

A glossary of terms used to describe phasmids

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

Abstract

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

Key words

Phasmida, Glossary, Terminology, Morphology.

Introduction

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

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

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

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

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

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

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

Glossary of morphological terms

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

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

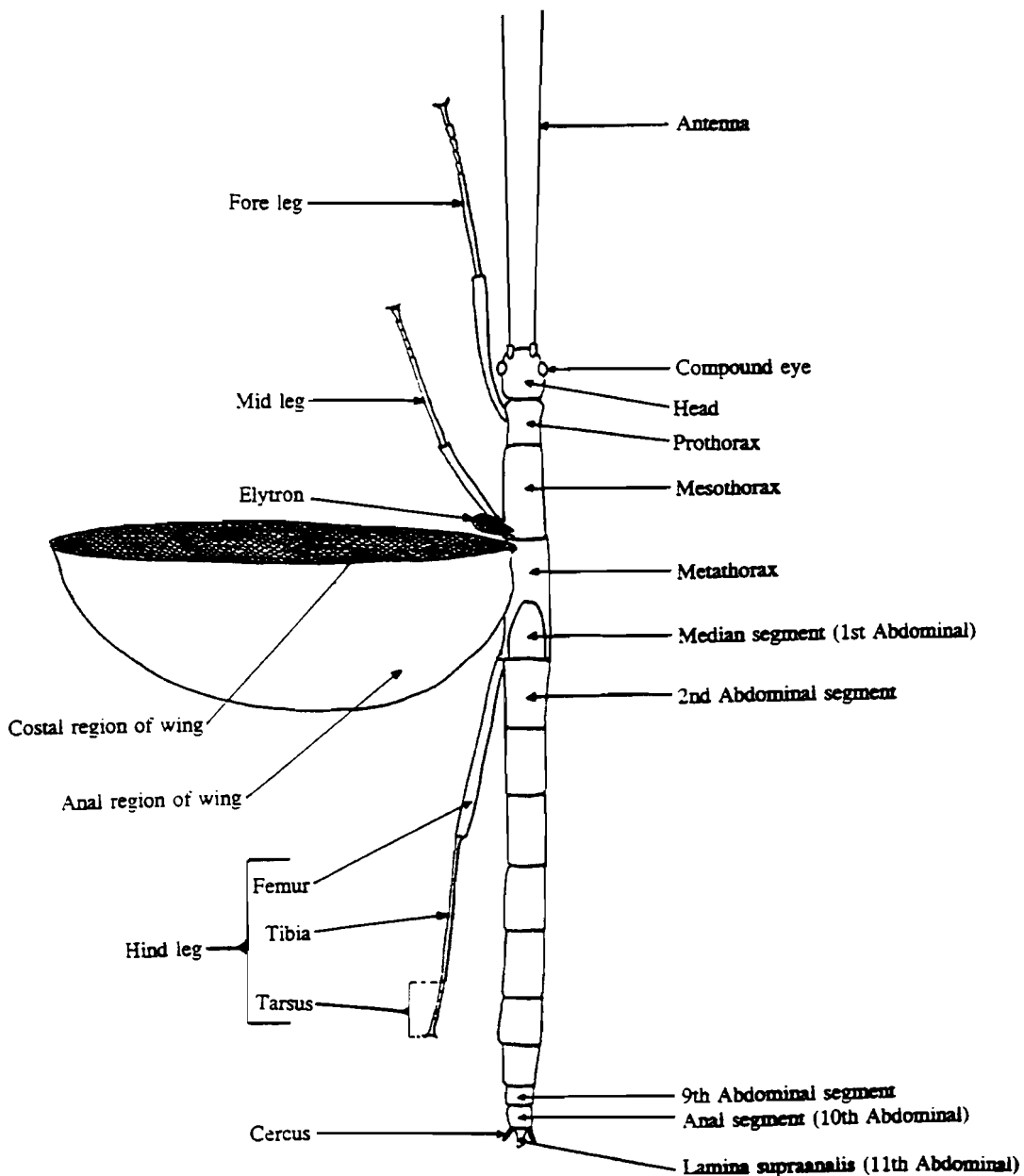


Figure 1. Basic features of a typical phasmid.

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

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

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

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

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

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

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

Vomer subanal: See Vomer.

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

The carinae of the legs

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

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

Descriptions of surfaces

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

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

Wing venation

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

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

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

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

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

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

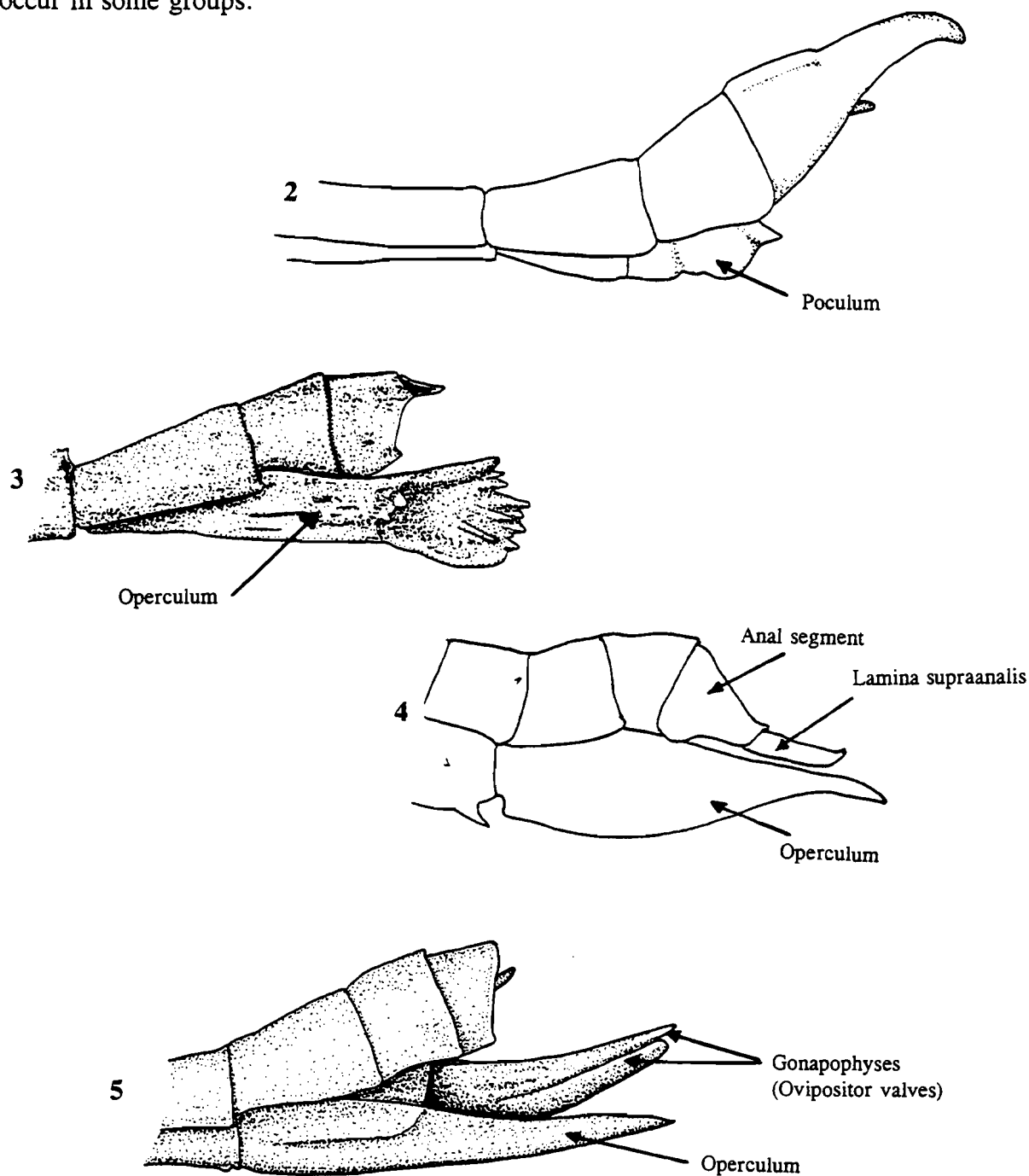
Table 1 Equivalent names used for veins by Ragge and Hamilton.

External genitalia of phasmids

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

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

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



Figures 2-5.

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

Male genitalia

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

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

Female genitalia

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

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

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

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

References

- Chapman, R.F. (1982) *The insects: structure and function*. [3rd ed.] Hodder & Staughton, London.
Günther, K. (1933) Über eine kleine Sammlung von Phasmoiden und Forficuliden aus Melanesien. *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 44(2): 151-164.

- Günther, K.** (1970) Chapter 12, Cheleutoptera (Phasmoidea) pp. 58-61, in Tuxon, S.L. *Taxonomist's glossary of genitalia in insects*. [2nd edition] Munksgaard, Copenhagen.
- Hamilton, K.G.A.** (1971) The Insect Wing, Part I. Origin and development of wings from notal lobes. *Journal of the Kansas Entomological Society*, **44**(4): 421-433.
- Hamilton, K.G.A.** (1972a) The Insect Wing, Part II. Vein homology and the archetypal insect wing. *Journal of the Kansas Entomological Society*, **45**(1): 54-58.
- Hamilton, K.G.A.** (1972b) The Insect Wing, Part III. Venation of the orders. *Journal of the Kansas Entomological Society*, **45**(2): 145-162.
- Hamilton, K.G.A.** (1972c) The Insect Wing, Part IV. Venational trends and the phylogeny of the winged orders. *Journal of the Kansas Entomological Society*, **45**(3): 295-308.
- Imms, A.D.** (1925-1994) *A general textbook of entomology*. London. [Many revised editions].
- Key, K.H.L.** (1970) *Phasmatodea (Stick-insects)* in CSIRO, *The Insects of Australia*, volume 1. pp. 348-359.
- Lelong, P.** (1996a) Le dictionnaire des phasmes. *Le Monde des Phasmes*, **32**: 15-20.
- Lelong, P.** (1996b) Le dictionnaire des phasmes (suite). *Le Monde des Phasmes*, **33**: 16-26.
- Lelong, P.** (1996c) Le dictionnaire des phasmes (suite). *Le Monde des Phasmes*, **34**: 17-25.
- Nichols, S.W.** (1989) *The Torre-Bueno Glossary of Entomology (Revised edition)*. New York Entomological Society.
- Ragge, D.R.** (1955) The wing-venation of the order Phasmida. *Transactions of the Royal Entomological Society of London*, **106**: 375-392.
- Rehn J.A.G. & Rehn J.W.H.** (1938) The Orthoptera of the Philippine Islands, Part 1. - Phasmatidae; Obriminae. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **90**: 389-487.
- Scudder, G.G.E.** (1961) The comparative morphology of the insect ovipositor. *Transactions of the Royal Entomological Society of London*, **113**(2): 25-40.
- Sellick, J.** (1992) The phasmid egg. *Phasmid Studies*, **1**(1): 8-9.
- Snodgrass, R.E.** (1935) *Principles of Insect Morphology*. McGraw-Hill, New York.
- Snodgrass, R.E.** (1937) Male genitalia of Orthopteroid insects. *Smithsonian Miscellaneous Collection*, **96**(5): 107 pages [Phasmatodea, pp. 23-29].