomen.

Housing

As they easily drop legs, this species should be kept in a large cage, the larger the better. I personally find a wooden cage with netting all around the best one for such species, so that the insects can easily climb; glass might be a difficulty for them. When the cage is too dry or too ventilated you can always use some plastic on the outside. It is better to make a door in the front, but leave a border of about 100mm at the top. This will help you cleaning out the cage, because when disturbed they always immediately climb upwards. Once in the cage at the top, they will refuse to walk down the 100mm border, so they just keep on wandering around at the ceiling. It

would not be very practical to choose a cage with a lid at the top, especially when there are a lot of nymphs in it!

Behaviour

Of course, like most stick insects, this species defends itself passively, i.e. by means of camouflage, but they also have active defence. Both nymphs and adults of this species are very nervous when disturbed. At the slightest disturbance in the air they start walking around. Once picked up, they often start panicking. When this happens, it is quite difficult to keep one on your hand; they just want to run away and/or fall down. This is easy to understand, because in nature falling down means disappearing from the predator. Cleaning out a cage full of nymphs of this *Baculum* sp. might cause you to panic, however they have to be handled carefully. When they fall down, they often stretch all their legs forward. This should be understood as a warning, although it is not you who may get in danger, but the insect itself: when touched in this attitude, they often simply throw away some legs, as if they have too many of them!

Comments

This species might be a nervous one, but still I have nice memories of it. The colours of the adults differ from the dull brown or green of most other *Baculum* spp. which are in culture. The nymphs are very colourful as are nymphs of three of the other *Baculum* spp. which are in culture from Vietnam (PSG 157, 158 and 159).

Acknowledgements

I would like to thank my father, Jacques Potvin, for the black ink drawings he made to illustrate this article.

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Water balance in phasmids and other insects.

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Key words

Phasmida, Water balance, Excretion, Respiration, Cuticle.

The ability to regulate their water levels very effectively has possibly been one of the most important driving forces in bringing about the huge diversity and number of insect species present in terrestrial environments today. Indeed, insects just in the Order Phasmatodea live in a huge variety of environments, from *Dares* spp. in the rain forests of Borneo to *Gratidia* spp. living in the scorching grasslands of Africa.

Many species of stick insect do drink very readily, for example *Eurycantha* spp., but this is by no means always the case. Spraying of some species in culture can quickly lead to their demise and according to some keepers is entirely unnecessary, if the humidity is at the correct level many of the commoner species will live for many generations without ever drinking. So how do these insects prevent themselves from drying out?

Firstly, it must be noted that many phasmids are not nearly so sensitive to water loss as we are. A human being can lose around 8% of its body weight in water before it becomes lethally dehydrated and dies. Even a camel can only tolerate a 25% decrease in water levels. Most dry-adapted insects, however, can happily survive the loss of nearly 60% of their body water without suffering any harm at all. Naturally, some insects will be more sensitive than others to water loss, but clearly they are in a completely different league from us in this respect.

Even though they may be much more tolerant to water loss than we are, this does not mean that stick insects simply allow water to be lost from them freely. At every point where water might be lost, it seems that the insects as a whole have devised ingenious methods for reducing that loss. In general, insects lose water by the same three routes through which we ourselves lose water. These are: (1) Over the body surface (ie. in insects over the cuticle), (2) From their respiratory surfaces, (3) Via excretion of waste products. Adult female insects also lose water in egg production, but this is largely unavoidable as it is vital that the developing embryo is surrounded by a solution containing the correct concentration of salts and nutrients. The remaining three routes for water loss must all be tightly controlled for the system to work efficiently and effectively in retaining water inside the insect.

(1) The Cuticle

This consists largely of chitin microfibrils, surrounded by a protein matrix. The water content of this varies widely and it is certainly not impermeable to water. This permeability could cause great problems for a stick insect. An important factor for water conservation in any animal is its Surface Area: Volume ratio (SA:V). As any animal gets smaller this gradually increases (there is no need to go into the maths here). Stick insects are relatively large by insect standards, but even so, their SA:V is much higher than our own. This is exacerbated by the fact that a long thin stick insect-shaped cylinder has a much larger surface area than a short fat cylinder of the same volume. Hence, the SA:V will be even higher for a phasmid. Also, leaves are specifically shaped to give maximal SA:V by being thin and flat, just the same shape as a leaf insect. With more surface area, there is more chance for water loss over the cuticle. How then is this prevented?

On the surface of the cuticle is the cuticulin layer, a mixture of waxes and lipids just one molecule thick that lies just over the last proteinaceous layer of the exocuticle. This may be protected by a cement layer which can help prevent mechanical damage to the wax. The cuticulin layer is very

important, as this layer is almost entirely responsible for preventing water loss over the cuticle, as can be demonstrated if you dust an insect with alumina powder. The powder, due to its gentle abrasive properties, rubs off the wax layer and consequently the insect will lose water as rapidly as an earthworm in the same ambient conditions. This treatment has no long term effects on the insect, as it has wax channels within its cuticle from which it can renew this wax layer either when it is damaged or when it is stretched as the cuticle expands during feeding.

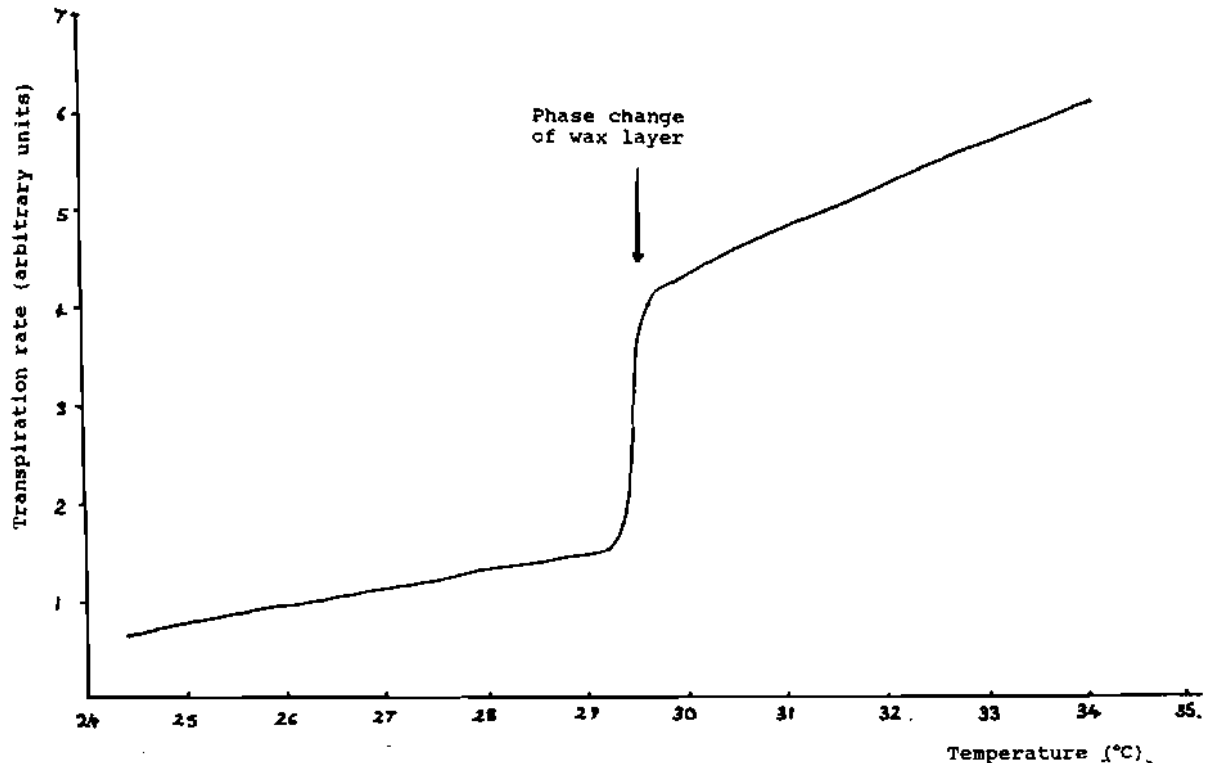


Figure 1 The effect of temperature on the permeability of the cuticle.

The wax is thought to be in a semi-crystalline state; if you heat up an insect, at 29°C there is suddenly a large jump in transpiration (ie: water loss) rate from the insect; see figure 1. The temperature at which this phase transition takes place obviously will vary between species, but possibly sets the upper temperature at which the insect can effectively control its water content without having to imbibe large quantities of water. The wax layer is situated near the surface of the insect because, during ecdysis, the insect will try to minimise its losses by reabsorbing as much of its old cuticle as it can. An impermeable lipid layer would prevent this reabsorption and so must be kept to the outermost layers of the cuticle.

(2) Respiration

When an organism is respiring, it faces a conflict of interests in a dry environment. Oxygen will only cross a cell membrane in solution. This means that any respiratory surface must be kept moist. However, this leaves the insect with a large surface area from which water may readily evaporate, dehydrating the animal very quickly.

Phasmids, like most other terrestrial insects, respire via a tracheal system: a network of internal tubes which carry air directly to the respiring tissues. This internalisation of the respiratory surfaces is common to most terrestrial animals, but insects really excel in reducing water loss from their respiratory surface by maintaining tight control over their spiracles. Spiracles are the small

valves on the surface of the thorax and abdomen of the insect, one pair for each obvious segment in stick insects. They resemble eyes (see diagrams of an abdominal and thoracic spiracle: figures 4 and 5) and the "eyelids" operate under precise nervous control to change the aperture of the opening. This process allows what is known as "cyclic respiration". If you measure the carbon dioxide (CO_2) output and oxygen (O_2) intake of an insect (no easy task, as they respire very slowly), you can see that, in dry conditions, the two do not appear to be linked in any way (see Figure 2). How is this pattern of ventilation achieved through just a single opening?

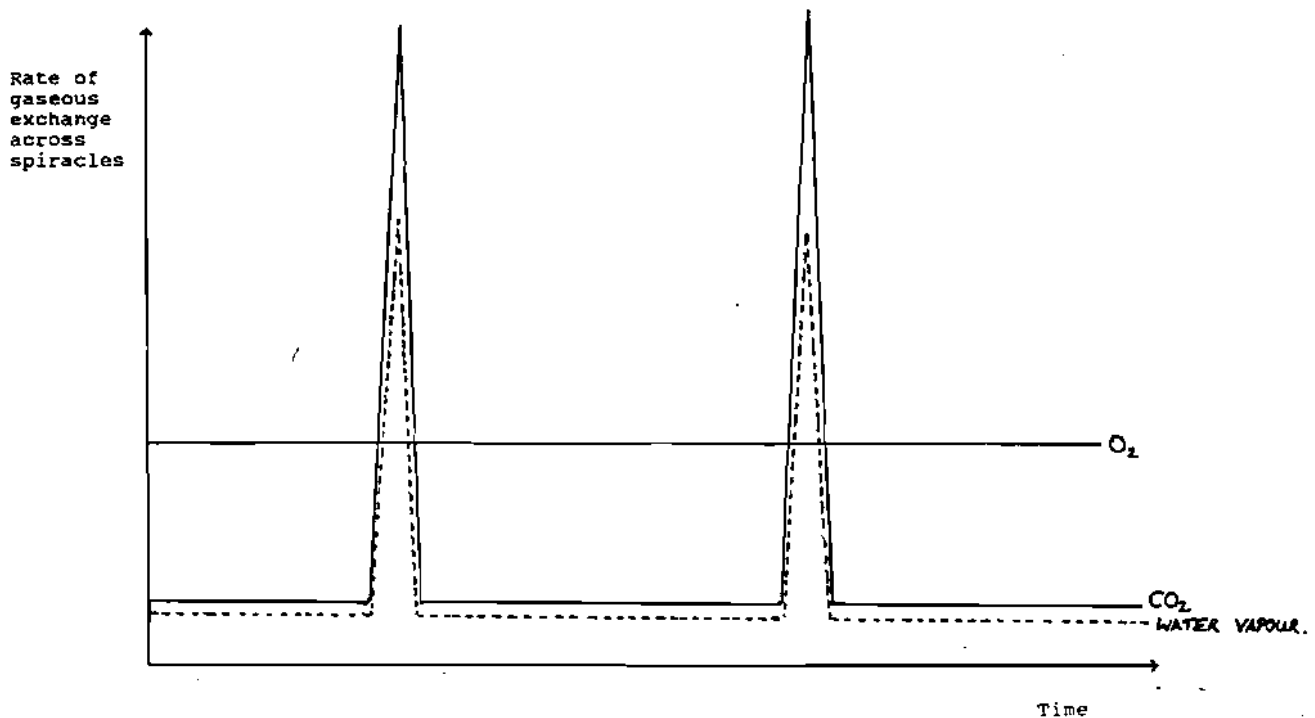


Figure 2 Cyclic respiration.

The process is very elegant and occurs in two stages:

i) The spiracle is almost closed as in figure 3(i), allowing only a very small entry channel for the air. O_2 is used up by the cells, and CO_2 produced. However, CO_2 is much more soluble in water than O_2 and therefore tends to remain in solution instead of crossing the cell membrane into the tracheole. This causes a reduction of pressure in the trachea, which, just like sucking on a straw, draws air into the open end (especially O_2 as it also is diffusing down quite a steep concentration gradient). The miniature "wind" created in this way effectively blows any water vapour away from the spiracle, so almost completely blocking water loss.

ii) Of course, this means that CO_2 levels will be building up in the cells and tracheae and so this potentially harmful waste product will eventually need to be expelled. This is done by opening the spiracles wide and actively pumping the CO_2 out of the cytoplasm in the cells as shown in figure 3(ii). This also allows water to leave the spiracles quite easily, but this phase is only short-lived, and the water curve follows roughly the CO_2 curve on the graph, so that in the long term, the water loss is much less than if the spiracles were open all the time.

If you have a magnifying glass (and a fair amount of patience!) you can watch the spiracles on

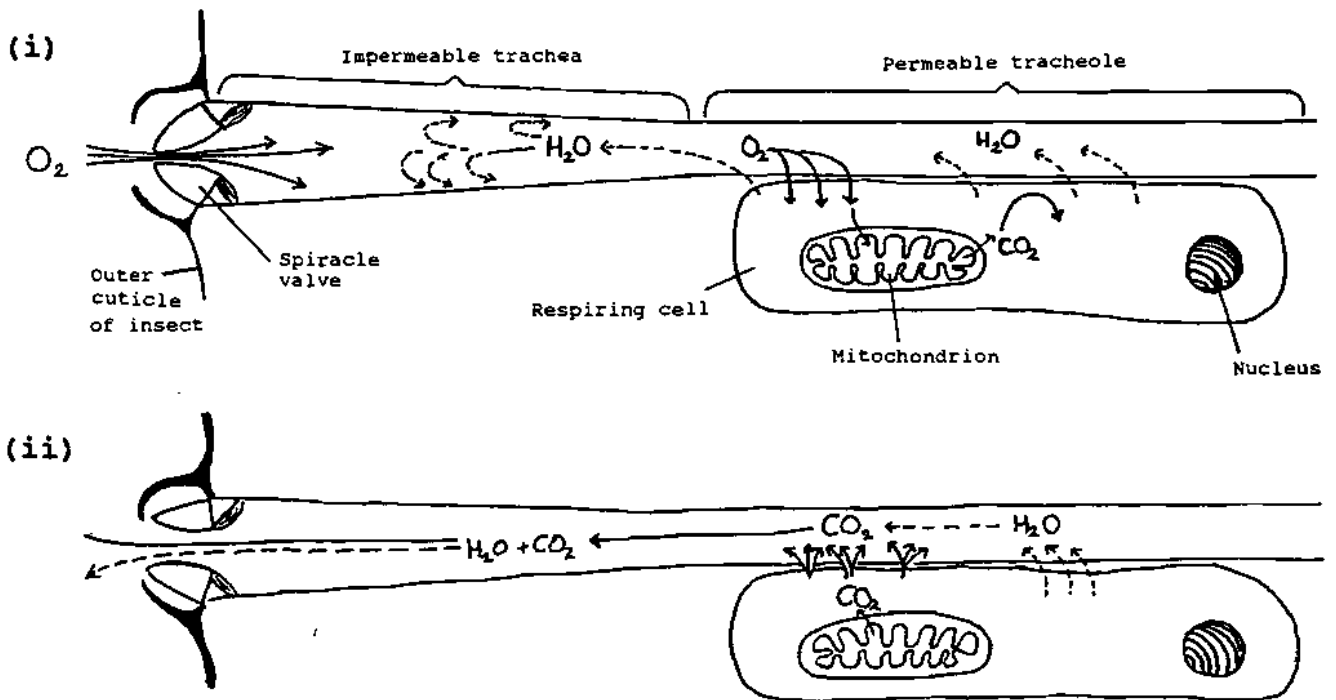


Figure 3 Gas exchange inside the tracheole.

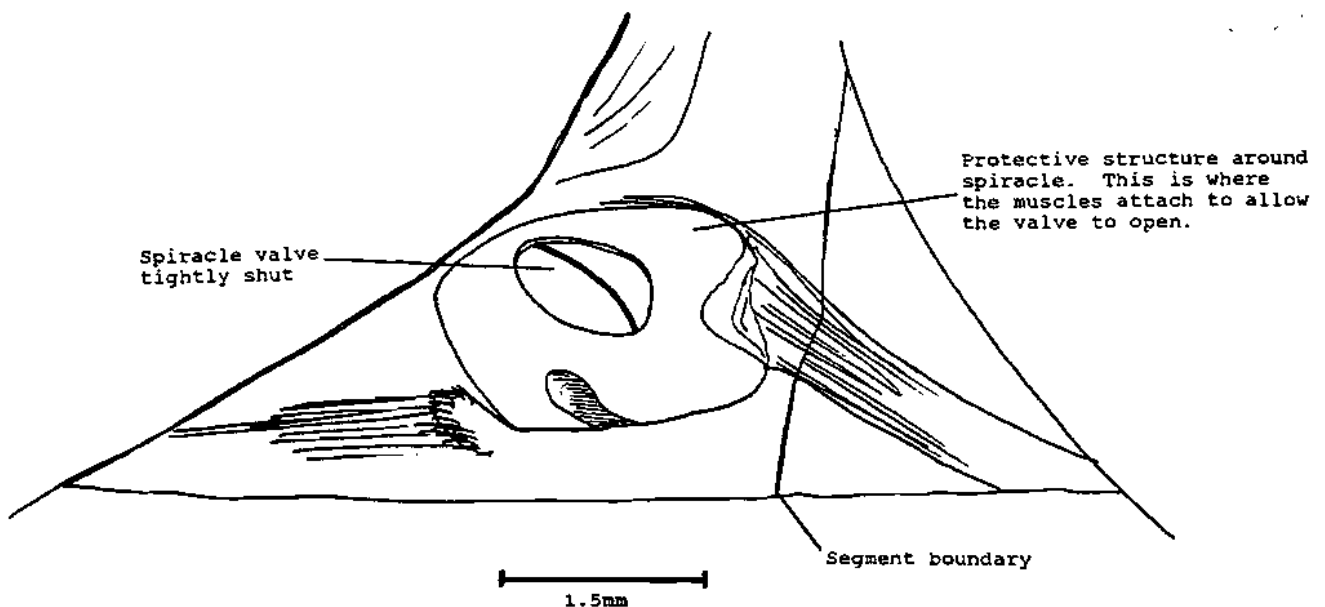


Figure 4 Closed spiracle on 4th abdominal segment of ♀ *Gigantophasma pallipes* Sharp

some of the larger insects eg. *Extatosoma tiaratum*, rhythmically opening and then almost closing, so controlling this process (see Figures 4 and 5). In a confined adult *Carausius morosus* I

measured a rate of about three to four cycles per minute in a very humid environment, although I would expect the cycles to be much longer than this if the insect were short of water.

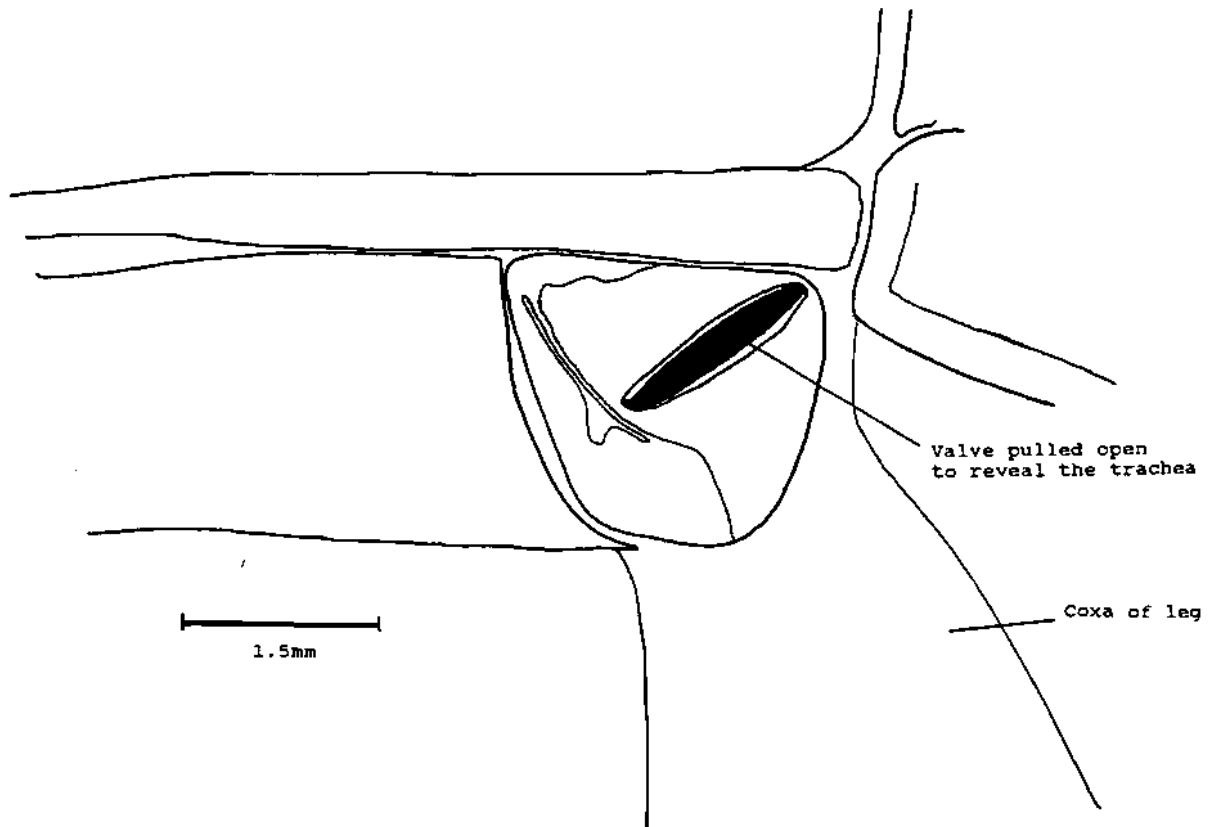


Figure 5 Open spiracle on 2nd thoracic segment of ♀ *G. pallipes*.

(3) Excretion

The excretory system is possibly the most specialised defence that insects possess against excessive water loss. All animals need a way to get rid of toxic waste products, and this is especially important for herbivores such as phasmids which may have to cope with a whole range of poisons that the plants on which they feed produce to ward them off. This is especially true for fern eaters such as *Carausius sechellensis* which may even have to deal with cyanide, which some ferns produce as a defence against herbivory.

Insects excrete substances from their haemolymph by using their malpighian tubules. These are a number (two to several thousand) of blind-ended tubes that splay out from the junction between mid and hind gut. The tube walls are only one cell thick, but still, in comparison with most other animals, are relatively impermeable to anything unless given specific hormonal cues to open up the various ion channels, or to activate pumping mechanisms. This impermeability creates a very slow flow rate into the tubes and consequently throughout the excretory system, and this in turn allows reabsorption of a lot of the water from the tubules and later from the hind gut. The basic mechanism for filtration is to pump potassium (K^+) ions out of the haemolymph of the insect and into the lumen of the tubule. This causes water to follow by osmosis, and then other solutes may follow, possibly including molecules of large molecular weight (e.g. up to 10000g/mole), which enter through small gaps between the cells. Added to this is the active transport of various specific toxins which particular species might encounter during their lives, such as alkaloids from plants,

or magnesium and sulphate ions from salty water. This process is summarised in figure 6.

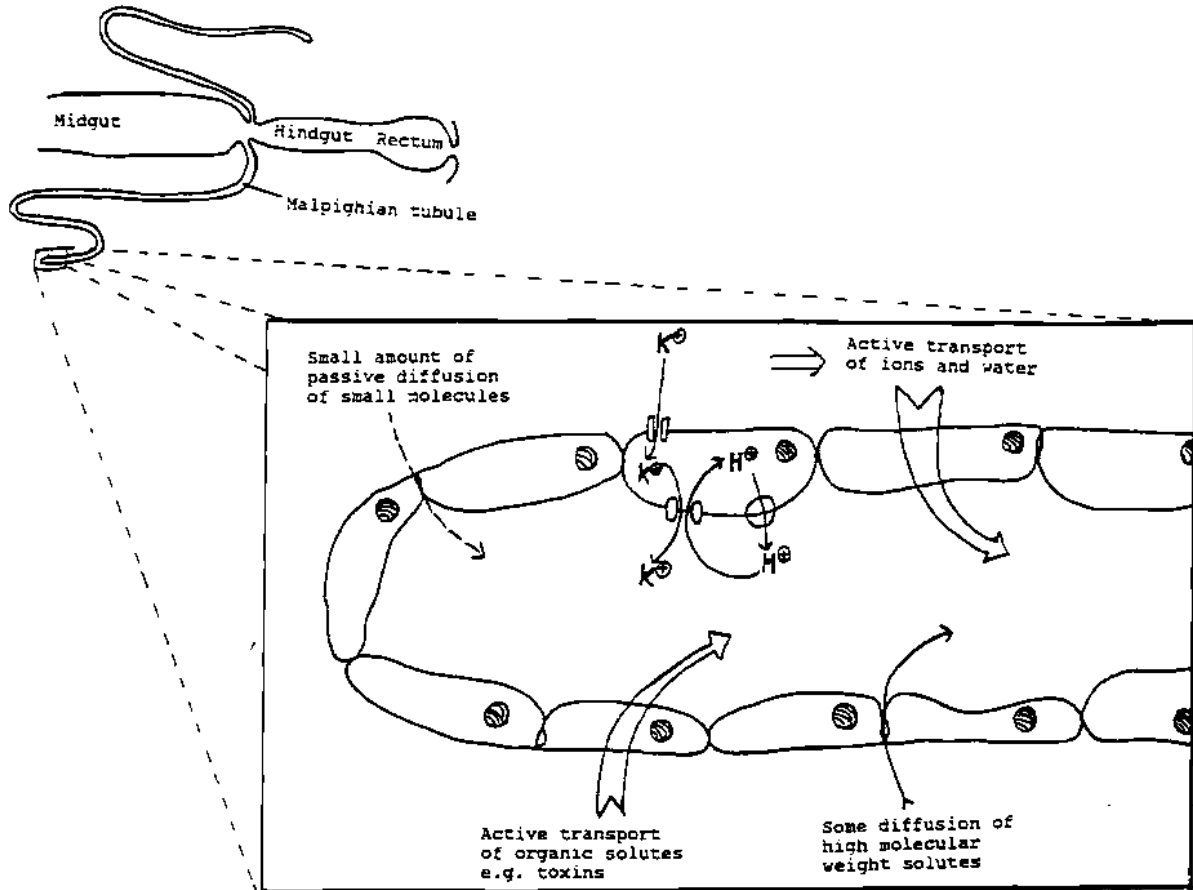


Figure 6 Excretion of substances in the malpighian tubules.

An important feature of insect water conservation is their "choice" of excretory product. Mammals excrete mostly urea, which requires around 50-100cm³ of water for every gram of nitrogen excreted. Insects (along with many reptiles and birds) go one better and excrete uric acid. This is virtually insoluble, especially as potassium urate to which it is converted in the tubules of the insect, and consequently only needs 10cm³ of water to excrete one gram of nitrogen. It is a little more energetically costly to make than urea, but the water-saving advantages seem to outweigh this slight disadvantage. Even this water may be absorbed again into the haemolymph in some insects to cut down even further on water losses. Nearly all of the useful solute and water reabsorption occurs in the hind gut of the insect. Amino acids and sugars are hauled back into the insect, probably via coupled transport to ions which the insect will be pumping back into its body, and this will draw some water out of the tubes back into the insect. However, the bulk of the water retrieval occurs in the rectum of the insect, again using just a single layer of cells to perform the entire concentrating task as is shown in figure 7. The effectiveness of this retrieval is shown in that many species of phasmod drop almost completely dry faeces. This concentration of wastes and toxins in the rectum could pose a serious danger to the living cells in the rectum lining. These are protected, however, by a lining of cuticle, impermeable to the large toxin molecules, but permeable to water and ions. This, therefore allows nearly all the water to be removed from the faeces without harm to the insect.

Combining these three approaches to the problem of water loss, the phasmods and other insects

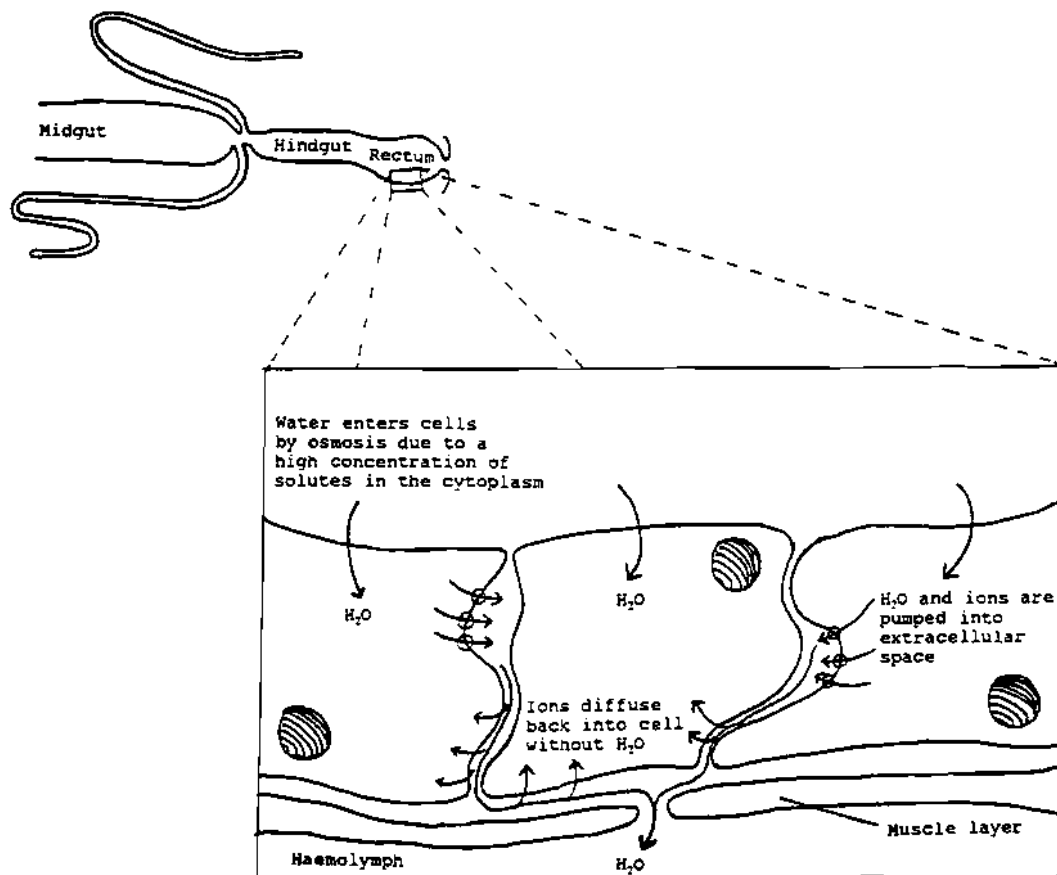


Figure 7 Reabsorption of water in the rectum.

have managed to survive in sizes and climates inaccessible to other terrestrial animals, and have thus been able to increase in number and diversity to the millions of species alive today. There is a final twist to the story, however, in that phasmids do not always want to be conserving water. A newly emerged imago of some holometabolous flying insect species, such as some Diptera, may lose up to 80% of their body water on their final moult to lighten themselves for flight (Maddrell, lecture 1995). Also, during flight, a lot of "metabolic water" is produced from the aerobic breakdown of glucose in the flight muscles. This amount can quickly exceed the amount being excreted by the malpighian tubules, and would therefore weigh the insect down. In both these cases, therefore, the excretory system is hormonally thrown into reverse, excreting phenomenal amounts of fluid very rapidly (for example, *Rhodnius* sp., a blood sucking bug from South America, can excrete its own body weight in water in only 15 seconds after a full blood meal), so quickly reducing the water load.

In conclusion, I hope that this summary of insect osmoregulation has shown how a few relatively simple structures (certainly in comparison with the mammalian kidney!) have enabled the phasmids and other insects to exercise exquisite control over their body water, allowing them to adapt to a huge range of environmental conditions.

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Lectures given by Dr William Foster and Dr Simon Maddrell on Insect Biology in January 1995 at Cambridge University.

The culture of Bornean phasmids.

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Key words

Phasmida, Culture potential, Borneo, Taxonomic assessment, Polyphagy, Monophagy

Introduction

At the PSG meeting at the Natural History Museum, London, on 22nd 1995, I gave an illustrated lecture on the species of Bornean phasmids which have been reared in captivity. The talk stressed that the "culture potential" i.e. the likelihood of establishing a culture, of a given species appears to depend upon the flight capability of the species. There is a close correlation between culture potential and taxonomic position; this is not unexpected as flight capability is generally closely linked to the taxonomic position of phasmids. This article summarises the lecture.

Since December 1987 I have visited Borneo on 7 occasions, spending a total of about six months on the island. Borneo is the third largest island in the world and is composed of four political units: Brunei (an independent country), Kalimantan (part of Indonesia), Sarawak (a State of Malaysia) and Sabah (also part of Malaysia). Most of my collecting has been done in Sarawak, although I spent five weeks in Kalimantan, three in Brunei, and two in Sabah.

My first visit to Borneo was a two week holiday with my wife and Lee Yong Tsui in December 1987 and January 1988, during this time we stayed with Dr Lee's family in Sarawak. Although not a collecting trip, seven species were collected over two nights and five of these were bred in the UK. All subsequent trips have been made specifically to collect phasmids and, whenever possible, to attempt to rear them in the UK. On each of these trips, with the exception 1993, I was accompanied by another member of the Phasmid Study Group, these were: Patrick van der Stigchel (1989), Paul Jennings (1990), Ian Abercrombie (1991 & 1994) and Paul Inglis (1992). During collecting trips to Sabah (one week in 1990 and one week in 1992), we were accompanied for some of the time by PSG member C.L. Chan who lives in Kota Kinabalu, Sabah. While in Brunei for a week in 1994 we stayed at the home of PSG member Mel Herbert who collected with us. I have spent 88 nights collecting phasmids in Borneo, with a mean of about five hours searching per night.

Prior to 1988 most of the species which have been cultured from Borneo were originally cultured from stock collected by Allan Harman or Jonathan Cocking in the early 1980s; most of these have since been supplemented by my own collections. A few of the early attempts, although listed on the PSG species list, were never established in culture and in two cases (PSG 65 and PSG 68) the identity of the species are unknown.

There are about 300 species of phasmid recorded from Borneo; there are also many undescribed species and some species which have been described from elsewhere but not yet recorded from Borneo. I have collected females of about 140 species and feel that I have sufficient data to make reliable predictions about the likelihood of establishing any given species in culture. Essentially the chance of establishing a culture depends on the flight capability of the females, if the females can fly there is little likelihood of establishing a culture. The reason for this appears to be related to their degree of polyphagy.

The data below summarises the Bornean species which have been successfully maintained in captivity in the UK. To qualify as being "successfully maintained", the species must have been kept alive for at least one month after arrival in the UK, or, in the case of eggs, nymphs must progress to at least second instar; in both cases the insects must feed on plants grown in the UK. In most cases successful maintenance has resulted in sustainable cultures. Although I have

personally maintained most of the following species in captivity there are a few which were originally only maintained by my companions, notably *Nearchus redtenbacheri* by Paul Jennings, and *Dinophasma saginata* and *Hoploclonia abercrombiei* by Ian Abercrombie.

For convenience the data is grouped by subfamily. In some cases the number of species recorded from Borneo is not clear because of the uncertain status of some nominal species. I have included a few species which are known to occur in Borneo but have only been cultured from sources outside Borneo.

Heteropteryginae

Although the members of the tribe Heteropterygini have wings, none can fly, with the possible exception of the males of *Heteropteryx dilatata*. All members of the other two Bornean tribes, Obrimini and Datamini, are wingless. The subfamily contains 24 or 25 Bornean species (25 if *Aretaon asperimus* and *A. muscosus* are distinct species). All 16 species which have been collected have been reared in captivity; 15 have given rise to sustainable cultures. The descriptions of two of the species listed in this subfamily have not yet been published. The following have been successfully maintained in captivity:

Heteropterygini: *Haaniella dehaani* (Westwood), *H. echinata* (Redtenbacher), *H. grayi* (Westwood), *H. saussurei* Kirby, *H. scabra* (Redtenbacher), *Heteropteryx dilatata* (Parkinson).

Obrimini: *Aretaon asperimus* (Redtenbacher), *Hoploclonia abercrombiei* Bragg, *H. cuspidata* Redtenbacher, *H. gecko* (Westwood).

Datamini: *Dares ulula* (Westwood), *D. validispinus* Stål, *D. verrucosus* Redtenbacher, *Datames borneensis* Bragg [in press], *Epidares nolimetangere* (de Haan), *Spinodares jenningsi* Bragg [in press].

Phasmatinae

There are about 13 species recorded from Borneo, all are in the tribes Baculini and Pharnaciini. The females of both these tribes are wingless. I have collected only four species, two have been successfully reared. In addition *Pharnacia serratipes*, has been reared from West Malaysian stock. The species which have been successfully maintained in captivity are all in the Pharnaciini: *Nearchus redtenbacheri* Dohrn, *Pharnacia kirbyi* (Brunner), *P. serratipes* (Gray).

Phyllinae

Four species are recorded from Borneo, three have been reared although none of the reared stock originated in Borneo: *Phyllium bioculatum* Gray, *P. giganteum* Hausleithner, *P. pulchrifolium* Audinet-Serville.

Aschiphasmatinae

This subfamily contains 27 species from Borneo. I have collected about 19 species although in some cases only males were found. The only ones to be reared are all in the same genus, *Dinophasma*, this is the only genus in the subfamily in which the females are always wingless. These three species all feed on Fuchsia and numerous early attempts to rear them on other foodplants were unsuccessful. However Paul Jennings has recently raised second generation stock of *D. guttigera* on bramble.

The three species which have been successfully maintained are: *Dinophasma guttigera* (Westwood),

D. kinabaluensis Bragg [in prep], *D. saginata* (Redtenbacher).

Lonchodinae

All members of this subfamily are wingless. The only Bornean species which I have collected but have not maintained in captivity are two species which died before reaching the UK.

The following species have been successfully maintained in captivity: *Carausius sanguineoligatus* (Brunner), *C. chani* (Hausleithner), *C. cristatus* Brunner, *C. abbreviatus* (Brunner), *C. mirabilis* (Brunner), *Lonchodes amaurops* Westwood, *L. brevipes* Gray, *L. everetti* (Brunner), *L. haematopus* Westwood, *L. harmani* Bragg & Chan, *L. jejunos* (Brunner), *L. modestus* (Brunner), *L. strumosus* (Brunner), *Phenacephorus auriculatus* (Brunner), *P. cornucervi* Brunner, *P. sepilokensis* Bragg, *P. spinulosus* (Hausleithner), *Prisomera nigra* (Brunner).

Necrosiinae

The majority of this subfamily are winged and capable of flight. There are about 170 species recorded from Borneo, about 20 of these are wingless or have reduced wings. Of the non-flying species, I have collected 8 and successfully reared 4. Of the fully winged species I have collected 75 and only managed to get one species, *Calvisia conicipennis*, to feed in captivity; although adults were kept alive for several months and eggs hatched, the nymphs refused to feed. *Orxines macklottii* has not previously been recorded from Borneo, however C.L. Chan has two specimens from Sabah; this species has been reared in the UK with stock originating in Java.

Only six species have been successfully maintained in captivity: *Acacus sarawacus* (Westwood), *Asceles margaritatus* Redtenbacher (wingless variety), *Calvisia conicipennis* (Bates), *Diesbachia hellotis* (Westwood), *Centema hadrillus* (Westwood), *Orxines macklottii* (de Haan).

In addition to those listed above *Sipyloidea sipylus* (Westwood) is in culture from Madagascar; the Bornean *Sipyloidea warasaca* (Westwood) has been synonymised with this species but there are a number of differences between Madagascan cultured material and Bornean material so I have excluded this species from the list.

Analysis of culture potential

Of the species which I have collected, approximately 1% of flying species have been maintained in captivity compared to 87.5% of flightless species. Although flightless species are generally found in larger numbers, this does not account for the difference, in several cases wingless species have been maintained and cultures established from a single specimen while common flying species cannot be maintained. The data shows a clear link between the flight capability of the females and the culture potential.

The possibility of maintaining a species in captivity is dependant on finding a suitable foodplant. Obviously a flying insect can be more selective about foodplants as it is able to move around more freely in search of an appropriate plant. However this only applies to the adult insects, some other factor must also exert an effect on the nymphs.

Of the subfamilies under consideration, only two seem to select sites for depositing the eggs, the others scatter their eggs more or less randomly. Those that scatter their eggs are able to move easily in search of food. Newly hatched Phylliinae nymphs climb rapidly and can probably glide from tree to tree so finding a suitable plant may not be difficult. Nymphs of Lonchodinae and Phasmatinae have long legs and can climb quickly in search of a foodplant, as both groups appear

to be quite polyphagous, finding a suitable plant should be quite easy. The ability to drop to the ground and climb rapidly means that they can soon reach the leaves of another plant if their first choice is unsuitable.

The Heteropteryginae bury their eggs in the ground; this group are generally slow moving, however, as they are usually highly polyphagous, finding a suitable foodplant near the ground presents no difficulty. Several species readily feed on leaf litter (i.e. leaves which have been dead, and on the bottom of the cage for several months) in captivity.

The majority of the Necrosiinae lay eggs in specific places, using various mechanisms to ensure that the eggs remain in place. At least two genera, *Asceles* and *Paraloxopsis* pin their eggs to the leaves of plants. *Calvisia* and at least some *Sipyloidea* glue the eggs to leaves and stems, eggs removed from the bodies of other species suggest that this method is probably used in other genera such as *Marmessiodea* and some *Sosibia*. Many species produce cylindrical eggs with a pointed polar end and appear to push the eggs in to gaps e.g. cracks in bark, these include members of *Acacus*, *Aruanoidea*, *Centema*, *Diesbachia*, *Echinoclona*, *Galactea*, *Necroscia*, *Nescicroa*, *Orthonecroscia*, and *Orxines*. These methods ensure that the nymphs hatch out in a place selected by the adult female, so these insects can be monophagous or at least highly selective feeders without the nymphs having to climb up several unsuitable tall trees in the rainforest.

The Aschiphasmatinae are generally capable of good flight but appear to drop their eggs to the ground, this appears to contradict the situation in the Necrosiinae. However all the species observed feeding in the wild have been found on shrubs, or in one case a smallish tree with low branches, the newly hatched nymphs would not have far to climb in order to reach suitable foliage, and if the eggs are only dropped from a low bush they would not travel far from the foodplant. In addition the nymphs of this group seem to move more rapidly than many phasmids, this ability would help the nymphs to reach suitable food.

Non-Bornean winged phasmids

Although there are currently five winged species of Necrosiinae in culture from outside Borneo, this is a minute proportion when one considers the subfamily contains about 800 species, most of which can fly. Most of the cultured Necrosiinae do not fly, only one of the flying species, *Sipyloidea sipyilus*, attaches its eggs to plants.

Winged members of the Phasmatidae often have heavy bodies and the females would have difficulty flying, furthermore the eggs are dropped to the ground, polyphagy would therefore be expected. Several species of this group, most from Australia, are being reared in captivity.

Winged Pseudophasmatinae are generally good fliers. Only two species are being reared in captivity, both feed only on privet in captivity although they drop their eggs to the ground.

Summary

The available evidence suggests that there is very little chance of culturing a phasmid in the UK if the females fly well. The ability to fly well is associated with selective egg deposition above ground level, and with monophagy or very restricted polyphagy. Females which are unable to fly are associated with the random scattering, or burying, of eggs; they tend to be polyphagous and relatively easy to culture.

Polyphagy in *Clonopsis gallica* (Charpentier): a survey of woody plant species.

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Key words

Phasmida, *Clonopsis gallica*, plant acceptability, relative preference, foodplant ranking, leaves, petals, plant family, plant species, polyphagous behaviour.

Abstract

A survey of 50 woody plant species was carried out to determine the relative acceptability of the leaves (under "non-forced diet" conditions) as a potential food source for *Clonopsis gallica* (Charpentier). Twenty-five of the 29 species accepted are reported here for the first time as potential foodplants. These species belong to the following taxonomic families: Betulaceae, Cornaceae, Fagaceae, Rhamnaceae, Rosaceae, Saliceae, Tiliaceae and Ulmaceae. Under field conditions *C. gallica* appears to be most commonly found feeding on rose and bramble (Rosaceae). An examination of 18 other Rosaceae revealed that not all were accepted. Out of eight evergreen species tested only two were accepted and these were both Rosaceae. Where flower material was provided the petals were readily eaten, even in species where leaf material was avoided.

Introduction

Clonopsis gallica (Charpentier) appears to be widely distributed within France (with the exception of eastern, northern and north-eastern France) and throughout many coastal regions of The Mediterranean and North Africa (Brock, 1991; Chopard, 1951; Finot, 1890; Lelong, 1994). Observations concerning the feeding behaviour of *C. gallica* (Table 1) indicate that it is polyphagous for at least 12 plant species, though under field conditions it is most commonly found feeding on *Rosa* and *Rubus* species. However 12 out of the 18 observations cited in Table 1 provide an inadequate description of the foodplant material identified (e.g. species names have been omitted). For example, *C. gallica* was reported to feed on *Prunus* sp. (see Bullini, 1981) though this description is clearly deficient since the *Prunus* genus contains numerous species and hybrids (Davies, 1987; Stace, 1991). In addition no information is available concerning plant families or species which are not eaten by *C. gallica*. A more comprehensive survey of potential foodplants is therefore warranted in order to evaluate more fully the polyphagous behaviour of this phasmid.

The main aim of the present study was to investigate the acceptability of leaves (and in some cases flowers) of a wide range of plant species as a potential food source for *C. gallica* under captive conditions. The material provided was always tested in the presence of the standard rosaceous foodplants (i.e. rose or bramble). This allows freedom of expression of relative food preferences (i.e. "non-forced diet" conditions). A subjective ranking has been made for the acceptability of the test species relative to the standard foodplant species. Wherever possible a complete taxonomic description of the plant material used has been given (i.e. family, genus, species, and cultivar where either relevant or known), together with any further details. Some of this material was found growing within the vicinity of rose and bramble plants on which *C. gallica* was found feeding under field conditions. The handling of thorny foodplants such as rose and bramble can be awkward and such material may inflict wounds on both insect and experimenter during a moment of inattention, particularly when cleaning out rearing cages. A search for a thornless potential substitute was therefore a further aim.

Materials and methods

a) Rearing conditions

The present study was carried out in 1994 and 1995. The phasmid species used, *Clonopsis gallica* (Charpentier), has been in culture by the author since summer 1991, the present parthenogenetic stock originating from three females found on bramble and rose plants growing in the author's

garden (Villagrains, Gironde, S.W. France).

Reference	Plant species	conditions	place or region of field observation
Brock (1991)	¹ <i>Cytisus scoparius</i>	F	Algarve, S. Portugal
	¹ <i>Cytisus</i> sp.	F	
Bullini (1981)	² <i>Crataegus</i> sp.	F C	Mediterranean region
	² <i>Prunus</i> sp.	F C	
	² <i>Rosa</i> sp.	F C	
	² <i>Rubus</i> sp.	F C	
	³ <i>Coriaria myrtifolia</i>	C	
	² <i>Potentilla</i> sp.	C	
	¹ <i>Genista</i> sp.	C	
	⁴ <i>Hypericum perforatum</i>	C	
Gangwere & Morales Agacino (1973)	⁵ <i>Daphne gnidium</i>	F	Javea, S.E. Spain
Garnier, Langlois & Lelong (1994)	<i>Rosa</i> sp.	F	Escalquens (Haute-Garonne, S.W. France)
	² <i>Prunus spinosa</i>	F	
Guye (1995)	<i>Rosa</i> sp.	F	Villagrains (Gironde, S.W. France)
	<i>Rubus</i> sp.	F	
Scali & Mazzini (1981)	⁶ <i>Pistacia lentiscus</i>	C	
Voy (1954)	<i>Rosa</i> sp.	F C	Montfort-en-Chalosse (Landes, S.W. France)
	<i>Rubus</i> sp.	C	

Table 1. Published data concerning foodplant species of *Clonopsis gallica* under field (F) and captive (C) conditions. Families of the plants are indicated by: ¹Leguminosae, ²Rosaceae, ³Coriariaceae, ⁴Guttiferae, ⁵Thymelaeaceae, ⁶Anacardiaceae.

Around 200 specimens (of approximately the same developmental stage) were reared in a wooden cage measuring 60cm length x 44cm breadth x 50cm height. The front of the cage was removable and made of a 1.4 mm mesh netting to provide adequate aeration. Since *C. gallica* prefers cool conditions, i.e. 18-20°C (see Brock 1991), the rearing tank was kept in an unheated north-north-west facing room away from direct sunlight. Throughout the study day temperatures were within the range of 17-23°C (mean value of 18.7°C \pm standard deviation of 1.6) and night temperatures within the range 14-20°C (mean value of 16.5°C \pm standard deviation of 1.5). The threshold temperature for feeding in this species appears to be around 10°C (Guye, unpublished observation). Since the cage was in a poorly lit location artificial lighting was provided. A low-energy electronic lightbulb (9 watts, Globolux 110 - Orion, Austria) was programmed to give 16 hours of light (500-600 lumens) for every 24 hour period. Reasons for choosing this type of lightbulb were two-fold. First heating effects are minimal: the surface of the bulb is cool enough for an insect to walk on it without injury. Second, a significant financial saving is made relative to an incandescent bulb of similar light output due to the considerably lower power consumption

and longer operational life.

Branches of the standard foodplant, bramble (*Rubus fruticosus* agg.), possessing both young mature (recently fully-expanded) and immature (expanding) leaves were replenished each week. These were placed in a jar of water, the cut-end of the stems passing through holes drilled in the plastic screw-cap cover. In general an attempt was made to harvest fresh material early in the morning, while the vegetation was still covered in dew. Since the water content of leaf tissue is near to its maximum daily value at around dawn, due to nocturnal rehydration (Kramer, 1983), plant material harvested around this time was considered to be of better quality than that harvested later during the day. Alternatively plant material harvested later in the day was rehydrated by immersion in a bowl of tap water for one to two hours. Water droplets on plant material were allowed to evaporate before the material was placed in the rearing cage. Neither *C. gallica* nor its foodplant were sprayed with water since this species appears to prefer a fairly dry environment.

b) Feeding trials

The comprehensive field guide of Stace (1991) was used to check the identity and taxonomy of the plant material used. Plant hybrids which have attained a geographic distribution that is no longer tied to that of their parents (i.e., those that occur at least sometimes in the absence of both parents) are treated exactly like 'species', and are indicated in Table 2 with the multiplication sign inserted between the generic name and the specific epithet, i.e. *Fragaria* x *ananassa* and *Spiraea* x *vanhouttei* (Stace, 1991).

Feeding trials were carried out on second to fifth (adult) instars of *C. gallica*. The standard foodplant material was supplemented once each week with other plant species (see Table 2). The exception to this was branches of immature leaves of *Quercus robur* which were replaced twice a week as the quality of this material declined visibly within three to four days of harvesting (i.e. the leaves blackened). All material was harvested from plants growing outdoors with the exception of *Fragaria* x *ananassa* which was greenhouse-grown.

The main aim of this investigation was to determine potential foodplant acceptability for *C. gallica* under conditions of foodplant choice rather than under "forced-diet" conditions: the latter would be the case if alternative species were given in the absence of the standard foodplants. A relative ranking for the acceptability of each species as a foodplant was then given, using bramble as a reference. The ranking was as follows: not eaten (-), briefly sampled on contact but no further feeding (+), sampled and some subsequent feeding (++), and prolonged feeding (+++). The ranking used was a visual estimation of the leaf surface area consumed during a single feeding period (it did not refer to the total amount of leaf material eaten within a week).

Results and discussion

The leaves of 25 different plant species are reported here for the first time as potential food sources for *C. gallica* under captive conditions. These species were eaten to varying degrees and were as follows: *Alnus glutinosa*, *Betula pendula*, *Corylus avellana*, *Castanea sativa*, *Cornus sanguinea*, *Quercus petraea*, *Q. robur*, *Q. rubra*, *Frangula alnus*, *Chaenomeles japonicum*, *Cotoneaster buxifolius*, *Crataegus monogyna*, *Fragaria* x *ananassa*, *Prunus armeniaca*, *P. domestica*, *P. insititia*, *P. persica*, *P. persica* x *amygdalus*, *Pyracantha coccinea*, *Pyrus communis*, *Rubus idaeus*, *Salix aurita*, *S. cinerea*, *Tilia cordata* and *Ulmus carpinifolia* (Table 2). Where flower material was offered (*Cytisus scoparius*, *Ulex europaeus*, *Malus domestica* and *Rosa* sp.) the petals were readily eaten. It is interesting to note that in two of these species (*U. europaeus* and *M. domestica*) leaf material was not eaten.

Out of 18 Rosaceae, in addition to rose and bramble, five species were not eaten (i.e. *Cotoneaster lacteus*, *Cydonia oblonga*, *M. domestica*, *Prunus avium* and *Spiraea x vanhouttei*). More than one species was examined for the Caprifoliaceae, Grossulariaceae and Oleaceae. For each of these three families leaves were not eaten though it remains to be determined if this is typical for these families. Only one out of three Leguminosae was accepted.

The ranking method used to indicate relative acceptability (i.e. surface area of leaf tissue consumed by a phasmid in a single feeding period) is meant only as a rough guide. A more precise study should include a calculation of the weight of material consumed since more surface area would be expected to be eaten for a plant with thin leaves than for one with thick leaves, assuming that both species are equally palatable. In many cases it appeared that the plant species being tested was consumed only by a small proportion of the phasmid population used (i.e. in some cases only two or three leaves on a branch were eaten, though these leaves may have received a ranking of "+++"). Therefore the ranking given was limited to the feeding behaviour at the level of an individual polyphagous phasmid: it did not quantify the extent of polyphagy at population level (i.e. it did not define the percentage of individuals in a given population showing polyphagy).

One of the aims of the present work was to identify potential foodplant species that may be used as a substitute for rose or bramble. The ideal candidate would be a non-thorny evergreen. Evergreen material is particularly useful during late winter and early spring when the quality of bramble growing outdoors may be poor. Additionally, in the absence of easily available outdoor material, the alternative species should be easy to propagate (e.g. from cuttings or suckers) and grow relatively rapidly. Several non-thorny species are eaten, though *Cotoneaster buxifolius* represents the only non-thorny evergreen species (Table 2). However this species is slow-growing. Assuming that a winter food source is not required many of the above could be used though *Rubus idaeus* probably represents the best choice since it is the most closely related to bramble.

Quercus robur and *Castanea sativa* appear at opposite ends of a spectrum regarding the number of insect species found associated with them, i.e. 284 versus five insect species respectively (Anon., 1980). Though association does not necessarily imply herbivory (i.e. some of these insects will be predatory), it may be assumed that these figures are likely nevertheless to reflect an extreme difference in the number of insects feeding on these species. It was therefore a surprise to find *C. sativa* to be so readily accepted by *C. gallica*.

Differences in the acceptability of the different *Quercus* spp. examined may be due to differences in the surface characteristics of the leaves, particularly with regard to hairiness. For example *Q. robur* and *Q. rubra* were readily accepted and these species have glabrous leaf surfaces. However, *Q. petraea* (poorly accepted) and *Q. toza* (not eaten) have pubescent leaf surfaces. Similarly the avoidance of both *Cydonia oblonga* and *Cotoneaster lacteus* may be due to the pubescent to tomentose nature of the lower leaf surfaces.

The results of the present study, together with previous work, clearly demonstrate that *C. gallica* is a highly polyphagous species, i.e. a total of 36 species are accepted to varying degrees (Tables 1 and 2). However the percentage of individuals showing polyphagous behaviour within a given population needs to be determined. In addition, it remains to be determined whether alternative species may provide a suitable food source to rose or bramble. The most important criterion for such a food source is that it allows *C. gallica* to complete its life-cycle and reproduce. Alternative food material, though apparently non-essential, may nevertheless play a role as a dietary supplement in providing a "balanced nutrition". Such questions are under investigation by the present author.

Table 2. Feeding behaviour of *Clonopsis gallica* in captivity on a range of woody plant species (see following page for explanation).

Plant family	Taxonomic name (common name)	Acceptability of leaves	Further details
Aceraceae	<i>Acer negundo</i> (ashleaf maple)	-	D
Araliaceae	<i>Hedera helix</i> (ivy)	-	E 1
Berberidaceae	<i>Mahonia aquifolium</i> (Oregon grape)	-	E 1
Betulaceae	<i>Alnus glutinosa</i> (alder)	+++	D
Betulaceae	<i>Betula pendula</i> (silver birch)	+++	D
Betulaceae	<i>Corylus avellana</i> (hazel)	+++	D 1
Caprifoliaceae	<i>Lonicera periclymenum</i> (honeysuckle)	-	D 1
Caprifoliaceae	<i>Viburnum tinus</i> (viburnum)	-	D 1
Caprifoliaceae	<i>Sambucus nigra</i> (elder)	-	D 1
Celastraceae	<i>Euonymus europaeus</i> (spindle tree)	-	D 1
Cornaceae	<i>Cornus sanguinea</i> (dogwood)	++	D
Fagaceae	<i>Castanea sativa</i> (sweet chestnut)	+++	D 2
Fagaceae	<i>Quercus petraea</i> (sessile oak)	+/++	D 2
Fagaceae	<i>Q. robur</i> (pedunculate oak)	++/+++	D 1 2
Fagaceae	<i>Q. rubra</i> (red oak)	+++	D 3
Fagaceae	<i>Q. toza</i> ("tauzin" oak)	-	D 3 4
Grossulariaceae	<i>Ribes rubrum</i> (red currant)	-	D
Grossulariaceae	<i>Escallonia macrantha</i> (escallonia)	-	E
Juglandaceae	<i>Juglans regia</i> (walnut)	-	D
Leguminosae	<i>Cytisus scoparius</i> (broom)	++	D 5
Leguminosae	<i>Robinia pseudoacacia</i> (false-acacia)	-	D T 1
Leguminosae	<i>Ulex europaeus</i> (gorze)	-	D T 5
Oleaceae	<i>Ligustrum vulgare</i> (privet)	-	E
Oleaceae	<i>Syringa vulgaris</i> (lilac)	-	D 1
Oleaceae	<i>Fraxinus excelsior</i> (ash)	-	D 2
Rhamnaceae	<i>Frangula alnus</i> (alder buckthorn)	++/+++	D
Rosaceae	<i>Chaenomeles japonicum</i> (ornamental quince)	++	D 1
Rosaceae	<i>Cotoneaster buxifolius</i> (box-leaved cotoneaster)	++	E
Rosaceae	<i>C. lacteus</i> (late cotoneaster)	-	E
Rosaceae	<i>Crataegus monogyna</i> (hawthorn)	++	D T
Rosaceae	<i>Cydonia oblonga</i> (quince)	-	D 6
Rosaceae	<i>Fragaria x ananassa</i> (garden strawberry)	+++	D 7
Rosaceae	<i>Malus domestica</i> (apple)	-	D 5
Rosaceae	<i>Prunus armeniaca</i> (apricot)	++	D 8
Rosaceae	<i>P. avium</i> (sweet cherry)	-	D 1 9
Rosaceae	<i>P. domestica</i> (plum)	++/+++	D 10
Rosaceae	<i>P. insititia</i> (French cherry plum)	++/+++	D 1 11
Rosaceae	<i>P. laurocerasus</i> (laurel)	+	E 1
Rosaceae	<i>P. persica</i> (peach)	++	D
Rosaceae	<i>P. persica x amygdalus</i> (peach-almond hybrid)	++	D
Rosaceae	<i>Pyracantha coccinea</i> (firethorn)	++/+++	E T
Rosaceae	<i>Pyrus communis</i> (pear)	++	D
Rosaceae	<i>Rosa</i> sp. (garden rose)	+++	D T 5
Rosaceae	<i>Rubus fruticosus</i> agg. (bramble)	+++	D/E 12
Rosaceae	<i>R. idaeus</i> (raspberry)	+++	D
Rosaceae	<i>Spiraea x vanhouttei</i> (Van Houtte's Spiraea)	-	D
Saliceae	<i>Salix aurita</i> (eared willow)	++	D
Saliceae	<i>S. cinerea</i> (grey willow)	++	D
Tiliaceae	<i>Tilia cordata</i> (small-leaved lime)	++	D
Ulmaceae	<i>Ulmus carpinifolia</i> (smooth-leaved elm)	++	D 1
Vitaceae	<i>Vitis vinifera</i> (grapevine)	-	D

Key to table 2.

Acceptability of leaves: This column indicates relative feeding preferences as follows: not eaten at all (-); briefly sampled on contact but no further feeding (+); sampled and some subsequent feeding (++); prolonged feeding (+++).

Further details: (D) deciduous; (E) evergreen; (D/E) intermediate between D and E; (T) possessing thorns; (1) found growing within a 10 metre radius of bramble and rose foodplants where *C. gallica* was originally found feeding; (2) only immature leaves provided; (3) only immature leaves eaten/mature leaves avoided (4) an oak species generally limited to southwestern Europe; (5) petals of flowers readily eaten; (6) cv. Champion; (7) cv. Elsanta, greenhouse-grown; (8) cv. Bergeron; (9) cv. Napoleon Bigarreau and a garden escape of unknown provenance were tested; (10) cv. Reine-Claude d'Ouillans; (11) cv. Mirabelle de Nancy; (12) [agg.] = aggregate - most taxa of the subgenus *Rubus* form an extremely complex group which is difficult to classify and so are often known collectively by this name.

Addendum

Since this article was prepared I have been informed that *C. gallica* may also be found feeding on *Prunus dulcis* (wild almond) and *Dorycnium suffruticosus* (dorycnium) under field conditions (Philippe Lelong, personal communication). Therefore *C. gallica* appears to be polyphagous for at least 38 plant species.

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The survival of newly-hatched leaf insects.

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Key words

Phasmida, *Phyllium bioculatum*, Predation, Dispersal, Ants.

Introduction

Leaf insects belong to the Phylliidae family of leaf and stick insects. They are only found in tropical Asia, Australia, and the Seychelles. There may be around twenty species of *Phyllium* (Brock, 1992: 46). The species we were studying was *Phyllium bioculatum* Gray. They are red upon hatching but turn green within three to seven days. They possess no defences such as sting, taste, etc. (as far as we know), relying on their ability to camouflage themselves against leaves. They are hatched from eggs which are laid at the rate of about three per day per female. Once hatched, the insects take 95-110 days to become fully grown, males maturing more quickly than females. Female leaf insects are heavy-bodied and flightless, while males are winged and fly freely. The average female will lay perhaps 500 eggs in her lifetime yet on average only two need to survive to maturity to maintain the population. What are the main biological controls that limit the population?

Red ants of the genus *Oecophylla* are common inhabitants of the trees which leaf insects use as their food plants. The ants make their nests by gluing leaves together with a kind of silk from the mandibles of their larvae, which they wield in their jaws. These ants not only spray formic acid from a modified sting gland but also use it in their bite, cocking the abdomen over the head and releasing acid onto the jaws (Skaife, 1979: 250). They will use their defences to protect their nests, or if they feel that there is a threat in the form of another insect in their immediate surroundings. Although their main food source appears to be "honeydew" from coccids, you also see them carrying small insects along to their nests. If you place a crumb of cooked chicken's egg yolk where they are foraging it is rapidly devoured and carried off by the ants. One frequently sees files of ants following well defined (to them!) paths along the trunk and branches of the tree on which they are living.

The purpose of this experiment is to observe the interaction of red ants with the leaf insects on their way up a tree, and to determine the seriousness of the threat that these red ants represent to the leaf insects.

Method

Eleven leaf insects, six of them were one day old and the remaining five newly hatched (seconds old), were individually released at the bottom of two adjacent mango trees, one of their natural foodplants (Woolman & Dharmasiri, 1995: 34). They were observed for their reactions to their surroundings, especially in their encounters with red ants which were considered likely predators. A map was drawn of one of the trees and the progress of the nymphs marked on it. Due to the problems of keeping track of the nymphs in three dimensions, however, this did not prove very useful. The weather at the time was unusually blustery and overcast with a temperature of 27°C.

It should be pointed out that the nymphs were being released into their natural habitat and that experience from many earlier releases suggested that they would cope successfully with most ant-contacts.

Observations

Nymph 1

The first leaf insect was released at the bottom of the first tree, where it remained still among the leaves. It remained there for about one minute, and then raced up the trunk of the tree to the leaves at the top, not stopping once on its way and not intercepted by any predators. It took about two minutes to reach near the top of the tree. At that point a gust of wind blew it off the tree trunk and we lost sight of it.

Nymph 2

The second one was released from the same spot, it slowly moved up about 5cm and then stopped, pausing for about two minutes. It then continued upwards, about 5cm further, and then stopped again for about the same amount of time. It continued this pattern all the way up the trunk, pausing sometimes for over five minutes at a time. At times it seemed to be in danger of being blown off by the wind. This insect too faced no opposition from other insects on its way up the tree.

Nymph 3

The third one released on this tree did encounter a red ant, the ant seemed to nibble at the leaf insect's leg for a second or two, and then the ant moved on, leaving the leaf insect alone. The nymph moved on and found a leaf quite low down on the tree where it crawled onto the underside and stayed for at least an hour (when we stopped our observations).

Nymph 4

This one paused 35 seconds and then climbed up steadily. It met an ant trail and almost got attacked but backed off quickly and escaped. It moved more or less horizontally around the tree to the right, paused for a minute and a half and then resumed its climb upwards safely.

Nymph 5

This one climbed steadily up the trunk and onto one of the lower branches. It crossed an ant trail unnoticed by the ants. It climbed up higher than any of the others. It stopped for two minutes at a height of 10m and then resumed its ascent until we lost sight of it.

Nymph 6

This encountered no other insects at all on its way up. It went directly up the tree.

Nymphs 7-11

During the course of the observations, at 8.40am, three eggs hatched almost simultaneously, while two more hatched a minute later (a sixth hatched about an hour later). The hatching process was very swift. It took no longer than ten seconds for them to worm their way free of the eggshell. At this stage their abdomen was cylindrical and the colour almost black. They immediately scurried across the ground and up the trunk of the tree, climbing approximately one metre up before pausing, each in a slightly overhung spot, to expand their abdomens. They remained there for about 15 minutes by the end of which time their abdomens were the bright reddish (with a fine tracery of black lines) typical of a very young nymph. Three of them then continued on up the tree, pausing and stopping occasionally for a few minutes at a time. One of them encountered a red ant and immediately dropped off the trunk to escape. The other two reached the top without any interference. Of the remaining two, one waited 45 minutes before climbing on up, whilst the fifth one was still in its initial resting place over an hour later.

Discussion

How much of a threat do red ants really pose to newly hatched leaf insect nymphs? It seems as if the immediate threat is small, even though there was a large colony of red ants in one of the mango trees. All of the insects we released reached the top intact, only one of them (nymph 3) actually being detained by an ant and even then being left alone after the first nibble. This indicates only 9% experience any opposition at all. Out of about 150 nymphs released onto various trees in the school grounds only three fatal encounters were observed. The problem cases occurred when the leaf insect's path converged, at a shallow angle, with a busy ant trail. With such a wide area as a tree trunk, the chance of this is quite small. Additionally, there is a suggestion that ants and nymphs make different choices. There seems to be a tendency for ant trails to keep to the low-points on the bark whilst the leaf insect nymphs appear to favour the prominences. Certainly in our detailed observations, 11 out of 11 insects did not intersect any ant paths at a shallow angle. Surprisingly, when the nymphs crossed an ant-trail at right angles, they nearly always passed through unscathed. If they bumped into an ant they backed off swiftly, moved a little to one side, and then scurried forward again. This generally took them through the line before the ants registered their presence. It is likely that there is more to this than just the element of swiftness and surprise.

It is strange, given that these ants are generally thought of as predators, that when an ant did intercept a leaf insect the ant generally left it unattacked. The coloration and bearing of the nymphs is very similar to that of large soldier ants. They even hold their body off the ground the same way. It may be that the worker ants mistake the nymphs for their own kind in these brief encounters. A mimicry of this sort was suggested for *Extatosoma tiaratum*, another phasmid with ant-like nymphs, by Key (1970).

Ants are one potential predator of leaf insect nymphs but what about birds and lizards? It takes a couple of days for the nymphs' coloration to start to match that of the leaves. When they make the journey up their trees they are bright red, easy to spot by the human eye, and no doubt just as easy to spot by a bird or any other visual predator. Although they are harmless, does this red act as a warning colour, in an attempt to trick predators, as many other insects which are dangerous also have bright colours? The curling up of the abdomen in a scorpion-like fashion may add to this deception. On one occasion two nymphs were observed passing within 50cm of a garden lizard, *Calotes versicolor* (Daudin), on an adjacent branch; the lizard ignored them. If one thinks about it, being green would not help them on the climb up the tree, the trunk is not green and their movement would give them away. It should be noted that the red colour is not as conspicuous as one might think once the nymph has settled underneath a leaf. Many of the mango leaves have bright red spots and patches, perhaps in reaction to fungal attack, and the nymph becomes just one more red fleck in the leaf.

Their similarity to ants, and their bright colour, may be why so many of these insects seem to reach the top of the trees alive. The overwhelming majority of eggs hatch in the daytime, mostly before midday. Interestingly, if the young nymphs are released at night they are very reluctant to move on up the tree-trunk. After dark, warning colours and mimicry would be no help in avoiding tree frogs, geckoes, scorpions and other denizens of the tropical forest.

In the daytime, some of them seemed to be in no hurry to reach the top, pausing many times along the trunk, others climbed from bottom to top without a stop. This variability might help ensure that at least some of the nymphs survive the journey in any particular situation. The insects seemed to be attracted to shaded areas, possibly because these areas are usually caused by the presence of

leaves above them. Perhaps they can sense the shade and this is what guides them to safety. It seemed that the leaf insects knew where the leaves were, as if they could see the leaves with eyes. We several times watched a nymph reaching out at full stretch for a leaf just beyond its grasp.

On more than one occasion we observed nymphs being blown off the tree trunk. They are very thin and light and in a high wind could be carried almost any distance. The gene-pool may be kept mixed through having adult males that can fly but this would not help the species reach new habitats. Storm-blown nymphs could do so, and this may be an important dispersal mechanism.

Conclusion

We conclude that red ants, and other predators, do not pose a serious threat to newly hatched leaf insects. This may be because the leaf insects can see to avoid them, because of the leaf insects' bright "warning" colouring, or because of their striking similarities to the ants themselves.

Our study is limited to the hazards associated with the first few minutes of a leaf insect's life outside the egg. While there are common sense reasons to assume that this is a particularly dangerous time, it would be helpful to have some data on the remaining portion of the insect's life! The next step must be to make field observations of eggs, juveniles and adults under wild, or semi-wild conditions.

Acknowledgement

The authors conducted this study under the supervision of C. Woolman.

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PSG 72, *Phyllium giganteum* Hausleithner.

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Key words

Phasmatodea, *Phyllium giganteum*, Breeding, Rearing.

Classification

This species had been sold by dealers in Malaysia many years ago. Hausleithner had a specimen which he originally believed to be *Phyllium pulchrifolium* Serville but later received another specimen with some eggs and recognized that it was an undescribed species. Then in 1984 he described it as *Phyllium giganteum*.

Culture history

Phyllium giganteum was in culture in mid 1984 (Fox, 1984: 6) and the culture may have been started in 1983, or even earlier.

Distribution

This species is only recorded from West Malaysia (Cameron Highlands and Tapah Hills) and Sarawak. The thirteen females I have in my collection also come from West Malaysia. It seems to be quite common in West Malaysia, as large numbers of dead and living ones are sold by Malaysian dealers every year.

Adults

As the name suggests, this is the largest species of this genus to be described so far. It is a very typical member of this genus, being very flattened and leaf-like. It is interesting to see that all our cultures here in Europe are parthenogenetic. The thirteen wild caught specimens in my collection (FH 25-28 & FH 571-579) range from 96-109mm in body length while my culture stock mainly ranges from 100-105mm. The maximum width of the body ranges from 52-57mm in my wild caught specimens. The head is quite big for *Phyllium* spp., being 12mm long. The antennae are very short (5.5mm) as in all *Phyllium* females. The sides of the mesonotum are serrated heavily

and the whole is granulated quite strongly. The tegmina are quite smooth for *Phyllium* spp. and reach lengths of 55-64mm. As in all *Phyllium* spp., except *Phyllium celebicum* de Haan, there are no hind wings. All the legs have lobes, but the lobes of the fore femora are very wide, being nearly triangular; the edges are covered by several, very small teeth. The abdomen is very

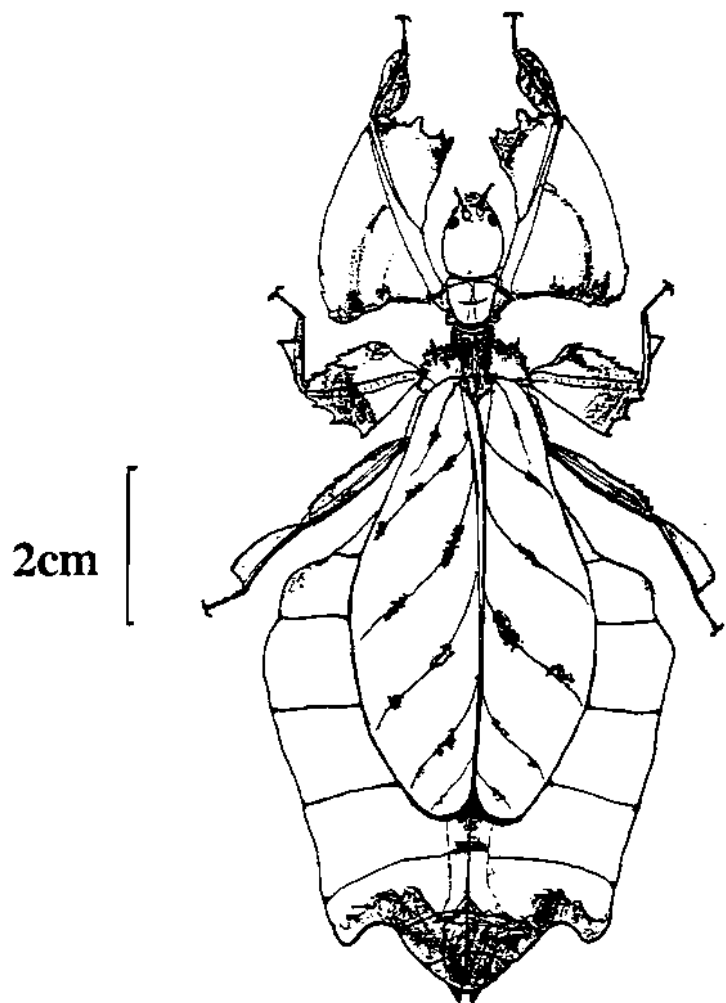


Figure 1 *Phyllium giganteum* female, typical coloration of culture stock.

broadened with irregular edges. The lateral margins of the 8th abdominal segment extend backwards, similar to *P. frondosum* Redtenbacher and *P. pulchrifolium* Serville; the lobes are however much smaller than in the other species.

Coloration is quite variable and interesting. Our cultured specimens are usually of a light green colour with several brown patches on the abdomen, tegmina, and legs. However the wild caught ones in my collection vary greatly from a uniform light or dark green to nearly brown. There are also specimens looking like our cultured ones and some with many small brown patches and spots all over the body, legs and head. Altogether they have much stronger colours which I think mainly depends on the foodplants. The wild caught ones often show leaf-fungus and virus-like spots and blemishes on the underside of their abdomens which I have also never seen in any of my culture.

As our cultures are all parthenogenetic, I am not describing the male, which has been described by Paul Brock (1994).

Eggs

These are about 6mm long, 4.5mm high and 4.8mm wide. Their colouring is a greyish brown or black and with age they become more or less brown. The operculum is cone shaped with a height of 1.5-1.8mm. The micropylar plate is elongated with the mid part being thicker than the ends. The whole egg is covered by several big holes and is granulated. When incubated at about 25°C and quite damp conditions, hatching takes some 6-8 months. Eggs of wild caught specimens usually have hatching rates of about 80-90% while those of bred specimens do not have more than 30%. The adults are not very prolific egg layers and egg production is not very frequent. There might be days, when each specimen produces up to three eggs and then a whole week when not a single egg is produced.

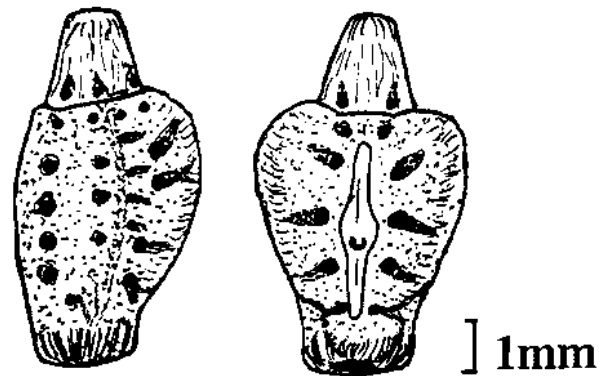


Figure 2 Lateral and dorsal views of egg.

Nymphs

These are dark orange-brown with several darker patches on the legs and body when newly hatched and have a body length of about 22mm with a maximum body width of the abdomen of 7mm. The lobes on the 8th abdominal segment do not project as far back as in the adults and the abdomen is more pointed and rhombic. They are the biggest nymphs of *Phyllium* spp. which I have ever seen. When they have started feeding, they change colour to a light apple green while there are still many brown markings on the legs and body. I have not counted but I think they have to do seven skin sheds before they get to adult.

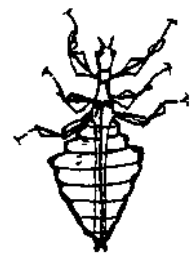


Figure 3 First instar nymph.

When nymphs are kept in plastic boxes or a larger cage full of fresh food, which provides a high humidity, and are not sprayed, they will grow very well and the mortality rate within the first instar will be kept to a minimum. I have had success rates of more than 95%. In my experience, when the nymphs have reached second instar there will not be any more losses.

Defence

Not surprisingly, defence is almost entirely reliant upon camouflage. While the younger nymphs are quite active, the larger ones will often drop from the foodplant and remain motionless for some time.

Development

Directly after hatching, the young nymphs are quite active and try to climb as high up into the leaf region as possible. After about two weeks, when they have fed, they change to a green colour and are not as active any more. After about three to four weeks they make their first skin change and turn to a uniform light green colour. The nymphs have to do about seven skin changes before they become adult, which usually takes about ten months or more. The adult females start producing eggs some 10 weeks after they have done their final skin shed.

Foodplants

In captivity, this species feeds readily on bramble (*Rubus* spp.) and Oaks (*Quercus* spp.). According to Michael Yeh (personal communication), in the wild they feed on guava (*Psidium guajava*) and Mango (*Mangifera* sp.). My *Phyllium bioculatum* and *Phyllium celebicum* also feed on pyracantha but I have not yet offered it to *P. giganteum*.

Breeding

In my opinion, this species is not really difficult to breed, however the hatching rates are often very low and there might be some problems with the final moult, when the humidity is too low. This species prefers high temperatures of 25-28°C and a high humidity of at least 70%. However, they should in my opinion not be sprayed at all, except the eggs of course. It is important that they always have plenty of fresh food and are best fed with oak when it is available, as they prefer it to bramble. They do also not accept dirt, either on the floor of the cage or on the foodplant, and plenty of light and fresh air must be provided. For the young nymphs, it is important to make sure, there is always enough food within the cage as they often walk along the sides and might never get in contact with food, when there is not.

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PSG 89, an unidentified species of Necrosciinae.

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Key words

Phasmatodea, Necrosciinae, Rearing, Breeding.

Culture history

This species was collected together with PSG 90, *Parahyrtacus gorkomi* Hausleithner, by Eric and Johan van Gorkom on Mindoro Island in the Philippines in August 1985. Both species are very common in the Puerto Galera area, but neither was found further to the south of the island. A report on rearing this species appeared in the *PSG Newsletter* in 1990 (Herbert, 1990).

Classification

This species is still unidentified, but by comparison with some dead specimens of other similar species in my collection, I found out that it is closely related to PSG 143 and *Sipyloidea meneptolemus* (Westwood) from Singapore; I collected two other very similar species at Tana Toraja, Sulawesi earlier this year. It is however certain that it belongs in the subfamily Necrosciinae.

Adults (Figs. 1 & 3)

This is a small, thin species, having well developed wings in both sexes and is a very good flyer.

The female reaches a body length of 65-75mm and an overall length of about 95 mm. The antennae are long (40mm), thin and coloured black. The head is quite big, very slightly elongated and possesses a heart-shaped orange patch between the eyes. The pronotum is smoother than the head and about twice as long as wide. The mesonotum is very elongated and not covered by any spines or tubercles.

The metanotum is

also twice as long as wide and possesses a well developed pair of wings, spanning about 80-85mm. The elytra however are very small, being only 2mm long and not covering the base of the wings

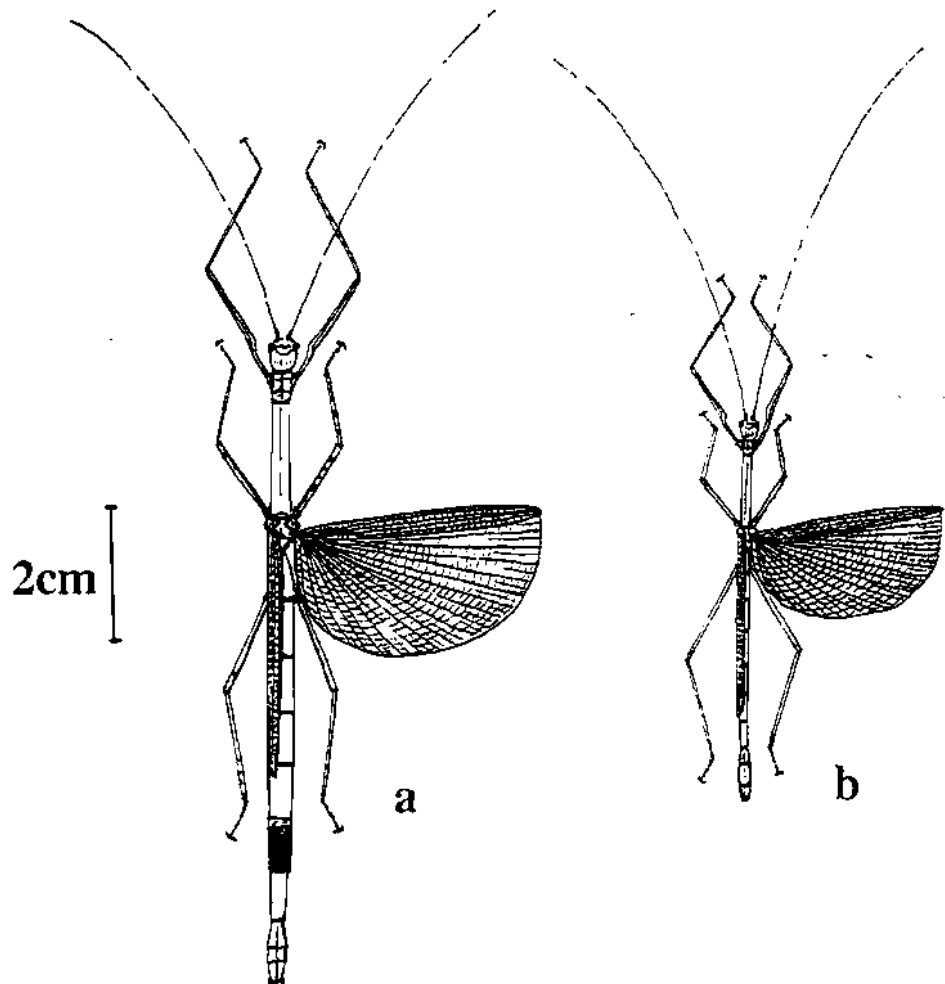


Figure 1 Adults: a) female, b) male.

as they do in most winged species of this subfamily. The abdomen can reach a thickness of 2.5-3mm when in full egg production. The operculum is quite short and does not reach to the end of the abdomen. The legs are all relatively short, thin and spineless. The main coloration is a mid brown with many small lighter and darker spots and patches. However, the fifth abdominal segment is coloured dark brown to black. The wings are coloured translucent greyish-brown.

The males are much smaller and thinner, reaching only body lengths of 48-52mm (75mm overall) and a maximum body width of about 2mm. The coloration is also very similar but there is no big black patch on the fifth abdominal segment. However, there is a black stripe running along the pronotum and mesonotum. The wings reach the end of the fifth abdominal segment and span some 75mm.

Eggs (Fig. 2)

These are very small, being only 1.8mm long, 1.4mm high and 1.2mm wide. The whole egg is covered by a net like structure and amongst the newly laid eggs, two colour forms can be seen; some are greyish brown and others are light grey. However, the first form seems to be much more common with a ratio of 5:1. The operculum is round, more or less flat. The micropylar plate is very elongated and reaches from the operculum to the polar end of the egg, where a dark patch can be seen. It is pointed at the ends and thicker in the middle, where the micropylar cup is situated.

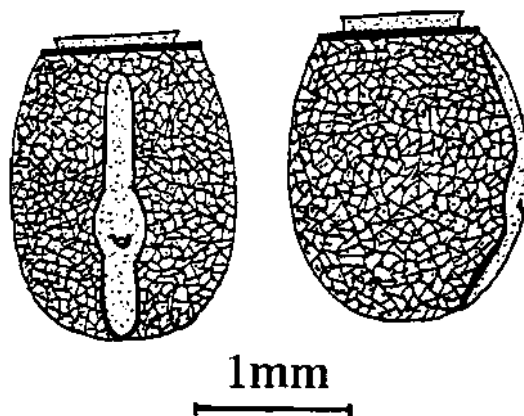


Figure 2 Dorsal and lateral views of egg.

The females are quite prolific egg layers and can lay up to ten per 24 hours. They are simply dropped to the floor and hatch after 2-3 months depending to the temperature. Hatching rate is very high at about 85%.

Nymphs

The nymphs are about 8mm in body length when newly hatched and have very long legs and antennae, looking very fragile. The colouring is dark yellow. Later the nymphs change to a green colour and they can be sexed from third instar onwards, by the males having a dot on the end of their abdomens.

The mortality in the first instar is not as high, as one may expect to be, within my culture it is about 20%. All the nymphs, which survive first instar will become adult.

Defence

As already said, these insects are very good flyers and will fly off readily when disturbed, especially the males which are much thinner and not as heavy as egg laying females. When held between the fingers, females will make fast movements with their abdomens and there will be a yellowish liquid coming out of their mouths. This latter reaction is mainly shown by the nymphs, when not running away very quickly. However, when handling them, care must be taken, as they tend to lose legs easily.

It is also interesting to see that when you just leave the adults to crawl on your hand, they will soon

slow down and sit tightly onto one finger, with the legs outstretched.

Foodplants

This species feeds readily on bramble (*Rubus* spp.), rose (*Rosa* spp.), pyracantha (*Pyracantha* sp.) and privet (*Ligustrum* sp.). Nothing else has been tried so far.

Rearing

This is an easy and very productive species, which does not require a lot of room for a culture. It prefers high temperatures (24-28°C) and high humidity of at least 70%. Care should be taken of too low humidity and too much air circulation, as they will then get problems with skin sheddings, especially with their final skin sheds. As already said, they are not very easy to handle, as they move very fast and loose legs easily.

I have seen that this species is not widely cultured in England which I can not really understand as it is a real pest. However, I have now given hundreds of eggs to several members and the livestock coordinator and hope that it will be more widely cultured in the future.

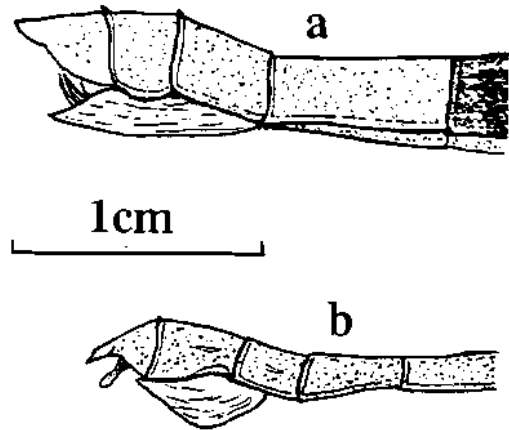


Figure 3 Abdomen: a) female, b) male.

Reference

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**Variation in three Bornean species of Lonchodinae: *Carausius cristatus* Brunner, *Lonchodes modestus* (Brunner), and *Lonchodes strumosus* (Brunner).
P.E. Bragg, 51 Longfield Lane, Ilkeston, Derbyshire, DE7 4DX, U.K.**

Key words

Phasmida, Rearing, Variation, Borneo, *Carausius cristatus*, *Lonchodes modestus*, *L. strumosus*.

Introduction

In terms of variation within a species, the Lonchodinae appear to be a rather inconsistent subfamily, some members exhibit almost no variation while others show some remarkable variation in colour, size, and shape. Variation in size and colour are to be expected as both are subject to the effect of environment as well as genetic control, size for example may be influenced by diet, or by temperature. Variation in body shape is however a different matter, and it is in this respect that the Lonchodinae is an inconsistent group. One member of the subfamily, *Phenacephorus cornucervi* Brunner, is perhaps the most variable phasmid in the world, I have yet to see two identical females although the males are always more or less identical.

Bornean members of the genus *Carausius* Stål show little variation although in the related *Lonchodes* Gray variation is not unusual; *Carausius cristatus* Brunner seems to be an exception. The genus *Lonchodes* contains species showing little variation (e.g. *Lonchodes brevipes* Gray), and species showing considerable variation, including the two under consideration here: *L. modestus* (Brunner), and *L. strumosus* (Brunner). In the case of *Lonchodes modestus* the species appears to have been described three times because of the variations which occur. In the cases of *L. strumosus* and *C. cristatus* no variation has been recorded previously. All three species have been reared successfully and it is as a direct result of attempts to rear them that these variations have been observed.

For each species I have given a description, including the variations; examples of the variations are also illustrated. A complete set of measurements for each species is given in table 1; these are taken from the largest and smallest specimens in my collection and include both wild caught and reared specimens.

***Carausius cristatus* Brunner, 1907**

Carausius cristatus Brunner, 1907: 270; Hausleithner, 1990: 396, fig 2b (egg); Hausleithner, 1991: 224, figs 5, 6a-c (♂).

Culture history

The culture PSG 120 is derived from four females and three males which I collected in 1990 at an altitude of 1580m, near Mt Kinabalu Park Head Quarters in Sabah. This was supplemented by eggs from two females which I collected from the same locality in 1992.

Distribution

Brunner's original description of the species states that it is from Kinabalu, Borneo. I have found it to be a common species around Kinabalu Park HQ, frequently seeing it at night along many of the paths through the forest. The Sarawak Museum has a single specimen from Mt Kinabalu; I believe there are also some specimens in Leiden Museum but I do not have any notes on where they were collected. Hausleithner (1990: 396) refers to a specimen, identified by Brunner, which is labelled "Brunei"; such a vague locality is of little use as what is now Sabah was part of Brunei until 1877, depending on when it was collected, it is even possible that the specimen was from Kinabalu. The only other published record is Hausleithner's (1991: 224) record of specimens collected by C.L. Chan at Kinabalu Park H.Q. There is therefore only one confirmed locality for

this species.

Variation

Females and the offspring from the original 1990 collection were very consistent, with no lobes on the head or body, even the colour was quite uniform. This was also true of the females which I collected on my second trip in 1992, I was therefore rather surprised when some of the offspring from this second collection had lobes on the head, thorax, and abdomen. Rearing these enabled me to identify a female which had remained unidentified from my first trip! As one would expect, the males show no such variation.

Females (Figures 3-5 & 8-9)

Body and legs mid to dark brown, lighter coloured specimens often with two dark triangular patches on 5th abdominal segment, ventral surface of body may be paler than dorsal; posterior face of hind femora reddish near the base. Head, body and legs granulate, body finely tuberculate, tubercles often darker than base colour. Dorsal surface of body with a fine longitudinal carina. Femora and tibiae with setose carinae. Body of more or less uniform width throughout (about 4mm).

Antennae almost as long as fore legs, basal segment flattened, second segment swollen, remainder slender. Head one-and-a-half times longer than wide, with a transverse ridge between the eyes (figure 9); rarely with two lobes forming a large crest between the eyes (figures 5 & 8).

Pronotum longer than wide, anterior margin slightly raised. Mesonotum widening very slightly, rarely with a transverse crest on the posterior margin (figure 5). Metanotum three times longer than the median segment. Mesosternum and metasternum granulate and finely tuberculate. Abdominal segments 2-6 of similar length, 7th slightly shorter, 8th short, 9th very short with hind margin raised, 10th very short with apex indented, lamina supraanalis short with a rounded apex. Rarely the posterior margin of 5th segment has a transverse crest (figure 5). Abdominal sternites 2-6 granulate, 7th and operculum granulate and tuberculate. Praeopercular organ composed of a depression and two triangular lobes. Operculum deep, with a slight keel and a rounded apex. Cerci short and cylindrical.

Fore and middle femora longer than the tibiae, hind femur shorter than the tibia. Base of fore femur strongly compressed and incurving; ventro-posterior carina with two small spines near the apex. Middle and hind femora strongly laterally compressed; anterior and posterior ventral carinae with 2-3 spines near the apices, one spine on ventro-posterior of middle femur is a triangular serration, others are all minute spines. Fore tibia with a lamina of uniform width running along the dorsal surface. First tarsomere of fore tarsus lobed.

Typical specimens lack the crests on the head, mesonotum and 5th abdominal segment. Of my four

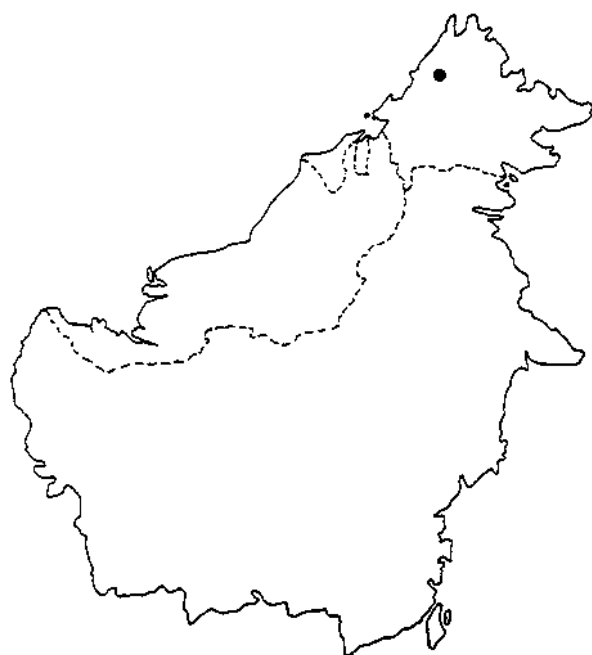


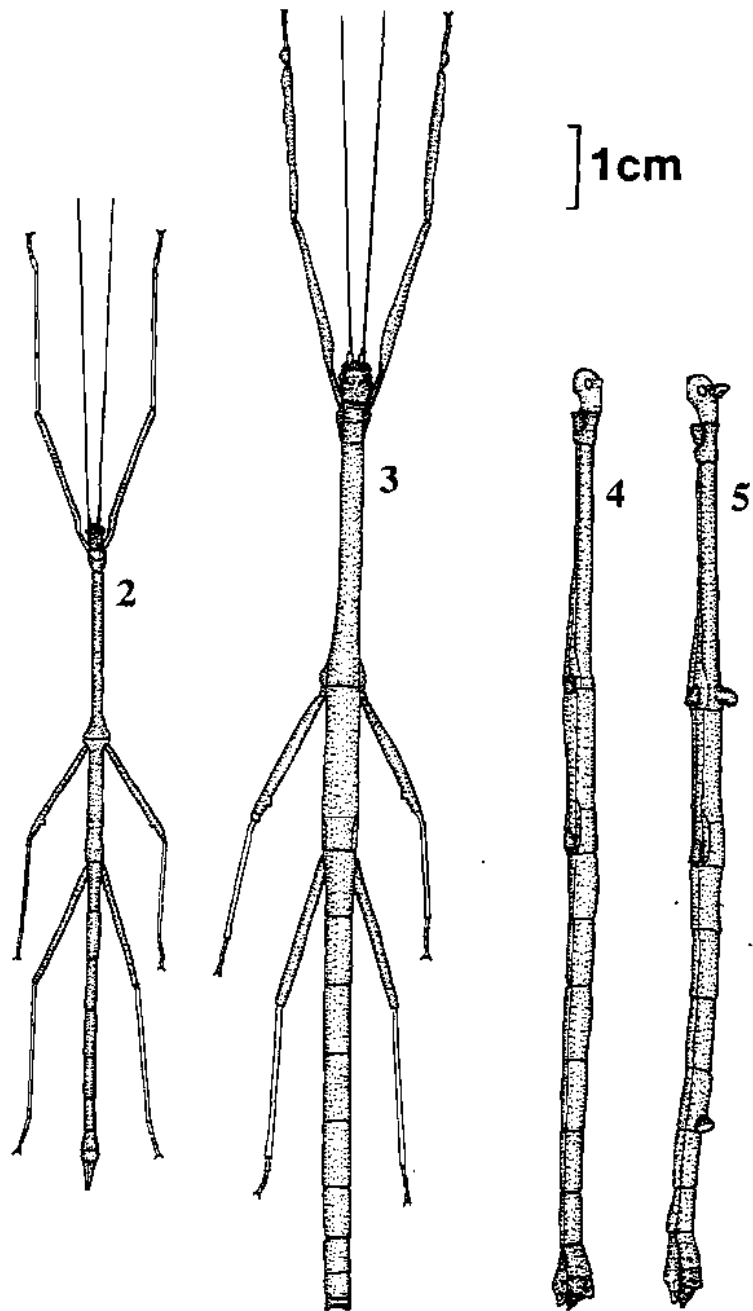
Figure 1 Distribution of *Carausius cristatus*.

crested specimens, one has only the head and abdominal crests, the others have all three crests.

Males (Figures 2, 6-7 & 10)
Body and legs dark green, with a small pair of black spines on the metanotum, hind femur with basal two-thirds of posterior surface red. Whole body slender and of uniform width (about 1.5mm). Head, body and middle femora granulate, mesonotum and metanotum finely tuberculate; carinae of tibiae setose.

Antennae long and slender, longer than the fore legs; basal segment flattened. Head almost twice as long as wide, with two large spines between the eyes (Figure 10).

Pronotum one-and-a-half times longer than wide, anterior margin indented. Mesonotum of uniform width, granulate and finely tuberculate. Metanotum and median segment distinguishable only with magnification (and then with difficulty); both are slightly wider than the mesonotum. The posterior of the metanotum has a pair of small black spines (figure 7). Abdominal segments 2-7 of similar length and four times longer than wide, 8th shorter and widening, 9th wider than long, 10th laterally flattened and divided longitudinally. Poculum short, reaching to end of 9th tergite, angular, with a rounded rim (figure 6). Cerci short and conical.

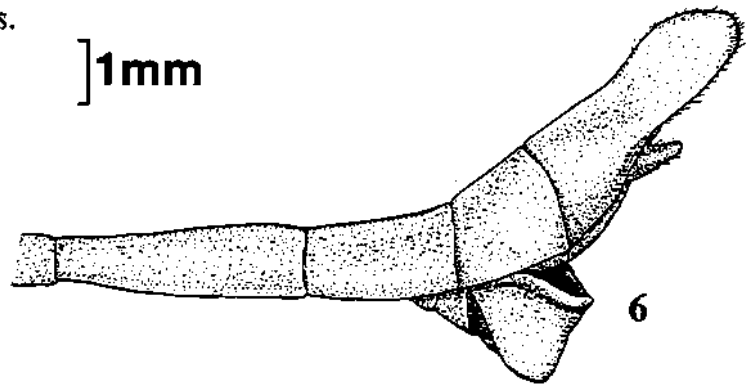


Figures 2-5 *Carausius cristatus*, 2 male, 3 & 4 typical female, 5 variation in the female.

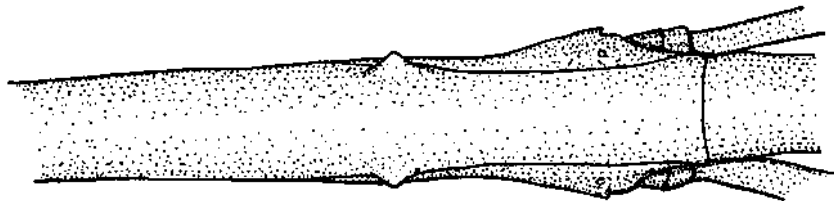
Figures 6-10 *Carausius cristatus*

- 6 Male: apex of abdomen
- 7 Metanotum of male, showing spines.
- 8 Head of female with crest.
- 9 Head of typical female.
- 10 Head of male.

1mm

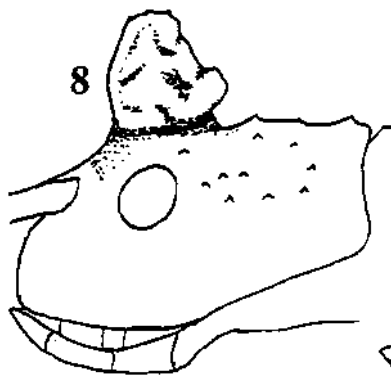


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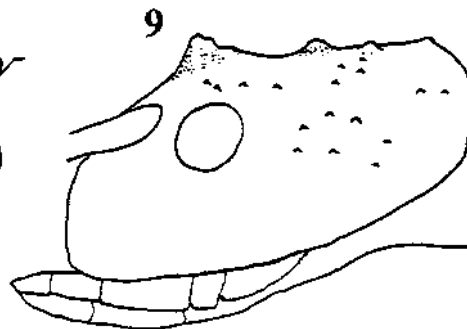


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1mm



8



9



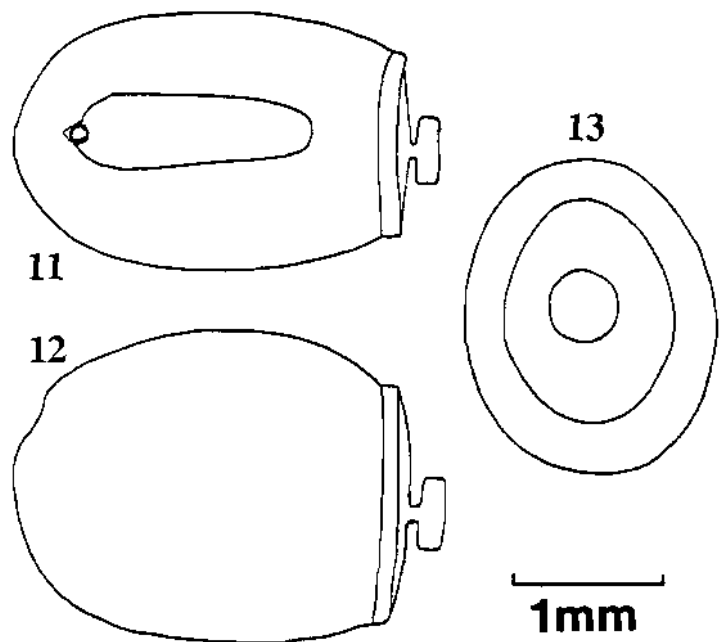
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1mm

Fore femora sharply curved and compressed at the base, with a pair of small spines near the apex of the ventro-posterior carinae. Middle femora with a small spine on each ventral carina near the apex, often with an additional minute or small spine. Hind femora laterally compressed, ventral carinae each with two minute spines near the apex. Tibiae all unarmed.

Eggs (Figures 11-13)

Capsule ovoid, longer than high, with a small collar; micropylar plate on a very slightly swollen mound. Capsule and micropylar plate uniformly mid brown, surface densely punctate. In dehydrated eggs the capitulum is darker brown than the capsule. Micropylar plate oval, narrower at the opercular end, with the micropylar cup at the polar end. Operculum oval, slightly narrowing at dorsal surface, with a central capitulum. Typically: length 2.6-2.7mm, height 1.9-2.0mm, width 1.7-1.8mm, capitulum length (dehydrated) 0.25-0.35mm.



Figures 11-13 *Carausius cristatus* egg: dorsal, lateral, and opercular views.

Rearing

This seems to be an easy species to rear. I kept them in a 60cm x 30cm x 30cm cage my standard construction (Bragg, 1987, 1989), with the sides fully enclosed with polythene to maintain a high humidity. They feed readily on bramble, eucalyptus, raspberry, rose and pyracantha, and would probably accept quite a wide variety of plants although I have not tried any others. Some of my wild caught adults lived for seven months; as I have no idea how long they had already been adult, and I did not record this for ones which I reared, I do not know how long they live. It would be reasonable to expect them to live for more than seven months as adults.

They lay about 10 eggs per week (1.35 per day, measured from November to February) and the hatch rate seemed reasonably high although I did not measure it. Eggs take six months to hatch when kept at room temperature.

Before I stopped keeping this species I gave away quite a lot of eggs so there should be plenty of cultures within the PSG.

Lonchodes modestus (Brunner, 1907)

Prisomera modestum Brunner, 1907: 286.

Prisomera modesta; Giglio-Tos, 1910: 24.

Lonchodes modestus (Brunner); Günther, 1932: 384, fig 11.1 (♂), 11.2 (♀), 13.10 (♀), 13.15 (♂); Günther, 1943: 153; Hausleithner, 1989: 102, fig 3g (egg).

Prisomera modestissimum Brunner, 1907: 286. Synonymised by Günther, 1932c: 384.

Prisomera excretum Brunner, 1907: 289. Synonymised by Günther, 1932c: 384.

Günther considered that *Prisomera modestum*, *P. modestissimum* and *P. excretum* were variations on a single species. Although I have not examined the original specimens described by Brunner, the variation in size and form of this species makes it very likely that Brunner could have considered the variations to be different species. Giglio-Tos was uncertain about the identity of his specimen, although he did not say so, it is possible that he had difficulty deciding between the three species described by Brunner. It is worth remembering that Brunner, Giglio-Tos and Günther did not have the opportunity to rear these insects and see the eggs and variations which are produced.

Culture origins

The culture of PSG 138 is derived from several sources. The original material is from the Indonesian island of Lombok and I believe it was collected by Eric van Gorkom. Although I have only seen eggs of this stock they agree with the eggs of my own stock; Frank Hennemann sent me a sketch of the middle femur of a Lombok specimen, this also agrees with my material. I have collected this species in three areas of Borneo. I collected one pair from Sepilok in Sabah in 1990, and in 1993 I collected several specimens from two areas of Central Kalimantan: a logging camp at Kelambenkari which is on the river Sabangau near Palangkaraya, and a logging camp on the Ratu Miri River. Although the female from Sabah lived for five months and laid 43 eggs, I now know that these eggs were unusually pale which may be related to the fact that none of them hatched. The specimens from Kalimantan died before I returned home but a number of eggs had been laid and a culture was established from these. Eric van Gorkom has also collected *L. modestus* in Kalimantan. Material collected in Kalimantan by Eric, and my material from Kelambenkari is much smaller than my material from Ratu Miri and Sepilok.

Distribution

In addition to Sepilok, Palangkaraya, and Ratu Miri, I have examined specimens in Leiden Museum from Bettotan, which is near Sandakan in Sabah, from Balekpapan in East Kalimantan, from Long Bloe Oe in Central Kalimantan, and from a rather vague central East Borneo ("Midden O-Borneo"). Giglio-Tos (1910: 24) recorded the species from Samarinda, in Kalimantan. Although Giglio-Tos was not certain of the identity of his two specimens, this is understandable given the variation in this species so I am assuming that they were correctly identified. All specific localities are plotted as dots on the distribution map (figure 14), the vague locality is indicated by a large ring in the middle of East Kalimantan.

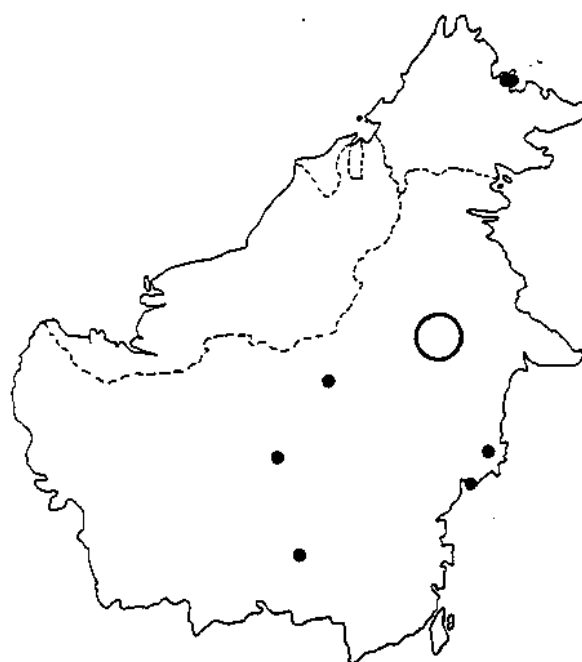
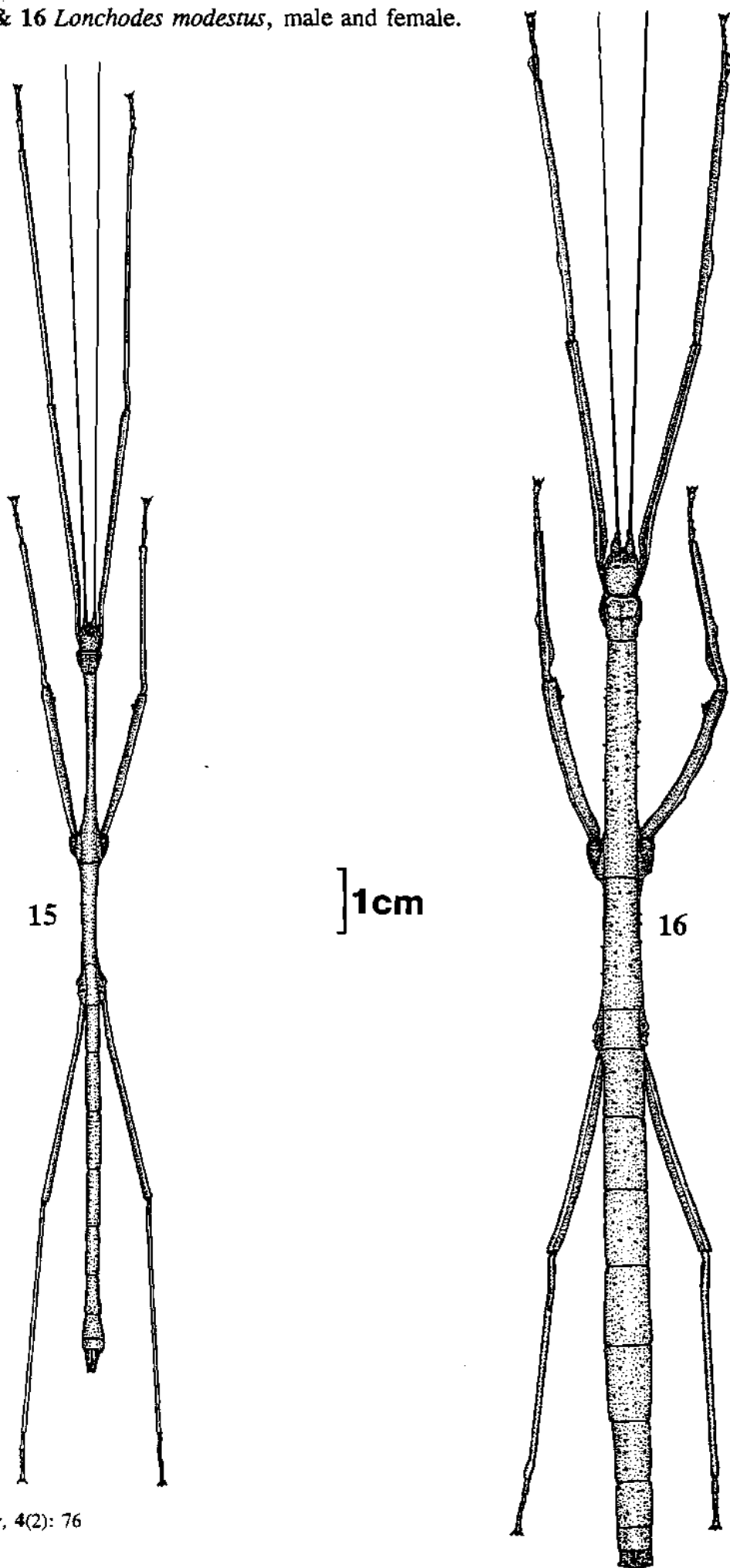


Figure 14 Distribution of *Lonchodes modestus*.

Female (Figures 16-22)

Head, body and legs mid-brown, or mid-green, or combination of these colours; base of fore femur and posterior surface of hind femur red; posterior surface of hind tibia may be red. Legs speckled with dark brown; body occasionally with some dark speckles or small dark patches, and occasionally with some pale grey patches. Head, dorsal surface of body, ventral surface of

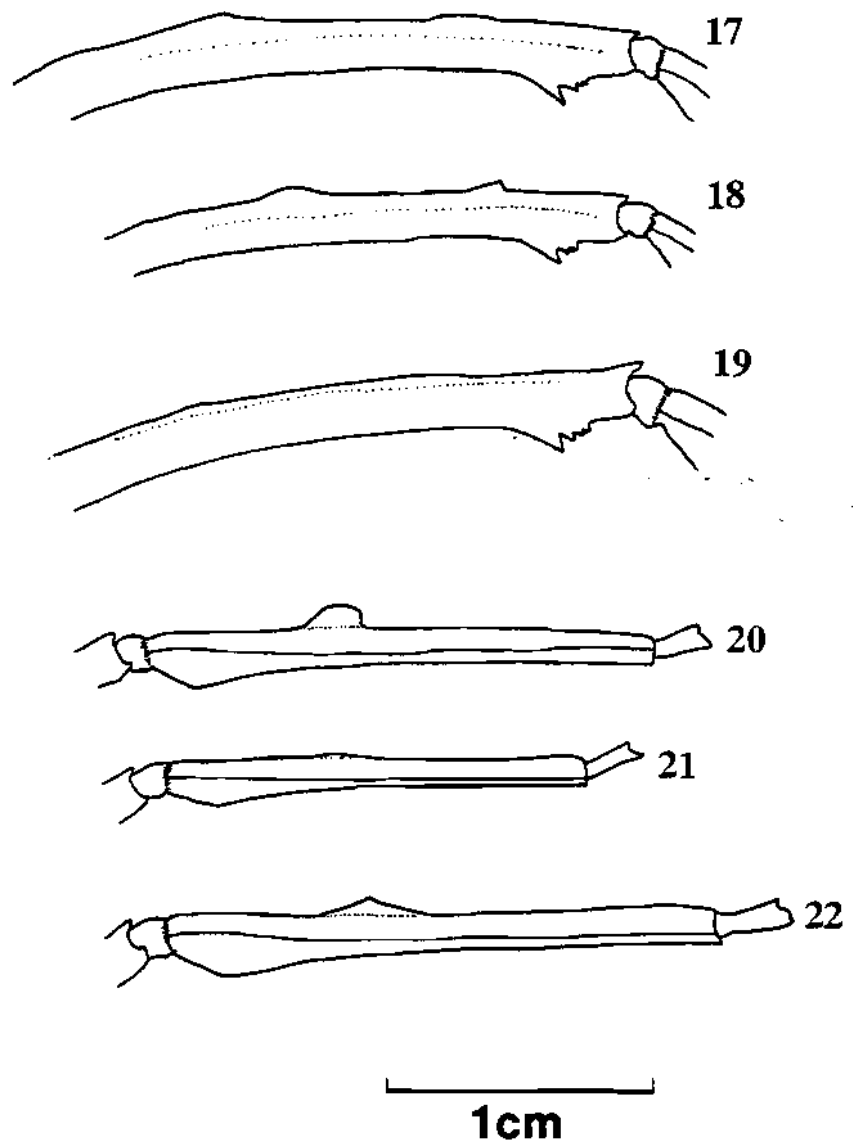
Figures 15 & 16 *Lonchodes modestus*, male and female.



thorax, and legs densely granulose and finely tuberculate.

Antennae about as long as the fore legs. Head slightly longer than wide, with a small ridge between the eyes, top of the head slightly rounded. Pronotum about one-and-a-half times longer than wide. Mesonotum widening gradually. Metanotum widening slightly, two-and-a-half or three times longer than median segment. Abdominal segments 2-6 of uniform width and length, 7th slightly shorter and narrowing, 8-10 short and of uniform width, 10th with a small longitudinal carina, lamina supraanalis short with a rounded apex. Occasionally (PEB-1841 only) abdominal segments 1-7 have a small tubercle on the hind margin, on 5th segment this can be quite a large swollen double tubercle. The praeopercular organ is a triangular lobe which narrows abruptly at the mid point. Operculum straight, keeled, with a rounded apex. Cerci short and conical.

Fore femur with base strongly compressed and incurving, apex of ventro-posterior carina with one small and, occasionally, one minute spine. Ventro-posterior carina of mid femur with one medium and two minute spines at the apex, ventro-anterior with one small and two minute spines at the apex. Hind femora strongly laterally compressed, ventral carinae with two minute spines at the apex. Dorsal surface of middle femur variable, ranging from two almost imperceptible swellings to two triangular lobes (Figures 17-19). Anterior tibia variable, dorsal surface with or without a small rounded lobe one third of the way from the base. Base of mid tibia with a very small triangular lobe on the ventral surface; dorsal surface variable, ranging from no perceptible lobe to a distinct triangular or almost semicircular lobe (Figures 20-22). Hind tibia without lobes. Fore tarsus with a rounded lobe on basal tarsomere, lobe varies in size. All tarsi with 4th tarsomere extremely short.



Figures 17-19 *L. modestus*: mid femora of females.

Figures 20-22 *L. modestus*: mid tibiae of females.

The lobes on the femora and tibiae are relatively larger and therefore much more obvious in the female nymphs than in the adults.

Male (Figures 15 & 23)

A typical *Lonchodes* male; slender, with the body and legs unarmed except for the usual spines on the undersides of the apices of the femora. Head, body and legs granulate; mid-brown, or reddish-brown, or greenish-brown, or a combination of these colours; posterior surface of hind femora reddish brown. Body of uniform width throughout, except for slight widening where the legs join the body.

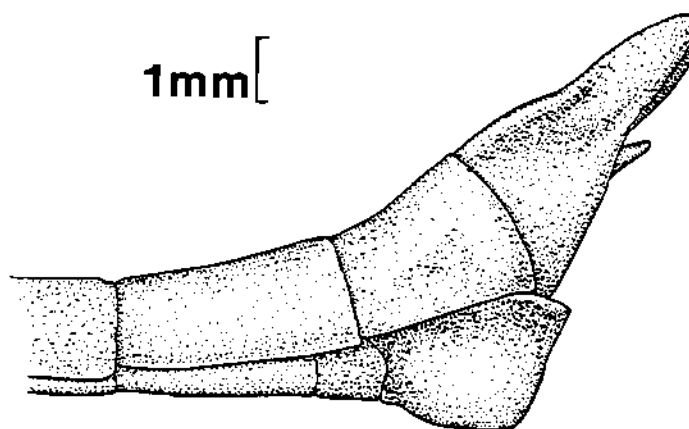


Figure 23 *L. modestus* male: apex of abdomen.

Antennae longer than the fore legs, basal segment flattened. Head longer than wide, with two small tubercles on a slight transverse ridge between the eyes; eyes brown or yellow-orange.

Pronotum slightly longer than wide. Middle of mesonotum 1.6mm wide. Metanotum arched, almost three times longer than median segment. Abdominal segments 2-7 of similar size, 8th half as long, 9th slightly shorter than 8th, 10th split and laterally compressed to form two triangular lobes (Figure 23) with small spines on the inside. Poculum short, deep, rounded, setose. Cerci short and conical.

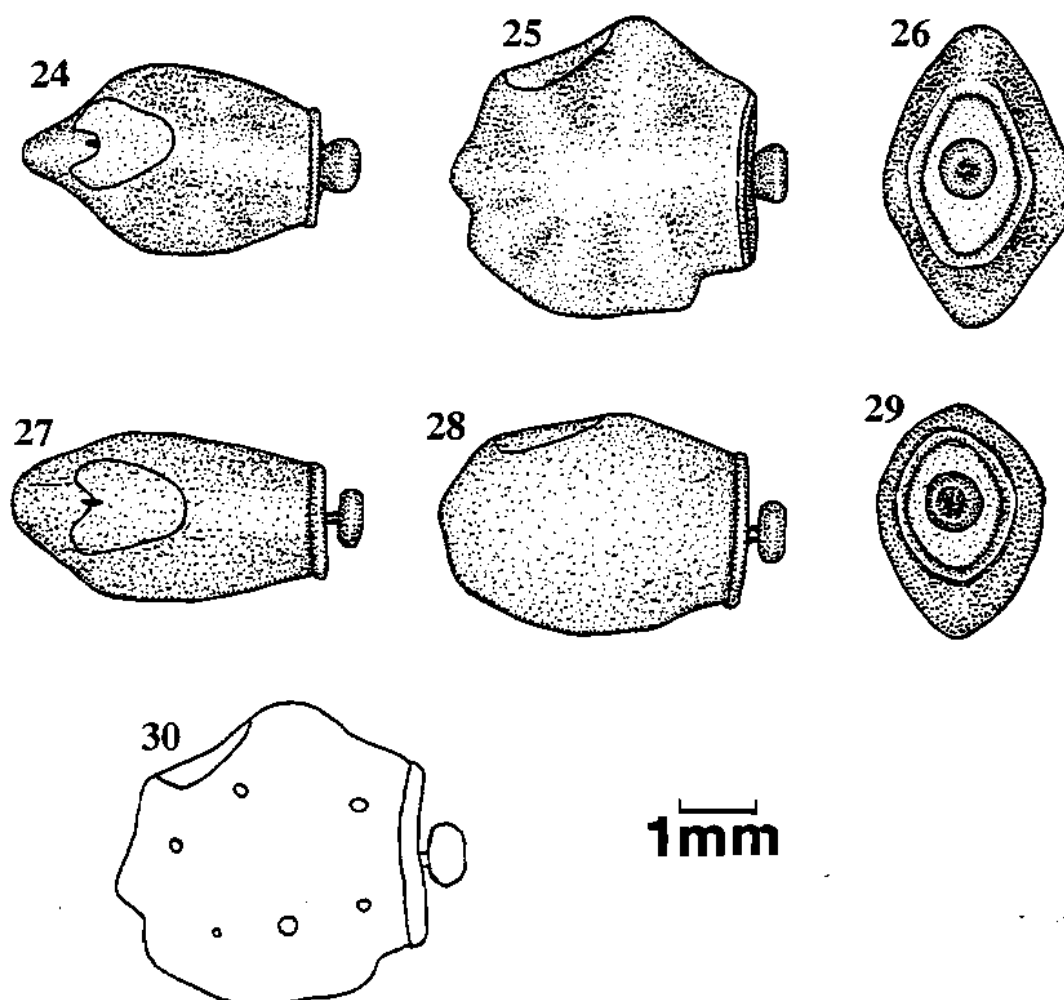
Fore femur with base strongly compressed and incurving, apex of ventro-posterior carina with 1-2 minute spines. Dorsal surface of mid femur smooth, very rarely with an almost imperceptible swelling. Ventro-posterior carina of mid femur with one medium and two minute spines at the apex; ventro-anterior carina with one small and two minute spines at the apex. Hind femora strongly laterally compressed, ventral carinae each with two minute spines at the apex. Base of mid tibia with a very small triangular lobe on the ventral surface.

Egg (Figures 24-30)

Capsule as high as long, narrower than high; shape complex (Figure 25), indented at polar end, narrow at opercular end, with six more or less triangular depressions on each lateral surface; surface finely punctate; opercular end with a small collar. Capsule mid to dark brown, usually with a small white spot in each depression (Figure 30), micropylar plate and collar pale cream, capitulum cream. Micropylar plate almost an equilateral triangle with rounded corners, apex towards operculum, micropylar cup close to polar end of plate. Operculum flat, a narrow oval tending towards a rhombus, with a central capitulum which is very easily detached. Typical measurements: length 3.9-4.2mm, height 3.9-4.0mm, width 2.4-2.5mm, capitulum length (fresh) 0.5mm.

Eggs produced by my only specimen from Sepilok (PEB-1841) were uniformly pale yellow and did

not hatch, otherwise they were indistinguishable from the typical eggs.



Figures 24-26 & 30 Normal eggs of *L. modestus*.

Figures 27-29 Abnormal eggs of *L. modestus*.

Abnormal eggs (Figures 27-29) were consistently produced by one captive reared female from stock reared from material collected at Palangkaraya and Ratu Miri. Capsule longer than high, higher than wide; shape tending towards cylindrical, with only a few slight depressions on the lateral surfaces; surface finely punctate, with distinct collar (larger than in a normal egg). Capsule dark grey, lacking distinct white spots although a few pale spots may be visible under magnification; capitulum yellow-orange. Micropylar plate grey, otherwise as in normal eggs. Operculum similar to a normal egg, but wider (Figure 29). Typical measurements: length 4.1-4.3mm, height 2.8-2.9mm, width 2.0-2.1mm, capitulum (fresh) 0.5mm.

These abnormal eggs are very similar to Hausleithner's illustration (1989, fig 3g) of an egg removed from the body of a type specimen, this suggests that this individual is producing the eggs in an incompletely developed form. It remains to be seen if they will hatch.

Eggs are laid at a rate of about 3 per week and take about six months to hatch.

Variation

This species shows variation in coloration, size, shape of lobes on the middle femur and on the middle tibia, and in the shape and coloration of the egg. The variation in the shape of the eggs is probably not normal. Variation in the size of adults appears to be dependant on the geographical origin, specimens from Kelambenkari and the unknown Kalimantan locality are considerably smaller than my other specimens.

Rearing

I have reared these in my standard cages, with nymphs reared at high humidity in enclosed cages, the adults are currently being successfully maintained in a drier and better ventilated cage. This species is quite easy to rear although males and some of the females only survived 1-2 months, other females survived more than seven months as adults. It is possible that the early deaths were due to insufficient ventilation as they were in a fully enclosed cage at the time.

Lonchodes modestus feeds on bramble, eucalyptus, hawthorn, oak, pyracantha, raspberry, and rose; I have not tried any other plants.

Lonchodes strumosus (Brunner, 1907)

Prisomera strumosum Brunner, 1907: 287.

Lonchodes strumosus (Brunner); Günther, 1932c: 379, pl. 9.2, 12.11, 13.7.

The male and egg have not been described previously, and the female has only been described from a nymph. Both the original description and Günther's illustrations are based on the same single female nymph.

Origin of the culture

In August 1990 I collected a female from 210m on Mt Serapi in Sarawak. This arrived safely in the U.K. and went on to lay over 100 eggs and started the culture PSG 127. In August 1991 Ian Abercrombie found an adult female at 670m on Mt Serapi; this supplemented the culture by laying a few eggs before it died.

Distribution

This species seems to be relatively rare. On my various trips to Borneo only six specimens have been found although I have spent many nights collecting on Mt Serapi. I have found one adult male and two nymphs on Mt Santubong, and two females (including Ian's) and one male on Mt Serapi. The Sarawak Museum has three male specimens: one from "Matang Road" collected in 1911, and two from Kuching



Figure 31 Distribution of *L. strumosus*.

collected in 1900. Kuching is now quite a modern city and so much larger than in 1900 that it is extremely unlikely that this species still occurs in Kuching. Matang road runs from Kuching to the base of Mt Serapi, there is no way of knowing from which part of the road it came. There are no published records of this species except the vague "North Borneo" of Brunner's original specimen. Although "North Borneo" probably refers to what is now Sabah (previously British North Borneo), this may not be the case, so I have omitted this from the distribution map (Figure 31).

Female (Figures 34-38 & 41)

Body and legs mid-brown, or dark brown, or silver-grey, mottled with dark grey or dark brown. Fore legs often with yellowish-brown markings; posterior surface of hind femur bright red. Body granulose, tuberculate, scabrous and usually verrucose; of uniform width except where large verrucose swellings protrude.

Antennae as long as the fore legs, basal segment wide and flattened. Head flat, longer than wide. Pronotum one-and-a-half times longer than wide. Mesonotum usually with a verrucose swelling near the anterior; this is highly variable, at the extremes it may be absent (PEB-694, figure 36) or it may double both the width and height of the mesonotum (PEB-693, figures 34-35). Occasionally there are swellings on the anterior of the metanotum and on the median segment; there may be transverse crests on the posteriors of the mesonotum and the median segment (none of my specimens have a crest on the metanotum). Metanotum one-and-a-half times longer than median segment.

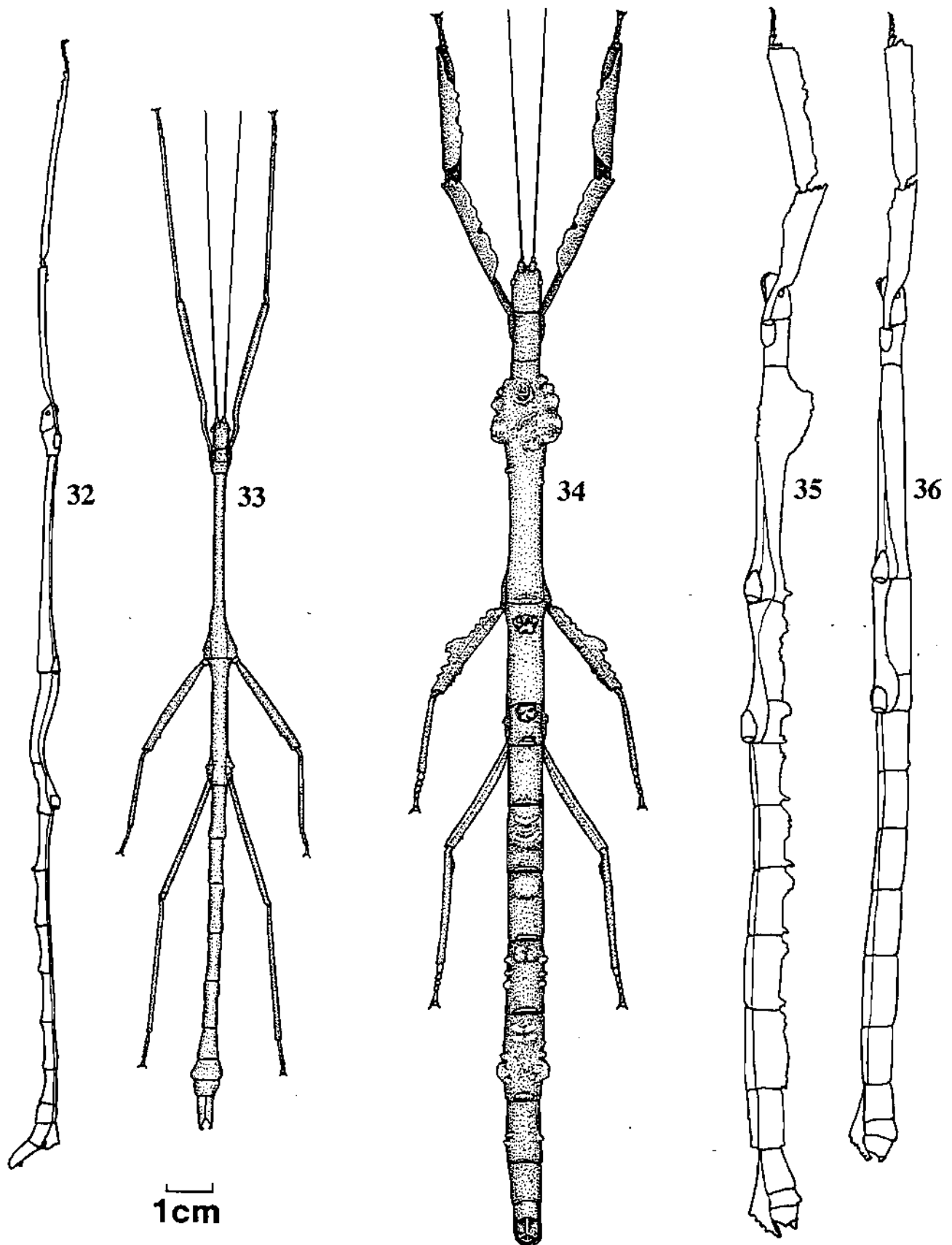
Abdominal segments 2-7 twice as long as wide, often with verrucose swellings on the anterior margin, posterior margin, and lateral surfaces. Although very variable, verrucose swellings are most common on anterior of 3rd segment and on the lateral margins of the 5th; the 2nd often has a transverse crest on the posterior margin. Segment 8 as long as wide, 9-10 short. Lamina supraanalis varies from short, rounded and carinate (Figure 37), to a long flattened lobe (Figure 38). The praeopercular organ is a roughly diamond-shaped ridge, with two small lobes at the posterior. Operculum flat, with a short apical keel, and two lateral carinae; the apex is verrucose.

Fore femur and fore tibia have a large curved lamella on the dorsal surface and smaller lamellae on the ventral carinae; there is little variation in the shape of the lamellae. When the legs are together the lamellae form a hollow tube which is the same diameter as the body. Middle femur with a series of lobes on the dorsal surface (Figure 41), composed of 4-5 small lobes basally, a large lobe which is curved on the basal side and serrated on the apical side, and 2-3 small lobes apically; there is little variation between specimens. Ventral carinae of middle femur each with three small triangular spines and two minute spines near the apex. Middle tibia with a slight lamella on the dorsal surface. Hind femur laterally compressed, with a small triangular lobe on the ventral surface near the base; with two small triangular spines near the apex of the ventro-posterior and ventro-anterior carinae. Tarsi all short with tarsomeres 1-4 decreasing in size evenly.

Male (Figures 32-33 & 39-40)

Long slender body, legs unarmed except for spines on the apices of the ventral carinae of the femora. Distinguished from other *Lonchodes* species which are in culture by the strongly arched metanotum and the swollen posterior margins of the abdominal segments. Head, body and legs dark brown and granulose both ventrally and dorsally; posterior surface of hind femora red or reddish-brown.

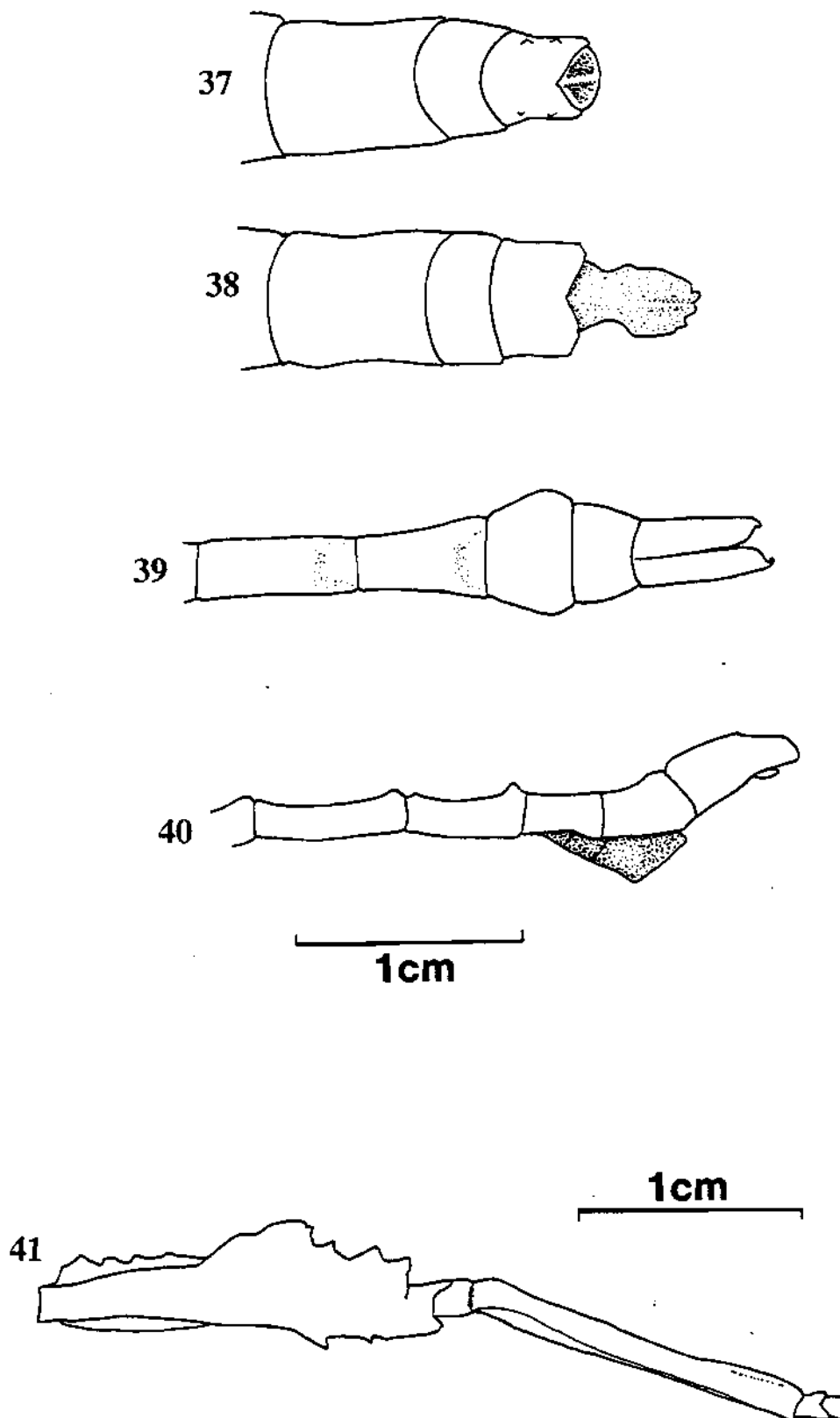
Figure 32-33 *L. strumosus*, dorsal and lateral views of two different males.
Figures 34-35 *L. strumosus*, dorsal and lateral views of female (PEB-693).
Figure 36 *L. strumosus*, lateral view of female (PEB-694).



Figures 37-38 *L. strumosus*, apex of female abdomens.

Figures 39-40 *L. strumosus*, apex of male abdomen.

Figure 41 *Lonchodes strumosus*, middle femur of female.



Antennae longer than the fore legs, basal segment flattened. Head about twice as long as wide, with two small tubercles on a slight swelling between the eyes. Pronotum slightly longer than wide. Middle of mesonotum 2.0mm wide. Metanotum strongly arched (Figure 32), about four times longer than median segment but frequently indistinguishable from the median segment. Abdominal segments 2-6 of similar size, 7th shorter and widening, 8th short widening then narrowing (segment is hexagonal), 9th short and narrowing, 10th split and to form two rectangular lobes (Figures 39-40) with small spines on the ventral surface of the apex. Posterior of segments 2-7 with a raised swelling, anterior of third segment with a pair of small tubercles. Poculum short, deep, angular, posterior with a small longitudinal carina; apex truncated. Cerci dorso-ventrally flattened, short, with rounded apices.

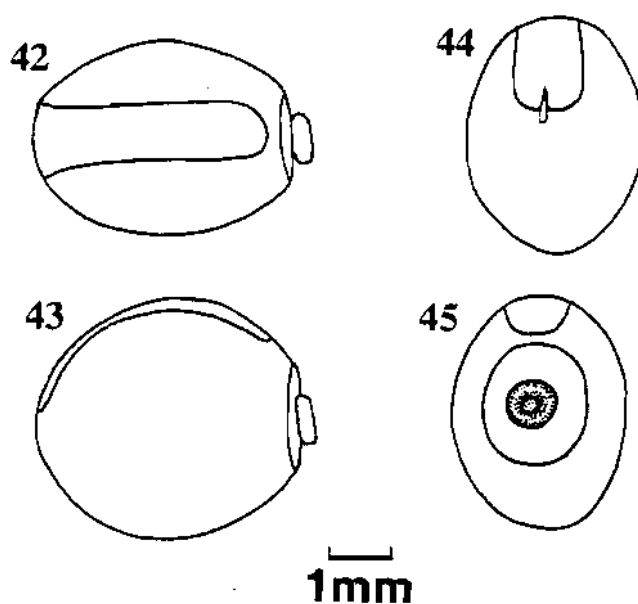
Fore femur with base strongly compressed and incurving, apex of ventro-posterior carina with two small triangular spines. Dorsal surface of mid femur with a slight angular swelling, occasionally smooth. Ventro-posterior carina of mid femur with two medium, and two minute spines at the apex; ventro-anterior carina with two minute spines at the apex. Hind femora strongly laterally compressed, ventro-anterior carina with two small spines at the apex, ventro-posterior carina with two minute spines at the apex. Dorsal surface of anterior tibia with a narrow lamella which widens at the apex.

Variation

For some time after collecting the first female from Mt Serapi I considered this to be an undescribed species as there are few described species of *Lonchodes* of this size and it was clearly not one of those. After rearing more females I realised that it is variable and that the species had been described from a penultimate instar female nymph with a smaller mesonotal swelling. The femoral lobes of the females seem to be quite consistent but the form of the body varies greatly, ranging from the almost completely smooth specimen collected by Ian Abercrombie (Figure 36), to the extremely verrucose specimen which I originally collected (Figures 34-35). Although the females of this species are very variable; as usual in *Lonchodes*, the males show no significant variation.

Egg (Figures 42-45)

Capsule a laterally compressed sphere; smooth, without any surface ornamentation. Uniformly mid brown, with micropylar plate almost imperceptibly lighter. Micropylar plate a broad band running from the polar end almost to the operculum, widening slightly at the polar end, apices of the band rounded; micropylar plate is not raised above the capsule. Micropylar cup indistinct. Operculum oval, flat, with a central capitulum on a narrow stalk. Typically: length 4.3mm, height 3.9mm, width 3.2mm, capitulum length (dehydrated) 0.3mm.



Figures 42-45 Egg of *L. strumosus*: dorsal, lateral, polar, and opercular views.

Rearing

In captivity this species seems to need good ventilation to do well. Most of my first generation died, either as young nymphs or almost immediately after becoming adult; this was probably due to insufficient ventilation because Ian Abercrombie had much better results in well ventilated cages. The egg laying rate is about 1.6 per day. Unfortunately I have mislaid some of my records for this species so I do not know the exact number of eggs laid by the original specimen although I think it was about 180, neither do I know the hatch rate although it was at least 30% because I have over 65 preserved specimens from the first generation. The original specimen was caught on 13th August 1990 and the first egg hatched on 22nd February 1991, i.e. 6 months incubation at room temperature.

The females of *L. strumosus* are excellent stick mimics. When disturbed, and when at rest during daylight, the fore legs are brought together and held straight in line with the body, the middle legs are folded and held against the body, and the hind legs are held straight alongside the body. The fore legs enclose the antennae and match the diameter of the body so well that the head and legs are indistinguishable from the body. The females will remain motionless in this position for some considerable time. If the legs are carefully forced open the insect will shed the leg and still remain motionless. Particularly in the first three instars, this species often hangs from the foodplant by its back feet only; occasionally they hang by just the front feet.

Lengths (mm)	<i>C. cristatus</i>		<i>L. modestus</i>		<i>L. strumosus</i>	
	♀	♂	♀	♂	♀	♂
Total	98-126	75-89	110-159	88-118	143-165	111-131
Antennae	> 32-41	41-51	58-86	66-95	38-46	58- > 59
Head	4.5-5.0	3.5	5.5-7.5	4.0-4.5	6.5-7.5	4.5-5.0
Pronotum	5.0	3.0	5.0-7.5	3.0-4.5	8.0-8.5	4.0
Mesonotum	26.5-32.5	20.5-24.5	25.0-36.5	21.5-29.5	33.0-41.0	29.5-36.5
Metanotum	11.0-16.5	10.0-13.0	12.0-20.0	11.5-17.0	16.5-17.5	16.0-18.5
Median segment	4.5-6.0	4.0-4.5	5.0-7.5	4.0-5.0	7.0-7.5	4.0-5.5
Fore femur	19.0-22.5	20.0-21.0	27.5-39.5	28.0-38.0	22.0-25.0	23.5-28.0
Fore tibia	17.0-20.0	19.5-22.0	23.5-41.5	30.0-40.0	20.5-24.0	28.0-32.0
Fore tarsus	5.5-6.0	5.0-6.0	6.0-11.0	8.0-10.0	6.5-7.0	5.5
Mid femur	15.0-18.0	14.0-15.5	19.5-26.5	20.0-24.0	16.0-19.0	16.5-19.0
Mid tibia	13.0-15.5	12.0-14.0	19.5-24.0	20.0-23.0	14.0-15.5	14.0-15.0
Mid tarsus	5.0	4.0-4.5	7.0-9.0	6.0-7.5	6.5-7.0	5.0
Hind femur	17.0-20.5	15.5-18.0	24.5-34.0	24.0-32.0	18.5-22.5	19.5-23.0
Hind tibia	18.0-21.0	17.5-21.5	26.5-37.0	29.0-37.0	18.5-22.0	21.0-25.0
Hind tarsus	5.5-6.0	4.0-5.0	7.0-9.0	7.5-8.0	7.5-8.0	6.0

Table 1 Measurements of the longest and shortest specimens of each species.

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Reviews and Abstracts.

Phasmid Abstracts

The following abstracts briefly summarise articles which have recently appeared in other publications. 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.

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.

Aubin, J.M. (1994) Description de trois individus intersexues (ou gynandromorphe) chez *Oreophoetes peruana* (Saussure, 1868). *Le Monde des Phasmes*, 27-28: 21-22.

Describes three examples of gynandromorphs in *Oreophoetes peruana* (Saussure). Following the description is a list of 21 references to gynandromorphs which have appeared in *Le Monde des Phasmes* or in *The Phasmid Study Group Newsletter*.

Baarda, G. (1994) Voer!!! *Phasma*, 4(14): 3-6.

Discusses thornless foodplants for phasmids.

Bernard, G. (1995) Un incubateur à eau chaude. *Le Monde des Phasmes*, 29: 12-13.

Describes and illustrates an incubator for phasmid eggs. The eggs are placed in a small aquarium (320mm x 170mm x 180mm) on absorbent paper over sponge, below the sponge is warm water which is heated by a 25W aquarium heater.

Bartman, G. & Brock, P.D. (1995) Observations on the appearance and behaviour of species of the stick-insect genus *Timema* Scudder (Phasmida: Timematodea). *Bulletin of the Amateur Entomologists' Society*, 54(402): 197-203, pl. 95S & 95T.

Discusses the defensive behaviour, mating behaviour, foodplants, and coloration of several species of *Timema* and describes and illustrates the egg of *T. chumash* Hebard. There are four colour photographs showing three species: *T. chumash* (mating pair; ♀), *T. podura* (♂), *T. californicum* (♀).

Bi, D. & Li, T. (1994) A new species of the genus *Datames* Stål (Phasmatodea: Bacillidae) from Guangxi. *Entomotaxonomia*, 16(4): 254-256.

Describes *Datames guangxiensis*, a new species from China. [In Chinese with English summary].

Bradley, J.T., Masetti, M., Cecchettini, A. & Giorgi, F. (1995) Vitellogenesis in the allatectomized stick insect *Carausius morosus* (Br.) (Phasmatodea: Lonchodinae). *Comparative Biochemistry and Physiology (B) Comparative Biochemistry and Molecular Biology*, 110(1): 255-266.

Effects of allatectomy on vitellogenesis in adult *Carausius morosus* were examined using rocket immunoelectrophoresis, polyacrylamide gel electrophoresis, fluorographic identification and quantitation by liquid scintillation of in vivo ³⁵S-methionine-labelled proteins, and light microscope autoradiography. In normal adults and in adults allatectomized as last instar nymphs, Coomassie

blue-stained vitellogenin (Vg) was first detectable in the haemolymph between 3 and 5 days after adult emergence. Allatectomy of 11-18 day old adults produced no detectable effects on subsequent Vg synthesis, secretion or uptake, but ovarian follicles in adults that had been allatectomized as nymphs were less efficient at taking up Vg than were those in sham-operated animals. Compared to sham-operated controls, adults allatectomized as nymphs displayed an increased rate of accumulation of newly synthesized Vg in the haemolymph, a decreased rate of accumulation of vitellin in terminal follicles, a decrease in the size of yolk spheres containing newly synthesized vitellogenic protein in the peripheral ooplasm, and alterations in the size distribution of terminal follicles. Thus, post-induction vitellogenesis and primary induction of Vg synthesis in *C. morosus* do not require active corpora allata (CA), but a normal rate of Vg uptake may be JH-facilitated.

Bragg, P.E. (1995) A review of the subfamily Korinninae (Phasmida: Pseudophasmatidae), with the description of a new species. *Tijdschrift voor Entomologie*, 138(1): 45-50.

The subfamily Korinninae is reviewed. A key to genera and species is provided. *Kalocorinnis pulchella* (de Haan), was previously placed in a different suborder, was found to be the senior synonym of *Kalocorinnis calopteryx* Günther. Variation in the males of *K. pulchella* is discussed and illustrated. A new species, *Kalocorinnis wegneri*, from Borneo, is described and illustrated. The female of *Korinnis errans* Günther is illustrated. An egg of *K. wegneri* is the first egg to be described and illustrated from this subfamily.

Bragg, P.E. (1995) A new species of *Lopaphus* Westwood, described from Borneo (Insecta: Phasmida: Heteronemiidae: Necrosiinae). *Zoologische Mededelingen Leiden*, 69(9): 105-111.

The genus *Lopaphus* is recorded from Borneo for the first time. The species, *L. borneensis* spec. nov. is described from a series of seven males and five females which were collected in Kalimantan in 1925, two specimens from Sabah, a female collected in 1986 and a male in 1987, and a male which was collected by the author in Brunei in 1991. The female resembles *L. brachypterus* (de Haan) but is more slender and is readily distinguished by the shape of the mesonotum. The male, female and egg are all illustrated. A modification of Redtenbacher's key to the genus is provided.

Bragg, P.E. (1995) *Centema hadrillus* (Westwood, 1859) P.S.G. n° 146. *Le Monde des Phasmes*, 5-9.

A translation of the report on *Centema hadrillus*, from *Phasmid Studies*, 3(2): 23-27.

Brock, P. (1995) Masters of disguise. *Minolta Image*, 1995(3): 15.

This magazine article is a colour feature on the author's photography, with brief text. Includes a picture of the author and Michael Yeh in the Tapah Hills, West Malaysia, and photographs of four species of phasmids: A green female *Acanthoxyla geisovii* (Kaup), a female *Acrophylla titan* (Macleay), a female *Eurycnema cercata* Redtenbacher displaying its wings, a mating pair of *Timema chumash* Hebard. An earlier issue of the same magazine (1993(3): 35) featured a female *Phyllium giganteum* Hausleithner, and a gynandromorph of *Heteropteryx dilatata* (Parkinson) which had male features on one side of the body and female on the other.

Bueschges, A. (1995) Role of local nonspiking interneurons in the generation of rhythmic motor activity in the stick insect. *Journal of Neurobiology*, 27(4): 488-512.

Local nonspiking interneurons in the thoracic ganglia of insects are important premotor elements in posture control and locomotion. It was investigated whether these interneurons are involved in the central neuronal circuits generating the oscillatory motor output of the leg muscle system during rhythmic motor activity. Intracellular recordings from premotor nonspiking

interneurons were made in the isolated and completely deafferented mesothoracic ganglion of the stick insect in preparations exhibiting rhythmic motor activity induced by the muscarinic agonist pilocarpine. All interneurons investigated provided synaptic drive to one or more motoneurone pools supplying the three proximal leg joints, that is, the thoraco-coxal joint, the coxa-trochanteral joint and the femur-tibia joint. During rhythmicity in 83% ($n = 67$) of the recorded interneurons, three different kinds of synaptic oscillations in membrane potential were observed: (1) Oscillations were closely correlated with the activity of motoneurone pools affected; (2) membrane potential oscillations reflected only certain aspects of motoneuronal rhythmicity; and (3) membrane potential oscillations were correlated mainly with the occurrence of spontaneous recurrent patterns (SRP) of activity in the motoneurone pools. In individual interneurons membrane potential oscillations were associated with phase-dependent changes in the neurone's membrane conductance. Artificial changes in the interneurons' membrane potential strongly influenced motor activity. Injecting current pulses into individual interneurons caused a reset of rhythmicity in motoneurons. Furthermore, current injection into interneurons influenced shape and probability of occurrence for SRPs. Among others, identified nonspiking interneurons that are involved in posture control of leg joints were found to exhibit the above properties. From these results, the following conclusions on the role of nonspiking interneurons in the generation of rhythmic motor activity, and thus potentially also during locomotion, emerge: (1) During rhythmic motor activity most nonspiking interneurons receive strong synaptic drive from central rhythm-generating networks; and (2) individual nonspiking interneurons some of which underlie sensory-motor pathways in posture control, are elements of central neuronal networks that generate alternating activity in antagonistic leg motoneurone pools.

The experimental work was done with *Carausius morosus* and *Cuniculina impigra*.

Bueschges, A., Schmitz, J. & Baessler, U. (1995) Rhythmic patterns in the thoracic nerve cord of the stick insect induced by pilocarpine. *Journal of Experimental Biology*, **198**(2): 435-456.

Bath application of the muscarinic agonist pilocarpine onto the deafferented stick insect (*Carausius morosus*) thoracic nerve cord induced long-lasting rhythmic activity in leg motoneurons. Rhythmicity was induced at concentrations as low as 1×10^{-4} mol/l pilocarpine. The most stable rhythms were reliably elicited at concentrations from 2×10^{-3} mol/l to 5×10^{-3} mol/l. Rhythmicity could be completely abolished by application of atropine. The rhythm in antagonistic motoneurone pools of the three proximal leg joints, the subcoxal, the coxo-trochanteral (CT) and the femoro-tibial (FT), was strictly alternating. In the subcoxal motoneurons, the rhythm was characterised by the retractor burst duration being correlated with cycle period, whereas the protractor burst duration was almost independent of it. The cycle periods of the rhythms in the subcoxal and CT motoneurone pools were in a similar range for a given preparation. In contrast, the rhythm exhibited by motoneurons supplying the FT joint often had about half the duration. The pilocarpine-induced rhythm was generated independently in each hemiganglion. There was no strict intersegmental coupling, although the protractor motoneurone pools of the three thoracic ganglia tended to be active in phase. There was no stereotyped cycle-to-cycle coupling in the activities of the motoneurone pools of the subcoxal joint, the CT joint and the FT joint in an isolated mesothoracic ganglion. However, three distinct 'spontaneous, recurrent patterns' (SRPs) of motoneuronal activity were reliably generated. Within each pattern, there was strong coupling of the activity of the motoneurone pools. The SRPs resembled the motor output during step-phase transitions in walking: for example, the most often generated SRP (SRP1) was exclusively exhibited coincident with a burst of the fast depressor trochanteris motoneurone. During this burst, there was a switch from subcoxal protractor to retractor activity after a constant latency. The activity of the FT joint extensor motoneurons was strongly decreased during SRP1. SRP1 thus qualitatively resembled the motoneuronal activity during the transition from swing to stance of the middle legs

in forward walking. Hence, we refer to SRPs as "fictive step-phase transitions". In intact, restrained animals, application of pilocarpine also induced alternating activity in antagonistic motoneurone pools supplying the proximal leg joints. However, there were marked differences from the deafferented preparation. For example, SRP1 was not generated in the latter situation. However, if the ipsilateral main leg nerve was cut, SRP1s reliably occurred. Our results on the rhythmicity in leg motoneurone pools of deafferented preparations demonstrate central coupling in the activity of the leg motoneurons that might be incorporated into the generation of locomotion *in vivo*.

Carlberg, U. (1994) Bibliography of Phasmida (Insecta): VIII. Supplement I (1930-1984). *Beitrage zur Entomologie*, **44**(1): 243-250.

The literature on the order Phasmida published during the period 1930-1984, which previously had been missed, has now been listed. A total of 109 scientific papers, chapters in books, theses, reports etc. are listed. A systematic index is included.

Coiffier, O. (1994) Observations sur les pattes régénérées chez *Eurycantha calcarata* Lucas, 1869. *Le Monde des Phasmes*, **27-28**: 16-17.

Illustrates a normal and a regenerated tarsus of *Eurycantha calcarata* Lucas. The regenerated tarsus consists of a four segmented tarsus and an additional basal tarsomere.

Cruse, H., Bartling, C., Cymbalyuk, G., Dean, J. & Dreifert, M. (1995) A modular artificial neural net for controlling a six-legged walking system. *Biological Cybernetics*, **72**(5): 421-430.

A system that controls the leg movement of an animal or a robot walking over irregular ground has to ensure stable support for the body and at the same time propel it forward. To do so, it has to react adaptively to unpredictable features of the environment. As part of our study of the underlying mechanisms, we present here a model for the control of the leg movement of a 6-legged walking system. The model is based on biological data obtained from the stick insect. It represents a combined treatment of realistic kinematics and biologically motivated, adaptive gait generation. The model extends a previous algorithmic model by substituting simple networks of artificial neurones for the algorithms previously used to control leg state and interleg coordination. Each system controlling an individual leg consists of three subnets. A hierarchically superior net contains two sensory and two 'premotor' units; it rhythmically suppresses the output of one or the other of the two subordinate nets. These are continuously active. They might be called the 'swing module' and the 'stance module' because they are responsible for controlling the swing (return stroke) and the stance (power stroke) movements, respectively. The swing module consists of three motor units and seven sensory units. It can produce appropriate return stroke movements for a broad range of initial and final positions, can cope with mechanical disturbances of the leg movement, and is able to react to an obstacle which hinders the normal performance of the swing movement. The complete model is able to walk at different speeds over irregular surfaces. The control system rapidly reestablishes a stable gait when the movement of the legs is disturbed.

Delfosse, E. (1994) Observations sur la régénération de différents membres. *Le Monde des Phasmes*, **27-28**: 14-15.

Illustrates regenerated legs and antennae in several species of phasmid. Examples include regenerated legs in *Baculum thaili* Hausleithner, *Carausius morosus* (Sinéty), *Eurycantha calcarata* Lucas, *Extatosoma tiaratum* (Macleay), *Lonchodes brevipes* Gray, and *Phyllium bioculatum* Gray. Examples of regenerated antennae include *E. calcarata* and *Sipyloidea sipyilus* (Westwood), the latter has regenerated a tarsus in place of the lost antenna.

Delfosse, E. (1994) Élevage de *Phyllium bioculatum* Gray, 1832. *Le Monde des Phasmes*, 27-28: 35-40.

Notes on the rearing of *Phyllium bioculatum* Gray. Includes 14 illustrations, including males, females, nymphs, eggs and cages.

Deschandol, A. (1995) Soortbeschrijving: groene glanstak; PSG No. 82: *Rhaphiderus scabrosus*. *Phasma*, 5(17): 1-5.

A report on rearing *R. scabrosus*. The article includes a colour photograph of the female, and five drawings by Xavier Singy.

Deschandol, A. (1995) Y a-t-il jamais eu de *Phyllium* dans l'île Maurice? *Le Monde des Phasmes*, 30: 11-13.

Discusses the record of *Phyllium bioculatum* Gray from Mauritius. The only record of *Phyllium* from Mauritius is Gray's record of 1843. It is suggested that this record was in error.

D'Hulster, K. (1994) Verzending van wandelende takken. *Phasma*, 4(14): 11-13.

Discusses methods of posting phasmids under three headings: Dead material, Living material, Eggs.

D'Hulster, K. (1994) Eigenaardigheden bij de voortplanting van de wandelende takken. *Phasma*, 4(14): 19-23.

A general review of parthenogenesis in phasmids.

D'Hulster, K. (1995) Kooien / Behuizing. *Phasma*, 5(17): 6-11.

Discusses cages and some of the associated problems for rearing phasmids. Construction details are given for a cage described by P. Bragg in 1989 [see *Bulletin of the Amateur Entomologists' Society*, 48(365): 160-161].

Dupré, G. (1995) Régime alimentaire des phasmes de Singapour. *Le Monde des Phasmes*, 30: 17-19.

This article lists all the foodplants of phasmids from Singapore which were originally given in Seow-Choen, Pin, Brock & Seow-En (1994) *Malayan Nature Journal*, 47: 393-396.

Garnier, G., Langlois, F. & Lelong, P. (1994) Etude *in situ* de la mobilité du phasme *Clonopsis gallica* (Charpentier, 1825) "Première partie". *Le Monde des Phasmes*, 27-28: 3-9.

A study of the mobility of *Clonopsis gallica* (Charpentier) in the wild. Part one considers the horizontal mobility.

Garnier, G., Langlois, F. & Lelong, P. (1994) Etude *in situ* de la mobilité du phasme *Clonopsis gallica* (Charpentier, 1825) "Deuxième partie". *Le Monde des Phasmes*, 27-28: 23-28.

Part two of this study examines the vertical mobility of *Clonopsis gallica* (Charpentier) in the wild.

Giorgi, F., Cecchetti, A., Locci, M.T., Masetti, M. & Bradley, J.T. (1995) A fat body-derived protein is selectively sulfated during transit to ovarian follicles in the stick insect *Carausius morosus*. *Developmental Biology*, 167(1): 379-387.

A monoclonal antibody raised against ovarian follicles of the stick insect *Carausius morosus* reacted with two related polypeptides of 157 and 85 kDa in both the ovary and the haemolymph. In vitro cultured fat body proved capable of releasing the 157 kDa polypeptide into the culture

medium and processing it to the lower molecular weight polypeptide of 85 kDa. This was further demonstrated by in vitro exposure to (35S)methionine. Under the same culturing conditions, ovarian follicles proved incapable of synthesizing and/or secreting the 85 kDa polypeptide. However, in vivo (35S)methionine-labelled ovarian follicles released both polypeptides when cultured in vitro for up to 24 hr. Vitellogenin polypeptides were labelled in vivo following exposure to (3H)glucosamine, while 157 and 85 kDa polypeptides were labelled only in ovarian follicles exposed in vivo to sodium (35S)sulphate. Under in vitro conditions, the 157 kDa polypeptide could be labelled with sodium (35S)sulphate only if ovarian follicles were co-cultured with fat body. No sulphation occurred in fat body or ovarian follicles cultured separately. These experiments suggest that the 157 kDa polypeptide is a fat body-derived polypeptide that is sulphated upon transfer to the ovarian follicle.

Gorkom, J. van (1994) Naar de Wereld van het regenwoud. *Phasma*, 4(15): 14-21.

A travel story about Sumatra, concluding with some comments on some of the phasmids collected.

Gorkom, J. van (1994) Soortbeschrijving: rode varentak. *Phasma*, 4(16): 1-2.

Records of *Oreophoetes peruana* (Saussure): specimens were collected from Tarapoto, Peru by Didier Mottaz in September 1984, these were used to establish a culture. Specimens were found in Ecuador, at Rio Verde and Misahualli, by Oscar van Gorkom and Heinz van Herwaarden in August 1989. Oscar van Gorkom and Frank Nijssen found this species at Rio Pastaza in 1993. A colour photograph of the male is included.

Gorkom, J. van (1994) Het geslacht *Haaniella* (verzamelde gegevens). *Phasma*, 4(16): 11-15.

A summary of the species of *Haaniella* which are in culture. Includes colour photographs of *Haaniella echinata echinata*, *Haaniella echinata scabra*, *Haaniella muelleri* and *Haaniella dehaani*.

Gorkom, J. van (1995) *Eurycantha calcarata* (PSG 23) en *Eurycantha* species (PSG 44) overeenkomsten en verschillen. *Phasma*, 5(17): 12-17.

Discusses and illustrates the similarities and differences between the two cultures of *Eurycantha calcarata* numbered PSG 23 and PSG 44. The article includes eight drawings, and two colour photographs which show a female from each culture.

Gorkom, J. van (1995) Overleven door bedotten en vermommen. *Phasma*, 5(17): 19-22.

A general discussion of the predators and defences of phasmids.

Gorkom, J. van (1995) Soortbeschrijving: briljante tak. *Phasma*, 5(18): 9-10.

Comments on rearing *Menexenus laetus* (Kirby). The article includes drawings of the egg and apex of the male's and of the female's abdomen. A colour photograph of the male and female is also included.

Gorkom, J. van (1995) Aanvullende informatie bij de nummers 153 t/m 160 van de P.S.G. soortenlijst. *Phasma*, 5(18): 11-14.

Comments on recent additions to the PSG culture list, species 153-160. Includes drawings of a male and an egg of *Ctenomorphodes tessulatus* (Gray), and the egg of *Acrophylla titan* (Macleay).

Hennemann, F. (1995) *Calvisia coerulescens* Redtenbacher, eine wenig bekannte Phasmide aus West-Malaysia und die Erstbeschreibung des Männchens (Phasmatodea). *Entomologische Zeitschrift*, **105**(16): 321-325.

The species *Calvisia coerulescens* Redtenbacher 1906 [correct date is 1908] has so far been described only in the female sex. In this paper, a more detailed description of the female is given and the newly discovered male is described.

Hennemann, F.H., Gehler, A.S. & Conle, O.V. (1995) *Parapachymorpha quadrispinosa* n.sp. aus Thailand, mit einer taxonomischen Revision der Gattung und der Erstbeschreibung des Männchens von *Parapachymorpha spinosa* Brunner (Phasmatodea: Phasmatidae: Pachymorphinae). *Entomologische Zeitschrift*, **105**(19): 386-394.

Parapachymorpha quadrispinosa n.sp. is described and figured in the female sex. The male is still unknown. The hitherto undescribed male of *Parapachymorpha spinosa* Brunner 1906 [correct date is 1907] is described and figured and a taxonomic review of the genus *Parapachymorpha* Brunner, 1893 is given.

Langlois, F. (1995) L'oeuf de *Stratocles variegatus* (Stoll, 1813). *Le Monde des Phasmes*, **29**: 3-9.

Describes and illustrates the egg of *Stratocles variegatus* (Stoll). Illustrations include eight SEM photographs showing the surface and sections through the capsule, and one drawing.

Lefranc, Y. & Roubaud, P. (1995) Point de vue et vue par point. *Le Monde des Phasmes*, **29**: 22-24.

Discusses the structure of the eye and vision in *Extatosoma tistaratum* (Macleay).

Lelong, P. (1995) *Bacteria* sp. Guyane Française. *Le Monde des Phasmes*, **29**: 15-18.

A description and report on rearing an unidentified species of *Bacteria* which was collected in French Guiana. The male, female and egg are well illustrated.

Lelong, P. (1995) *Phasma necydaloïdes* (Linné, 1763). *Le Monde des Phasmes*, **29**: 19-21.

A description and report on rearing "*Phasma necydaloïdes*" which was collected in French Guiana. The male, female and egg are all illustrated.

[Note: The species *P. necydaloïdes* (Linnaeus, 1763) belongs in the genus *Pseudophasma* Kirby, and the species is a junior synonym of *P. phthisicum* (Linnaeus, 1758) - P.E. Bragg.]

Lelong, P. (1995) *Bacillus atticus atticus* Brunner, 1882. PSG n° 156. *Le Monde des Phasmes*, **30**: 23-25.

A report on rearing the parthenogenetic phasmid *Bacillus atticus atticus*. The female and eggs are both illustrated.

Lelong, P. (1995) *Ramulus* sp. PSG n° 141. *Le Monde des Phasmes*, **30**: 26-28.

A report on rearing the *Ramulus* sp., PSG culture 144, from Zaire. The male, female and eggs are all illustrated.

Nederlof, L.J. (1995) Wandelende bladeren, een familie apart. *Phasma*, **5**(19): 1-5.

Discusses rearing of *Phyllium* spp.; includes illustrations of several specimens.

Nijssen, F. (1994) Takkenreis naar Ecuador (18 juli t/m 11 augustus). *Phasma*, 4(14): 7-10.

The second part of the description of a phasmid collecting trip to Ecuador, continued from *Phasma* 4(13): 11-16. Places visited included Banos and Selva Alegre. Phasmids collected included species of *Agathemera*, *Bacteria*, *Calynda*, *Dyme*, *Libethra*, and *Paraphasma*.

Potvin, W. (1994) Een nieuwe *Libethra* uit Ecuador. *Phasma*, 4(15): 6-10.

Describes the rearing, and illustrates a species of *Libethra* which has recently come into culture from Ecuador. This article originally appeared in *Phasmid Studies* 2(2): 59-61 in December 1993.

Rapp, G. (1995) Eggs of the stick insect *Graeffea crouanii* Le Guillou (Orthoptera, Phasmidae). Mortality after exposure to natural enemies and high temperature. *Journal of Applied Entomology*, 119(2): 89-91.

The eggs of the coconut stick insect *Graeffea crouanii* develop on the ground beneath the palms where they are subject to desiccation and attacks by parasitoids or predators. Eggs were exposed in petri dishes to assess the significance of natural enemies in the field. After 1 year the parasitoids *Paranastatus verticalis* and *P. nigriscutellatus* had emerged from only 1% of a total of 240 eggs, predators had attacked 70%. Eggs were offered to potential predators. The ants *Pheidole megacephala* and *Tapinoma melanocephalum* and the rodents *Rattus exulans* and *R. rattus* accepted them. Egg mortality after exposure to different temperatures was observed in climatic chambers. Nymphs emerged from 62% of a total of 120 eggs kept at 20°C. All eggs exposed to 30°C and 40°C became desiccated.

Rastel, D. (1994) Une approche personnelle de la simplification des conditions d'élevage des phasmes. *Le Monde des Phasmes*, 27-28: 10-13.

Describes a cage arrangement and a method for rearing phasmids. The method involves using boxes of sand at the bottom, upturned boxes placed crosswise above these, and leaves being laid on the top.

Sanjayan, K.P., Muralirangan, M.C., Suresh, P., Suresh Chand, D. & Albert, S. (1995) Insect diversity in a natural scrub-jungle vegetation of a forest ecosystem in Tamil Nadu, India. *Entomologist*, 114(3 & 4): 179-194.

Quantitative data of the insect fauna of a natural scrub-jungle ecosystem at Nanmangalam Reserve Forest (Tamil Nadu, India) is assessed at the community level in relation to the seasonal changes in the habitat. A package of collection techniques involving using of light trap, scented trap, pitfall trap, sticky trap, sweep net and search out, was employed. 379 species of insects belonging to 13 orders were encountered over the year. Coleoptera, Orthoptera and Lepidoptera were the most significant orders present in the forest. A good correlation existed between the number of species and the number of individuals collected. A bimodal curve was obtained when the total insect abundance and species abundance are plotted with season with a small peak in February and a major in September. The seasonal changes in the abundance of the insect fauna are not as a result of proportional changes in each insect order. Coleoptera were less affected by the high summer temperature of the forest. Diversity indices such as alpha, H', N₁ and N₂ were computed and compared in relation to season. The total insect biomass of the forest is discussed in relation to the net plant productivity of the forest. Phasmida were found to comprise 3.2% of the biomass of the insect community. Seven species of phasmids were found with a total of 221 individuals. [Although this paper deals with phasmids only in passing, an abstract is included here because it is rare for such studies to give data for Phasmida, usually they are grouped with "orthopteroid orders" or "small orders". - P.E. Bragg]

Seow-Choen, F. (1995) The longest insect in the world. *Malayan Naturalist*, 48(4): 12.

This short article records and illustrates a female *Pharnacia serratipes* (Gray) from Tasik Chini, West Malaysia, which has a body length of 278mm and an overall (including the legs) length of 555mm. This specimen has the longest overall length of any insect although the body length is less than that which has been recorded for several specimens of *Pharnacia kirbyi* (Brunner).

Spreter, V. (1995) Opdat de wandelende bladeren zouden dansen. *Phasma*, 5(19): 10-21.

A translation of "Pour que dansent les phyllies" which appeared in *Le Mondes des Phasmes*, 19: 16-21, in 1992. The translated article includes some additional material: three colour photographs showing a female *Phyllium bioculatum*, a female nymph of *P. celebicum*, and a female *P. giganteum*; the text is translated without any additional comments.

Tinti, F., Mantovani, B. & Scali, V. (1995) Reproductive features of homospecific hybridogenetically-derived stick insects suggest how unisexuals can evolve. *Journal of Evolutionary Biology*, 8(1): 81-92.

Hybridogenetic reproduction has been demonstrated in both vertebrate and invertebrate unisexual hybrids. Its most peculiar feature is the transmission to the progeny of one invariant genome (hemiclone) through the egg and the replacement of the other by host fathering males. *Bacillus* hybridogens are the only known example of hemiclinal invertebrates; their comparison to *Poeciliopsis* and *Rana* systems helps in understanding peculiar and shared features of vertebrate and insect hybridogenesis. In *P. monacha-lucida*, the experimental production of non-hybrid progeny through the reunion of the maternal hemiclone with a homospecific paternal genome provided by males of the maternal ancestor leads to inviable or severely impaired sterile specimens, whereas in *Rana esculenta* viable offspring are the rule. The comparable synthetic *B. rossius* progeny (Rr) embodying the maternal R hemiclone and a paternal r haploset, appear perfectly viable and fertile, clearly demonstrating compatibility between the two homospecific genomes, and also supporting a lack of deterioration of the R hemiclone. This condition can be ascribed to the recent origin of the hemiclones, and also to the absence of lethal recessives, owing to their most likely derivation from an automictic doubling in the parthenogenetic mechanisms of the maternal ancestor. However, the hybridogenetic system breaks down in the gamete production of the majority of Rr females, since normal allele segregation also occurs in their progeny. These reproductive modes suggest a likely evolutionary dynamic for newly originated hybridogens: to achieve stability, an interruption of reproductive interactions with the maternal ancestor seems necessary. In stick insects, this constraint appears to be fulfilled in both areas of sympatry. The microevolutionary pathway suggested by the ecological scenario also supports the possibility that a shift of hemiclinal stick insect strains to clonality has occurred.

Viscuso, R., Sottile, L. & Narcisi, L. (1994) Ultrastructural characteristics of the epithelium of the spermatheca and copulatory bursa of *Baculum thaili* Hausleithner (Phasmatodea). *European Archives of Biology*, 105(1-2): 19-31.

The ultrastructural study, using SEM and TEM, of sexually mature virgin and mated females of *Baculum thaili* revealed that the ultrastructural organization of the epithelium of the spermathecal tubules is uniform along the entire length of the tubules whereas the epithelium of the copulatory bursa presents peculiar characteristics according to the region in question. While the epithelium of the greater part of the latter organ is composed solely of epidermal cells, the epithelium in the dorsal-median region thickens due to the presence of numerous gland units and acquires an ultrastructural organization generally comparable to that found at the level of the spermathecal tubules. On the basis of the ultrastructural characteristics observed substantially the same in both the mated and virgin females - the authors suggest that the function of the copulatory bursa is far

more complex than that of simply storing sperm. Moreover, it seems likely that this activity is correlated to that of the spermatheca with which it is closely connected anatomically.

Woerkom, A. van (1995) Het herkennen van wandelende bladeren aan de hand van hun eieren. *Phasma*, **5**(19): 6-7.

Illustrates the eggs of seven species of *Phyllium*: *P. bioculatum*, *P. caudatum*, *P. celebicum*, *P. elegans*, *P. giganteum*, *P. keyicum*, and *P. siccifolium*.

Publications noted

The following publication has been noted but no abstract has been received.

Mohrherr, C.J., Maruska, K., Raabe, M., Riehm, J.P. & Rao, K.R. (1994) Primary structure of a pigment-dispersing factor from the stick insect, *Carausius morosus*. *Society for Neuroscience Abstracts*, **20**(1-2): 914.

Sandoval, C.P. (1994) The effects of the relative geographic scales of gene flow and selection on morph frequencies in the walking-stick *Timema christinae*. *Evolution*, **48**(6): 1866-1879.

Scali, V., Tinti, F., Mantovani, B. & Marescalchi, O. (1995) Mate recognition and gamete cytology features allow hybrid species production and evolution in *Bacillus* stick insects. *Bolletino di Zoologia*, **62**(1): 59-70.

Erratum

Phasmid Studies. **4**(1): 12, paragraph 5: the 5th line incorrectly reads "Subsequent treatments of *B. carinulatus* have placed it in *Baculum*...." it should read "Subsequent treatments of *B. pseudoporus* have placed it in *Baculum*....".