

## A preliminary review of the classification of the zygaenid subfamily Procridinae (Lepidoptera)

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### Summary

In his revision of the Zygaenidae of the world, ALBERTI (1954) divides the Zygaenid subfamily Procridinae into the two tribes Callizygaenini and Procridini. As typical for the subfamily, he mentions 9 main characters ("Leitmerk-male"). Three of them refer to the head and the wing, the other six to the sclerotized parts of the genitalia of the male and female. Studies of type material from all regions of the world have shown that the real autapomorphies of the Procridinae are found in the interior female genitalic structures. Of the nine characters mentioned as typical for Procridinae by Alberti, none is unique to this subfamily as all of them are shared with at least one other group of Zygaenidae. Therefore they cannot be used as autapomorphies for the Procridinae. As the type species of the tribe Callizygaenini, *Callizygaena auratus* (Cramer, 1779) (= *nivimacula* Felder, 1874), lacks the autapomorphies of the subfamily Procridinae, the tribe has to be excluded from the Procridinae and is considered to form a distinct subfamily of the family Zygaenidae. The remaining species in the Procridinae can be divided into two groups, the *Adscita-Illiberis*-group and the *Artona*-group. Both are considered to form well-separated tribes within the subfamily. The *Adscita-Illiberis*-group has a world-wide distribution, whereas the *Artona*-group is restricted to the Indo-Australian and Afrotropical regions with a few species occurring also in the eastern Palaearctic region. Observations on the biology support the evidence provided by results based on morphological characters.

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### The monophyly of the Procridinae

The Procridinae are the only subfamily of the Zygaenidae with a world-wide distribution, whereas all other subfamilies are restricted to smaller areas. On the American and Australian continents they are the only representatives of the family. The nine principal characters ("Leitmerkmale" sensu Alberti) of the Procridinae are :

1. Proboscis only sometimes reduced
2. Chaetosemata always present

3. Analis [CuP] always present
4. Ovipositor absent
5. Ductus seminalis inserted into corpus bursae near orifice of ductus bursae (and not from ductus bursae itself)
6. Ductus bursae frequently with specialized structures
7. Uncus single and pointed, without sensory hairs
8. Valva well developed
9. Aedeagus never thorn-shaped

A critical review of these characters shows that not one of them is a real autapomorphy of the subfamily, as the Procridinae share most of them with at least one other subfamily of the Zygaenidae.

### Notes

- ad 1) As far as is known the proboscis is reduced in only two genera of Procridinae (*Theresimima* Strand, 1917 [1 species] and *Rhagades* Wallengren, 1863 [1 of 4 species]) in which it is approximately two-thirds shorter than normal. It is fully developed in all Zygaeninae except in the relict species *Pryeria sinica* Moore, 1877, and in nearly all the Chalcosiinae except a few genera in which it is shorter (e.g. *Aglaope* Latreille, 1809, *Chalcosiopsis* Swinhoe, 1894, *Boradia* Moore, 1879). It is partly reduced in the Phaudinae and totally absent in the Anomoeotinae and Himantopterinae. These three groups are treated as subfamilies of the Zygaenidae by ALBERTI (1954). The Anomoeotinae and Himantopterinae are now accepted as distinct families within the superfamily Zygaenoidea and the Phaudinae may also form a separate family perhaps including the *Lactura*-group according to larval and female genitalic characters (Kirky, pers. comm.). Within the remaining three subfamilies of Zygaenidae, the Zygaeninae, Chalcosiinae and Procridinae, the character 'proboscis only sometimes reduced' does not represent an autapomorphy of the Procridinae.
- ad 2) Well developed chaetosemata are present in all Zygaeninae, Chalcosiinae and Procridinae. The presence of chaetosemata is therefore a family character of the Zygaenidae.
- ad 3) The vein CuP (analis sensu ALBERTI, 1954) is present in all Zygaeninae, Chalcosiinae and Procridinae. It is therefore a family character of the Zygaenidae.
- ad 4) Absence of an ovipositor occurs in all Zygaeninae and in all Procridinae, except the Central American genus *Gonioprocris* Jordan, 1913 in which a small ovipositor is developed. A well developed ovipositor is present in the Chalcosiinae. As this character is shared by both the Zygaeninae and Procridinae it cannot be an autapomorphy of the subfamily Procridinae and is considered to be plesiomorphic.
- ad 5) The ductus seminalis is inserted into the ductus bursae near the antrum in the Zygaeninae and in some Chalcosiinae (e.g. tribe Heteropanini),

but arises from the corpus bursae in most Chalcosiinae and all Procrinae. Therefore this character does not represent an autapomorphy of the subfamily Procrinae.

- ad 6) The ductus bursae has many very strange and specialized structures in most Procrinae but there are also groups within this subfamily in which the ductus is simple. The specialization of the ductus bursae (e.g. the evolution of a praebursa) is a good autapomorphy for certain subgroups of the Procrinae but not an autapomorphic character for the entire subfamily.
- ad 7) It is true that nearly all Procrinae have a single and pointed uncus mainly without any sensory hairs. All Zygaeninae and many Chalcosiinae (e.g. Chalcosiini) have a double uncus. In those Chalcosiinae in which a single uncus is developed (e.g. Cyclosiini), it is rarely pointed and bears sensory hairs. Nevertheless there are some Chalcosiinae which have a single uncus which lacks hair (e.g. some *Cyclosia* Hübner, [1820]) and there are specializations of the uncus known in some Procrinae (e.g. *Neoprocris* Jordan, 1915). Therefore this character is also not a good autapomorphy of the subfamily Procrinae.
- ad 8) All Zygaeninae, Chalcosiinae and Procrinae have a well-developed valva which is a plesiomorphic character.
- ad 9) The aedeagus is thorn-shaped in the tribes Agalopini, Aglaopini and Chalcosiini of the subfamily Chalcosiinae, but normal and tube-like in the tribes Cyclosiini and Heteropanini. In all Zygaeninae and Procrinae it is not thorn-shaped. The character 'aedeagus never thorn-shaped' does not represent an autapomorphy of the subfamily Procrinae.

Although according to recent research the characters of Alberti do not represent good autapomorphies of the subfamily there is no doubt that this group is a monophyletic unit and its status as a subfamily of the Zygaenidae is justified. The main characters that clearly separate the Procrinae from all other Zygaenid subfamilies are :

1. *Female genitalia with ductus seminalis lacking pseudobursa or bulla seminalis.*

As in most families included in the superfamily Zygaenoidea, there is a well-developed pseudobursa present in the Zygaeninae and Chalcosiinae. The lack of a pseudobursa in the Procrinae is therefore considered to be a secondary reduction, or plesiomorphic.

2. *Lagena in receptaculum seminis absent.*

In Zygaeninae and Chalcosiinae and, as far as checked, in all other families included in the superfamily Zygaenoidea a well-developed lagena is present, as in most ditrysian Lepidoptera. The reduction of the lagena in the Procrinae is therefore considered to represent a good autapomorphic character of the group.



3. A pair of accessory glands is present close to the ooporus which may represent a structure homologous to Petersen's gland in the Zygaeninae.

These glands differ in shape and structure from those of the Zygaeninae. They are lacking in the Chalcosiinae. There is one group of Procridinae in which these glands are secondarily reduced or transformed into a different structure (*Pollanisus* Walker, 1854, *Hestiochora* Meyrick, 1887 and *Onceropyga* Turner, 1906 in Australia). According to recent research Petersen's gland in the Zygaeninae produces a secretion which is supposed to prevent predators and possibly fungi from attacking the eggs (Naumann, pers. comm.). As the Australian group is not able to produce this liquid due to the absence or the modification of the glands another defence system has been developed. The females of the three above-mentioned Australian genera are characterized by their abdominal hairtuft. When laying eggs the long, hair-like scales of this hairtuft are glued to the surface of the eggs, giving the egg clusters a hedgehog-like appearance. The tips of these scales are poisonous and an aphid, for example will die within a quarter of an hour after touching them. It is therefore possible that the glands have evolved into a special subcuticular poisonous area in which the spiny scales are situated. When the scales become attached to the egg by their distal part, the proximal part is covered with poison as in a poisonous dart.

4. Larva without chemical defence system.

In the larvae of Zygaeninae and Chalcosiinae a special cuticular defence system is present (POVOLNÝ & WEYDA, 1981; FRANZL & NAUMANN, 1984; 1985; WITTHOHN & NAUMANN, 1984a; 1984b). Similar defence systems have also been discovered in other Zygaenoidea (Naumann, pers. comm.). It is not yet clear whether the lack of such a cuticular defence system in larvae of the Procridinae is a secondary loss or a primary situation.

### The subdivision of the Procridinae into tribes

ALBERTI (1954: 209), in his revision of the family, divided the subfamily Procridinae into the two tribes Callizygaenini and Procridini. He was convinced that both are monophyletic units within a monophyletic subfamily. His opinion was based on studies especially of genitalia structures and the presence or absence of a medial stem in the wing venation. Unfortunately Alberti did not check *Callizygaena aurata* (Cramer, 1779) (= *nivimacula* Felder, 1874), the type-species of *Callizygaena* Felder, 1874. This species and a small group of other congeneric South East Asian species lack the characteristic autapomorphies of the subfamily Procridinae.

The following characters show that the *Callizygaena*-group neither belong to the Procridinae nor to the Zygaeninae or Chalcosiinae:

1. Valva dish-like and strongly sclerotized as in Zygaeninae, with setae at distal margin pointing inwards but with one single, stout, triangular, not

distally pointed and very strongly sclerotized uncus (in the Zygaeninae there is a double-lobed uncus present and in the Procridinae and Chalcosiinae the valva is completely different, never so strongly sclerotized and distally rounded) (Fig. 1).

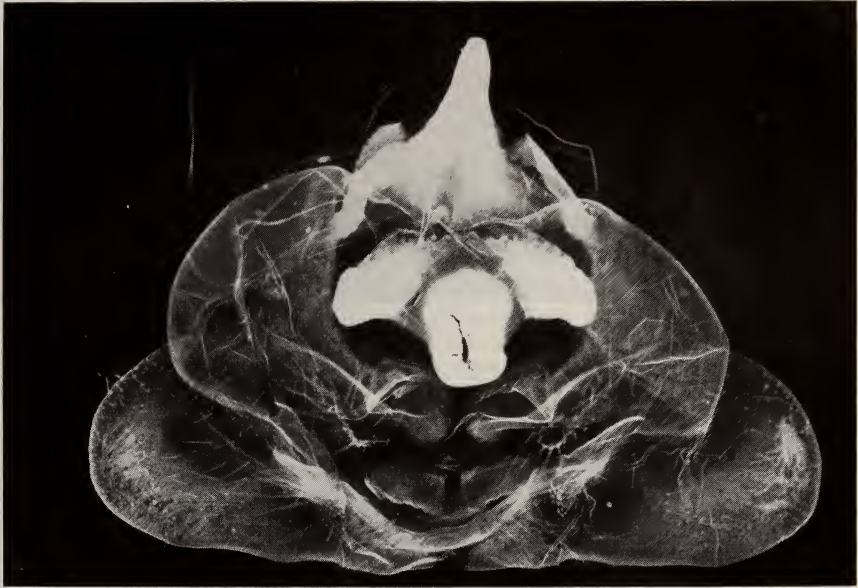


Fig. 1. Male genitalia (Valva-tegumen-uncus-part) of *Callizygaena aurata* (Cramer, 1779), S. India, Mullacore (BMNH/London).

2. Aedeagus a tiny, slender and straight spine (in Procridinae tube-like and much larger compared with the size of the specimens and in the Zygaeninae also much larger with a lamina dorsalis and lamina ventralis present).
3. Corpus bursae with characteristic signa (signa never present in the Procridinae).
4. Ductus seminalis arising from the proximal part of the ductus bursa and not from the corpus bursae (as in the Procridinae) or from the distal part of the ductus bursae (as in the Zygaeninae).
5. A pseudobursa (= bulla seminalis sensu Alberti) is present, as in the Zygaeninae and Chalcosiinae (absent in the Procridinae).
6. Receptaculum seminis with well developed lagena, as in all Zygaenoidea except the Procridinae.

7. Petersen's gland or homologous structures absent (present in the Zygaeninae and Procridinae, also absent in the Chalcosiinae).

Consequently, the *Callizygaena*-group of the Zygaenidae has to be excluded from the subfamily Procridinae and treated as a distinct subfamily of the Zygaenidae, **Callizygaeninae stat.n.**

According to the author's studies the remaining genera of Procridinae can be placed into two subgroups or tribes :

(a) Tribus Procridini Boisduval, [1828]

(b) Tribus **Artonini trib. n.**

The tribe Procridini is still a mixture of several monophyletic subgroups which may be described as separate tribes later, if necessary. The tribe Artonini is a monophyletic unit based on the following autapomorphies :

1. Chaetosema triangular, extending forward between the compound eye and the ocellus (Fig. 2). In all other Procridinae the space between the compound eye and the ocellus is covered with smooth, flat scales and the chaetosema is not extended.



Fig. 2. Chaetosema of a primitive Artonini from Australia. SEM-photo by Colin Beaton, CSIRO, Canberra, Australia.





Fig. 3. Lateral view of a female *Turneriptocris coronias* (Meyrick, 1886) with dorso-lateral evagination at abdominal segment 2 (see arrow). Photo by John Green, CSIRO, Canberra, Australia.

2. Abdomen with small dorsolateral evaginations on segments 2 and 7 (Fig. 3). These evaginations are secondarily reduced in some subgroups. Only on the second abdominal segment are these lateral evaginations present in the Australian genus *Pollanisus* Walker, 1854, and there are no lateral evaginations in the Australian genus *Hestiochora* Meyrick, 1887, but as *Hestiochora* is closely related to *Pollanisus* and there are clear synapomorphies indicating the monophyly of these two genera, the reduction of the lateral evagination has to be interpreted as a secondary loss.
3. Valva fan-shaped with a stronger, sclerotized costal and basal margin and a very translucent, strongly folded central part. This type of artonoid valva is present in its basic and simple form in the primitive Australian genera (e.g. *Pollanisus* Walker, Fig. 4) while it has evolved into very complicated structures in most of the tropical genera. However, even if the structures are very complicated the ground-plan of the fan-shaped artonoid valva is still visible.

The Procradini have a world-wide distribution with the exception of the temperate parts of Australia. The Artonini occur only in the Afrotropical Region, in South East and East Asia and Australia, including the temperate parts and the island of Tasmania.

## Conclusion

Having excluded the former tribe Callizygaenini from the subfamily Procrinae, the remaining genera within the latter form a monophyletic unit. The



Fig. 4. Artonoid valva type of a primitive Artonini, *Pollanisus subdolosus* (Walker, 1865), male Holotype, Australia (BMNH/London).

monophyletic origin of the Procridinae is supported by four autapomorphies. The subfamily is newly divided into two tribes. The tribe Procridini consists of several monophyletic groups and subgroups, but at the present time there are no characters known which are clear autapomorphies of the whole tribe. The tribe Artonini is monophyletic, based on three autapomorphies. The Callizygaeninae are considered to form a distinct subfamily of the Zygaenidae.

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