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LIFE-HISTORY PATTERNS AMONG CARABID SPECIES

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Evolutionary biologists aim to get a grip on evolutionary processes by assuming that natural selection would control special life-history traits, which are assumed to promote the fitness of species. With the help of models they try to explain the effect of special life-history traits in the evolution of life histories in general. Many of the models used are, in fact, extensions of the concept of r and K selection or are based on similar deterministic ideas. Examples of vertebrates are usually preferred, though invertebrates are thought to be subject to the same 'rules'. In the present paper by comparing the more generally occurring life-history traits among carabid species it is tried to find out which life-history traits dominate the life histories of West-European carabid species. Most of these traits governing the populations of carabid species of Drenthe (the Netherlands) appear to differ from those advanced by evolutionary biologists. 'Dispersal power' and 'turnover frequency' are especially significant. They show remarkable departures from the generally accepted schemes. These divergencies are explained and the possible causes of diverging life-history traits among carabid species are discussed. The need to do more comparative investigations of life-history traits in groups of related species in order to test the current thoughts about the role of life-history patterns in the course of evolution is emphasized.

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Since the publication of MacArthur & Wilson's 'Island biogeography' (1967), in which the concept of r and K selection was introduced, the study of life-history traits has become highly fashionable, especially among population ecologists and American evolutionary biologists. It is a pity, however, that these studies were mainly restricted to vertebrates and were theoretical. Apparently, many evolutionary biologists thought it possible to predict which life-history patterns (combinations of life-history traits) were most important for evolutionary progress, and with the help of mathematical models they tried to illustrate the effects of these life-history patterns on the success and survival of species (e.g. Gadgil & Bossert 1970, Cody 1971, Schaffer 1972, 1974a, b).

This trend in evolutionary biology was severely criticized by Stearns (1976). Regrettably, however, Stearns did not suggest doing comparative investigations among genetically related species on life-history traits in relation to the prevailing properties of the environments where these respective species thrive best (are most 'fit'). It might be expected that life-history traits, which improve survival and reproduction, are most favoured by natural selection in environments where the species is most fit. Therefore, when comparing these life-history traits for genetically related species, i.e. species in the same taxonomic group (see e.g. Den Boer 1980), but living in different kinds of habitat, one can expect to get some insight into the relationship between life-history patterns and prevailing environmental conditions. It would especially be interesting, to check whether or not the theoretically predicted patterns indeed emerge as the most important patterns from such a comparative field study.

After a symposium 'On the evolution of behaviour in carabid beetles' (Den Boer et al. 1979), and stimulated by the paper of Stearns (1976), the first author tried to make a provisional comparison of the life-history traits of carabid species of stable habitats (forests) with those of carabid species of unstable habitats (banks of rivers and pools, and agricultural fields) (Den Boer 1979a). Since that time the comparison of life-history traits always has been a point of general interest somewhere in the background of the investigations on the population dynamics of carabid beetles at the Wijster Biological Station.

In the present paper we will give and discuss the results of a comparison of life-history patterns among the carabid species of our area (Drenthe), which are representative for the greater part of western Europe.

Therefore, we will first discuss the concept of r and K selection of MacArthur & Wilson (1967), then the life-history traits considered to be most important by Stearns (1976), and finally we will compare these with our present knowledge of life-history patterns among carabid species.

r and K selection

The best known and most cited attempt to connect animal numbers with life-history patterns was the introduction of the dichotomy of species into r-selected and K-selected species by MacArthur & Wilson (1967). This dichotomy was based upon the well-known equation for logistic population growth of Verhulst (1838): dN/dt= rN.(K-N)/K, in which r is the 'intrinsic rate of natural increase', i.e. the maximum potential rate of reproduction, and K is the carrying capacity of the environment, i.e. the maximum number of individuals the habitat can support under the current conditions.

'As an example of how K selection and r selection can be in opposition, consider different situations in which crowding can either reduce the per capita food supply to a precariously low level, or else not have this effect. In an environment with no crowding (r selection), genotypes which harvest the most food (even if wastefully) will rear the largest families and be most fit. Evolution here favors productivity. At the other extreme, in a crowded area (K selection), genotypes which can at least replace themselves with a small family at the lowest food level will win, the food density being lowered so that large families cannot be fed. Evolution here favors efficiency of conversion of food into offspring – there must be no waste' (MacArthur & Wilson 1967: 149).

Note that the concept of r and K selection is entirely theoretical. It is based on a very simple and unidirectional notion of natural selection. Den Boer et al. (1993: 257/258) wrote about natural selection: '... the longer a natural population persists in a certain area, the better will the frequency distribution of genotypes fit the distribution of selective events, which is the same as saying, the better the population becomes adapted to the variability of local conditions. ... In our opinion this state of affairs is the base for significant evolutionary processes, because such processes can only continue over a sufficiently long period as long as natural selection can shift from one genotype to another within a very broad frequency distribution of genotypes, i.e. a frequency distribution that has developed and was moulded under environmental conditions that varied in space and time and was maintained by risk spreading.'

Nevertheless, the concept of r and K selection got much attention among population ecologists, who often called the species they studied either r- selected or K-selected, without, in most cases, doing any research into the suggested selection processes. Meanwhile, the usage of these terms has so broadened that almost any life-history dichotomy is likely to be termed r and K selection (Atkinson 1979). Parry (1981) recognized four different meanings for the terms r and K selection:

a) r selection is selection for maximum population growth in uncrowded populations; K selection is selection for competitive ability in crowded populations. This is the original meaning, which we cite above.

b) r selection is the density-independent component of natural selection; K selection is the density-dependent component of natural selection. (This density-dependent component can be crowding, but it might also be predation, or parasitism, etcetera).

c) r species occur in habitats which are ephemeral; K species occur in habitats with a long durational stability. (Apart from the fact that stability of a habitat will directly affect many life-history traits and thus natural selection, mainly in a stable habitat the available time for population growth can be expected to be sufficient to result in crowding).

d) r selection is the allocation of a large proportion of resources to reproduction; K selection is the allocation of a small proportion of resources to reproduction. (High reproductive effort should be associated with small young, and low reproductive effort with large young).

For a review of the publications in which these different meanings of r and K selection are used we refer to Parry (1981). Although the concept of r and K selection has stimulated much of the recent research into life-history patterns, it has also led to considerable confusion around life-history traits and population numbers.

It will be evident that knowledge about the relationship between life-history patterns and population numbers cannot only be based upon theoretical concepts that in the field usually are difficult to quantify reliably; for example, the amount and direction of selection processes, the numerical effect of density-dependent versus density-independent mortality, the degree of stability of habitats, or the allocation of resources to reproduction or otherwise. The inclusion of such appealing but vague concepts will mostly only contribute to vaguely formulated investigations and ambiguous results.

Therefore, it seems preferably first to find out what are the most important life-history traits, and the most frequently occurring life-history patterns in field populations, and then theorize about the possible significance of these patterns for the course of evolution, and not the other way round. See also Stearns (1992: 206/207).

The life-history traits recognized by Stearns (1976)

In an extensive and critical review of the literature Stearns (1976) tried to summarize our present knowledge about the relationship between life-history traits and principal features of the environment. He especially criticized the fact that conclusions are drawn from models that were not tested in the field: 'First, theories accumulate, few of them formulated in common terms, much faster than evidence can be assembled to test them. The result is confusion of untested ideas which are judged, not on their ability to withstand empirical tests, but on the difficulty of the mathematics used or the obscurity of the theoretical development' (l.c.: 36). It can be added that the models developed, in some way or another, are extensions of the logistic growth equation and thus of the ideas of r and K selection of MacArthur and Wilson.

Other of Stearns' criticisms concern the patterns of causation: 'Within the biological community, there is a subterranean split between those who believe that for every phenomenon there is a single cause at a given level of explanation, and those who believe that there can be multiple causes for certain phenomena operating at the same level of explanation' (l.c.: 37). The idea of multiple causes is worked out and illustrated with enlightening examples in Hilborn & Stearns (1982). In his paper of 1976 Stearns tried to find out which combinations of life-history traits

Table 1. Number of eggs laid in three succeeding years by each of 30 females of the carabid beetle *Pterostichus versicolor* (=*coerulescens*) in the laboratory at 19 °C and with superabundant food. All females reproduced for the first time in 1976; hibernation occurred in the field (modified after Van Dijk 1982: table 5).

	Number of eggs laid in			total number of eggs laid
	1976	1977	1978	
1	0	92	0 +	92
2	0 +	–	–	–
3	1	3	224	228
4	1	98	59 +	158
5	3	72 +	–	72 *
6	5	61	164	230
7	9	2	94	105
8	11	5	87	103
9	25	18	31 +	74
10	42 +	–	–	42 *
11	45	89	171	305
12	48	276	291	615
13	72	50	169	291
14	79	1 +	–	80 *
15	79	10	204	293
16	81	88	278	447
17	83	169 +	–	252 *
18	93	215 +	–	308 *
19	93	32	292	417
20	95 +	–	–	95 *
21	112	87	0 +	199
22	115	17	89	221
23	119	280	146	545
24	122	114	114	350
25	124	95 +	–	219 *
26	128	54	70 +	252
27	134	252	0	386
28	147 +	–	–	147 *
29	197 +	–	–	197 *
30	261	315	98	674
Total	2324	2495	2581	5984 +
mean	77.5 ± S.E. 11.94	99.8 ± S.E. 19.26	129.1 ± S.E. 21.04	1412 *
N	30	25	20	

+ = died during hibernation in the field; * = total number of eggs laid by females that did not complete all three reproduction periods.

After reproduction had finished the individually brand-marked females were placed in large enclosures in the field to hibernate; as far as not died in winter the females were recaptured in early spring by placing many small pitfalls along the inner sides of the enclosures.

have evolved most frequently to counter specific difficulties for survival and reproduction offered by the environment, i.e. which traits most directly determine the 'fitness' of the species.

He calls such combinations of life-history traits 'tactics': 'I define a tactic as a set of coadapted traits designed, by natural selection, to solve particular ecological problems' (Stearns 1976: 4). We prefer it to call such combinations of traits 'life-history patterns', in order to avoid any suggestion of teleology.

The life-history traits that should affect fitness most according to the current literature (Stearns included) are: (1) brood size; (2) relative size of the young; (3) the age distribution of reproductive effort, i.e. semelparity (a single reproduction period per female), and iteroparity (repeated reproduction by each female); (4) the interaction of reproductive effort with adult mortality, i.e. the possible occurrence of a 'trade-off' between fecundity and survival of adults; (5) age at first reproduction.

Life-history traits in fluctuating environments

In seasonal environments with an unpredictable start of the favourable season Stearns expected that '... the optimal tactic consists of generating a distribution of hatching times in the clutch that matches the historical probability distribution of the optimal date for reproduction' (l.c.: 28). He based this expectation on the 'spreading of risk' hypothesis of Den Boer (1968).

Environmental conditions that vary from year to year would select clutch sizes both smaller and more variable than the most productive size. In this connection Stearns refers to a paper by Murdoch (1966), in which he stated that carabid beetles live longer and survive into the next season after having decreased their reproductive effort, i.e. a trade-off between survival and fecundity.

This conclusion of Murdoch (1966) was severely attacked by Van Dijk (1979), who especially blamed Murdoch for not having studied the fecundity of surviving beetles in following seasons. Table 1 clearly shows that after the first reproductive season the total reproductive effort (number of eggs laid) of surviving beetles (n= 25) and of beetles that did not survive the first winter (n= 5) did not differ significantly (Mann-Whitney: P= 0.28). The same applies to the second reproductive season, both for the numbers of eggs laid during two seasons (n= 20 and n= 5; P= 0.46), and for those laid during the first season only (P= 0.38). But the beetles that survived all three reproductive seasons did produce significantly more eggs during these three seasons than those that died during the third winter (P= 0.0073), i.e. just the reverse of what would be expected from a trade-off between reproduction and survival. Both during the first season and during the first two seasons the beetles that survived all three seasons did not produce numbers of eggs that were significantly different from those of beetles that died during the last winter (P= 0.20 and P= 0.36 respectively). See also Van Dijk (1994), where it is shown that similar results are obtained when the beetles are not fed 'optimally' as occurred in the experiments of Van Dijk (1979). The greater reproductive capacity of the beetles that survived all three winters became apparent only during the third reproductive season.

Of course, this does not mean that in other species a trade-off between reproduction and survival may not occur. But we have the impression that, on theoretical arguments alone, it is too often assumed that such a trade-off would occur, whereas it is only rarely demonstrated in reliable field data or tested by experiments (see also Stearns 1992: Appendix 2).

This is not a biased statement, but is based on careful studies. Aukema (1990a) studied the genetics of the wing-dimorphism in three species of the carabid genus *Calathus*. Among other things he wanted to know whether or not there are other differences between the long-winged and short-winged morphs than the difference in wing development. Contrary to our expectations, he found that the long-winged morph produced significantly more eggs over a longer period than the short-winged morph (Aukema 1991, 1994).

Hence, the extra reserves used by long-winged beetles to produce large wings and wing-muscles did not frustrate the production of eggs as compared with egg production of short-winged beetles, i.e. there was no 'trade-off' between the forming of large wings and wing-muscles and the size of egg production, on the contrary. In retrospect the above results are not unreasonable, because the long-winged beetles can fly away from the population and colonize vacant sites. And colonization has a better chance of success when the beetles produce as many eggs as possible. But this story also illustrates how careful one has to be when assuming a 'trade- off'.

Ideas about such trade-off's are based upon the 'budget-concept', i.e. each individual can dispose of similar and only restricted reserves, and these can either be used solely for high reproduction, or partly for other processes as well, such as the development of wings and wing-muscles, a longer life, etc., with lower reproduction as a consequence (e.g. Cody 1966). In our opinion, it is forgotten that individuals of the same species are not similar and can differ importantly in their basal metabolism (see e.g. Gotthard et al. 1994), which may lead to significant differences in development time, fecundity, longevity, etc. between individuals (compare Table 1).

As far as Stearns (1976) knew, no theoretical work had been done on optimal life-history patterns in environments that change randomly in time. He assumed that when conditions are favourable the optimal pattern should be: rapid development and a total commitment of available reserves to reproduction that produces a resting stage. Such a life history is indeed found among many animals and plants of deserts, e.g. in the branchiopod (Notostraca) *Triops cancriformis*, which develops rapidly and reproduces in temporary pools originating from heavy rainfall, followed by many years in a resting stage (eggs). A comparable situation is found in trees where the seeds are only released after a fire, which also creates the right conditions for germination of the seeds, e.g. in *Pinus contorta*.

'If progeny can grow faster as larvae outside the parent (when resources for the young are abundant and predation pressure is low), then many small progeny will be favored. If resources for young are scarce, or predator risk to small size classes is high, then the parent will tend to produce a few large progeny' (Stearns 1976: 31).

But Stearns realizes very well that there are many exceptions to this 'rule'. It is a pity that many evolutionary biologists immediately connect the production of many small young versus a few large ones to r and K selection, and thus omitted to observe the life history more closely. For instance, there are good reasons to assume that the production of big eggs, different kinds of parental care, the development of one or a few young inside the mother, etc. are not so much connected with an overall scarcity of resources for the young, but more with a high probability of the occurrence of unfavourable physical conditions for them. As well these traits may be associated with the difficulties of small young finding rapidly enough, sufficient of the most adequate – and possibly abundantly present – food to survive this early and most vulnerable stage of their development.

It is often stated that reproductive effort should increase with age. Indeed, Table 1 gives a clear example of that: in 10 out of 15 females that survived all three winters egg production was highest during the third reproductive season. And in three others of these females it was highest in the second reproductive season. Klomp (1970) found a similar phenomenon for the clutch sizes of birds, with the partridge from England as an exception. We expect, however, there will be more exceptions to this 'rule', and not only among birds. More of such 'rules' are constructed by evolutionary biologists (see e.g. Williams 1966), predominantly from theoretical considerations, such as optimalization models. Hence the situation in evolutionary biology is similar to that in population ecology: too many theories, a predominance of deterministic or pseudodeterministic (see Feller 1939) models, insufficient reliable field observations, and a too devoted belief in simple 'rules'.

The new book of Stearns (1992) shows that the adequate study of life histories did not progress remarkably during the last decades, in spite of: 'Life histories lie at the heart of biology; no other field brings you closer to the underlying simplicities that unite and explain the diversity of living things and the complexities of their life cycles. Fascinating in themselves, life histories are also the keys to understanding related fields. Life history theory is needed to understand the action of natural selection, a central element of evolution, the only theory that makes sense of all of biology. It also helps to understand how the other central element, genetic variation, will be expressed. The evolution of life-history traits and their plasticities determines the population dynamics of interacting species. Its explanatory power, barely tapped, could reach as far as communities. There is much to be done' (l.c.: 9).

Broadly speaking, we agree with Stearns, especially with the very last sentence, and therefore it is the more regrettable that life-history theory is still largely based upon optimalization models, trade-off's and deterministic mathematics. The book of Roff (1992) on the same subject gives a similar picture as that of Stearns about the study of life histories.

To generate testable hypotheses about the processes underlying life-history patterns it will be necessary first to do an extensive comparative investigation of life-history traits, their variation and combinations, among related species, and next to find out how the differences and variations of life-history traits among these related species might be connected with their genetics, dynamics, choice of habitat and food preferences. As advocated by Stearns (1976) only when sufficient investigations have been done might it be interesting to return to theoretical considerations and models: 'Not only do theories accumulate, but the manner of their accumulation decreases the likelihood that they will be tested. An enormous amount of effort is being put into the development of ideas for which no one has established connections with the real world. If the field is to progress, we must get away from the practically Scholastic approach surfacing in such papers, and get back to rigorous empiricism' (l.c.: 37).

Results

Life-history patterns among carabid species

Carabid species from stable and from unstable habitats

Although we do not pretend to be able to improve life-history theory substantially – even less to tell evolutionary biologists how to do their research – we thought it useful to stimulate discussions about the kind of results that might arise from a comparative study of life-history traits among related species. Den Boer (1979a: Tables 1 and 2) made a first step in this direction. He compared the life-history traits of the 14 most common carabid species of forests with those of the 16 most abundant carabid species of agricultural fields and waste sites, in order to approach the current interpretation of r and K selection as closely as possible (see Parry 1981).

In each of the groups there are both spring, summer, autumn and winter reproducing species (Den Boer et al. 1990). In both groups most species are iteroparous with only a single semelparous species in each group. We could not discover any striking difference in the numbers of eggs produced between species of the two groups, but this aspect asks for more painstaking investigations than have been done to date. More consistent differences in the life-history patterns between these two groups were found in a combination of night- or day-activity, degree of polyphagy, and powers of dispersal, especially presence or absence of dispersal by flight. Flight observations are made by catching flying carabid beetles with window traps (vertical glass plates, see Southwood 1976: 193). Such window traps were operating during more than 20 years around the Wijster Biological Station (Den Boer 1979a).

Taking together the results of this provisional study we got the impression that for carabid species of the temperate regions (at least in western Europe) among the more significant life-history traits dispersal power is most closely connected with the current environmental conditions. In other words, carabid species will show a rate of dispersal that is indicative of the rate of population 'turnover' (Den Boer 1977). Species living in rather stable habitats (forests, old heath areas, old peat moors) show a low population turnover and low powers of dispersal, because individuals leaving the population area usually have only a low chance of surviving and reproducing. Features favouring dispersal will be selected against. On the other hand, species living in ephemeral habitats (agricultural fields, banks of pools and rivers) are forced to show a high population turnover. Individuals leaving the population area may have a better chance to survive and reproduce than individuals staying there. In such species features favouring dispersal are not expected to be selected against (Den Boer 1990a).

Although evolutionary biologists usually do not consider 'dispersal power' to be a life-history trait, we neglect possible theoretical objections and, in the following, we will also call 'dispersal power' a life-history trait (see also Roff 1994). 'Dispersal power' determines the 'design for survival of the species' (Stearns 1976), since it might be connected with fecundity, as was shown by Aukema (1991, 1994) and was discussed before.

In 1992 Stearns (p.10) says: 'Life history traits figure directly in reproduction and survival.' Indeed, dispersal power does usually figure in reproduction and survival, but indirectly, i.e. by opening the possibility to found new populations. In this case it would not be a direct 'fitness-feature', but an indirect one.

Comparison of life-history traits of carabid species with theoretical expectations

About some life-history traits that are highly valued by evolutionary biologists we can establish the following for carabid beetles:

a) 'Concerning relative size of the young'. All carabid species, just like many other insects (Ross 1956: 165), lay relatively big eggs with much yolk, which will give the young larvae a reasonably good start after hatching. But there are differences: *Carabus*-species (adults 14-26 mm) especially develop and lay relatively low numbers of rather big eggs, as do some small carabids, such as some species of *Trechus* and *Bembidion* (adults 2-5 mm). On the other hand, some *Calathus*-species (adults 8-14 mm, Aukema 1991), and *Nebria brevicollis* (10-12 mm, Nelemans 1987) lay many much smaller eggs. Within the same population of a species eggs usually are of the same size (but see Ernsting & Isaaks 1994).

Many carabid beetles exhibit some kind of simple parental care, especially *Abax*-species (Brandmayr et al. 1979) and some other species of forests. As far as there is some relationship with environmental conditions, we can establish that most *Carabus*- and all *Abax*-species occupy forest areas. There are no indications, however, that parental care would have anything to do with competition, i.e. with K selection.

b) Most carabid species are iteroparous (more than one reproduction period per female). The few semelparous species known so far are not especially living under conditions of r-selection: *Nebria brevicollis* prefers light forest, though it also occurs in other more or less shaded sites; *Loricera pilicornis* occupies wet shaded sites (Lindroth 1945: 1992). Population numbers of semelparous species fluctuate more widely than those of iteroparous species living under similar conditions. An example of such a difference in field populations is given by Den Boer (1979b: 163, and fig. 3). The semelparous species mentioned by Den Boer (1979a) are more or less specialized for the catching of collemboles (Hengeveld 1980).

c) The interaction of reproductive effort with adult mortality (trade-off) for carabid beetles was discussed before.

d) Concerning 'age at first reproduction' we can confirm that most autumn breeding carabid species reproduce immediately after eclosion of the adults (e.g. *Calathus melanocephalus*: Van Dijk 1972, 1973). But the advantage of a low chance of dying at this time is more than nullified by the long larval development of 7-9 months in the most unfavourable season (winter) when mortalities are very high (Van Dijk & Den Boer 1992: tables 4, 5, 6).

Young beetles of the semelparous autumn breeder *Nebria brevicollis* aestivate for 2-3 months before reproducing in September-November, and this is accompanied by an additional mortality of 10-30% (Nelemans et al. 1989). This apparently unfavourable way of life is undoubtedly connected with the origin of *Nebria*-species as inhabitants of cold regions, such as northern Canada, northern Scandinavia and higher regions of the Rocky Mountains and the Alps, where the young beetles have to overwinter before reproducing (Kavanaugh 1985; Gereben 1994). Hence, *N. brevicollis* is 'locked in', so to speak, to a way of life that was adequate for its ancestors. It may no longer be able to 'escape' from that, in spite of the disadvantages connected with a life-history pattern that combines semelparity, autumn breeding and aestivation. Although this life-history pattern is far from 'optimal' (see also: White 1993), *N. brevicollis* is an abundant species in temperate Europe and it thrives well there, albeit with wide fluctuations of numbers (Den Boer 1979b: fig. 3).

Spring breeding carabid species have the advantage of a short larval development, though often under too dry conditions, but young beetles have to overwinter before reproducing, which is accompanied with appreciable mortality (Den Boer 1979b: table 2). Possibly, some winter breeders have combined larval development in spring and summer with reproduction of just eclosed beetles in winter and early spring. But in many winters weather conditions are such that any kind of activity, let alone reproduction, is impossible. So, per force and at the cost of high losses, winter breeders become early spring reproducers. Moreover, some winter reproducers, e.g. *Bradycellus harpalinus*, migrate before reproduction. This, too, introduces high mortalities.

Among carabid species there is no distinct relationship between 'time of reproduction' and environmental conditions, with the trivial exception that in open, wet sites only spring breeders occur, simply because larvae cannot survive in sites that are usually inundated in winter and early spring. Also, in dry heathland and blown sand areas with sparse vegetation, mainly winter breeders occur, possibly because the very small first instar larvae of these species can only escape desiccation in these dry habitats in winter and early spring. But in other kinds of habitat in the Netherlands carabid species reproduce in many different times of the year: Den Boer (1980: table 3; Den Boer et al. 1990). See also Greenslade (1965) and Murdoch (1967).

A general comparison of life-history patterns of carabid species living in Drenthe (The Netherlands)

The comparison of carabid species from forests with those from unstable habitats may be biased in that it might give a too clear dichotomy. It is not sure, of course, that species from other kinds of habitat will nicely fit into the picture developed above. Therefore, it is advisable also to make a more general comparison of the life-history traits of carabid species. For methods of the collection of necessary data we refer to Den Boer (1977), with the remark that the data used in the following do not cover the period 1959-1967 as in Den Boer (1977), but the period 1959-1985.

Figure 1, in which 68 carabid species are ranked according to the period of reproduction, distinctly illustrates that in each time of the year reproduction is possible for at least some carabid species. The period of reproduction is not related to dispersal power: relatively good dispersing species (m and d) as well as poorer dispersing ones [(m), (d) and b] are distributed randomly among the 68 species (Mann-Whitney: P= 0.77). In relatively stable habitats (F, H, S, H+S, H+P, H+F, F+R) significantly more carabid species are autumn breeders (asterisk in fig. 1) than in less stable habitats (W, A, R, W+A, A+R, S+A, S+R, H+W): Mann-Whitney, P= 0.0003. Autumn breeding seems to be a life-history trait that is closely connected with stability of the habitat.

Well dispersing carabid species, which are not only fully winged or wing-dimorphic with a high fraction of winged specimens, and are also observed in active flight (catches in window traps), are more often found in less stable habitats than carabid species with low powers of dispersal, i.e. no flight observations and often unwinged or wing-dimorphic with a low fraction of winged specimens: r_s (Spearman)= +0.42 (P= 0.0006). As discussed by Den Boer (1990a) carabid species living for many generations in stable habitats gradually lose 'dispersal power' (reduction of both wing-muscles and hindwings). This process again diminishes the number of opportunities to found new populations by flying individuals, in which genes associated with dispersal might be multiplied.

This process towards brachyptery in stable habitats has been advanced by the changing of stable habitats into less stable agricultural fields by man, causing the remnants of stable habitat to become highly fragmented and isolated. As a result brachyptery is most likely to be strongly associated with stability of the habitat in forests, usually the oldest remnants of stable habitat in cultivated regions, more so than in heath areas. In our area, however, old forest has nearly completely disappeared, while stable heath areas are highly fragmented and at most a few thousands years old.

species	no.	habitat	dp	Mar Apr May June July August Sept Oct Nov Dec Jan Feb 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Asaphidion flavipes	44	H+A	m	◇◇◇◇◇◇◇◇◇◇
Pterostichus nigrita/rhaeticus	137	W	m	◇◇◇◇◇◇◇◇◇
Pterostichus diligens	133	W	d	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus minor	135	W	d	◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus strenuus	139	F+W	d	◇◇◇◇◇◇◇◇◇◇◇
Pterostichus oblongopunctatus	138	F	(m)	◇◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus quadrifoveolatus	130	B	m	◇◇◇◇◇◇◇◇◇◇◇◇◇
Syntomus foveatus	114	H+S	(d)	◇◇◇◇◇◇◇◇◇◇
Agonum assimile	6	F	(m)	◇◇◇◇◇◇◇◇
Agonum ericeti	8	H+P	b	◇◇◇◇◇◇
Amara communis	26	A+R	m	◇◇◇◇◇◇◇◇◇
Amara familiaris	31	A+R	m	◇◇◇◇◇◇◇◇
Carabus nemoralis	78	F	b	◇◇◇◇◇◇◇
Loricera pilicornis	112	W	m	◇◇◇◇◇◇◇◇◇◇◇◇◇
Amara famelica	30	W	m	◇◇◇◇◇◇◇◇◇◇
Carabus arvensis	75	H	b	◇◇◇◇◇◇◇
Amara aenea	21	S+A	m	◇◇◇◇◇◇◇◇◇◇◇
Dyschirius globosus	95	H+A	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus vernalis	140	W	m	◇◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus versicolor	132	H	(m)	◇◇◇◇◇◇◇◇◇◇◇◇◇
Notiophilus aquaticus	119	H	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Notiophilus palustris	122	F	d	◇◇◇◇◇◇◇
Notiophilus rufipes	124	F	(m)	◇◇◇◇◇◇◇◇
Agonum sexpunctatum	18	W	m	◇◇◇◇◇◇
Clivina fossor	86	H+A	d	◇◇◇◇◇◇◇
Harpalus affinis X	99	A	m	◇◇◇◇◇◇◇◇◇◇◇◇
Harpalus latus *	103	H+F	(m)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Notiophilus biguttatus X	120	F	d	◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Carabus cancellatus X	76	H	b	◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇
Calathus rotundicollis *	73	F	d	◇◇◇◇◇◇ ◇◇◇◇◇◇◇
Cymindis macularis *	88	S	b	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Bembidion lampros X	54	W+A	d	◇◇◇◇◇◇◇◇◇◇◇
Harpalus quadripunctatus *	105	F	m	◇◇◇◇◇◇◇◇◇◇
Abax parallelepipedus *	1	f	b	◇◇◇◇◇◇◇◇◇◇◇◇◇
Agonum fuliginosum X	9	F	d	◇◇◇◇◇◇◇◇◇◇◇
Anisodactylus binotatus X	42	A	m	◇◇◇◇◇◇◇
Harpalus solitaris *	102	H	m	◇◇◇◇◇◇◇
Agonum obscurum *	17	H	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Pterostichus lepidus X	134	H+S	b	◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Harpalus rufipes *	104	A	m	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Amara plebeja X	35	A	m	◇◇◇◇◇◇◇◇◇◇
Amara lunicollis X	34	H+W	m	◇◇◇◇◇◇◇◇◇◇◇◇
Harpalus rufipalpis *	106	R	m	◇◇◇◇◇◇◇◇◇
Pterostichus melanarius *	141	A	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Trechus secalis *	148	F	b	◇◇◇◇◇◇◇◇◇◇◇◇◇
Cymindis vaporariorum *	89	H	d	◇◇◇◇◇◇◇◇◇
Leistus terminatus *	109	F+H	(m)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Calathus erratus *	68	H+S	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Broscus cephalotes *	66	S	m	◇◇◇◇◇◇◇◇◇◇
Amara brunnea *	25	F	m	◇◇◇◇◇◇◇◇◇
Calathus melanocephalus *	70	H	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Amara equestris *	29	H	(m)	◇◇◇◇◇◇◇◇◇◇
Pterostichus niger *	136	F+R	(m)	◇◇◇◇◇◇◇◇◇◇
Trechus obtusus *	146	F+R	d	◇◇◇◇◇◇◇◇◇◇◇◇
Notiophilus germinyi *	121	S	d	◇◇◇◇◇◇◇◇◇◇◇
Olisthopus rotundatus *	125	H	(d)	◇◇◇◇◇◇◇◇◇◇◇◇◇
Calathus fuscipes *	69	S+R	d	◇◇◇◇◇◇◇
Carabus problematicus *	80	F	b	◇◇◇◇◇◇◇◇
Nebria brevicollis *	117	F	m	◇◇◇◇◇◇◇◇◇◇◇◇◇◇
Nebria salina *	118	H	m	◇◇◇◇◇◇◇◇◇
Leistus rufomarginatus *	110	F	(m)	◇◇◇◇◇◇◇◇◇◇
Trichocellus placidus X	150	F	m	◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇
Trichocellus cognatus X	149	H	m	◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇
Bradycellus ruficollis X	65	H	m	◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇
Bradycellus harpalinus *	64	H	d	◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇
Amara infima X	33	S	(d)	◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇ ◇◇◇◇◇
Bembidion nigricorne X	56	S	b	◇◇◇◇◇◇ ◇◇◇◇◇◇◇
Bradycellus caucasicus X	62	H	d	◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇

Nevertheless, both in remnants of forest and in those of heath we find about the same numbers of species with low powers of dispersal [(m),(d) and b] and with high powers of dispersal (m and d) respectively: $\chi^2 = 0.138$ (d.f.=1, P= 0.70), this most probably because remnants of really old forest in the Netherlands have either disappeared completely or are too small to keep viable populations of poorly dispersing carabid beetles for a long time. However, among the four macropterous forest species only *Trichocellus placidus* (150), a species of small patches of young forest and of forest borders, is regularly caught in window traps (in flight), whereas among the six macropterous species of heath there are three regular flyers, *Amara lunicollis* (34), *Trichocellus cognatus* (149) and *Bradycellus ruficollis* (65).

So far the general conclusions drawn from fig. 1 do not deviate significantly from those reached by Den Boer (1979a), who compared 14 forest species with 16 species from unstable habitats.

The picture can be completed now with: (a) Spring breeders can be found both in stable and in unstable habitats, autumn breeders mainly in stable habitats, but winter breeders are almost restricted to sandy sites. (b) The still surviving poorly dispersing species are mostly found in remnants of stable habitat, whereas well dispersing species occur both in stable and in unstable habitats with some preference for the latter.

Grüm (1984) suggested that the fecundity of autumn breeders would be higher than that of spring breeders. In general we have the same impression (Nelemans 1987; Aukema 1991; Van Dijk & Den Boer 1992), though we wonder whether the autumn breeder *Carabus problematicus* will fit this picture (Rijnsdorp 1980): females of *C. problematicus* produce low numbers of rather big eggs, whereas females of the autumn breeding *Calathus*-species and of *Nebria brevicollis* produce many rather small eggs. The actual egg production has to be studied more closely, since data from the dissection of females often are not reliable (Van Dijk 1986b).

Life-history patterns among closely related species

Figure 1 enables us to study the effect of genetic relationships on life-history traits, assuming that taxonomically related species are also genetically related (compare Den Boer 1980). When comparing species within genera we find that some genera are rather homogeneous, i.e. characterized by a special life-history pattern:

Calathus-species are wing-dimorphic (except *C. mollis*), night-active, autumn breeding, polyphagous carnivores, which lay many small eggs. Most *Harpalus*-species (in fig. 1: 5 out of 6) are macropterous, polyphagous autumn breeders that also consume plant material and mainly occupy poor grassy sites (Desender & Turin 1989; Turin et al. 1991); *Bradycellus*-species are polyphagous, macropterous or wing-dimorphic winter breeders of sandy sites; *Agonum*-species and most *Amara*-species (in fig. 1: 6 out of 9) are spring or early-summer breeders. Most *Amara*-species are polyphagous (including plant material) and macropterous (in fig. 1: 7 out of 9) species of unstable habitats, whereas the four *Carabus*-species in fig. 1 are brachypterous, lay a few relatively big eggs, and are associated with stable habitats; they are polyphagous carnivores that digest their prey outside the body by bringing digesting fluids into it. *Nothiophilus*-species are all very similar looking (fast running, small beetles with large eyes), oligophagous hunters of collemboles (Hengeveld 1980), which often show diverging reproduction periods (119: *aquaticus*, 120: *biguttatus*); *Leistus*-species are night-active, oligophagous hunters of springtails with specialized morphological adaptations for catching their rapid prey, and which reproduce late in autumn after a period of aestivation; in many respects *Nebria*-species resemble *Leistus*-species, except for the morphological adaptations to catch springtails.

But other genera, for instance *Pterostichus*, are very heterogeneous in many respects: dispersal power is very different among the 11 species of fig. 1 (3 m, 3 d, 3 (m), 1 (d), 1 b), 8 species are spring breeders, one

Fig. 1. Reproductive periods of the 68 most abundant carabid species of Drenthe (the Netherlands) ranked from early reproducers (March-May) until late reproducers (October and in winter, sometimes continued in early spring). For each species the expected dispersal power (dp) is indicated: m= fully winged (macropterous), (m)= wings relatively small, often not suitable for flight, d= wing-dimorphic with a high fraction of fully winged specimens (>2%), (d)= wing-dimorphic with a low fraction of fully winged specimens (< 2%), b= unwinged (brachypterous). Also the preferred habitat of each species is indicated: W= wet, open habitats, e.g. banks of pools and small rivers, B= sites where forest or peat has been burned, R= ruderal and other waste sites, A= agricultural fields, S= blown sand areas fixed by vegetation and dry heathland, H= mainly moist heathland, P= peat moor, F= forest. Species indicated by an asteriks must be considered autumn breeders with winter larvae, those indicated by an X possibly also are autumn breeders, but the presence of winter larvae is not convincingly shown. Also, the species numbers (no.) are given. These numbers are also indicated in table 3. Here we mention the names which have recently changed: 130 = *Pterostichus quadrifoveolatus* (*angustatus*), 132 = *P. versicolor* (*coerulescens*), 141 = *P. melanarius* (*vulgaris*), 114 = *Syntomus* (= *Metabletus*) *foveatus*, 121 = *Notiophilus germinyi* (*hypocrita*), 99 = *Harpalus affinis* (*aeneus*), 102 = *H. solitaris* (*fuliginosus*), 104 = *H. rufipes* (*pubescens*), 106 = *H. rufipalpis* (*rufitarsis*), 73 = *Calathus rotundicollis* (*piceus*), 1 = *Abax parallelepipedus* (*ater*), 109 = *Leistus terminatus* (*rufescens*), 62 = *Bradycellus caucasicus* (*collaris*), 65 = *B. ruficollis* (*similis*). See also: Den Boer (1977: table 2 and appendix A, part I).

species a summer breeder, and two species autumn breeders; also the preferred habitats differ highly among species (1 F, 2 H, 1 F+R, 1 F+W, 4 W, 1 A, 1 B).

If we take still closer 'genetic relationship', i.e. comparing the life-history traits of species that are taxonomically difficult to separate and thus often are considered sibling species, we detect a remarkable phenomenon: such closely related species usually occupy quite different habitats, in most cases one of the species living in (light) deciduous forest and the other(s) in open sites (heath areas or agricultural sites). For our area (Drenthe) examples of such pairs or triplets (the forest species in front) are: *Amara brunnea* / *A. bifrons*; *Amara pseudocommunis* / *A. communis* / *A. convexior*; *Agonum assimile* / *A. krynickii* (Den Boer 1962); *Agonum fuliginosum* / *A. gracile*; *Agonum moestum* / *A. versutum* / *A. viduum*; *Notiophilus palustris* / *N. germinyi*; *Nebria brevicollis* / *N. salina*; *Trichocellus placidus* / *T. cognatus*; *Bradycellus sharpi* / *B. verbasci*; *Trechus obtusus* / *T. quadristriatus* (Den Boer 1965); *Pterostichus oblongopunctatus* / *P. quadrifoveolatus* (Den Boer et al. 1993); possibly also *Pterostichus strenuus* / *P. diligens*; *Harpalus quadripunctatus* / *H. latus*; and there may be still more.

It is tempting, of course, to speculate about the possible origin of such species pairs (or triplets). It can be imagined that when man cut or burnt down more and more of the original and secondary forest of our and surrounding areas, many carabid species of the forest were deprived of their preferred habitat. Because of that most exclusively forest species, such as *Molops*, *Abax*, *Carabus*, *Cychrus* and *Calosoma*-species, may have become extinct in the course of time. Indeed, at present in the better forest remnants left in Drenthe you find only *Carabus nemoralis* and *Abax parallelepipedus*, and in dryer parts *Carabus problematicus*, but in only a very few of them possibly also *Carabus coriaceus*, *Cychrus rostratus* or *Calosoma inquisitor*.

However, the species inhabiting forest borders and openings, and light secondary forest, probably had a better chance to survive and reproduce, because during the many centuries of a primitive agriculture in these regions, many areas were abandoned because the nutrients became exhausted, and birches, rowan, poplars, and other pioneer trees would soon have grown up in them. Most of these carabid species may have had genotypes that could survive and reproduce in these abandoned agricultural fields or in the heath areas ultimately originating from these exhausted fields being used for cattle grazing. This grazing prevented recovery of the forest, and such areas gradually changed into heath and poor grassland. The latter is still indicated by incidental catches of *Pterostichus oblongopunctatus* at Kralo Heath (an old heath area) far from the nearest forest, and of *Cychrus rostratus* at previously cultivated (buckwheat), old peat moors. In this way in the course of time large populations of such diverging genotypes may have become isolated for periods of time long enough for speciation to occur, but sufficiently short to retain a morphology about similar to that of the ancestor beetles in the forest.

Of course, we can neither confirm this hypothesis, nor repeat the historical course of events experimentally at a sufficiently large scale. Just as in all evolutionary hypotheses we can only bring up circumstantial evidence. In the present case the pair *P. oblongopunctatus* / *P. quadrifoveolatus* may give us a hint in this direction: *P. quadrifoveolatus* especially settles down at sites where woods or wood remnants have been burnt. In Den Boer et al. (1993: 243) we described a simple experiment to show that beetles of this species can easily find such sites. In the context of the above hypothesis it seems obvious that *P. quadrifoveolatus* separated from *P. oblongopunctatus* because of our distant ancestors' habit of burning secondary forest to easily clear the area for agriculture.

It may even be assumed that speciation has already occurred in response to the more recent intensification of agriculture, i.e. to the transition from a primitive agriculture over large areas to the concentration on rather small areas (in Dutch: dorps-es) that were kept fertile with cattle dung (and later with artificial fertilizer). Perhaps the pair *Calathus melanocephalus* / *C. cinctus* (Aukema 1990b) is an example of speciation as a result of such a transition; *C. melanocephalus* being more restricted to heath and other poor open soils, whereas *C. cinctus* (*erythroderus*) occurs more in abandoned agricultural fields of the present period. In accordance with this assumption *C. cinctus* lives as a kind of nomad, settling down in recently abandoned fields and disappearing again after some years, often temporarily forming mixed populations with *C. melanocephalus* (see e.g. Van Dijk 1986a). Although *C. cinctus*, like *C. melanocephalus*, is wing-dimorphic, in most sites 70% or more of its individuals are long-winged and a lot of these may fly frequently (Aukema 1990a, 1991). Populations of *C. melanocephalus* usually show less than 1% long-winged individuals (e.g. Den Boer 1977: table 3), although a newly founded population in the new IJsselmeerpolder Oost Flevoland is an exception with 20-30% long-winged beetles (Den Boer 1970; Aukema, 1990a). As could be expected for an autumn breeding nomad, *C. cinctus* produces about 75% more eggs than *C. melanocephalus* (Aukema 1991).

A classification of life-history patterns among carabid species

With the data presented and discussed in previous sections we tried to provisionally classify the carabid

Table 2. Provisional scheme of a classification of life-history patterns of carabid species of western Europe.

(1) Spring breeding (summer larvae): well dispersing species with a high turnover of populations
  a. macropterous species of unstable or temporary habitats
  b. macropterous or wing-dimorphic species of unstable, stable or transitional and/or changing habitats
(2) Spring breeding (summer larvae): rather badly dispersing species with a generally not very high turnover of populations and occupying stable habitats
  a. macropterous species, possibly with low powers of dispersal
  b. wing-dimorphic species with low powers of dispersal
  c. brachypterous species with poor powers of dispersal
(3) Species with a complex reproduction cycle and variable developmental periods and occupying stable habitats
(4) Summer or autumn breeding (winter larvae): well dispersing species with a high turnover of populations
  a. macropterous species of unstable or temporary habitats
  b. wing-dimorphic species of unstable and/or transitional or changing habitats
(5) Summer or autumn breeding (winter larvae): rather badly dispersing species with a not very high or low turnover of populations
  a. macropterous species of stable and/or transitional habitats
  b. wing-dimorphic species of stable habitats
  c. brachypterous species of stable habitats
(6) Late autumn breeding with summer diapause: low powers of dispersal and a low turnover of populations
(7) Winter or early spring breeding: inhabitants of open, sandy sites with a high turnover of populations
  a. macropterous species with good powers of dispersal
  b. wing-dimorphic species with rather good powers of dispersal
(8) Winter or early spring breeding: inhabitants of open, sandy sites with a not very high turnover of populations
  a. wing-dimorphic or brachypterous species with low powers of dispersal

species of Drenthe according to some life-history traits. A scheme of this is presented in table 2.

We consider 'time of reproduction' to be the principal life-history trait, and discriminated between three groups of species: spring breeders with summer larvae, autumn breeders with winter larvae and winter breeders with summer larvae. 'Fecundity' is, as said before, partly connected with this main division: autumn breeders laying generally more and smaller eggs than spring breeders and winter breeders. However, this difference could not be incorporated in table 2, because exact data were not available for all species. A finer classification of 'fecundity' seems impractical or even irrelevant. Apart from great individual differences in egg production among females of the same population (compare table 1), egg production is determined to a great extent by quality and quantity of the food and by temperature (Van Dijk 1994). Under the highly variable conditions in the field, differences between individuals and even between most species in size of egg production may usually disappear completely. We expect that this not only applies to carabid beetles, but to arthropods in general.

More important is 'age distribution of reproduction' (semelparity versus iteroparity). But so far, we could only detect a few semelparous carabid species, most species being iteroparous (i.e. individuals do survive several winters and reproduce each year). More research has to be done on this subject.

As said before, we consider 'dispersal power' an important – though indirect – life-history trait, because it is closely connected with the turnover of populations, i.e. with the frequency of extinctions and (re)foundings of groups in time (Den Boer 1985, 1990a, b, De Vries & Den Boer 1990). Hence, our provisional classification of life-history patterns of carabid species is based upon: 'time of reproduction', 'turnover of populations', and 'dispersal power' (expressed in terms of wing and flight-muscle development and relative frequencies of flight: catches in window traps), and 'preferred habitat(s)', in that order: table 3.

Although our classification is only based upon data of carabids from Drenthe, we expect that it will apply to large parts of West-, North- and Central Europe as well. We compared our data with those of Larsson (1939) for Denmark, Lindroth (1945: 1992) for Fennoscandia, Thiele (1977) for Western Germany, and that of several authors for Central Europe (e.g. Skuhravý 1959; Novák 1964), and we could not discover important departures from the species occurring in Drenthe.

The most striking feature of table 3 certainly is the numerical dominance of well-dispersing spring breeders of unstable and transitional habitats [groups (1)a and (1)b]. Especially among the less abundant species (table 3B) the number of *Acupalpus*, *Agonum*, *Amara*, *Bembidion* and *Dyschirius* species is remarkable. Most of these species reproduce in wet habitats, are macropterous and fly frequently. In our opinion this phenomenon highlights the impoverishment of the carabid fauna of stable habitats of our area: because of a fragmentation of natural areas, which has been pushed too far, many species with poor powers of dispersal have become extinct (Den Boer 1977; De Vries & Den Boer 1990).

The dominance of well-dispersing spring breeders

Table 3. Provisional classification of the carabid species of Drenthe (the Netherlands) according to the life-history patterns in the scheme of table 2. The numbers behind the species are used in fig. 1 and refer to Den Boer (1977: table 2 and appendix A, part I).

A. the most abundant species (mentioned in fig. 1)

(1) a. *Agonum sexpunctatum* (18: wet), *Amara aenea* (21: agr.), *A. communis* (26: agr.), *A. famelica* (30: wet), *A. familiaris* (31: agr.), *A. plebeja* (35: agr.), *Anisodactylus binotatus* (42: agr.), *Asaphidion flavipes* (44: agr.; Coll.), *Harpalus affinis* (99: agr.), *Loricera pilicornis* (112: wet; Coll.), *Pterostichus minor* (135: wet; 95% macr.), *P. nigrita/rhaeticus* (137: wet; see Koch & Thiele, 1980), *P. quadrifoveolatus* (130: burn), *P. vernalis* (140: wet)

b. *Agonum fuliginosum* (9:wet, forest borders; 28% macr.), *Amara lunicollis* (34: wet, grass; macr.), *Bembidion lampros* (54: agr., wet; 17% macr.), *Clivina fossor* (86: agr., wet; 90% macr.), *Dyschirius globosus* (95: agr., wet; 0.1% macr.), *Notiophilus palustris* (122: forest borders; 7% macr.), *Pterostichus diligens* (133: wet, grass; 4% macr.), *P. strenuus* (139: meadows, forest; 23% macr.)

(2) a. *Agonum assimile* (6: forest borders), *Notiophilus rufipes* (124: forest; Coll.), *Pterostichus oblongopunctatus* (138: forest), *P. versicolor* (132: heath, poor meadows)

b. *Syntomus foveatus* (114: sandy heath; 1.2% macr.)

c. *Agonum ericeti* (8: peat moor), *Carabus nemoralis* (78: forest), *C. arvensis* (75: heath), *Pterostichus lepidus* (134: sandy heath)*

(3) *Abax parallelepipedus* (1: forest; brach.), *Calathus rotundicollis* (73: lighr foresr; 93% macr.), *Notiophilus aquaticus* (119: heathy areas; 1.2% macr.; Coll.), *N. biguttatus* (120: light forest; 74% macr.; Coll.), *Carabus cancellatus* (76: heathy areas; brach.)

(4) a. *Harpalus rufipalpis* (106: poor grassland) *H. rufipes* (104: agr.)

b. *Calathus fuscipes* (69: trans.; 0.9% macr.), *Pterostichus melanarius* (141: agr.; 2% macr.), *Trechus obtusus* (146: forest borders; 3% macr.)

(5) a. *Amara brunnea* (25: light forest), *A. equestris* (29: heath), *Broscus cephalotes* (66: sand), *Harpalus latus* (103: forest, heath), *H. quadripunctatus* (105: forest borders), *H. solitaris* (102: heath), *Nebria salina* (118: trans.), *Pterostichus niger* (136: all habitats)

b. *Agonum obscurum* (17: wet grass; 0.1% macr.), *Calathus erratus* (68: sand; 0.2% macr.), *C. melanocephalus* (70: sandy heath; 0.2% macr.), *Cymindis vaporariorum* (89: heath; 6% macr.), *Notiophilus germinyi* (121: sandy heath; 3% macr.), *Olisthopus rotundatus* (125: heath; 21% macr.)

c. *Carabus problematicus* (80: dry forest), *Cymindis macularis* (88: sand), *Pterostichus lepidus* (134: sandy heath)*, *Trechus secalis* (148: forest)

(6) *Leistus rufomarginatus* (110: forest; macr.), *L. terminatus* (109: grass, trans.; macr.), *Nebria brevicollis* (117: light forest, trans.)

(7) a. *Bradycellus ruficollis* (65: heath), *Trichocellus cognatus* (149: heath), *T. placidus* (150: light forest)

b. *Bradycellus caucasicus* (62: heath), *Bradycellus harpalinus* (64: grassy heath)

(8) a. *Amara infima* (33: sand; 1.3% macr.), *Bembidion nigricorne* (56: sand; brach.)

**Pterostichus lepidus* seems to be both a spring and an autumn breeder (Van Dijk, pers. comm., and Paarmann, 1990).

B. less abundant species

(1) a. *Acupalpus brunnipes, A. consputus,, A. dubius, A. exiguus, A. flavicollis, A. meridianus, A. parvulus* (*dorsalis*) *Agonum albipes* (*ruficorne*), *A. dorsalis, A. gracile, A. marginatum, A. muelleri, A. piceum, A. thoreyi, A. versutum, A. viduum, Amara anthobia, A. ingenua, A. ovata, A. similata, A. spreta, Bembidion assimile, B. bruxellense* (*rupestre*), *B. doris, B. femoratum, B. obliquum, B. properans, B. quadrimaculatum, B. varium, Blethisa multipunctata, Dyschirius aeneum, D. luedersi, D. politus, D. thoracicus* (*arenosus*), *Elaphrus cupreus, E. riparius, Omophron limbatus, Oodes helopioides, Stenolophus mixtus, S. teutonus*

b. *Amara convexior, Badister dilatatus, Bembidion guttula, B. tetracolum* (*ustulatum*), *Calosoma inquisitor, Chlaenius nigricornis, Cicindela campestris, C. hybrida, Demetrias atricapillus, Dromius agilis, D. angustus, D. melanocephalus, D. quadrimaculatus, D. spilotus* (*quadrinotatus*), *Harpalus anxius, Notiophilus substriatus, Panageus cruxmajor*

(2) a. *Agonum krynickii, A. livens, A. moestum, Anisodactylus nemorivagus, Badister bullatus* (*bipustulatus*), *B. sodalis, B. unipustulatus, Bembidion humerale, Lebia chlorocephala, Odocantha melanura*

b. *Carabus clathratus, C. granulatus, Syntomus* (*Metabletus*) *truncatellus, Pterostichus anthracinus*

c. *Bembidion mannerheimi* (*unicolor*), *Carabus nitens, Cicindela germanica, Cychrus caraboides rostratus*

(3) *Carabus coriaceus*

(4) a. *Amara apricaria, A. aulica, A. bifrons, A. consularis, A. convexiuscula, A. fulva, A. majuscula, Asaphidion pallipes, Calathus ochropterus* (*mollis*), *Harpalus distinguendus, H. rubripes, H. smaragdinus, H. tardus, Trechus quadristriatus, T. discus*

b. *Calathus cinctus* (*erythroderus*)

(5) a. *Amara pseudocommunis, A. kulti, A. praetermissa, A. quenseli, Miscodera arctica, Nebria livida*

b. *Calathus ambiguus, Synuchus nivalis*

c. *Calathus micropterus, Masoreus wetterhalli, Patrobus atrorufus* (*excavatus*), *Stomis pumicatus*

(6) *Leistus spinibarbis*

(7) a. *Bradycellus verbasci*

b. *Bradycellus csikii*

(8) a. *Bradycellus sharpi*

3A: between brackets behind the species an indication of the preferred habitat.
macr.= macropterous; brach.= brachypterous; agr.= occupying agricultural fields and other ruderal or disturbed sites; wet= occupying banks of pools and rivers and other wet sites; burn= reproduces at sites where woods or remnants of wood has been burnt; grass= prefers dense grass vegetations; trans.= occupying transitional sites between forest and heath or grassy vegetations; sand= occupying blown sand areas with only little vegetation; Coll.= specialized in the hunting of Collemboles.
For estimates of dispersal power and turnover frequencies of the most abundant carabid species of Drenthe see Den Boer (1990a: table 1; 1990b: table 4).
3B: between brackets behind the species old names.

over less well-dispersing ones is less apparent among the most abundant species (table 3A), because the number of wet habitats has also decreased dramatically in the last hundred years. Only a few of the species of wet habitats could still be called 'abundant'. But the difference between the number of well-dispersing [(1)a+(1)b] species (A: 21; B: 57) and that of the badly dispersing [(2)a+(2)b+(2)c+(3)] species (A: 14; B: 18) is not significant (χ^2= 2.95; P= 0.10). As autumn breeders are almost restricted to dryer habitats the difference between the numbers of well-dispersing spring and autumn breeders is about the same for abundant and less abundant species (χ^2= 0.078; P= 0.80), and a similar result is found for the badly dispersing species (χ^2= 1.80; P= 0.20). Hence the abundant species (table 3A) are a fair sample of the carabid species of Drenthe.

Both for the spring breeders and for the autumn breeders the different life-history patterns we distinguish more or less reflect the expected evolutionary processes. When in the course of vegetational succession many previously unstable habitats become more and more stable, well-dispersing species occupying these habitats will gradually lose their powers of dispersal (Den Boer 1977, 1990a). As there are always unstable habitats, however (banks and moors, new openings in the forest resulting from storm or fire) most well-dispersing species will survive. Some of these will settle also in localities where stable habitats are not destroyed on a large scale by reclamations for agriculture and urbanisation. Today in the Netherlands there is a growing tendency to make 'new nature', e.g. by returning agricultural fields and the water meadows along our great rivers into more natural areas. Especially when these areas of 'new nature' become sufficiently large we may expect that ultimately among the (carabid) species that occupy these new areas the evolution from well dispersing to less well dispersing ones will be stimulated again.

DISCUSSION

'Life history theory deals directly with natural selection, fitness, adaptation, and constraint. It contributes to evolutionary thought the analysis of the phenotypic causes of variation in fitness and exposes the pervasive tension between adaptation and constraint, brought here into especially sharp contrast by the simultaneous application of optimality theory, quantitative genetics, trade-offs, and the comparative method to the explanations of the same patterns.' (Stearns 1992: 9).

This sentence indicates clearly that life-history theory in the first place indeed is theory (see also Roff 1992), because 'natural selection' is difficult to study directly under natural conditions, whereas both 'fitness' and 'adaptation' are difficult to objectify and quantify. Therefore, life-history theory is mainly based on thoughts about natural selection, fitness, adaptation and constraint, and these thoughts are illustrated by mathematical models and some general experience with special groups of organisms (vertebrates?). This does not mean, however, that occupation with life-history theory is a waste of time. On the contrary, contemplating such subjects is necessary to come to an efficient collecting of adequate data. But meanwhile life-history theory is also highly subject to changing fashion, and therefore is still largely based upon presently fashionable ideas about competition, optimalisation and restricted energy-budgets.

'In life history evolution the patterns to be explained are the full diversity of life cycles in living things. These range from the familiar cycle of birth, reproduction and death in birds and mammals, through alternating sexual and asexual generations of cladocerans, rotifers and some beetles and the modular life histories of many plants and bryozoans, to complex life cycles of algae, parasites, and corals. In what framework can all life histories be understood as variations of a few general themes?' (Stearns 1992: 11).

Hence, the task of life history theory should be, according to Stearns, to find a few 'general rules' with which life histories can be classified in groups. In our opinion, it is best to start this exercise with field data, as we have tried to do in table 3.

As 'habitats' are defined and classified differently for the different groups of organisms Stearns (1992) thinks it both simpler and more general to leave 'habitats' out of the classifications of life histories.

'Nevertheless, well qualified opinions assert it is worth trying to relate habitat to life history (...). These authors wants to explain patterns relating certain lineages to certain habitats. To satisfy, such explanations should demonstrate a mechanism that links habitats to life histories. According to this book, one candidate is the impact of habitats on age- and size-specific fecundity and mortality schedules. Thus we seek to understand not habitat ----> life history but habitat ---> mortality regime ---> life history.' (Stearns l.c.: 208).

We are sure that 'habitat' has more to contribute to life-histories than 'mortality regimes'. For instance, both 'fecundity', 'time of reproduction' and 'time of first reproduction' may be importantly influenced by 'habitat', more so in poikilothermic animals than in homoiothermic ones. In carabid beetles egg production is not only determined by genetic characters, basal metabolism (table 1) and food, but also to a high degree by temperature (Van Dijk 1983; Aukema 1991); both food quality and quantity and temperature are highly affected by 'habitat'. We have shown how spring and autumn breeding are connected with 'habitat' and season (climate). Therefore, to adequately recognize life-history patterns it does not suffice to consider 'habitat' as the determinant of 'mortality regimes'.

Another common belief is the assumption of the universal occurrence of trade-off's:

'One example is the production of spines and elongate helmets in waterfleas, *Daphnia*, in response to dissolved molecules that indicate the presence of invertebrate predators that prey less effectively on spiny, helmeted *Daphnia*. Helmets and spines are costly, individuals that do not produce them have higher reproductive rates, and therefore when predators are not present, the spines and helmets are not produced. This definition is most appropriately applied to variation within populations.' (Stearns 1992: 16).

But such an application is not adequate in all kinds of populations. As mentioned before, Aukema (1991) showed that long-winged morphs of *Calathus cinctus* and *C. melanocephalus* produce more eggs than short-winged ones, in spite of the fact that the production of functional wings and wing-muscles must be 'costly'. Moreover, Aukema mentions other examples of beetles where the winged morph is more productive than the wingless morph. 'From the data on fecundity of short-winged and long-winged *C. cinctus* and *C. melanocephalus* presented here, it is evident that in both species it is not the brachypterous morph but the macropterous one that has a higher Darwinian fitness.' (l.c.: 125). This also means that the gradual reduction of dispersal power in wing-dimorphic carabid populations living in stable habitats is not caused by a higher fitness of the brachypterous morphs, expressed in a higher egg production, as was supposed by e.g. Darlington (1943), and still stated by Roff (1990, 1994), but by winged individuals flying away from the population area, though often these do not succeed in colonizing new sites.

'According to Williams (1966) ..., an adaptation is a change in a phenotype that occurs in response to a specific environmental signal and has a clear relationship to that signal that results in an improvememt in growth, survival, or reproduction.' (Stearns 1992: 16).

If we apply this definition of adaptation to dispersal power, we may establish that a decrease or increase of dispersal power is a change in the frequency of genotypes that occurs in response to the environment becoming more stable or unstable. And, as we saw above (Aukema 1991), this may show a clear relationship either to survival – decrease of dispersal power in a stable habitat – or with reproduction -increase of dispersal power in an unstable habitat. Nevertheless, we do not expect that Stearns did have had dispersal power in mind as an example of a functional adaptation, because at first sight flying away from the population area where survival and reproduction are still possible, for many individuals only seems to mean suicide. However, since the survival time of each local population is limited, without any dispersal and the connected chance to colonize other suitable sites, the species will not survive much longer than the longest-living local population. In our opinion, this contradiction between individual profit and profit for the species has prevented evolutionary biologists seeing the evolutionary and ecological significance of dispersal and dispersal power.

Summarizing, this provisional comparison of life-history patterns of carabid species in relation to environmental conditions does not give much support to the current theoretical constructions and models of evolutionary biologists as expounded by Williams (1966), criticized by Stearns (1976), and extensively discussed by Stearns (1992) and Roff (1992). Most probably this lack of correspondence between theory and field practice results from the fact that even related animal species adapt to their habitats from very different starting-points. Because of that, the 'solutions' created by natural selection are also very different. Many of these 'solutions' may be far from 'optimal', simply because the historically given starting-points did not allow better ones.

Therefore, before continuing the construction of theoretical models of the evolution of life histories it seems necessary, or at least useful, to do more comparitive investigations on life-history patterns of species other than carabids.

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References

Atkinson, W. D., 1979. A comparison of the reproductive strategies of domestic species of *Drosophila*. – Journal of Animal Ecology 48: 260-264.

Aukema, B., 1990a. Winglength determination in two wing-dimorphic *Calathus*-species (Coleoptera, Carabidae). – Hereditas 113: 189-202.

Aukema, B., 1990b. Taxonomy, life history and distribution of three closely related species of the genus *Calathus* (Coleoptera, Carabidae). – Tijdschrift voor Entomologie 133: 121-141.

Aukema, B., 1991. Fecundity in relation to wing-morph of three closely related species of the *melanocephalus* group of the genus *Calathus* (Coleoptera; Carabidae). – Oecologia 87: 118-126.
Aukema, B., 1994. The evolutionary significance of wing dimorphism in carabid beetles (Coleoptera, Carabidae). – In: Dispersal polymorphism of insects, its adaptation and evolution, Proceedings of the Memorial and international Symposium in Okayama University, Juni 30- July 1, 1994: 173-181.
Brandmayr, P. & T. Zetto-Brandmayr, 1979. The evolution of parental care phenomena in Pterostichine ground beetles with special reference to the genera *Abax* and *Molops* (Coleoptera, Carabidae). – Miscellaneous Papers Landbouwhogeschool Wageningen 18: 35-49.
Cody, M., 1966. A general theory of clutch size. – Evolution 20: 174-184.
Cody, M. L., 1971. Ecological aspects of reproduction. – In: Farner & King (eds) Avian Biology, Academic Press, New York. pp. 462-512.
Darlington, P. J., 1943. Carabidae of mountains and islands. – Ecological Monographs 13: 37-61.
Den Boer, P. J., 1962. Twee nieuwe loopkeversoorten (Col., Carabidae) voor de Nederlandse fauna. – Entomologische Berichten 62: 88-95.
Den Boer, P. J., 1965. External characters of sibling species *Trechus obtusus* Er. and *T. quadristriatus* Schrk. (Coleoptera, Carabidae). – Tijdschrift voor Entomologie 108: 219-239.
Den Boer, P. J., 1968. Spreading of risk and the stabilization of animal numbers. – Acta Biotheoretica (Leiden) 18: 165-194.
Den Boer, P. J., 1970. On the significance of dispersal power for populations of carabid beetles (Coleoptera, Carabidae). – Oecologia 4: 1- 28.
Den Boer, P. J., 1977. Dispersal power and survival. Carabids in a cultivated countryside. – Miscellaneous Papers Landbouwhogeschool Wageningen 14.
Den Boer, P. J., 1979a. Some remarks in retrospect. – In: P. J. den Boer, H. U. Thiele & F. Weber (eds) On the evolution of behaviour in carabid beetles, Miscellaneous Papers Landbouwhogeschool Wageningen 18: 213- 222.
Den Boer, P. J., 1979b. The individual behaviour and population dynamics of some carabid beetles of forests. – Miscellaneous Papers Landbouwhogeschool Wageningen 18: 151-166.
Den Boer, P. J., 1980. Exclusion or coexistence and the taxonomic or ecological relationship between species. – Netherlands Journal of Zoology 30: 278-306.
Den Boer, P. J., 1985. Fluctuations of density and survival of carabid populations. – Oecologia 67: 322-330.
Den Boer, P. J., 1990a. The survival value of dispersal in terrestrial arthropods. – Biological Conservation 54: 175-192.
Den Boer, P. J., 1990b. Density limits and survival of local populations in 64 carabid species with different powers of dispersal. – Journal of Evolutionary Biology 3: 19-40.
Den Boer, P. J., H. U. Thiele & F. Weber (eds), 1979. On the evolution of behaviour in carabid beetles. – Miscellaneous Papers Landbouwhogeschool Wageningen 18.
Den Boer, P. J. & W. den Boer-Daanje, 1990. On life-history tactics in carabid beetles: are there only spring and autumn breeders? – In: N. E. Stork (ed) The role of ground beetles in ecological and environmental studies, Intercept, Andover, Hampshire. pp. 247-258.
Den Boer, P. J., J. Szyszko & R. Vermeulen, 1993. Spreading the risk of extinction by genetic diversity in populations of the carabid beetle *Pterostichus oblongopunctatus* (Coleoptera, Carabidae). – Netherlands Journal of Zoology 43: 242-259.
De Vries, H. H. & P. J. den Boer, 1990. Survival of populations of *Agonum ericeti* Panz. (Col., Carabidae) in relation to fragmentation of habitats. – Netherlands Journal of Zoology 40: 484-498.
Desender, K. & H. Turin, 1989. Loss of habitat and changes in the composition of the ground and tiger beetle fauna in four West European countries since 1950 (Coleoptera, Carabidae, Cicindelidae). – Biological Conservation 48: 277-294.
Ernsting, G. & A. Isaaks, 1994. Egg size variation in *Notiophilus biguttatus* (Col., Carabidae). – In: K. Desender, M. Dufrêne, M. Loreau, M. L. Luff & J. D. Maelfait (eds) Carabid beetles, ecology and evolution, Kluwer Academic Publishers, Dordrecht.. pp. 133-137.
Feller, W., 1939. Die Grundlagen der Voltarraschen Theorie des Kampfes ums Dasein in wahrscheinlichkeitstheoretischen Behandlung. – Acta Biotheoretica 5: 11-40.
Gereben, B. A., 1994. Habitat-binding of carabid beetles in a glacier retreat zone in the Zillertal Alps. – In: K. Desender, M. Dufrêne, M. Loreau, M. L. Luff & J. D. Maelfait (eds) Carabid beetles, ecology and evolution, Kluwer Academic Publishers, Dordrecht. pp. 139-144.
Gadgil, M. & W. Bossert, 1970. Life history consequences of natural selection. – American Naturalist 104: 1-24.
Gotthard, K., S. Nylin & Ch. Wiklund, 1994. Adaptive variation in growth rate: life history costs and consequences in the speckled wood butterfly, *Pararge aegeria*. – Oecologia 99: 281-289.
Greenslade, P. J. M., 1965. On the ecology of som British Carabidae with special reference to life histories. – Transactions of the British Society of Entomology 161: 150-179.
Grüm, L., 1984. Carabid fecundity as affected by extrinsic and intrinsic factors. – Oecologia 65: 114-121.
Hengeveld, R., 1980. Polyphagy, oligophagy and food specialization in ground beetles (Coleoptera, Carabidae). – Netherlands Journal of Zoology 30: 564-584.
Hilborn, R. & S. C. Stearns, 1982. On inference in ecological and evolutionary biology: The problem of multiple causes. – Acta Biotheoretica (Leiden) 31: 145-164.
Kavanaugh, D. H., 1985. On wing atrophy in carabid beetles (Coleoptera, Carabidae), with special reference to Neartic *Nebria*. – In: G. E. Ball (ed) Taxonomy, phylogeny and Zoogeography of beetles and ants, Dr. W. Junk publishers, Dordrecht. pp. 408-431.
Klomp, H., 1970. Clutch size in birds. – Ardea 58: 1-121.
Koch, D. & H. U. Thiele, 1980. Zur Ökologisch-physiologischen Differenzierung und Speziation der Laufkäfer-Art *Pterostichus nigrita* (Coleoptera, Carabidae). – Entomologia Generalis 6: 135-150.
Larsson, S. G., 1939. Entwicklungstypen und Entwicklungszeiten der dänischen Carabiden. – Entomologiske Meddelelser 20: 227-547.
Lindroth, C. H., 1992. Ground beetles (Carabidae) of Fennoscandia. A zoogeographic study. Part I. Specific knowledge regarding the species. – English translation by Smithsonian Institution Libraries of the German edition of 1945.
MacArthur, R. H. & E. O. Wilson, 1967. The theory of island biogeography. – Monographs in Population Biolo-

gy. Princeton, New York.
Murdoch, W. W., 1966. Aspects of the population dynamics of some marsh Carabidae. – Journal of Animal Ecology 35: 127-156.
Murdoch, W. W., 1967. Life history patterns of some British Carabidae (Coleoptera) and their ecological significance. – Oikos 18: 25-32.
Nelemans, M. N. E., 1987. On the life-history of the carabid beetle *Nebria brevicollis* (F.). Egg production and larval growth under experimental conditions. – Netherlands Journal of Zoology 37: 26-42.
Nelemans, M. N. E., P. J. den Boer & A. Spee, 1989. Recruitment and summer diapause in the dynamics of a population of *Nebria brevicollis* (Coleoptera, Carabidae). – Oikos 56: 157-169.
Novák, B., 1964. Synekolgická studie sezónniho výskytu střevlikovitých na řepných polich hané (Col., Carabidae). Acta Universitatis Palackianae Olomucensis. – Facultas rerum Naturalium 13: 101-251.
Paarmann, W., 1990. *Poecilus lepidus* Leske (Carabidae, Coleoptera) a species with the ability to be a spring and autumn breeder. – In: N. E. Stork (ed) The role of ground beetles in ecological and environmental studies, Intercept, Andover, Hampshire. pp. 259-267.
Parry, G. D., 1981. The meanings of r- and K-selection. – Oecologia 48: 260- 264.
Rijnsdorp, A. D., 1980. Pattern of movement in and dispersal from a Dutch forest of *Carabus problematicus* Hbst. (Coleoptera, Carabidae). – Oecologia 45: 274-281.
Roff, D. A., 1990. The evolution of flightlessness in insects. – Ecological Monographs 60: 289-421.
Roff, D. A., 1992. The evolution of life histories: theory and analysis. – Chapman & Hall, New York.
Roff, D. A., 1994. Habitat persistence and the evolution of wing dimorphism in insects. – American Naturalist 144: 772-798.
Ross, H. H., 1956. A textbook of entomology. – John Wiley & Sons Inc., New York, Chapman & Hall Ltd., London. Second Edition.
Schaffer, W. M., 1972. Evolution of optimal reproductive strategies. – PhD Thesis, Princeton University, Princeton.
Schaffer, W. M., 1974a. Selection for optimal life histories. – Ecology 55: 291-303.
Schaffer, W. M., 1974b. Optimal reproductive effort in fluctuating environments. – American Naturalist 108: 783-790.
Skuhravý, V., 1959. Přispěvek k bionomii polnich střevlikovitých (Col., Carabidae). – Rospravy Československé akademie věd, 69: 3-64.
Southwood, T. R. E., 1976. Ecological methods, with particular reference to the study of insect populations. – Chapman & Hall, London, 3rd impression.
Stearns, S. C., 1976. Life-history tactics: a review of the ideas. – Quarterly Review of Biology 51: 13-47.
Stearns, S. C., 1992. The evolution of life histories. – Oxford University Press, Oxford.
Thiele, H. U., 1977. Carabid beetles in their environments. A study on habitat selection by adaptations in physiology and behaviour. – Springer Verlag, Berlin.
Turin, H., K. Alders, P. J. den Boer, S. van Essen, Th. Heijermans, W. Laane & E. Penterman, 1991. Ecological characterization of carabid species (Coleoptera, Carabidae) in the Netherlands from thirty years of pitfall-sampling. – Tijdschrift voor Entomologie 134: 279-304.
Van Dijk, Th. S., 1972. The significance of the diversity in age composition of *Calathus melanocephalus* L. (Col., Coleoptera) in space and time at Schiermonnikoog. – Oecologia 10: 111-136.
Van Dijk, Th. S., 1973. The age-composition of populations of *Calathus melanocephalus* L. analysed by studying marked individuals kept within fenced sites. – Oecologia 12: 213-240.
Van Dijk, Th. S., 1979. On the relationship between reproduction, age and survival in two carabid beetles: *Calathus melanocephalus* L. and *Pterostichus coerulescens* L. (Coleoptera, Carabidae). – Oecologia 40: 63-80.
Van Dijk, Th. S., 1982. Individual variability and its significance for the survival of animal populations. – In: D. Mossakowski & G. Roth (eds), Environmental adaptation and evolution, Gustav Fischer, Stuttgart, New York. pp. 233-251.
Van Dijk, Th. S., 1983. The influence of food and temperature on the amount of reproduction in carabid beetles. – In: P. Brandmayr, P. J. den Boer & F. Weber (eds) Ecology of carabids: The synthesis of field study and laboratory experiment, PUDOC, Wageningen. pp. 105-123.
Van Dijk, Th. S., 1986a. Changes in the carabid fauna of a previously agricultural field during the first twelve years of impoverishing treatments. – Netherlands Journal of Zoology 36: 413-437.
Van Dijk, Th. S., 1986b. How to estimate the level of food availability in field populations of carabid beetles. – In: P. J. den Boer, M. L. Luff, D. Mossakowski & F. Weber (eds) Carabid beetles, their adaptations and dynamics, Gustav Fischer, Stuttgart.. pp. 371-384.
Van Dijk, Th. S., 1994. On the relationship between food, reproduction and survival of two carabid beetles: *Calathus melanocephalus* and *Pterostichus versicolor*. – Ecological Entomology 19: 263-270.
Van Dijk, Th. S. & P. J. den Boer, 1992. The life histories and population dynamics of two carabid species on a Dutch heathland. 1. Fecundity and the mortality of immature stages. – Oecologia 90: 340-352.
Verhulst, P. F., 1838. Notice sur le loi que la population suit dans son accroissememt. – Correspondences Mathématiques et Physiques 10: 113-121.
White, T. C. R., 1993. The inadequate environment. Nitrogen and the abundance of animals. – Springer Verlag, Berlin.
Williams, G. C., 1966. Adaptation and natural selection. A critique of some current evolutionary thought. – Princeton University Press, Princeton.

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NOTES ON THE MARINE VELIID GENERA *HALOVELOIDES*, *HALOVELIA* AND *XENOBATES* (HEMIPTERA-HETEROPTERA, VELIIDAE) OF PAPUA NEW GUINEA

Lansbury, I., 1996. Notes on the marine veliid genera *Haloveloides*, *Halovelia* and *Xenobates* (Hemiptera-Heteroptera, Veliidae) of Papua New Guinea. – Tijdschrift voor Entomologie 139: 17-28, figs. 1-53, tables 1-8. [ISSN 0040-7496]. Published 15 October 1996.
The marine veliid genera *Haloveloides* Andersen, *Halovelia* Bergroth and *Xenobates* Esaki from Madang Province, Nagada Harbour were studied in February-March, 1990 and April-May, 1992. Supplementary comments on the occurrence of marine veliids in New Britain are included. *Halovelia anderseni* sp. n. and *Xenobates pilosellus* sp. n. are described from Nagada Harbour. *Xenobates solomonensis* Lansbury is redescribed, the male for the first time. The distribution of the veliids at Nagada are set out in tabular form. Brief comments are given on the occurrence of species particularly the species diversity found in diurnal and nocturnal samples.
I. Lansbury, Hope Entomological Collections, University Museum, Oxford OX1 3PW, United Kingdom.
Key words. – Papua New Guinea: Madang and New Britain. Hemiptera Veliidae: *Halovelia*, *Haloveloides*, *Xenobates*, new species, distribution.

The marine Heteroptera fauna of Nagada Harbour has a remarkable number of species present including Gerridae, *Rheumatometroides serena* Lansbury; three possibly four species of *Halobates*; Hermatobatidae, *Hermatobates* species; Veliidae, Haloveliinae, *Haloveloides papuensis* (Esaki), *H. browni* (Lansbury), *Halovelia annemariae* Andersen, *H. anderseni* sp. n., *Xenobates solomonensis* Lansbury and *X. pilosellus* sp. n. The four described veliid species have been recorded from the Solomon Islands. Two other veliid species also recorded from the Solomon Islands and the 'north' coast of New Guinea, *Halovelia bergrothi* Esaki and *H. esakii* Andersen, these species were not found at Nagada Harbour.

Esaki (1926) gave the first account of the marine veliids collected by Biro from the north coast of Papua New Guinea. He quotes Dr. Biro on the occurrence of *Xenobates* Esaki on brackish water and *H. bergrothi* being found on rain water in a tree hole.

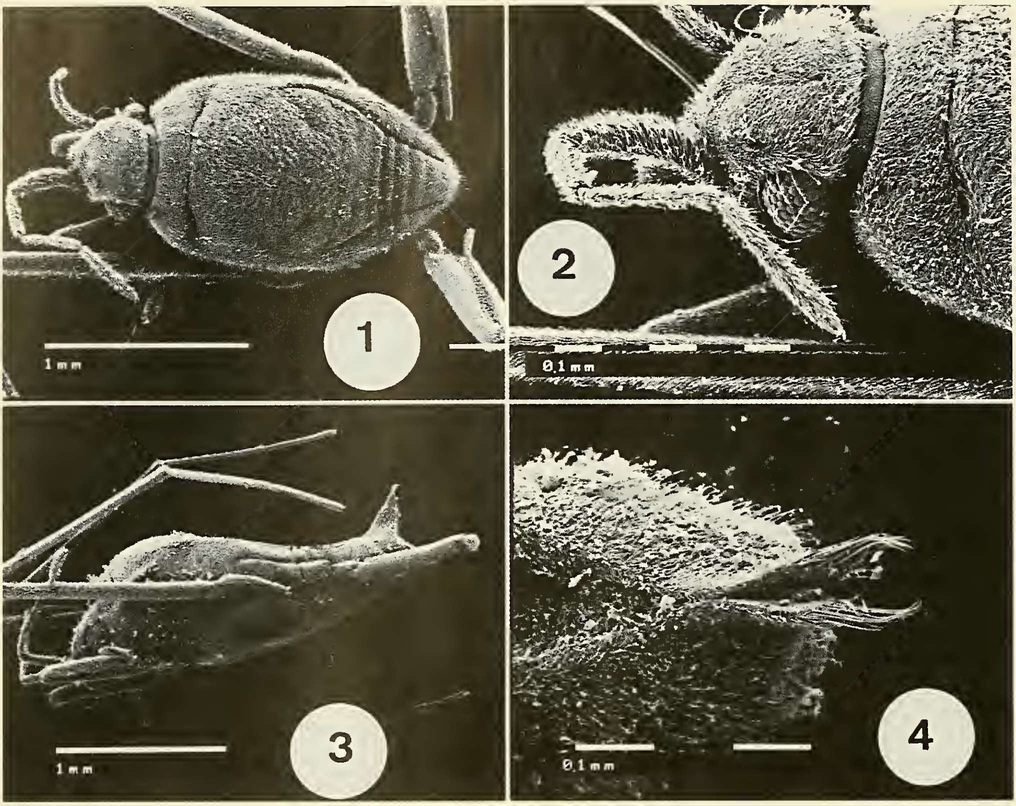
Halovelia Bergroth revised by Andersen (1989a and b) and *Haloveloides* Andersen (1992), *Xenobates* Esaki appears to be a less well defined genus. Andersen (1992) comments on the generic classification and gives a key to the genera of the Haloveliinae.

Materials and methods

Habitats at Nagada. – The sampling area is not large but does include a variety of micro-habitats close inshore, mangrove was absent from the area. The tidal levels do not vary by more than a metre, frequently far less. At low tide there are no extensive beaches with rocks and shallow pools. There is some erosion of the shore line, leading to trees falling into the sea which provides sheltered micro-habitats for marine bugs. Data on the species collected are presented in tabular form with a brief description of the habitats.

1990 Samples. – 'Jetty shade' walkway from shore to landing stage on piers constructed using tyres filled with concrete, walkway rough sawn timber. 'Coral rubble' shore line coral rubble wall, lower margin usually partially submerged, occasionally totally exposed. In places overhung with trees, some leaning over, others have fallen into the sea due to erosion 'coral rubble with trees'. 'Mvlt' (mercury vapour light trap) samples collected from a partially enclosed area on the landing stage supported on piers at the end of the jetty.

1992 Samples. – 'Mvlt' samples from a secondary landing stage overhung with trees, slightly more exposed than the 1990 site, subject to wave action. Samples collected with a hand net 300 pm mesh. Daylight samples; despite intensive searching, no veliids were seen between dawn to sometime after 12.00. Occasionally large flotillas were seen close inshore, al-



Figs. 1-4, *Halovelia anderseni* sp. n. – 1, ♂ dorsal aspect; 2. ♂ dorsal aspect; 3, ♀ lateral aspect of abdomen; 4, ♀ dorsal aspect of abdomen.

ways in the shade from 15.00 onwards, these flotillas were almost exclusively *H. papuensis.* The mvlt samples collected with hand net and were removed from the net by inverting the contents into a large container of dilute alcohol ca 30%. This technique frequently has the affect of causing the male genitalia and female ovipositor to be extruded. A minor problem is that salt particles adhere to the specimens which are not completely removed by washing in distilled water prior to storage in 70% alcohol. Light trap captures were totally random as it was impossible to see veliids whereas *Halobates* were extremely conspicuous.

The specimens from Madang Province and East and West New Britain and holotypes deposited in the Hope Entomological Collections, Universtity Museum, Oxford (OXUM). Paratypes and other material in the National Museum of Natural History, Leiden (RMNH) and the Zoological Museum, University of Copenhagen (ZMUC).

Systematics

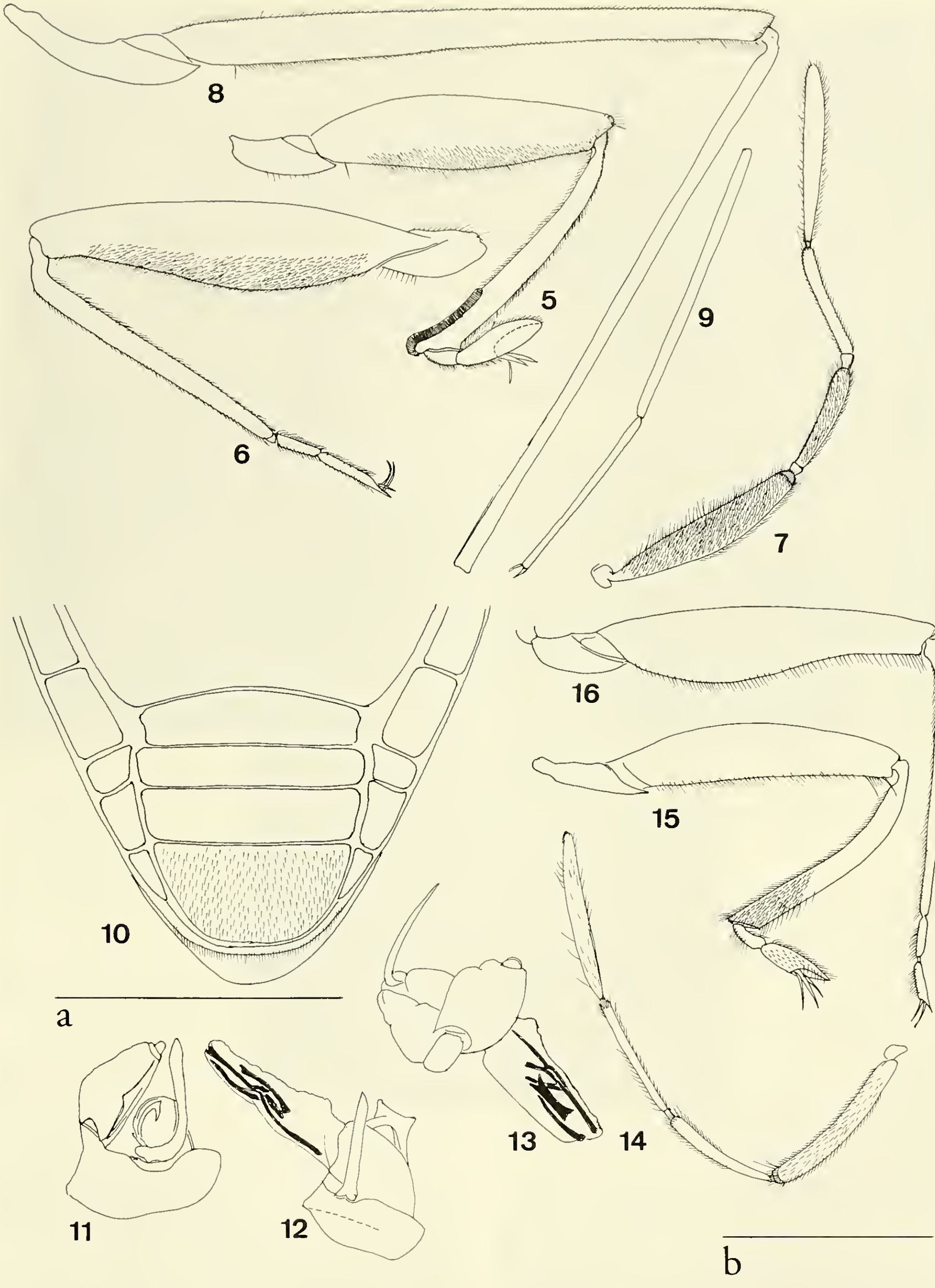
Halovelia anderseni sp. n.
(figs. 1-17, tabs. 1 and 4)

Type material. – Holotype male: Papua New Guinea, Madang Province, Madang, Nagada Harbour, 25.ii.1990, collected at light (in OXUM). – Paratypes same locality as holotype, 24.ii.-16.iii., 62♀♂ and 74♀. Paratypes same locality of holotype, 29.iv.-21.v., 302♂ and 160♀ (OXUM and RMNH). See table 4 for details of collecting sites.

Description

Adult apterous. – Males 1.94-1.97 mm long, maximum width 0.96-1 mm, females 2.2-2.4 mm long, maximum width 0.96-0.98 mm.

Coloration. – Male: Dark brown-black. Inner lateral margins of connexivum silvery pubescent. Head between eyes dark yellowish brown. Posterior margin of pronotum narrowly dark brown. Legs shining black, antennae black. Inner margins of front



Figs. 5-16. – 5-9, *Halovelia anderseni* sp. n. paratypes. – 5, ♂ front leg; 6, ♂ hind leg; 7, ♂ antennae; 8, ♀ middle femur and tibia; 9, ♀ middle tarsi. – 10-13, *Halovelia anderseni* sp. n. paratype male. – 10, tergite partially macerated; 11, genital capsule; 12, genital capsule extended; 13, genital capsule rotated. – 14-16. *Halovelia anderseni* sp. n. paratype female. – 14. antennae; 15. front leg; 16. hind leg. Scale bars (a for fig. 10 and b for all other figs.) .5 mm.

Table 1. Proportion of leg segments of *Halovelia anderseni* sp. n.

		Femur	Tibia	Tarsus I	Tarsus II
♂	front leg	36	31	4	9
♀	front leg	34	27	4	9
♂	middle leg	89	79	38	22
♀	middle leg	75	69	31	22
♂	hind leg	43	34	5	9
♀	hind leg	36	32	5	9

coxal margins brown, remainder of venter black.

Coloration. – Female: Similar to male.

Structure.– Male: Elongate fusiform (fig. 1). Head length 0.53× head width including eyes, widest interocular space 0.62× head width, eye width 0.3× interocular space. Antennae (figs. 2 and 7) segment 1-4 25:13:14:18, antennae 0.7× total length of insect. First antennal segment densely pilose, broader than fusiform 4th segment. Lateral margins of pronotum obsolescent. Meso and metanotum not clearly distinct. Tergites subequal length, 5th tergite and genital segment progressively longer. Connexivum slightly raised. Distal tergites partially macerated and slide mounted (fig. 10), connexival segments irregular. Metasternum posteriorly fringed with fine greyish pubescence. Sternites deeply depressed, genital segment large, genital capsule within abdomen, parameres conspicuous curving round capsule, meeting posteriorly. Genital capsule lateral aspect (fig. 11), parameres symmetrical, bluntly acuminate distally. Capsule rotated (fig. 12) showing vesica side view; (fig. 13) capsule rotated showing vesical sclerites from another aspect, parameres appearing distally acuminate.

Front leg (fig. 5) trochanter not spinose or tuberculate. Femora slightly sinuate, greatest width 0.2× length. Inner margin of tibia fringed with fine hairs, distally with a grasping comb extending round distal margin, tibial comb 0.35× length of tibia. Middle femora 0.9× total length of insect. Hind femora robust, greatest width 1.6× width of middle femora (fig. 6).

Structure. – Female: Rhomboid in outline. Head length 0.62× head width across eyes. Widest interocular space 0.62× head width including eyes. Eye width 0.27× interocular space. Antennae (fig. 14) segment 1-4 20:11.5:15:20, antennae 0.57× total body length, 4th segment not as fusiform as in male.

Thorax box-like, lateral margins straight, diverging slightly from the pronotum. Head pronotum and dorsum of thorax with a dense layer of fine grey pubescence. Anterior pronotal margin with a prominent dense transverse cluster of erect hairs. Pleura, pro and mesosternum dull, not conspicuously pilose. Anterior connexival segment erect with a row of erect hairs.

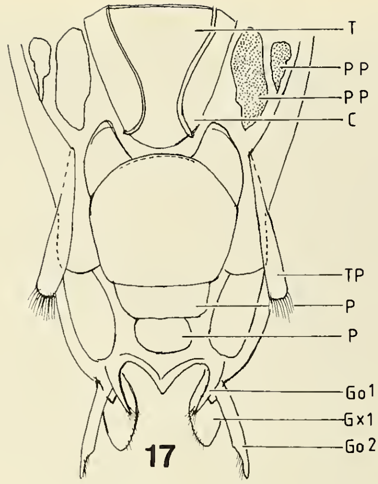


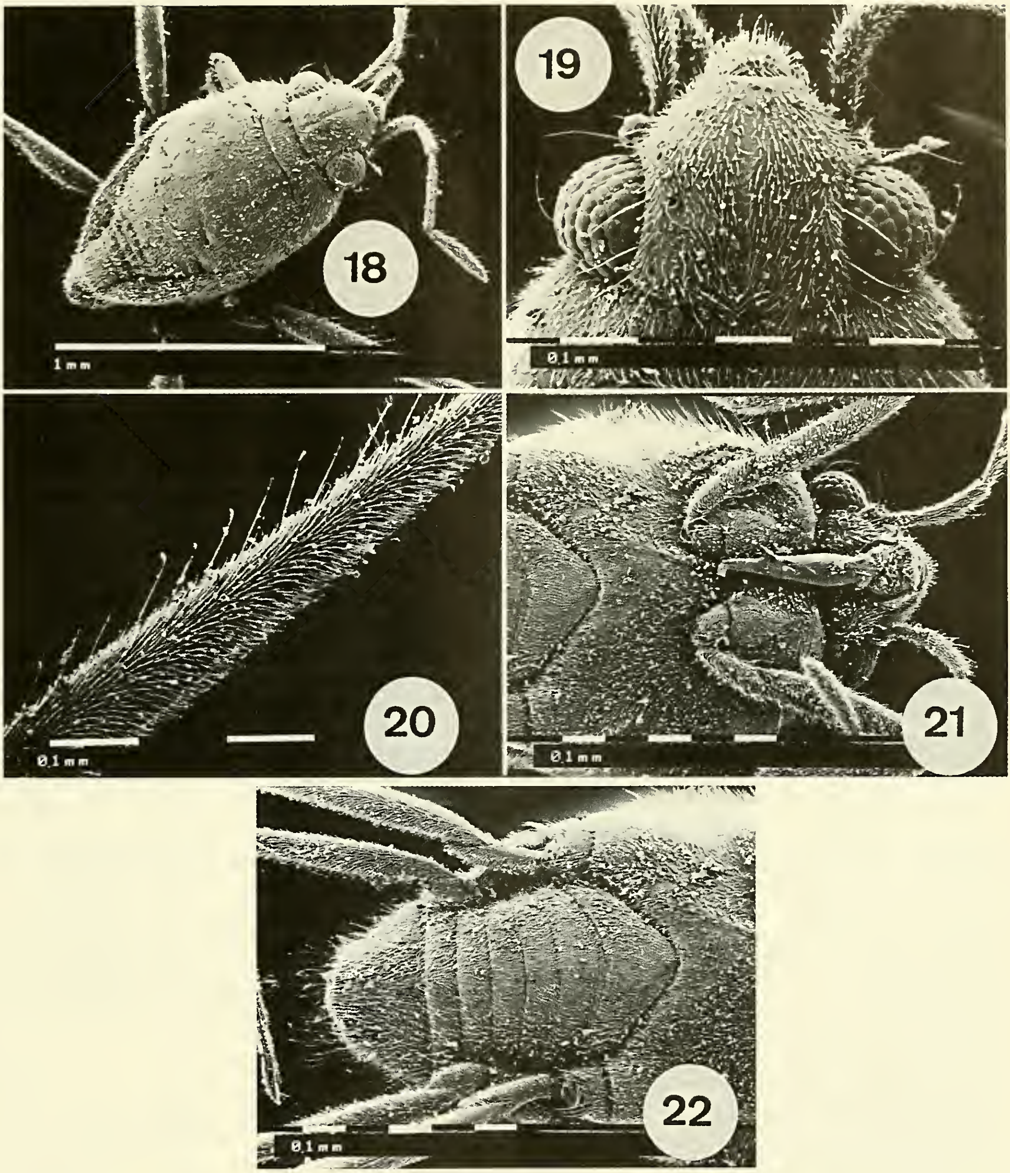
Fig. 17. *Halovelia anderseni* sp. n. paratype female. – Distal tergites partially macerated. Abbreviations T tergite; PP pleural plates; C connexivum; TP triangular plates; P proctiger; GO1 GO2 1st and 2nd gonopophyses; GX 1st gonocoxa.

First four visible tergites narrowing, enclosed by connexivum. Distally connexivum converging appearing to terminate with a prominent pilose triangular projection (figs. 3 and 4) Genital segment enlarged. Abdomen wider distally than proximally. Distal tergites and connexivum partially macerated, slide mounted (fig. 17) show that the triangular projections arise from the pleural margins of sternites. Pleural margins divided into several elongate plates. Eighth tergite bluntly triangular, lateral margins inflexed. Ovipositor and proctiger extended, first gonocoxa plate-like, 1st gonopophyses elongate, 2nd gonopophyses short and spinose.

Front leg (fig. 15) lower femoral margin straight, greatest width 0.17× length, tibia sinuate. Middle leg (fig. 8) femora 0.76× total length of insect. Hind leg (fig. 16) robust greatest width 0.22× length.

Etymology. – This species is dedicated to Dr. Nils Møller Andersen who has been of great assistance in naming the Veliidae found in the Nagada samples.

Remarks. – The male of *H. anderseni* sp. n. appears to key out to couplet 14 in Andersen (1989a) (*H. lannae* and *H. wallacei* Andersen), the parameres resemble *wallacei*. The female does not key out to the foregoing species as the antennal ratio of segment 2 is much shorter than the 3rd segment and therefore keys out to couplet 10 (*H. annemariae* and *novoguinensis* Andersen). The female of *H. anderseni* sp. n. is immediately recognisable by the distal triangular projections on the abdomen.



Figs. 18-22. *Xenobates pilosellus* sp. n. – 18, ♂ dorsal aspect; 19, ♂ dorsal view of head, 20, ♂ middle femur; 21, ♀ underside of head and pronotum; 22, ♀ abdomen ventrally.

Xenobates pilosellus **sp. n.**
(figs. 18-36, tabs. 2, 5 and 8)

Type material. – Holotype male: Papua New Guinea, Madang Province, Madang, Nagada Harbour, 14.ii.1990, collected at light (in OXUM). – Paratypes same locality as holotype, 22.ii.-16.iii., 134♂ and 477♀. Paratypes same locality as holotype 29.iv.-21.v., 21♂ and 49♀ (OXUM, RMNH and ZMUC). See table 5 for details of collecting sites.

Description

Adult apterous. – Males 1.3-1.44 mm long, maximum width 0.72-0.74 mm, females 1.6-1.72 mm long, maximum width 0.92-0.94 mm.

Coloration. – Male: Head antero-mesially with a longitudinal stripe and inner eye margins black, re-

Table 2. Proportion of leg segments of *Xenobates pilosellus* sp. n.

		Femur	Tibia	Tarsus I	Tarsus II
♂	front leg	23	20	2	7
♀	front leg	23	21	2	6.5
♂	middle leg	61	48	18	14.5
♀	middle leg	63	51	23	15.5
♂	hind leg	30	25	2	7
♀	hind leg	32	25	3	6

mainder orange brown. Anterior margin of pronotum black, remainder orange brown, remainder of dorsum black. Coxae and trochanters pale creamy yellow. Upper proximal margin of front femora pale brown, remainder of legs dark brown-black. Antennae, 1st segment proximally narrowly pale yellow, remaining segments dark brown-black. Pro-meso and metasternum pale orange brown. Pleural margins of thorax and sternites dark brown-black, mesially orange brown.

Coloration. – Female: Head and pronotum similar to male. Distal lateral margins of meso-metathorax with two (1+1) dark yellow blotches, remainder of dorsum black. Legs and antennae similar to male. Underside of head, thorax and abdomen pale orange brown. Pleura of thorax and sternites marginally dark brown-black, not as extensive as on male.

Structure. – Male: Fusiform (fig. 18). Head length 0.62× head width including eyes. Interocular space 0.54× head width. Eye width 0.39× interocular space. Head mesially with a slight median depression lacking pilosity (fig. 19). Cephalic trichobothria prominent. Lateral margins of head with 3-4 long hairs curving over the eyes. Antennae (fig. 23) segment 1-4 14 : 10.5 : 15 : 12, antennae 0.7× total length of insect, 4th segment fusiform. pronotal lateral margins obsolescent. Mesonotal suture visible laterally, metanotal suture visible laterally contiguous with connexivum. Mesothorax with two (1+1) fields of silver hairs extending onto connexivum. Tergites 3-5 with scattered silver hairs mesially, 6th tergite covered with evanescent silvery blue hairs extending onto connexivum. Anteriorly connexivum erect, distally outwardly reflexed. Distal tergites partially macerated, slide mounted (fig. 29), connexival segments regular. Thorax ventrally; dark pleural margins with semi-erect pubescence. Pale area of pro-meso and metasternum with short fine pubescence. Distal margin of meosternum fringed with fine hairs. Sternites 1-5 raised above transversely depressed 6th sternite. Distal median area of raised sternites conspicuously pilose. Genital segment large, capsule within segment, parameres symmetrical, curving round capsule (fig. 30).

Front leg (fig. 31) femora moderately robust, greatest width 0.2× median length. Tibia distally pilose. Middle leg (figs. 20, 32 and 33) femora fringed with long hairs, 0.84× total length of insect. Hind leg (fig. 34) femora slightly more robust than middle femora.

Structure. – Female: Rhomboid in outline. Head length 0.62× head width including eyes. Interocular space 0.51× head width. Eye width 0.45× interocular space. Antennae (fig. 24) segment 1-4 13.5 : 10 : 14.5 : 12.5, antennae 0.6× total length of insect. Lateral margins of prothorax densely pilose, straight diverging from pronotum to connexivum. Abdomen converging distally. Mesonotum with two (1+1) fields of short silvery hairs overlying the orange brown areas, between these a median black area with two (1+1) fields of silvery peg-like hairs. Metanotum anteriorly with longer silvery hairs overlying black pubescence. Mesonotum slightly raised above metanotum, the latter slightly raised mesially. Second and 3rd tergites laterally with two (1+1) fields of silvery hairs. Sixth and 7th tergites with scattered short silvery hairs. Tergites partially macerated, slide mounted (fig. 28), ovipositor partially extruded. Connexivum erect converging sharply posteriorly exposing pleura of distal sternites. Distal tergite densely pilose. Underside of head and thorax (fig. 21), pleural margins densely pilose. Sternum posterior of front legs triangularly raised 'Y' shaped. Mesosternum and sternites (fig. 22), genital segment densely pilose.

Front leg (fig. 35) femora with several prominent hairs ventrally, not as robust as male, tibia slightly sinuate. Middle leg (figs. 25, 26 and 27) femora slender, 0.75× length of insect. Hind leg (fig. 36) greatest femoral width subequal to middle femora.

Etymology. – The specific name alludes to the dense pubescence on the thoracic pleura and abdomen distally.

Remarks. – The three dark brown-black 'stripes' on the head on a orange brown field, densely pilose pleura and abdomen distinguish *Xenobates pilosellus* sp. n. from *X. solomonensis* Lansbury.

Xenobates solomonensis **Lansbury**
(figs. 37-53, tabs. 3 and 5)

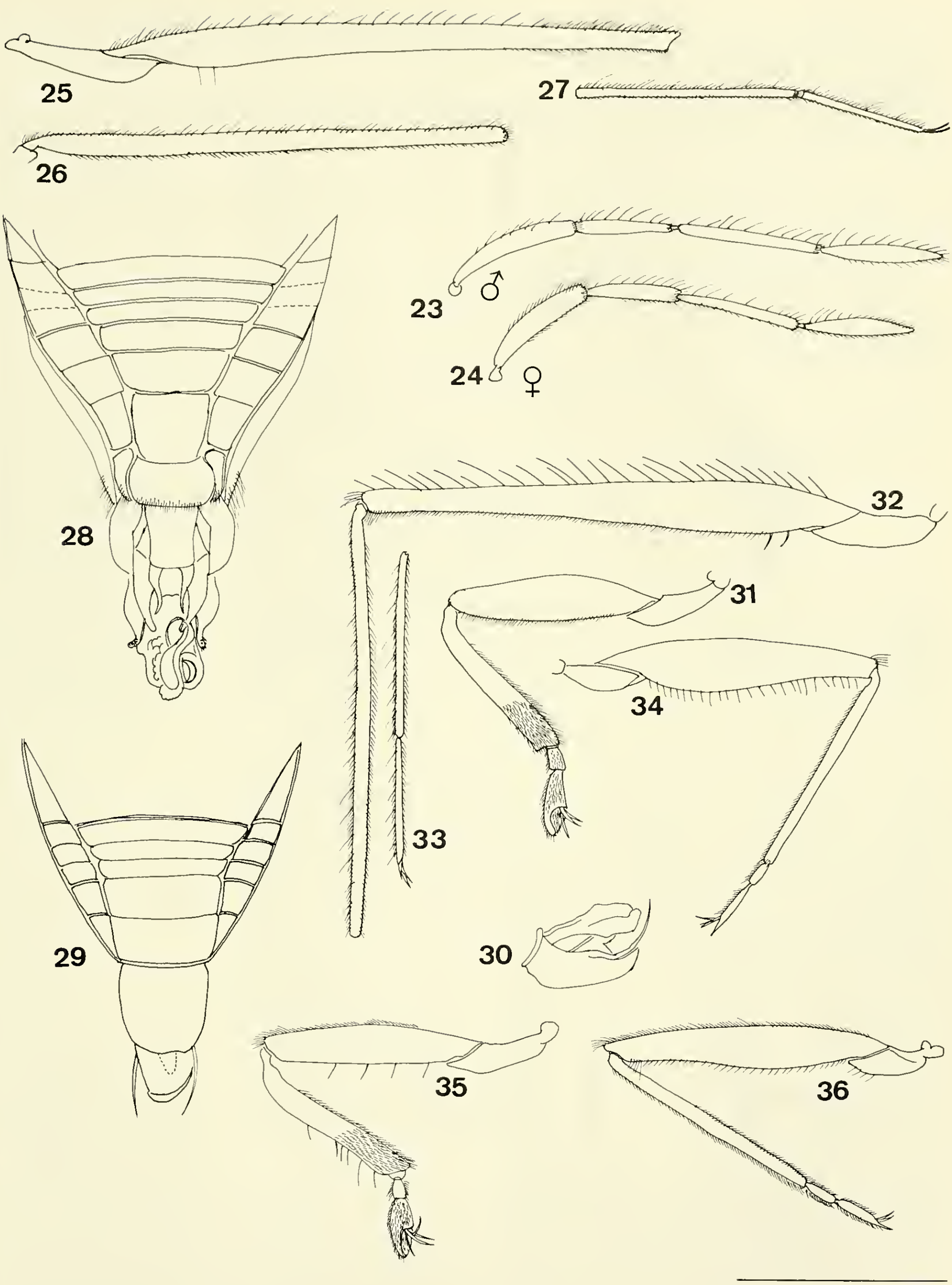
Xenobates solomonensis Lansbury, 1989: 107-109.

Redescription

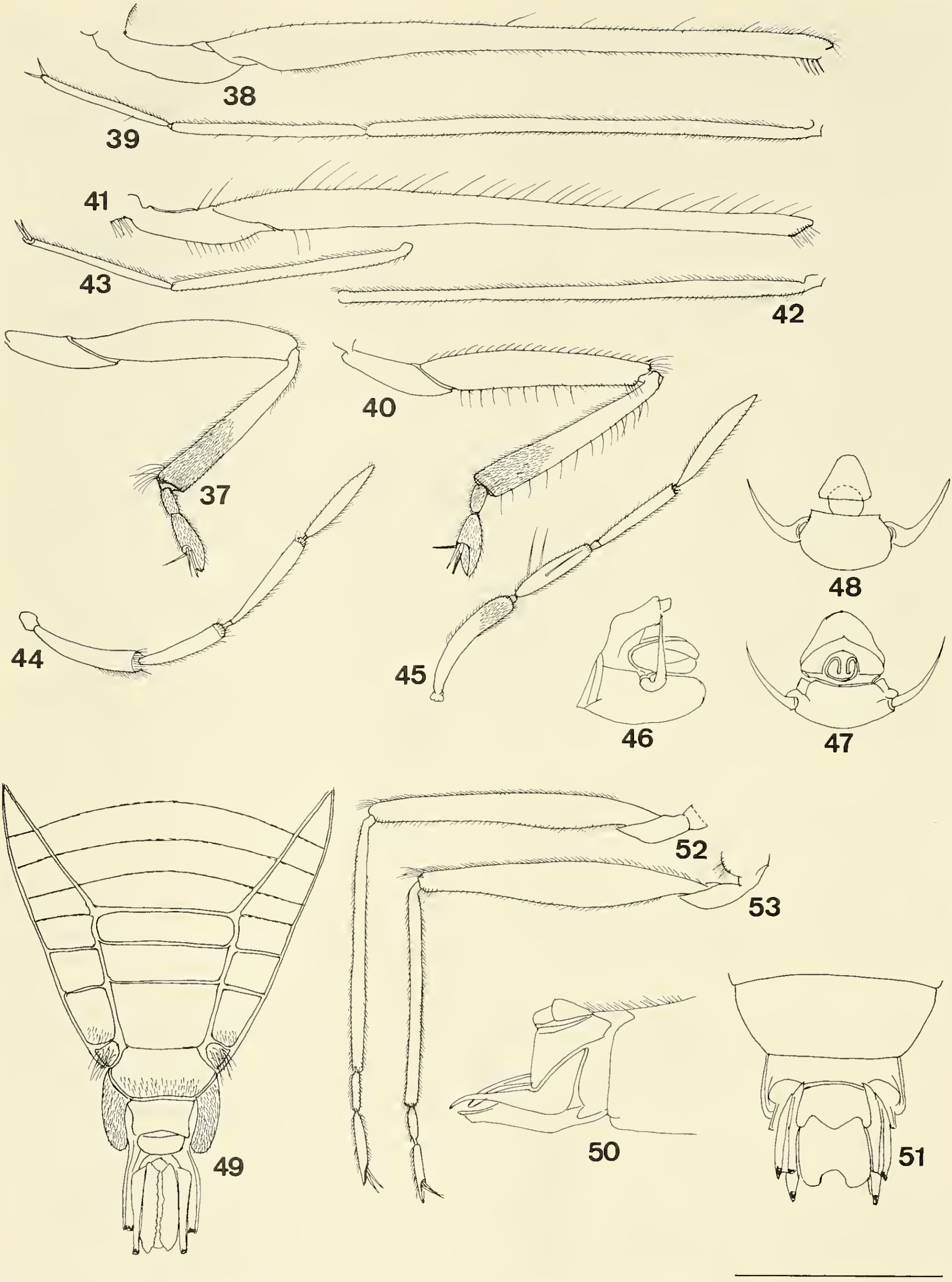
Adult apterous. – Males: 1.56-1.6 mm long, maxi-

Table 3. Proportion of leg segments of *Xenobates solomonensis* Lansbury.

		Femur	Tibia	Tarsus I	Tarsus II
♂	front leg	23	20	3	7.5
♀	front leg	26	22	3	8
♂	middle leg	64	52	21	16.5
♀	middle leg	68	54	25	17
♂	hind leg	32	25	3.5	7.5
♀	hind leg	32	27	3	8



Figs. 23-36. – 23-27, *Xenobates pilosellus* sp. n. paratypes. – 23, ♂ antennae; 24, ♀ antennae; 25, ♀ middle femur; 26, middle tibia; 27, ♀ middle tarsi. – 28-30, *Xenobates pilosellus* sp. n. paratypes. – 28, ♀ abdomen partially macerated; 29, ♂ abdomen partially macerated; 30, ♂ genital capsule. – 31-36. *Xenobates pilosellus* sp. n. paratypes. – 31, ♂ front leg; 32, ♂ middle femur and tibia; 33, ♂ middle tarsi; 34, ♂ hind leg; 35, ♂ front leg; 36, ♀ hind leg. Scale bar .5 mm.



Figs. 37-53. – 37-45, *Xenobates solomonensis* Lansbury. – 37, ♂ front leg; 38, ♂ middle femur; 39, ♂ middle tibia and tarsi; 40, ♀ front leg; 41, ♀ middle femur; 42, ♀ middle tibia; 43, ♀ middle tarsi; 44, ♂ antennae; 45, ♀ antennae. – 46-53, *Xenobates solomonensis* Lansbury. – 46, ♂ genital capsule; 47, ♂ genital capsule ventral aspect; 48, ♂ genital capsule end on aspect; 49, ♀ abdomen partially macerated; 50, ♀ lateral aspect of ovipositor; 51, ♀ ovipositor ventral aspect; 52, ♀ hind leg; 53, ♂ hind leg. Scale bar .5 mm.

Table 4. Occurrence of *Haloveloides* and *Halovelia* species at Nagada.

	Habitat	Time	*papuensis*		*browni*		*anderseni*		*annemariae*	
			♂	♀	♂	♀	♂	♀	♂	♀
1990										
17.ii.	jetty shade	18.00	14	2						
18.ii.	jetty shade	17.00	150	38						
22.ii.	jetty shade	17.00	9	2						
23.ii.	jetty shade	17.30	25	20						
24.ii.	mvlt	20.00-21.00		8	18	5	1	4		
25.ii.	mvlt	20.30-22.00	23	33	25	27	8	11	13	12
26.ii.	mvlt	20.15-21.5	24	6	31	13	9	26	46	53
27.ii.	jetty shade	16.00	36	40						
27.ii.	mvlt	20.30-21.30	21	22	17	15	8	7	29	31
1.iii.	jetty shade	15.00	312	218	5					
3.iii.	mvlt	21.00-22.00	5	5	7	3			6	8
4.iii.	rubble with trees	15.00	368	300	3					
4.iii.	rubble with trees	18.00	11	6						
5.iii.	fallen tree	16.00-17.15	116	23						
5.iii.	mvlt	20.30-21.30		4	2				7	5
6.iii.	submerged tree-jetty	16.00-17.00	16	4						
7.iii.	jetty shade	17.00	5	15		1	23		2	1
8.iii.	rubble with trees	16.00	42	12						
9.iii.	coral rubble	16.00	22	9						
9.iii.	mvlt	20.00-21.15	22	13	7	1	3	1		
10.iii.	coral rubble	16.00	31	2						
10.iii.	mvlt	20.15-21.15	10	4	1	5	1	5	3	8
12.iii.	mvlt	20.45-21.50	52	26	2	2		4	7	1
13.iii.	mvlt	21.00-22.00	28	50	6	5		3	9	9
24.iii.	mvlt	20.30-21.30	3	22	7	2	9	7	3	4
16.iii.	submerged tree	15.00	308	338	6	5				
16.iii.	mvlt	20.45-21.45	12	15	7	3	1	4	27	13
1992										
29.iv.	mvlt	20.00-.00	5	4			52	39	4	4
30.iv.	mvlt	20.15-21.15	2	3			11	8	12	3
1.v	mvlt	20.15-21.15	5	6				1		3
2.v.	mvlt	20.15-21.15	1	1						
4.v.	mvlt	20.15-21.30	8	12				2	2	
5.v.	mvlt	17.30-19.00	22	13						
7.v.	jetty shade	13.30	48	17						
7.v.	mvlt	20.30-21.30						1		
8.v.	mvlt	20.30-21.30		2						
11.v.	mvlt	20.00-21.30	15	18			1	1	4	5
12.v.	mvlt	20.00-21.00	8	27			1	1	1	1
13.v.	mvlt	20.00-20.30	3	4						
15.v.	mvlt	20.15-22.00	12	7			4	7	7	5
16.v.	mvlt	20.00-23.00	20	30			3	1	1	2
18.v.	mvlt	20.15-21.30	18	6						
19.v.	mvlt	20.00-22.00	38	39			16	16	8	4
20.v.	mvlt	20.30-21.45	91	58			212	79	43	8
21.v.	mvlt	20.30-21.30	10	35			1	5	18	11

mum width 0.82-0.84 mm, females 1.8-1.82 mm long, maximum width 0.98-1.02 mm.

Coloration. – Male: head and pronotum yellowish brown, anterior lateral margins of head with two (1+1) with irregular black blotches, lateral margins of pronotum black. Mesonotum black with a conspicuous field of silvery-yellow hairs, laterally with transverse bands of silver hairs. Tergites and connexivum black. Tergites 1-2 with fields of silver hairs, 6th tergite with longer scattered silver hairs. Thoracic pleura dark brown-black merging into pale brown ventrally. Pro-meso and metasternum pale yellowish brown. Sternites laterally dark brown-black graduating to pale brown. Antennae, 1st segment proximally pale yellow, remainder of segments black. Front coxae, trochanters and femora pale yellow, annulated dark brown distally, tibia and tarsi black. Middle and hind coxae and trochanters pale yellow, lower margins of

Table 5. Occurrence of *Xenobates* species at Nagada.

	Habitat	Time	*solomonensis* ♂	*solomonensis* ♀	*pilosellus* ♂	*pilosellus* ♀
1990						
22.ii.	jetty shade	17.00				2
23.ii.	jetty shade	17.30	1	1	1	1
25.ii.	mvlt	20.30-22.00	1	1	3	9
26.ii.	mvlt	20.15-21.50	6	3	13	51
27.ii.	mvlt	20.30-21.30	2	3	3	61
1.iii.	jetty shade	15.00	3	1	9	32
1.iii.	mvlt	20.30-21.00				1
3.iii.	mvlt	21.00-22.00	1	3	5	29
4.iii.	rubble with trees	15.00	1			
4.iii.	rubble with trees	18.00	1		1	2
5.iii.	fallen tree	16.00-17.15			11	8
5.iii.	mvlt	20.30-21.30		1	2	5
6.iii.	submerged tree-jetty	16.00-17.00	1	1	1	3
7.iii.	jetty shade	17.00			3	1
8.iii.	rubble with trees	16.00	8	3	13	21
9.iii.	coral rubble	16.00	12	9	13	1
9.iii.	mvlt	20.00-21.15	3	4	6	32
10.iii.	coral rubble	16.00	8	4	2	4
10.iii.	mvlt	20.15-21.15	3	8	17	28
12.iii.	mvlt	20.45-21.50	1		21	84
13.iii.	mvlt	21.00-22.00	2	2	8	56
14.iii.	mvlt	20.30-21.30			2	11
16.iii.	submerged tree	15.00	1	2		3
16.iii.	mvlt	20.45-21.45	1	2	2	33
1992						
29.iv.	mvlt	20.00-22.00				2
30.iv.	mvlt	20.15-21.15		3	1	4
1.v.	mvlt	20.15-21.15		2	1	
2.v.	mvlt	20.15-21.15		3		2
4.v.	mvlt	20.15-21.30			1	4
5.v.	mvlt	17.30-19.00		6	2	5
7.v.	jetty shade	13.30		2	1	
7.v.	mvlt	20.30-21.30	1		2	1
11.v.	mvlt	20.00-21.30	2	6		2
12.v.	mvlt	20.00-21.00	3	3	1	4
13.v.	mvlt	20.00-20.30		3	1	
15.v.	mvlt	20.15-22.00		1		1
16.v.	mvlt	20.00-23.00	18	12	1	3
19.v.	mvlt	20.00-22.00		6	5	10
20.v.	mvlt	20.00-21.45	6	15	5	4
21.v.	mvlt	20.30-21.30	1	2	1	6

femora pale brown, upper surfaces dark brown, tibia and tarsi dark brown-black.

Coloration. – Female: Head and pronotum bright yellowish brown, black pattern similar to male. Mesonotum mesially dark brown covered with semi-erect silvery hairs. Metanotum dark brown-black with short silver hairs. Tergites 1-2 black, laterally with silver hairs, 3-6 brown, distal margins black, tergites 5-6 with scattered silver hairs. Connexivum dark brown, upper margins narrowly black. Thoracic pleura and lateral margins of sternites reddish brown. Pro-meso and metasternum and sternites yellowish brown, 6th sternite shining. Antennae similar to male. Coxae and trochanters pale yellow. Front femora pale yellowish brown, paler on underside, tibia and tarsi black. Middle and hind femora either paler on lower surface or uniformly brown, middle and hind tibia and tarsi dark brown-black.

Structure. – Male: Fusiform. head length 0.58× head width, interocular space 0.57× head width including eyes, eye width 0.4× interocular space. Head with a prominent minutely sculptured median longitudinal depression. Head posteriorly with two (1+1) clusters of circular protuberances. Antennae (fig. 44) segment 1-4 13 : 10 : 13 : 12.5, antennae 0.6× total length of insect, 4th segment fusiform. Pronotal lateral margins obsolescent. Meso and metanotal sutures only visible laterally in partially macerated specimens,

Table 6. Occurrence of *H. papuensis* and *Halobates* immatures (imm.) at Nagada.

1990	Habitat	Time	*H. papuensis*	*Halobates*
18.ii.	jetty shade	17.00	many imm.	many imm.
23.ii.	jetty shade	17.30	30	50+
27.ii.	jetty shade	16.00	1000+	70+
1.iii.	jetty shade	15.00	1700+	170+
4.iii.	rubble with trees	15.00	850+	
5.iii.	fallen tree	16.00	300+	not counted
6.iii.	submerged tree jetty	16.00	70+	130+
8.iii.*	rubble with trees	16.00	500+	

* includes immature *Xenobates*

sutures obscured by dorsal pilosity on dry mounted specimens. Thoracic pleura, outer margins of connexivum and sternites pilose, genital segment shining and pilose. Thorax ventrally; mesosternum slightly raised 'Y' shaped, distal margin fringed with short hairs. Mesosternum and sternites 1-4 raised forming a rounded ridge, distal sternites deeply depressed. Genital capsule within segment, parameres partially visible curving round segment. Genital segment partially macerated, lateral aspect (fig. 46), ventral and end on aspect (figs. 47 and 48). Prothorax and proximal tergites forming an even convex curve, distal tergites slightly depressed. Connexivum slightly outwardly reflexed, inner margins silvery pubescent.

Front leg (fig. 37), femoral width 0.22× median length. Middle leg (figs. 38 and 39) femora fringed with hairs, not as pilose as female middle femora, 0.8× total length of insect. Hind leg (fig. 53) femora 0.5× length of middle femora, greatest width subequal to middle femora.

Structure. – Female: Rhomboid in outline. Head length 0.5× head width across eyes, interocular space 0.55× head width, eye width 0.39× interocular space. Median longitudinal depression more conspicuous than of male. Antennae (fig. 45) segment 1-4 14.5 : 11 : 13 : 13, antennae 0.57× total length of insect, 2nd segment spinose, 4th fusiform.

Lateral margins of prothorax pilose, straight and diverging from pronotum to connexivum. Prothorax raised above tergites, connexivum slightly outwardly reflexed, outer margins pilose. Abdominal tergites partially macerated, slide mounted (fig. 49). Ovipositor partially extruded, lateral aspect (fig. 50), ventral aspect (fig. 51). Mesosternum slightly raised 'Y' shaped, distal margin infuscated, less pilose than male. Metasternum and sternites uniformly rounded, not raised. Sternites mesially pilose distally, genital segment densely pilose.

Front leg (fig. 40) femora ventrally with long hairs, femoral width 0.19× median length. Middle leg (figs. 41, 42 and 43), femoral upper margin with many long hairs, femora 0.75× total length of insect. Hind leg (fig. 52) femora 0.47× length of middle femora, greatest width subequal to middle femora.

Remarks. – *Xenobates solomonensis* Lansbury described from the Solomon Islands, New Georgia, Munda, Holotype in OXUM. It differs from other described *Xenobates* by the bright orange yellow head in both sexes, the head of *X. pilosellus* sp. n. and *X. seminulum* (Esaki) differ by the much darker head.

Material. – See table 5 for samples from Papua New Guinea, Madang Province, Madang, Nagada Harbour, 1990 and 1992.

MISCELLANEOUS BIOLOGICAL NOTES

Haloveloides papuensis (Esaki): this species invariably encountered close inshore, usually within 2 metres. Large flotillas of specimens occurring in the shade of the jetty walkway or sheltering in the lee of partially submerged trees or amongst overhanging vegetation. Large samples e.g. over 500 specimens were taken with a single sweep of the net. *H. papuensis* flotillas move slowly, keeping very close together. Wave action created by boats passing at speed causing the flotillas to disperse rapidly, sometimes the rafts reassembling within a few minutes, on other occasions, flotillas amongst overhanging vegetation sometimes remaining dispersed. A feature of the *papuensis* flotillas is the presence of many teneral adults as well as large numbers of immature veliids and 1st and 2nd instar *Halobates* species.

Especially noticeable are the much lower numbers of *papuensis* attracted to light and no immatures were found in the samples although immature *Halobates* (3rd and 4th instar) were frequently more abundant than adult *Halobates*. The 1992 samples differ considerably from the 1990 samples, despite intensive sampling and searching, only one flotilla of veliids were found inshore on the 7.v. The number of

Table 7. Occurrence of *H. browni* in West New Britain.

1989	Location	♂	♀
1.vii	Dami Creek 'freshwater'	6	
29.vii	Kimbe, Dami near Talasea 200 m. offshore around pontoon oil drums	79	1
30.vii	Vovosi 500 m. offshore around exposed reef at low tide	108	3
2.viii	Dami near Talasea 200 m. offshore	42	

Table 8. Occurrence of *Xenobates* species in New Britain.

	Location	*pilosellus* ♂	*pilosellus* ♀	*solomonensis* ♂	*solomonensis* ♀
1988					
2.x	Dami Creek river mouth	6	6		
1989					
8-10.i	Dami Creek 'saline'	2	2		
9.iv	Kapiura River tidal creek	8	2		1
10.vi	Tamari Beach				2
20.vii	Dami Creek	8	7		
19.viii	Balima River near Ulamona		1		
1993					
28.iii	Bainings, Kleinwara River Ramada Pltn. (this river 'fed' upstream by freshwater springs R. Prior verbatim)**	13	17		

**East New Britain, specimens not 'typical' *pilosellus*.

papuensis at light appear to be consistent for both years. *Haloveloides browni* (Lansbury), in 1990 small numbers were taken at light, very few were taken close inshore. In 1992 no *H. browni* were found at Nagada. There is evidence that *H. browni* is an offshore species, in West New Britain samples collected by R.N.B. Prior support this possibility.

Despite searches offshore at Nagade Harbour, no specimens were found. *Halovelia anderseni* sp. n. and *H. annemariae* Andersen have a similar pattern of occurrence as *Haloveloides browni*. The 1990 specimens were mostly obtained in light trap samples. This pattern repeated in 1992. The larger than usual numbers of both species in the sample on the 20.v. are difficult to explain, weather conditions were noted as, sea smooth, tide ebbing imperceptibly and no wind, conditions were identical on the 21.v. but the sample was much smaller.

Xenobates solomonensis Lansbury and *X. pilosellus* sp. n. see table 5. *X. pilosellus* was found in larger numbers than *solomonensis* in 1990 whereas in 1992, *pilosellus* was less abundant. The data for both species is ambiguous, being found in almost every sample although *pilosellus* was more commonly found at light than *solomonensis*. Data from New Britain tends to support the hypothesis that *Xenobates* is an inshore genus, often being found where saline and freshwater mingle.

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References

Andersen, N. M., 1989a. The coral bugs, genus *Halovelia* Bergroth (Hemiptera, Veliidae). I. History, classification, and taxonomy of species except the *H. malaya*-group. – Entomologica scandinavica 20: 75-120.

Andersen, N. M., 1989b. The coral bugs, genus *Halovelia* Bergroth (Hemiptera, Veliidae) II. Taxonomy of the *H. malaya*-group, cladistics, ecology, biology and biogeography. – Entomologica scandinavica 20: 179-227.

Andersen, N. M., 1992. A new genus of marine water striders (Hemiptera, Veliidae) with five new species from Malesia. – Entomologica Scandinavica 22: 389-404.

Esaki, T., 1926. The water-striders of the subfamily Halobatinae in the Hungarian National Museum. – Annales Musei Nationalis Hungarici 23: 117-164.

Lansbury, I., 1989. Notes on the Haloveliinae of Australia and the Solomon Islands (Insecta, Hemiptera, Heteroptera: Veliidae). – Reichenbachia 26: 93-109.

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DESCRIPTION OF *HYLAEARGIA MAGNIFICA* MICHALSKI, A DAMSELFLY FROM PAPUA NEW GUINEA (ODONATA: ZYGOPTERA)

Michalski, J.C., 1996. Description of *Hylaeargia magnifica* Michalski, a damselfly from Papua New Guinea (Odonata: Zygoptera). – Tijdschrift voor Entomologie 139: 29-32, figs. 1-7. [ISSN 0040-7496]. Published 15 October 1996.

Hylaeargia magnifica is a new species of argiine damselfly from the Star Mountains (Victor Emanuel Range) of Papua New Guinea, and is only the second species of its genus. The species is at once distinguished from *H. simulatrix* by its bright blue, yellow, and green body coloration.

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Key words. – Odonata, Papua New Guinea, Argiinae, *Hylaeargia*, new species.

M.A. Lieftinck erected the genus *Hylaeargia* in 1949 to accommodate the single species *simulatrix*, which he described as 'peculiar by the sombreness of its colours' and noted its strong resemblance, both in general facies as well as in certain structural details, to the platycnemidid *Lochmaeocnemis malacodora* Lieftinck, which was remarkable on account of the two species being collected in the same locale.

Lieftinck (1949), describes *Hylaeargia* as having the 'stature of *Palaiargia*, but with a larger head, more slenderly built thorax, much narrower wings, and with an entirely different type of male anal appendages'. In Lieftinck's view, the arched and deeply emarginate hind lobe of the female prothorax, the long legs (the posterior femur of which reaches beyond the posterior margin of the first abdominal segment), and the unusual male anal appendages, clearly set *Hylaeargia* apart from all other regional Argiinae.

Lieftinck (1957), suggests that both *Hylaeargia* and *Papuargia* are probably derived from the *humida* group of the genus *Palaiargia*, which is identified by the bluntly rounded wing-tips, strongly curved origin of the vein M_3, the very oblique pterostigma, the relatively large and bulky thorax, and simple anal appendages.

The new species fits *Hylaeargia* in all particulars, but is clearly distinct from *simulatrix* on account of the male terminalia, female prothorax, and by the bold and distinctive body colors of the male.

The new species was inadvertently described in an article entitled 'New Guinea continued' (Michalski 1995): while it was not the author's intention, the brief general description provided in that article does indeed satisfy the International Code of Zoological Nomenclature, and therefore those notes may be considered a preliminary description of the species which follows.

Hylaeargia magnifica Michalski, 1995
(figs. 1-7)

Hylaeargia magnifica. – Michalski 1995: 15.

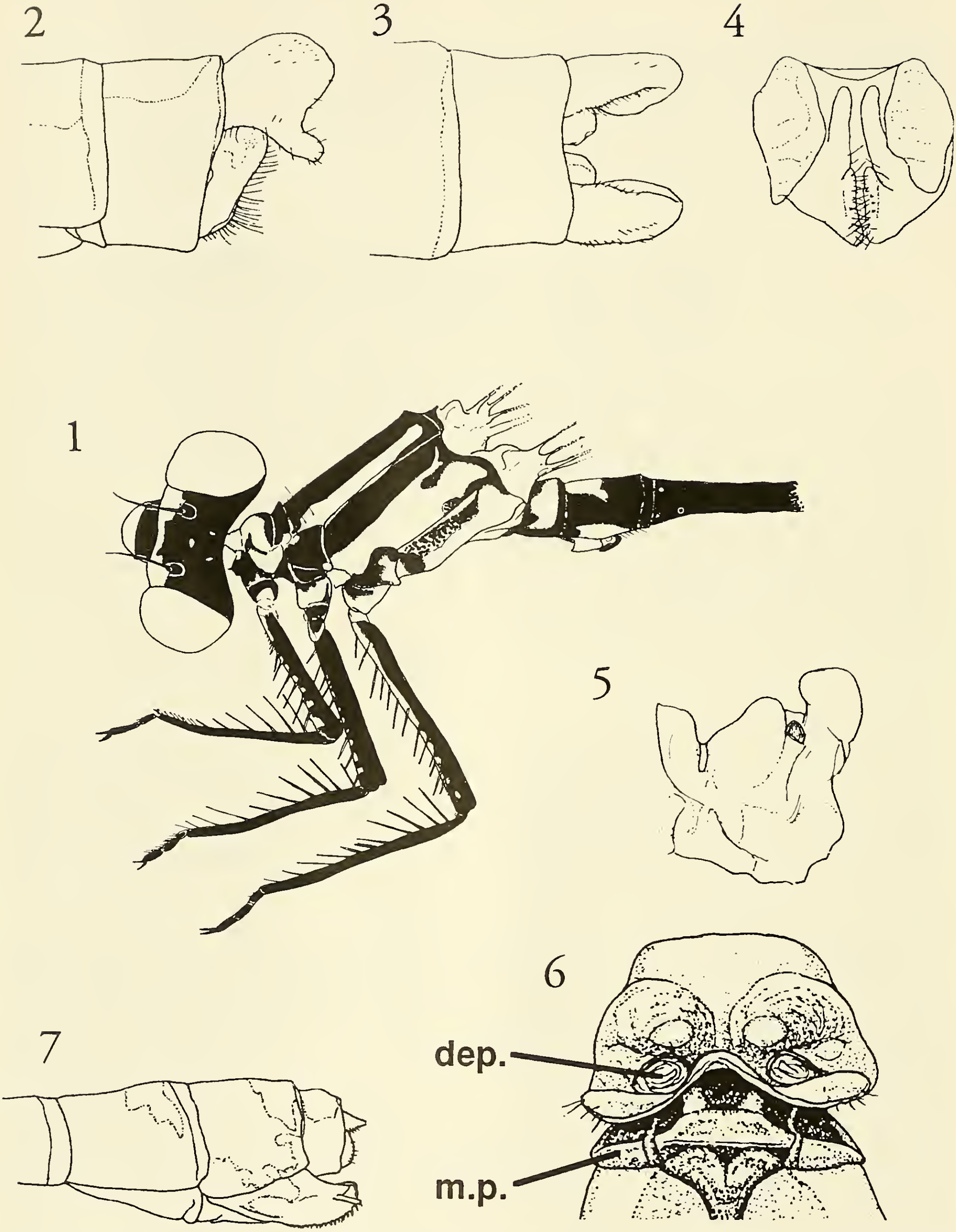
Type material. – Holotype male: Papua New Guinea. Sandaun (West Sepik) Province, Oksapmin District, Tekin Station, 2 August 1994, J. Michalski leg. Paratypes (including an allotype), same data, 3 ♂, 4 ♀. Holotype ♂ and allotype ♀ in RMNH Leiden, paratypes in the collection of the author.

Description

Male holotype. – This is a brightly marked, lively species of medium size and build, striped in vivid blue, green, and yellow set against velvet black.

Head. – Labrum clear, canary yellow, completely unmarked, as are the mandibles to either side. Clypeus entirely matte black. Frons clear, canary yellow, unmarked, the yellow continuing unbroken to the compound eyes, which themselves are brown in the upper three-fourths (deep blue in life), and canary yellow lower down. Epicranium entirely deep matte black, with no trace of pale postocular spots. Rear of head matte black.

Prothorax. – Bright sky blue, the hind lobe and rear portion of median lobe matte black; dorsum of prothorax also matte black in a broad band, isolating the pale areas into two large oval spots.



Figs. 1-7. *Hylaeargia magnifica* Michalski – 1, ♂ head and thoracic pattern; 2, ♂ terminalia, left lateral view; 3, same, dorsal view; 4, same, posterior view; 5, ♀ prothorax, left lateral view, 6; ♀ prothorax and mesostigmal plates, dorsal view, 7; ♀ terminalia, left lateral view.

Pterothorax. – A broad mid-dorsal band of matte black, about 1.5 times as broad as the pale antehumeral stripes to either side. Antehumeral stripes yellowish-green (bright leafy yellow-green in life), broadest anteriorly and narrowing steadily upward; antehumeral stripes reaching nearly to forewing bases. Mesopleural (humeral) suture bordered by a broad, complete stripe of matte black, as wide as the pale antehumeral stripe; humeral stripe extending to interpleural (first lateral) suture anteriorly, but narrowing rearward so that about one-sixth of the mesepimeron is left pale. This pale area, and all the remaining pale areas of the body, are of the deepest, boldest, electric blue coloration. Metepisternum almost entirely pale (blue in life). Upper end of the black humeral stripe reaching the wing bases, continuing as unbroken stripe along subalar carina, with downward extensions along the upper fourth of the interpleural suture and the upper half of the metapleural (second lateral) suture. A jagged, diagonal stripe of black between bases of second and third coxae and continuing rearward along upper edge of metinfraepisternum. Metepimeron pale with an isolated diagonal bar of black, about half the width of the metepimeron and nearly two-thirds its length, located in the dorso-anterior sector of the metepimeron. Venter of thorax pale (bluish), almost unmarked.

Legs. – Black, the interior surface of all femora bright, electric blue, the spines deep black.

Wings. – Hyaline, with no suggestion of smoky pigmentation; pterostigma black. Venation as described by Lieftinck for the genus.

Abdomen. – Segments mainly matte black with markings of bold, electric blue, as follows: sides of segment 1 entirely blue, dorsum with a broad, rearward-pointing triangle of black; segment 2 with large cup-shaped blue spot covering basal half or more of dorsum; segments 3-7 each with a pair of small, dorso-apical dots of blue (almost invisible in preserved specimens); segment 8 with the distal two-thirds or more bright sky blue, the anterior margin of the blue color convex; dorsum of segments 9 and 10 entirely bright sky blue; colors on segments 8-10 are clearly delimited in profile view, the upper halves blue and the lower halves black.

Terminalia. – Cerci (figs. 2-4) entirely matte black, bilobed in profile, the upper lobe wide and round, the lower lobe finger-like and projecting below the horizontal at an angle of around 45 degrees; the appendage taken as a whole presenting a shape like a mitten. Paraprocts entirely black, finger-like and upturned, mostly concealed in profile.

Female allotype. – Coloration similar to the male but with the dark colours of the head and thorax dark brownish-black.

Prothorax. – Posterior lobe (figs. 5-6) in dorsal view with the hind margin produced into a pair of raised, smoothly rounded ridges. Hind edge of median lobe with a pair of weakly-scleritized oval depressions; these appear to be so situated as to receive the 'thumbs' of the male cerci during copulation.

Pterothorax. – Mesostigmal plates as in figure 6, each lateral flange perpendicularly crossed by a rounded carina with the dorsal/posterior end teardrop-shaped. Antehumeral stripes bronzed olive-green, these stripes much broader than the mid-dorsal stripe separating them. Brown humeral stripe obliquely crossing the mesopleural suture, which is itself covered by a fine pale stripe; in other words, the humeral stripe is interrupted or jagged, comprising a broad, 'post-sutural' band over the mesepimeron, and narrowing to a fine point dorso-posteriorly; and a fine 'antehumeral' wisp of a brown stripe coming down from the forewing base and tapering to a point anteriorly, the two dark stripes separated by the merest hair of a pale line along the mesopleural suture.

Abdomen. – Segment 2 without any pale dorsal markings; dorsum of segments 8 and 9 with only a broad ring covering the apical one-third to one-half of each segment. Segment 10 entirely blue dorsally; appendages and ovipositor as in figure 7, brownish-black.

Dimensions. – Holotype male: abdomen + appendages 34.5 mm, hindwing 26.0 mm. Allotype female: abdomen + appendages 33.5 mm, hindwing 27.5 mm.

Dimensional range of the paratype series. – Abdomen + appendages 32.5-35.0 mm, hindwing 25.0-27.0 mm.

Variation within paratype series. – The paratypes include three males and three females. The males agree in all particulars with the holotype, except that the wings show a distinct brownish tint distributed evenly throughout the wing membrane. Of the three females, two were immature and, while their markings do not differ appreciably from the allotype, the pale areas of the body are of a frosty pale blue color, including the antehumeral stripes, which are green in the mature female. The immature females present the general facies of the female of North America's *Argia moesta*.

Etymology. – The species is named for its magnificent body coloration, which makes this insect among the most dramatic and lovely Zygoptera in the world.

Remarks. – All of the type series were taken on the same day, the first two or three around noon, the remainder on a return visit about three in the afternoon. The type locality is a small clear brook with a bed of battleship-grey, clayish soil (or rock?). It might have been soft grey limestone, as this is cave country. To reach the site one would take the broad, flat footpath which runs from the airstrip-serviced mission station of Tekin, towards the smaller village of Sabate, and from there to points westward, eventually leading to Telefomin. Between Tekin and Sabate, only a few minutes' walk out of Tekin, one comes to this grey-bedded stream where a waterfall about 8 feet high and six feet wide is visible just a few feet back from the road.

Mosses and ferns cling to the vertical face of this waterfall, but apparently this is not the favored retreat of *Hylaeargia*. Just past the fall is a muddy footpath going steeply uphill on the left. Following this path for only a few meters one comes across *H. magnifica* perching on tall grasses and branches over the small ravine through which the stream runs. At this point the stream is something less than one meter across and only ankle deep, and *magnifica* perches on any sunny vegetation without apparent preference (alighting on small ferns only inches from the ground as well as tree branches well out of reach). In behavior it is similar to the American *Argia* with its robust flight, frequent perching in sunny places and, it seemed at the time, fairly high population density. It did not take long to catch these eight specimens, however time did not permit a more extensive collection.

The only other odonate species encountered here was the libellulid *Diplacina hippolyte* Lieftinck. Only three or four meters upstream from this place the stream emerges from a meter-wide oval hole in the side of the hill. In my limited time I did not explore the stream downhill of the road, nor was I able to explore further uphill to see if the stream came to the surface further on.

The Tekin-Telefomin area will no doubt be a rich source of new material for any worker who chooses to spend time there. Tekin is a tiny station made up mostly of thatched grass-and-wood huts.

Hylaeargia magnifica is truly magnificent in life, with its rainbow of colors set against velvet black. The long black leg spines cross the electric blue of the femora in such a way as to create the effect of a string of blue lights along each leg. It is a pleasure to be able to introduce such a delightful species to the scientific community.

Key to the species of *Hylaeargia*

1. Insect of sombre coloration; the face dirty yellow with slight greenish intermingling, dorsum of synthorax matte bronzy-black, the lateral blue marks dull, not conspicuous in old individuals and often much obscured. Male superior anal appendages about 1.5 times as long as segment 10, sinuate and tapering to a rounded apex, in profile shaped something like an 'inflated Y', with the upper spur of the 'Y' short, broad and rounded, the lower spur more than twice the length of the upper, though not as broad, and pointing ventrad 45 degrees below the horizontal; the inferior appendages slightly less than one-half the length of the superiors. Posterior lobe of female prothorax in dorsal view with the hind margin produced into a pair of rearward-pointing, triangular peaks. Dist.: Central North New Guinea .... *simulatrix* Lieftinck
– Insect of brilliant coloration; the face bright canary-yellow, the antehumeral stripes bright leaf-green, the remainder of the body painted in deep electric-blue with velvet black sutures. Male superior anal appendages about equal in length to segment 10, in profile shaped rather like a boxing-glove, generally spherical with a downward- and rearward-projecting 'thumb'; the inferior appendages about one-half the length of the superiors. Posterior lobe of female prothorax in dorsal view with the hind margin produced into a pair of raised, smoothly rounded ridges. Dist.: Star Mountains (Tekin) .... *magnifica* Michalski

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References

Lieftinck, M. A., 1949. The dragonflies of New Guinea and neighbouring islands. Part VII. – Nova Guinea, new series 5: 133-139.

Lieftinck, M. A., 1957. Notes on some Argiine dragonflies with special reference to the genus *Palaiargia* Förster, and with descriptions of new species [and larval forms]. – Nova Guinea, new ser. (Vol. 8, Part 1): pp. 42.

Michalski, J., 1995. New Guinea Continued. – Argia 7(1): 12-17.

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UNTERSUCHUNGEN ZUR BIOAKUSTIK UND EVOLUTION DER GATTUNG *PLATYSTOLUS* BOLIVAR (ENSIFERA, TETTIGONIIDAE)

Pfau, H. K., 1996. Untersuchungen zur Bioakustik und Evolution der Gattung *Platystolus* Bolívar (Ensifera, Tettigoniidae). – Tijdschrift voor Entomologie 139: 33-72, figs. 1-22, tables 1-3. [ISSN 0040-7496]. Published 15 October 1996.

Bioacoustics and evolution of *Platystolus* Bolivar (Ensifera, Tettigoniidae).
The bioacoustics of *Platystolus* Bolívar, 1878 from the Iberian Peninsula is described and illustrated. The systematic status of different taxa is revised: *Callicrania* Bolívar, 1898 is placed in synonymy with *Platystolus*; the holotype of *P. selliger* is redescribed; *P. seoanei* is synonymized with *P. selliger*; *P. selliger meridionalis* subsp. n. is described; *P. lusitanicus* is raised to specific level and its neotype is designated. The phylogenetic trees of two subgenera, *Platystolus* ((((*P. martinezii* & *P. surcularius*) *P. obvius*) *P. ramburii*) *P. faberi*) and *Neocallicrania* subgen. n. ((((*P. serratus* & *P. lusitanicus*) *P. miegii*) *P. selliger*) *P. bolivarii*), are reconstructed (parentheses enclose different monophyla); presumably the subgenera represent sister groups.
Males and females in nearly all species of *Platystolus* communicate using an antiphony consisting of three parts: male initial song – female response ('Antwort') – male 'confirmatory response' ('Rückantwort'). Conclusions on the evolution of songs are drawn with regard to the phylogenetic tree. On the basis of its structure in *P. faberi* and *P. bolivarii*, the confirmatory response can be traced back to a second initial song verse, which was originally similar to the first verse, but has been strongly modified by reduction in most species. Only in *P. surcularius* the response is reduced, and the confirmatory response is lost.
Three different types of communication in Orthoptera are compared. The possible adaptive significance of the confirmatory response, and reasons for its reduction in *P. surcularius*, are discussed.
The geographic distribution of the species is documented and new locality records are added. The succession of dichotomic splittings in the cladogram indicates that the expansion of the genus started from the Cantabrian Mountains. *Platystolus* (*Neocallicrania*) expanded far southwards in the western part of the Iberian Peninsula, whereas in the East *Platystolus* (*Platystolus*) spread to the central parts of Spain.
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Key words. – Tettigoniidae, Ephippigerinae, *Platystolus*, *Callicrania*, bioacoustics, phylogeny, taxonomy, communication types, evolution, distribution new subspecies, new subgenus.

Die letzte zusammenfassende taxonomische Bearbeitung der Ephippigerinae der Iberischen Halbinsel (Peinado 1990) verzeichnet sieben Gattungen: *Baetica* Bolívar, 1903, *Callicrania* Bolívar, 1898, *Ephippiger* Berthold, 1827, *Ephippigerida* Bolívar, 1903, *Platystolus* Bolívar, 1878, *Steropleurus* Bolívar, 1878 und *Uromenus* Bolívar, 1878. Ihnen werden 45 Arten (das sind über 70% der bei Harz 1969 aufgeführten europäischen Sattelschrecken!) zugeordnet – mehr als die Hälfte der Arten sind für Spanien und Portugal endemisch.

Diese ungewöhnliche Vielfalt relativ großer, flugunfähiger Laubheuschrecken stellt den Biologen vor die Frage nach ihrer Evolution. Vergleichende Untersuchungen zur phylogenetischen Verwandtschaft der Gattungen und Arten (die ein notwendiges 'Grundgerüst' für ein evolutionsbiologisches Verständnis bildet) fehlen jedoch bis jetzt. Da auch die Stridulation, die bei der Klärung der Phylogenie oft hilfreich ist, nur für wenige Arten dokumentiert ist (siehe z.B. Hartley et al. 1974, Heller 1988, Pfau 1988, Robinson 1990, Hartley 1993), und die Biologie der meisten Arten überhaupt unbekannt ist, stellt die außergewöhnliche Radiation der Ephippigerinae auf der Iberischen Halbinsel bis heute eine offene, spannende Fragestellung dar.

In der vorliegenden Untersuchung werden die Gattungen *Platystolus* und *Callicrania* untersucht (wobei *Callicrania* als Synonym von *Platystolus* eingezogen wird; siehe 'Spezieller Teil', 'Bemerkungen zur

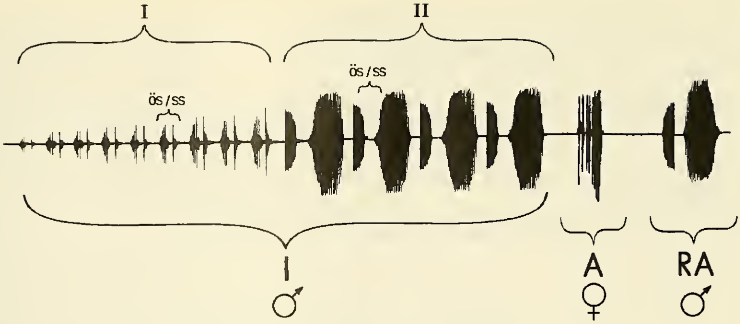


Abb. 1. Komponenten eines kompletten Initialgesang(I)-Antwort(A)-Rückantwort-(RA)-Duetts zwischen ♂ und ♀. Im Initialgesang sind die beiden Teile I und II sowie Öffnungssilben (ÖS) und Schließsilben (SS) gekennzeichnet.

Systematik'). Besonderes Augenmerk wird auf die Bioakustik der Arten, v.a. die Kommunikation zwischen Männchen und Weibchen, gerichtet. Es wird der Versuch unternommen, die phylogenetische Verwandtschaft durch Vergleich der morphologischen und bioakustischen Merkmale zu rekonstruieren und mit Hilfe der zur Zeit bekannten Verbreitungsmuster die Ausbreitungsgeschichte der Arten auf der Iberischen Halbinsel nachzuzeichnen.

Material und methode

Die vorliegenden Befunde sind das Ergebnis von neun 3- bis 6-wöchigen Reisen durch Spanien und Portugal, die zwischen 1981 und 1995 durchgeführt wurden.

Die Stimmen der Laubheuschrecken wurden mit einem Sennheiser Richtmikrofon (ME 80; maximale Aufnahmefrequenz 16 kHz) aufgenommen und entweder mit Hilfe eines Uher 4000 Report-Tonbandgeräts (Aufnahmegeschwindigkeit 19cm/sec) oder verschiedener DAT-Recorder (Sony TCD-D3, TCD-D7) gespeichert. Die Signale wurden digitalisiert (Atari Mega St4-Computer, in Kombination mit dem Multifunktions-Interface 'E-Labor Bipo' und der Oszilloskop-Software 'rho-Transient Plus' der Fa Rhothron; Abtastfrequenz 81.92 kHz), in einem Zeichenprogramm angeordnet und ausgedruckt.

Abgesehen von einzelnen Tonbandaufnahmen im Freiland (zu erkennen an '? °C' in den Abbildungen) saßen die Heuschrecken bei den Aufnahmen in Gazekäfigen (8.5 × 9 × 10cm). Da diese im Schatten standen, entspricht die gemessene Lufttemperatur der Körpertemperatur der Tiere – ein wesentlicher Tatbestand, da die Gesänge verschiedener Arten (und Unterarten) manchmal nur geringfügig unterschiedliche Silben-Längen und -Frequenzen aufweisen. Während der Reise wurden die Heuschrecken in einer Akku-betriebenen Kühlbox bei etwa 15 °C gehalten; die meisten Tiere lebten und sangen im Labor noch mehrere Wochen (bis zu 6 Monate) lang.

Die Männchen begannen in der Regel schon wenige Stunden nach dem Fang zu singen. Abhängig von Alter und Reifezustand der Tiere kam es jedoch oft erst nach vielen Tagen, manchmal erst nach bis 5 Wochen, zu kompletten Wechselgesängen zwischen Männchen und Weibchen (Abb. 1). Die Signale derartiger Duette wurden gleichzeitig, d.h. mit nur einem Mikrofon, erfaßt. Trotz der manchmal komplizierten Abfolgen von Stridulationen konnten die männlichen und weiblichen Anteile durch unterschiedliche Ausrichtung und Aussteuerung des Mikrofons (und zusätzlich, wenn möglich, durch direkte Beobachtung der Elytren) meist gut unterschieden werden; außerdem half die Impuls'struktur' der Silben.

Der 'normale' Gesang des Männchens wird hier als 'Initialgesang' bezeichnet, da er das Duett zwischen den beiden Geschlechtern einleitet, d.h. die Antwort des Weibchens 'initiiert'. Der ohne Anregung durch einen männlichen Initialgesang, seltener und ganz unregelmäßig erzeugte weibliche Gesang wird 'Spontangesang' genannt. Strukturell ist er von Antworten oft nicht zu unterscheiden. Beobachtungen an *P. obvius*, *P. miegii*, *P. selliger* und *P. martinezii* (zu *P. martinezii* vgl. auch Pfau & Schroeter 1988) im Freiland und Labor deuten darauf hin, daß der Spontangesang von begattungswilligen Weibchen von Zeit zu Zeit erzeugt wird und in der Nähe sitzende Männchen zu Initialgesängen anregt. Die akustische Reaktion des Weibchens auf den männlichen Initialgesang wird wie üblich als 'Antwort' bezeichnet, die anschließende männliche Reaktion als 'Rückantwort' (vgl. Pfau & Schroeter 1988). Die Männchen der meisten Arten – *P. obvius*, *P. faberi* und die *Neocallicrania*-Arten – neigten allerdings, meist erst nach längerer Einzelhaltung, dazu, dem Initialgesang auch ohne weibliche Antworten Rückantworten anzuhängen.

Die Homologisierung der Gesangssilben der verschiedenen Lautäußerungen wurde aufgrund ihres Kontextes (Gesangstyp, Duett-Teil, Versteil) vorgenommen und konnte z.T. durch weitere Kriterien (Öffnungs- oder Schließsilbe, 'Feinstruktur', d.h.

Impulsanordnung) gestützt werden. Eine Typisierung der Silben aufgrund ihrer Länge ('Makro-, Mikrosilben'; vgl. Heller 1988) erschien nicht sinnvoll, da lange Silben (etwa im Versteil II oder in der Rückantwort) leicht in kurze übergehen können und umgekehrt.

Die in der Beschreibung verwandten Bezeichnungen für die Dauer von Versen oder Silben sind relativ, d.h., sie beziehen sich vergleichend nur auf Stridulationen der hier behandelten Arten der Gattung *Platystolus*, die bei 21°C (± 1-2 °C) erzeugt wurden.

Im Fall der Verse bedeutet die Zeitkennzeichnung 'sehr kurz': unter 0.5 sec lang; 'kurz': 0.5 - 1.5 sec lang; 'mittellang': 1.5 - 2.5 sec lang; 'lang': 2.5 - 3.5 sec lang; 'sehr lang': über 3.5 sec lang.

Im Fall der Silben bedeutet die Zeitkennzeichnung 'sehr kurz': unter 0.05 sec lang; 'kurz': 0.05 - 0.1 sec lang; 'mittellang': 0.1 - 0.15 sec lang; 'lang': 0.15 - 0.2 sec lang; 'sehr lang': über 0.2 sec lang.

Die Fundorte der einzelnen Arten werden nur dann aufgeführt, wenn sie außerhalb des bisher bekannten Verbreitungsgebietes liegen oder aus anderen Gründen (Seltenheit der Art, fehlende neuere Funde, geographische Variabilität etc.) von Bedeutung sind. Da in den meisten Fällen nur wenige Fundorte bekannt sind, die auf den Reisen immer wieder aufgesucht wurden, sind Aussagen über die geographische Variationsbreite bis jetzt nur für einzelne Arten (etwa *P. selliger*, *P. faberi*) möglich.

SPEZIELLER TEIL

Bemerkungen zur Systematik

Ephippiger Ramburii Bolívar, 1878 wurde von Bolívar 1898 als Typusart der Gattung *Callicrania* festgelegt (siehe z.B. Peinado 1990). Da *Callicrania ramburii* ein wesentliches abgeleitetes Merkmal mit den Arten der Gattung *Platystolus* Bolívar, 1878 teilt – das breit und stärker kaudad vorgezogene Tergum X (siehe Abschnitt 'Phylogenie') –, muß die Art zu *Platystolus* gestellt und die Gattung *Callicrania* als Synonym von *Platystolus* eingezogen werden. Die restlichen Arten der ehemaligen Gattung *Callicrania* bilden anscheinend eine monophyletische Einheit; sie werden hier in einer eigenen Untergattung, *Neocallicrania*, zusammengefaßt.

Mit ähnlicher Bewertung der morphologischen Merkmale ordnete Harz (1969) die Art *Callicrania monticola* (Rambur, 1839), der mit *C. ramburii* synonymisiert wurde (Chopard 1951), der Gattung *Platystolus* zu, ohne allerdings die taxonomische Problematik aufzulösen. *C. monticola* wurde jedoch – aufgrund eines einmaligen Fundes einer männlichen Larve und eines Weibchens in der Gegend von Grenoble, Grande-Chartreuse (Frankreich) – nur sehr vage beschrieben und kann nicht sicher mit der nordspanischen, bis in die französischen Pyrenäen vordringenden Art *C. ramburii* synonymisiert werden (vgl. Peinado 1990). Durch einen Vergleich der weiblichen Subgenitalplatten wäre dieses Problem eventuell zu klären, da diese bei *C. ramburii* sehr charakteristisch ausgebildet ist. Da Rambur's (adultes?) *C. monticola*-Weibchen jedoch, entgegen verschiedenen Literaturangaben (Harz 1969, Peinado 1992), nicht im Muséum National d'Histoire Naturelle (Paris) vorhanden ist, und keinerlei Hinweise über seinen Verbleib auffindbar waren, schließe ich mich den Argumenten von Peinado an und behandle meine nordspanischen Funde als *Platystolus* (*Platystolus*) *ramburii*.

Peinado (1990) stellt sowohl *P. ramburii* als auch *P. obvius* zur Gattung *Callicrania*. Dieser Auffassung kann hier nicht gefolgt werden, da Cercusform und Tergum X-Ausbildung der Männchen beider Arten klar für eine Zugehörigkeit zu *Platystolus* sprechen (siehe Abschnitt 'Phylogenie'); auch im Hinblick auf die Form der männlichen Titillatoren weichen *P. ramburii* und *P. obvius* von den sehr einheitlichen Arten der Untergattung *Neocallicrania* ab. Die bei Peinado (1990) aufgeführten Übereinstimmungen mit '*Callicrania*' sind z.T. Symplesiomorphien, z.T. betreffen sie Merkmale, die nur schwer zu bewerten sind.

Callicrania miegi lusitanica (Aires & Menano, 1916) wird hier nicht als Unterart (vgl. Harz 1969, Peinado 1990), sondern als eigenständige Art, *Platystolus* (*Neocallicrania*) *lusitanicus*, betrachtet. Dafür sprechen 1) Synapomorphien, die *P. lusitanicus* nicht mit *P. miegii*, sondern mit *P. serratus*, einer eindeutig abgrenzbaren Art, teilt, 2) die voneinander abweichenden Initialgesänge und die unterschiedliche Tagesrhythmik von *P. lusitanicus* und *P. miegii* und 3) die Überschneidung der Verbreitungsareale östlich der Serra da Estrela in Portugal. Da Typusexemplare unbekannt sind (Peinado 1990), und auch eigene Nachforschungen erfolglos blieben, mußte für *P. lusitanicus* ein Neotypus designiert werden.

Der Holotypus von *Callicrania selligera* (Charpentier, 1825), der als verschollen galt (vgl. Harz 1969, Peinado 1990, 1992), konnte im Museum für Naturkunde (Berlin) aufgefunden werden. Ein Vergleich mit *C. seoanei* (Bolívar, 1877) ergibt, daß *C. seoanei* als Synonym von *C. selligera*, jetzt *Platystolus* (*Neocallicrania*) *selliger*, einzuziehen ist. Die Originalbeschreibung von Charpentier (1825) ist unzureichend, sie enthält z.B. keine Abbildungen. Verschiedene in der Literatur *C. selligera* zugeschriebene Abbildungen betreffen andererseits gar nicht diese Art: z.B. bildet Peinado (1990: Fig. 110) das bei Bolívar (1876: Lám. IV. fig. 8) dargestellte Pronotum von *Steropleurus andalusius* (Rambur, 1838) ab; Bolívar nahm jedoch 1907 die anfangs vermutete

Synonymie von *Uromenus* (*Steropleurus*) *andalusius* und '*Barbitistes selliger* Charpentier' wieder zurück. Wesentliche morphologische Details des Holotypus von *P.* (*N.*) *selliger* mußten daher hier neu beschrieben und abgebildet werden.

Harz (1969) grenzt *C. selligera* in seinem Bestimmungsschlüssel von anderen *Callicrania*-Arten (bis auf *C. bolivarii*; siehe unten) aufgrund eines am Hinterrand geraden Tergum X der Männchen ab. Bei *C. selligera* (incl. '*C. seoanei*'!) ist jedoch ebenfalls ein kaudaler Tergum X-Fortsatz vorhanden, der allerdings ein Gelenk zum Tergum X aufweist (und außerdem insgesamt geringer sklerotisiert ist). Da die Stellung der Cerci nach dem Tod zufällig ist, und der Tergum X-Fortsatz durch eine Einwärtsbewegung der großen Cercus-Innenzähne nach unten geklappt sein kann (siehe Abb. 13 a) oder nicht, ist das Merkmal 'gerader Tergum X-Hinterrand' in einem Bestimmungsschlüssel irreführend. Verschiedene in der Literatur als *C. selligera* beschriebene Funde wurden demnach nur 'zufällig' korrekt determiniert. Entsprechendes betrifft auch *P.* (*N.*) *bolivarii*, dessen Männchen ebenfalls einen Tergum X-Fortsatz besitzen, der (sekundär weitgehend membranös und enger mit dem Epiproct verwachsen) bei den meisten Exemplaren jedoch wenig auffällig ist: bei 'eingezogenem' Epiproct ist der Fortsatz nach unten umgeschlagen und fehlt dann nur scheinbar.

A. *Platystolus* (*Platystolus*) **Bolívar, 1878**

Diese Untergattung umfaßt die Vertreter der bisherigen Gattung *Platystolus* Bolívar, 1878 unter Hinzunahme von *P. ramburii*. Typusart der Gattung und damit der Untergattung ist *P. surcularius* (Bolívar, 1877). Die charakterisierenden Merkmale der Gruppe entsprechen weitgehend denen der bisherigen Gattung *Platystolus* (siehe z.B. Harz 1969), ergänzt durch zwei Präzisierungen (vgl. Abb. 19 f-k): 1) männliches Tergum X auf größerer Breite zweizipflig stärker nach kaudal vorgezogen (die Zipfel können sekundär verschmolzen sein); 2) männliche Cerci ungefähr in der Mitte oder subapikal bezahnt.

Platystolus (Platystolus) martinezii **(Bolívar, 1873)** (Abb. 2)

Ephippigera Martinezii Bolívar, 1873: 222.

Bioakustik. – Der Initialgesangsvers der Männchen ist lang bis sehr lang (Abb. 2 a; Übersichtsbild b). Er besteht aus zahlreichen sehr kurzen Schließsilben, die gegen Versende zunehmend dichter stehen. Öffnungssilben sind höchstens am Versanfang zu erkennen (a). Die ersten Silben sind leiser; nach wenigen Silben wird die volle Lautstärke erreicht. Die letzte Silbe ist oft etwas verlängert (b).

Die sehr kurze Antwort-Schließsilbe des Weibchens – manchmal wurden auch 2 oder 3 Silben erzeugt, seltener bis 5 – entspricht in ihrer Länge ungefähr der letzten (verlängerten) Silbe des männlichen Initialgesangs (b); sie zeigt einen unregelmäßigen Impulsaufbau, d.h. sowohl dichtere als auch lückigere Abschnitte (a-c).

Die Rückantwort des Männchens besteht aus mehreren (1 bis 7, meist 2 bis 4) kurzen Schließsilben, die länger (bis fast doppelt so lang) sind wie die weibliche Antwort-Silbe. Die Impulsdichte ist in den Rückantwort-Silben in der Regel deutlich geringer als in den Silben des Initialgesanges (b).

Die Männchen können auch durch Spontangesänge der Weibchen, die in diesem Fall einzelne Ge-

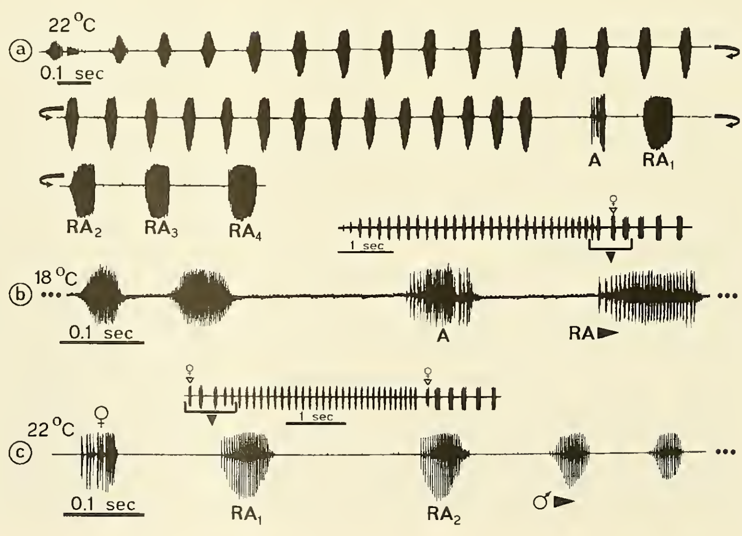
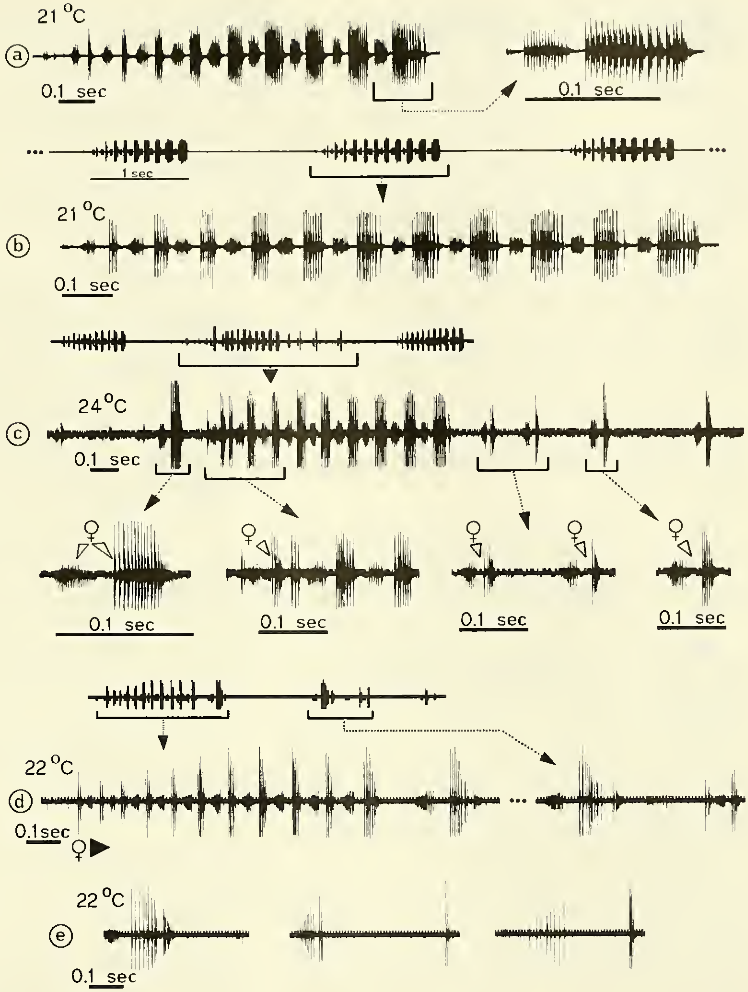


Abb. 2. *Platystolus martinezii*. Abkürzungen und Zeichen in den Abb. 2-7, 9, 12, 14-16 und 20: A Antwort; RA Rückantwort; ÖS Öffnungssilbe; SS Schließsilbe. Pfeile an den Zeilen-Enden und (folgenden) -Anfängen weisen auf zusammenhängende Lautäußerungen hin; überbrückte Pausen oder fehlende Gesangsteile werden durch Punkte gekennzeichnet. Einzelne Silben (oder manchmal auch Verse) wurden mit Zahlen-Indices versehen (z.B. A3, RA1), um im Text auf sie Bezug nehmen zu können (sie bilden jedoch für sich meistens keine vollständige Antwort oder Rückantwort). ? °C kennzeichnet Freilandaufnahmen.

Abb. 3. *Platystolus surcularius.* Abkürzungen siehe Abb. 2.



sangssilben darstellten, zur Rückantwort angeregt werden (c). Sie singen nach der Rückantwort meist sofort einen normalen Gesangsvers, dem dann eine ('reguläre') weibliche Antwort und erneut männliche Rückantworten folgen können (Übersichtsbild c).

Material. – 14.vi.1987, Trujillo (Provinz Caceres), 400m. Weitere Angaben siehe Pfau & Schroeter (1988). 25.vii.1991, La Garganta (südlich Bejar, Provinz Caceres, Sierra de Gredos), 1100m. Die Art wurde hier – im Gegensatz zum Fundort Trujillo – an Waldrändern und auf verbuschten Lichtungen aufgefunden.

Platystolus (Platystolus) surcularius (Bolívar, 1877) (Abb. 3)

Ephippiger surcularius Bolívar, 1877: 268.

Bemerkungen. – Im Juli 1991 wurden die Männchen vor allem im Innern von kugeligen Polsterpflanzen (*Centaurea* sp.) am Straßenrand gefunden. An den besonders heißen Tagen dieses Monats begann die Art erst bei niedereren Temperaturen am Abend, in einem Fall sofort nach einem lokalen Regen, zu singen. Die Hauptgesangsaktivität lag, auch in Gefangenschaft, in der Nacht; morgens waren im Gelände, so lange die Temperaturen noch niedrig waren, nur einzelne Männchen mit relativ kurzen Versserien zu hören. Nach dem trockenen Frühjahr und Sommer dieses Jahres waren die Männchen fast durchweg gelbbraun gefärbt; Weibchen waren nicht aufzufinden.

Mitte Juni 1992 waren am selben Ort nur Larven und einzelne frisch geschlüpfte Imagines zu finden. In den Getreidefeldern des Fundgebietes sang zu dieser Zeit *Pycnogaster graellsi* Bolívar, 1873. Erst gegen

Tabelle 1. Daten zur Kopulation im Labor.

Art	*Platyst. surcularius*	*Platyst. ramburii*	*P. faberi demandae*	*Platyst. miegii*	*P. selliger selliger*	*P. selliger meridionalis*	*Steropl.* aff. *stali*
Dauer in Minuten	6 (25 °C) 10 (22 °C)	75 (22 °C) 80 (22 °C)	40 (24 °C)	110 (22 °C)	65 (23 °C) 50 (25 °C)	40 (21 °C) 50 (23 °C)	20 (27 °C)
Kopulationsgesang ♂	+	–	–	+ *)	+	+	–

*) Das ♂ stridulierte während der Spermatophorenabgabe oder dann, wenn das ♀ Anstalten machte, sich von ihm zu trennen (dies geschah bei mehreren vergeblichen Paarungsversuchen).

Ende Juni fanden sich zahlreiche männliche Imagines auf verschiedenen Pflanzen am Straßenrand und auch im Getreide. Zwei Weibchen waren in den Blattachseln niedriger Cruciferen versteckt. Die Tiere dieses feuchteren Jahres waren grün bis olivgrün (Männchen) oder dunkelbraun (Weibchen). Beim Gesang der Männchen ist auffällig, daß synchron mit dem Vers-Rhythmus kräftige abdominale Atembewegungen stattfinden.

Bioakustik. – Das Männchen singt kurze Verse aus anfangs crescendierenden und länger werdenden sehr kurzen bis kurzen Schließsilben, zwischen welchen leisere Öffnungssilben deutlich sind (Abb. 3 a, b); die letzte Silbe ist gegenüber der vorletzten meist sprunghaft verlängert und kann als Rest des Teils II eines ursprünglich zweiteiligen Initialgesanges interpretiert werden (siehe Abschnitt 'Phylogenie'). Intensiv stridulierende Männchen reihen die Verse minutenlang mit gleichlangen Versabständen (Übersichtsbild b). Standen die Käfige zweier Männchen im selben Raum, respondierten die Tiere oft stundenlang ohne Unterbrechung, wobei die Einzelverse alternierten und so eine pausenlose Reihe bildeten.

Im Fall der Weibchen waren unterschiedliche Stridulationen zu vernehmen. In Abb. 3 c) sang ein Weibchen eine unregelmäßige Serie sehr kurzer Öffnungs- und Schließsilben in den Gesang eines Männchens hinein; die Serie begann bereits vor einem männlichen Vers und wurde nach dem Vers mit größer werdenden Silbenabständen fortgesetzt. Das Übersichtsbild zeigt, daß die Versabfolge des Männchens in diesem Fall etwas gestört wurde – das Intervall zum nächsten Vers ist verlängert. Meistens erzeugten die Weibchen jedoch Spontangesänge ohne Anregung durch einen männlichen Gesang. Diese stellten kurze bis mittellange Silbenserien dar, in denen die zunächst sehr kurzen Schließsilben schnell lauter und gegen Ende auch länger wurden (d); danach konnten noch weitere, unterschiedlich lange Silben in unregelmäßigen Abständen angefügt werden (die Zeitabstände einer gesamten Lautäußerung gehen aus dem Übersichtsbild d hervor).

Bei Verpaarungsversuchen im Labor verfolgten die (vorher eine längere Zeit isoliert gehaltenen) Weibchen die Männchen geradezu und sangen dabei einzelne Verse (vergleichbar dem ersten Abschnitt von d, nur meist länger). Manchmal wurden mehrere dieser Stridulationen in schneller Folge aneinandergereiht.

Während der auffallend kurzen Kopulation (siehe Tabelle 1) waren einzelne sehr kurze bis mittellange Silben zu hören (e); sie wurden vom Männchen vor allem während der Spermatophoren-Abgabe erzeugt. Derartige Kopulationsgesänge der Männchen haben anscheinend die Funktion, die Weibchen 'akustisch zu beschwichtigen', um eine vorzeitige Trennung der Kopula zu verhindern (vgl. auch Bailey 1991).

Bei Gefahr (z. B. beim Ergreifen) erzeugen beiden Geschlechter - ähnlich wie auch die anderen Arten von *Platystolus* (siehe z.B. Abb. 12 h: *P. miegii*; Abb. 15 l, m: *P. selliger*) – eine kurze 'Abschreck-Stridulation'. Solche scharfklingenden Verse sind nicht selten auch dann zu hören, wenn ein Tier ohne äußere Einwirkung zu Boden fällt und darüber 'erschrickt'.

Material. – 20.vii.1991, 15.vi.1992 und 29.vi.1992, östlich El Romeral (südöstlich Aranjuez, Provinz Toledo), 700m.

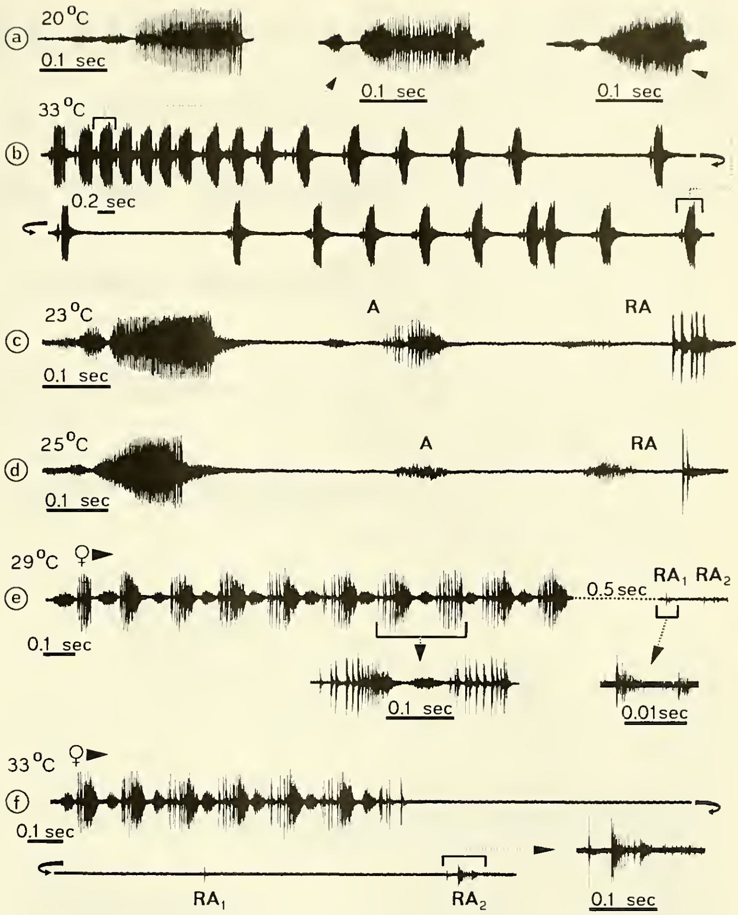
Platystolus (Platystolus) obvius (Navas, 1904) (Abb. 4)

Synephippius obvius Navas, 1904: 196, 198.

Bioakustik. – Der Gesang des Männchens besteht aus einzelnen langen bis sehr langen Schließsilben (Abb. 4 a, c, d), zwischen denen meist längere Pausen (5 bis 20 Sekunden und mehr) liegen. Morgens pflegten einzelne Männchen im Labor diese Silben minutenlang dichter zu reihen, d.h. mit kürzeren, nur 0.5 bis 1 Sekunde langen Pausen zu singen; in anderen Fällen waren längere Serien das Ergebnis einer wechselseitigen Anregung zweier Männchen (Respondieren). Die viel leisere Öffnungssilbe kann zweiteilig sein (a, c).

In Einzelfällen (bisher vor allem bei hohen Temperaturen beobachtet, siehe auch weiter unten) wurden die Silben zu über 10 Sekunden langen 'Versen' gereiht; diese zeigten zunächst eine hohe Silbenfrequenz, die danach abnehmen und unregelmäßig werden konnte (b). Der Impulsaufbau in den Silben variierte manchmal stärker – innerhalb der Silben wechselten z.B. dichtere und weniger dichte Abschnitte ab (siehe etwa die 3. Schließsilbe in b).

Abb. 4. *Platystolus obvius.* Abkürzungen siehe Abb. 2.



Längere Stridulationen dieser Art konnten bisher nur im Labor aufgenommen werden - sie entsprechen aber einigen im Freiland (nachmittags, an heißen Tagen) vernommenen Gesängen.

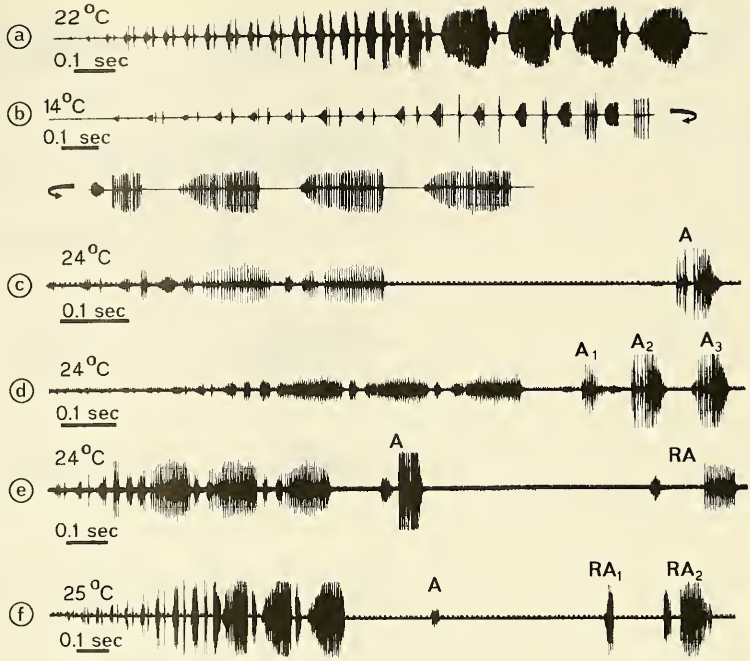
Das Weibchen antwortet auf den 'normalen' männlichen Initialgesang (der aus einer Öffnungs- und Schließsilbe besteht) mit einer mittellangen Schließsilbe, der eine sehr kurze, leise Öffnungssilbe vorausgeht (c). Die Impulsstruktur der Schließsilbe ist im Anfangsteil unregelmäßig und lückig; danach stehen die Impulse dichter. Diese (wie bei den anderen Arten von *Platystolus* vorhandenen) Unregelmäßigkeiten in der Impulsstruktur rühren daher, daß beim weiblichen Stridulationssystem die Zähnchenabstände der auf der Oberseite der rechten Elytre liegenden Feilen relativ unregelmäßig sind; da mehrere Feilenreihen vorhanden sind, die vom Plectrum gleichzeitig überstrichen werden (vgl. Pfau & Schroeter 1988), ist die Stridulation der Weibchen außerdem 'mehr-stimmig'.

Abb. 4 c) und d) zeigen typische Initialgesang-Antwort-Rückantwort-Sequenzen (wobei das Mikrofon in d vom Weibchen weggerichtet war). Die Schließsilbe der männlichen Rückantwort, die meistens deutlich leiser ist als die Schließsilbe des Initialgesanges, ist sehr kurz bis kurz und beginnt mit lauteren, unregelmäßig stehenden und zum Teil weit auseinanderliegenden Impulsen. Vor der Schließsilbe der Rückantwort tritt oft eine leisere Öffnungssilbe in relativ großem Zeitabstand auf (c, d).

In manchen Fällen ließen Männchen nach der Antwort des Weibchens und der eigenen Rückantwort eine schnelle Silbenserie folgen (vergleichbar b; siehe oben). Dies deutet darauf hin, daß versartige Silbenreihungen Ausdruck einer stärkeren Erregung der Männchen sind.

Die Spontangesänge der Weibchen stellen Silben-Serien dar, die von Anfang an laut sind (e). In ihnen können die ersten Schließsilben verkürzt sein; die weiteren Schließsilben sind mittellang. Die Silben

Abb. 5. *Platystolus ramburii.* Abkürzungen siehe Abb. 2.



zeigen meist eine ähnliche Impulsstruktur wie typische einzelne Antwortsilben (vgl. e und c). Auch durch diese weiblichen Spontangesänge, die deutlich leiser sind als die Initialgesänge der Männchen, wurden Männchen im Labor oft zu Rückantworten angeregt (e, f); auf die Rückantwort folgten dann meist normale, d.h. aus einem einzigen Silbenpaar bestehende Initialgesänge der Männchen.

Bei Störung (oder auch 'Erschrecken'; vgl. *P. surcularius*) erzeugen Männchen wie Weibchen eine Abschreck-Stridulation, die aus einer schnellen Serie von 5-10 Silben besteht (nicht abgebildet).

Material. – 18.viii.1990, Benasque (Provinz Huesca), 1700m. Die Gesänge waren am Tag und in der Nacht zu hören, bei heißem Wetter vor allem abends und nachts.

Platystolus (Platystolus) ramburii **(Bolívar, 1878) comb. nov.**
(Abb. 5)

Ephippiger Ramburii Bolívar, 1878: 443, 449.

Bemerkungen. – Die Art fand sich auf Farn- und Ginster-verbuschten Waldlichtungen. Gesangsaktivitäten waren am ganzen Tag und in der ganzen Nacht (sogar bei nur 9 °C) zu registrieren. In dichten Freilandbeständen war auffällig, daß sich die im Gelände verteilten Männchen zu 'im Kreis herumgehenden' Gesängen anregen konnten: fing irgendwo ein Männchen an zu singen, sangen in seiner (einige Sekunden langen) Pause mehrere weitere Männchen nacheinander, bis das erste Männchen wieder 'an die Reihe kam'. Von Zeit zu Zeit wurde minutenlang geschwiegen. Auffallend war die manchmal Stabheuschrecken-artige Fortbewegung: nach jeder Schrittphase blieben die Tiere stehen und versetzten den Körper in eine schaukelnde Bewegung. Zur Kopulation vgl. Tabelle 1.

Bioakustik. – Die kurzen (bis mittellangen) Initialgesänge des Männchens weisen im Teil I des Verses meist ein ausgeprägtes Crescendo mit sehr kurzen Öffnungs- und Schließsilben auf (Abb. 5 a). Die Schließsilben werden erst relativ spät, in einem Übergangsabschnitt zum Teil II, länger. Auf diese längeren Silben folgen im Teil II wenige (2-5, meistens 3) mittellange, laute Schließsilben. Auch im Versabschnitt II sind in der Regel sehr kurze Öffnungssilben vorhanden. Sie können jedoch fehlen; solche Gesänge klingen – v.a. bei niederen Temperaturen, bei welchen die Teil II-Schließsilben besonders lang ausfallen (b) – den Gesängen von *P. selliger* zum Verwechseln ähnlich.

Die Antwort des Weibchens kann aus einer einzelnen, kurzen Schließsilbe bestehen, der eine sehr leise, kürzere Öffnungssilbe vorausgeht (c, e). In anderen Fällen wurde vom Weibchen eine crescendierende, sehr kurze Silben-Serie (2-4 Schließsilben) als Antwort erzeugt (d). Die Impulsstruktur der Schließsilben der Antwort ist im Anfangssteil meistens typisch, d.h. auffällig lückig.

Die Pause zwischen dem männlichen Gesangsvers und der weiblichen Antwort fiel sehr unterschiedlich lang aus (c, d). Der Grund dafür könnte darin liegen, daß einzelne Männchen die Anzahl der Teil II-Silben im Initialgesang variierten. Sang ein Männchen z.B. nach einer Serie von Gesängen mit drei Teil II-Silben (d-f) auf einmal nur zwei dieser langen Silben (c), fiel die Pause deutlich länger aus: das Weibchen hatte sich anscheinend auf drei Teil II-Silben 'eingestellt'.

Die Rückantwort des Männchens besteht in der Regel aus einer einzelnen, kurzen bis mittellangen Schließsilbe (e), die relativ laut ist, nur wenig leiser als die letzten Teil II-Silben des Initialgesangs. Ihr geht eine leisere Öffnungssilbe voraus. Strukturell entspricht die Rückantwort-Doppelsilbe den Silbenpaaren des männlichen Initialgesangsteils II. Vor der Doppelsilbe kann noch eine sehr kurze Einzelsilbe stehen (f); seltener repräsentiert diese die Rückantwort allein. Bemerkenswert ist bei den bisherigen Aufnahmen das lange Zeitintervall zwischen weiblicher Antwort und männlicher Rückantwort.

Material. – 17.ix.1984, Abaurrea Alta (östlich Pamplona, Provinz Navarra), 1000m. 04.ix.1986, Burguete (nordöstlich Pamplona, Provinz Navarra), 800m.

Platystolus (Platystolus) faberi faberi Harz, 1975 & *Platystolus (Platystolus) faberi demandae* Schroeter & Pfau, 1987
(Abb. 6)

Platystolus faberi Harz, 1975: 17.
Platystolus faberi demandae Schroeter & Pfau, 1987: 46.

Bemerkungen. – Die Gebirgsart bevorzugt anscheinend die Nähe von Feuchtstellen. Die Gesänge waren im Freiland am Tag und in der Nacht zu hören, auch noch bei niedrigen Temperaturen (10 °C). Die Grundfarbe der Männchen und Weibchen war grün, oliv oder grau-grün; am 15.viii.1991 wurden am Collado de Aralla (Provinz Leon) auch einzelne tief weinrot gefärbte Exemplare von *P. faberi faberi* gefunden. Zur Kopulation vgl. Tabelle 1.

Bedauerlicherweise fehlt in der Beschreibung von

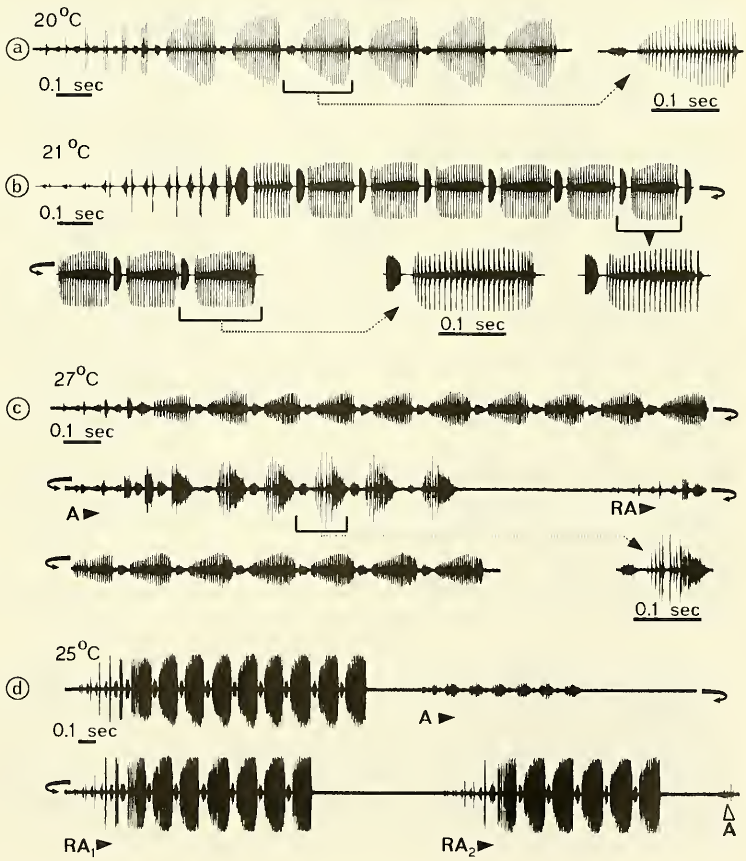


Abb. 6. *Platystolus faberi*. Abkürzungen siehe Abb. 2.

Platystolus faberi demandae (Schroeter & Pfau 1987) die Angabe für den Hinterlegungsort der Typusexemplare. Dies soll an dieser Stelle nachgeholt werden: Der männliche Holotypus sowie ein weiblicher Paratypus wurden im Hessischen Landesmuseum (Darmstadt) hinterlegt; weitere Paratypen befinden sich in der Privatsammlung Pfau.

Bioakustik. – Im relativ kurzen Teil I des männlichen Gesangsverses werden die sehr kurzen Schließsilben nur geringfügig länger, jedoch schnell lauter (Abb. 6 a, b). Bei *P. faberi faberi* folgen im Teil II dann 4-8 (selten bis 12) laute, abrupt stark verlängerte Schließsilben – der Gesamtvers ist kurz bis mittellang (a). Bei *P. faberi demandae* sind die Verse dagegen infolge der höheren Silben-Anzahl im Teil II (9-15 Silben) mittellang bis lang (b). Die erste Teil II-Silbe kann etwas verkürzt sein, die letzte ist manchmal verlängert (b). Den Schließsilben gehen leisere, sehr kurze Öffnungssilben voraus.

Die Impulsstruktur ist in den mittellangen bis langen Schließsilben des Teils II sehr gleichmäßig (a, b). Vor allem bei tieferen Temperaturen, am Morgen oder Abend, ist die Art im Gelände aufgrund dieser 'sägenden', im Vergleich zu anderen Arten besonders lauten Silben des Teils II gut zu erkennen.

Die Weibchen erzeugten 3-4 Sekunden lange, schnelle Spontangesänge (nicht dargestellt). Kurz nach der letzten Silbe des männlichen Initialgesangs antworteten einzelne Weibchen mit einer nur 2-3 Öffnungs- und Schließsilben langen Silbenserie; in anderen Fällen wurden längere Serien von bis über 10 Silbenpaaren erzeugt, die aus sehr kurzen, leisen Öffnungssilben und typisch-strukturierten (d.h. anfangs lückigen), kurzen bis mittellangen Schließsilben bestanden (c; *P. faberi faberi*). Sofort danach folgende männliche Stridulationen – ein Vers in c), zwei in d) – können als Rückantworten interpretiert werden. Auffällig ist, daß diese Rückantwortverse gegenüber dem Initialgesangsvers verkürzt sind (c); wird ein zweiter Vers gesungen, so ist er noch kürzer (d). In Abb. 6 d) wurde das Weibchen nach der zweiten Rückantwort des Männchens (RA2) zu einer erneuten, sehr stark verkürzten Antwort angeregt. Bei dieser Aufnahme saß das Weibchen gleichweit wie das Männchen vom Mikrofon entfernt, so daß hier das Verhältnis der Lautstärken zum Ausdruck kommt: der Unterschied der Signale beträgt (für Aufnahmen bis 16 kHz Grenzfrequenz) mindestens 10 dB.

Die große Ähnlichkeit von Initialgesang und Rückantwort bei *P. faberi*, einer relativ ursprünglichen Art, deutet darauf hin, daß die Rückantwort aus einem zweiten, nach der Antwort des Weibchens gesungenen Initialgesang hervorgegangen ist (siehe auch Abschnitte 'Phylogenie' und 'Funktion und Evolution der Rückantwort').

Anscheinend gibt es weder für das Weibchen noch für das Männchen akustische 'Marker', die anzeigen, wann das Ende des männlichen Initialgesangsverses, bzw. das Ende der weiblichen Antwort, erreicht ist. So kam es bei den Duetten immer wieder zu Überlappungen zwischen Initialgesang und Antwort bzw. Antwort und Rückantwort. In einigen Fällen war zu beobachten, daß nicht nur das Männchen, das den Initialgesangsvers erzeugt hatte, die Antwort des Weibchens mit einer Rückantwort 'bestätigte', sondern daß sich ein anderes Männchen mit einem Gesangsvers, der von vornherein bereits relativ kurz war und daher als Rückantwort interpretiert werden kann, einmischte.

Manche Männchen sangen nach längerer Haltung auch ohne Anwesenheit von Weibchen Serien von 2-3 Versen (später selten sogar bis zu 10 Versen), die nur durch kurze Pausen getrennt waren. Andere, meist sehr viel längere Vers-Serien waren dagegen das Ergebnis eines Respondier-Verhaltens zweier Männchen.

Material. – Fundorte für beide Unterarten und weitere Angaben vgl. Schroeter & Pfau (1987).

B. ***Platystolus (Neocallicrania)*** **subgen. nov.**

Typusart. – *P. selliger* (Charpentier, 1825). Die charakterisierenden Merkmale der Untergattung entsprechen weitgehend denen der bisherigen Gattung *Callicrania* (siehe z.B. Harz 1969), ergänzt durch zwei Merkmale: 1) männliches Tergum X kaudal mit relativ schmalem und kurzem Vorsprung, der fest angewachsen ist oder in einem Gelenk nach unten umgeklappt werden kann (vgl. Abb. 19 b-e); 2) Titillatoren charakteristisch (siehe Abb. bei Harz 1969).

Tabelle 2. Vergleich der Körpermaße (in mm) der ♂ von *P. serratus*, *P. lusitanicus* und *P. miegii*.

	Körper*)	Pronotum-länge (a)**)	Pronotum-breite (b)	b/a	Postfemur	Posttibia
P. serratus (Sagres) 5♂	34.5-38.5	8.3- 9.0	8.5- 9.4	1.0-1.1	18.3-20.0	19.7-22.0
P. serratus (Milfontes) 3♂	34.0-37.5	8.3- 9.6	10.3-12.2	1.2-1.3	19.2-20.7	20.8-24.3
P. lusitanicus (Aviz, Fundao, Sevilla) 3♂	37.0-40.2	7.7-10.3	8.6-10.6	1.0-1.1	19.8-23.3	21.3-25.3
P. miegii (Bejar) 7♂	41.0-47.5	10.8-12.0	8.5- 9.6	0.7-0.8	22.2-25.0	24.6-27.6

*) Tiere Alkohol-konserviert
**) In der Mitte gemessen

Diese Untergattung umfaßt die Vertreter der bisherigen Gattung *Callicrania* Bolívar, 1898, mit Ausnahme von *P.* (*P.*) *ramburii. P. lusitanicus* (bisher *Callicrania miegi lusitanica*) erhält Artstatus; *Callicrania seoanei* wurde als Synonym von *P. selliger* eingezogen.

Platystolus (Neocallicrania) serratus **(Bolívar, 1885) comb. nov.**
(Abb. 7, 8, 10, 11)

Ephippigera serrata Bolívar, 1885: 117.

Morphologie. – Maße der Männchen (im Vergleich mit *P. lusitanicus* und *P. miegii*) siehe Tabelle 2. Die Tiere von Sagres zeigten ein geringer seitlich eingekerbtes (weniger 'stachliges') Pronotum und standen in dieser Hinsicht zwischen *P. lusitanicus* (Abb. 10 a) und weiter nördlich (bei Milfontes und Melides) vorkommenden *P. serratus* (Abb. 10 e). Auch im Hinblick auf die Pronotum-Form (d.h. das Verhältnis Pronotum-Breite/-Länge; siehe Tabelle 2), die Dicke des Pronotum-Kaudalrandes und den Querschnitt des Pronotums (genauer die Konkavität der Paranota = Lateralausdehnung der Ober- und Unterkanten des Pronotum im Querschnitt) vermitteln die Tiere von Sagres zwischen *P. lusitanicus* und

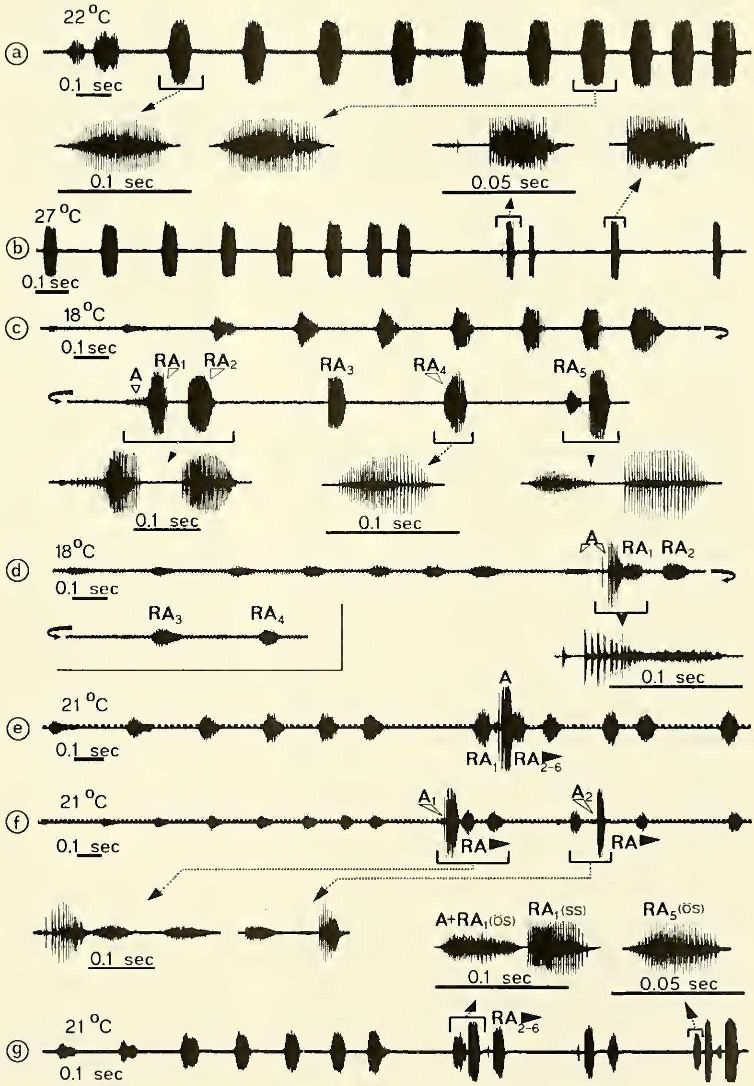


Abb. 7. *Platystolus serratus.* Abkürzungen siehe Abb. 2.

nördlichen *P. serratus*; die Ausprägung der Merkmale liegt also zwischen Abb. 10 a,b und e,f. In anderen Merkmalen (auch im Gesang; siehe weiter unten) stimmen die südlichen und nördlichen *P. serratus* dagegen überein: 1) die Seitenkiele des Pronotum biegen im vorderen Drittel steil nach unten ab und erlöschen ohne die Unterkante der Paranota zu erreichen (Abb. 10 g); 2) der Fortsatz des Tergum X der Männchen ist distal tief eingekerbt, der Epiproct charakteristisch ausgebildet (Abb. 10 h; siehe auch Beschreibung des Merkmals 13 in Abb. 18); 3) die Cerci sind verglichen mit *P. lusitanicus* und *P. miegii* etwas weiter distal bezahnt, der Spitzenbereich ist relativ kürzer (vgl. Abb. 10 h mit d).

Verschiedene gemeinsame Merkmale von *P. lusitanicus* und *P. serratus* stellen wohl Synapomorphien dar, die innerhalb von *P. serratus*, bei den nördlichen Populationen (Milfontes, Melides), weiterentwickelt wurden (siehe oben, Abschnitt 'Phylogenie' und Abb. 18: Merkmal 12 part.). Möglicherweise stellt der Rio Mira die Grenze zwischen den beiden unterschiedlichen *P. serratus*-Formen dar.

Zur Zähnchendichte der Feile des männlichen Singapparates vgl. Abb. 8.

Die Färbung eines Männchens von Sagres wird bei Schroeter & Pfau (1987) beschrieben. Die Tiere von Milfontes und Melides waren dagegen auf dem Pronotum und den abdominalen Terga auf dunkelgrünem bis schwärzlichem Untergrund weiß oder hellgelb getupft; sehr auffällig war bei ihnen die weiße abdominale Flankenhaut.

Bemerkungen. – Im Freiland (bei Milfontes) konnte beobachtet werden, daß die Männchen und Weibchen komplette Wechselgesänge sowohl bei größerem Abstand voneinander (ca 5 m) als auch bei sehr geringer Distanz (ca 10 cm) erzeugten.

Bioakustik. – Die Initialgesänge der Männchen von Sagres und Milfontes zeigten keine nennenswerten Unterschiede. Die Pausen zwischen den Gesängen waren im Freiland meist beträchtlich (ca 5 bis 15 Minuten!); in Gefangenschaft sangen einzelne Tiere dagegen auch längere Vers-Serien, mit Pausen von nur ca 0.5 Sekunden Länge zwischen den einzelnen Versen.

Der Gesang der Männchen ist leise (deutlich leiser als der von *P. miegii*) und klingt infolge einer sukzessiven Verkürzung der Silbenpausen, die meist schon nach der ersten Silbe beginnt, rhythmisch (vgl. Abb. 11). Die Silben sind kürzer als bei *P. lusitanicus* und *P. miegii*; bei gleicher Temperatur und Silbenzahl sind die Verse demzufolge beträchtlich kürzer als bei diesen beiden Arten (zur geographischen Variabilität von *P. lusitanicus* siehe Text zu dieser Art).

In den kurzen bis mittellangen Initialgesängen erreichen die (6-12, meist 7 oder 8) kurzen Schließsilben in der Regel schnell ihre volle Lautstärke (Abb. 7 a; Ausnahmen: c, g). Die Abstände der Impulse in den Silben sind entweder relativ konstant, oder sie werden im letzten Drittel der Silben vergrößert; letzteres betrifft vor allem die Silben ab der Vers-Mitte. Öffnungssilben fehlen oder sind höchstens ganz am Versanfang zu vermuten.

Die Antwort des Weibchens auf den Initialgesang besteht meist aus einer einzelnen sehr kurzen bis kurzen Schließsilbe, der eine leise Öffnungssilbe vorausgeht (d). Sie liegt zwar in der Regel zwischen dem männlichen Gesangsvers und der Rückantwort, kann aber auch verspätet erst innerhalb des Rückantwort-Teils erfolgen (e); im Fall der Abb. 7 e) wurde vom Männchen kurz nach der Antwort sofort ein Paar von Rückantwortsilben erzeugt, gewissermaßen also ein Neu-Beginn der Rückantwort vorgenommen (vgl. auch weiter unten). Manchmal sang das Weibchen zwei Antwort-Silben in größerem Abstand, so daß Antwort und Rückantwort 'überlappten' (f). Die weiblichen Schließsilben sind im Anfangsteil durch lückig stehende, mehr oder weniger unregelmäßige Impulse gekennzeichnet (d - f).

Die sehr kurzen bis kurzen Schließsilben der Rückantwort sind kürzer oder ähnlich lang wie die Silben des Initialgesangs (b, c); auch in ihnen nimmt die Impuls-Dichte im letzten Drittel meist deutlich ab. Abb. 7 g) zeigt, daß die Rückantwort lauter ausfallen kann als der Initialgesang.

Zu Beginn der Rückantwort wurde oft ein enger stehendes Schließsilben-Paar erzeugt, dem in größerem Abstand weitere, einzeln stehende Schließsilben folgten (b - d, f). Den Schließsilben können – gut sichtbar meist bei der letzten Rückantwort-Silbe – Öffnungssilben vorausgehen (siehe z.B. RA5 in c). Statt einzeln stehender Silben können an das erste Schließsilben-Paar auch weitere Paare angefügt werden, z.T. mit gut hörbaren Öffnungssilben (e, g).

Bei einzelnen Männchen war die Variabilität des Gesanges erstaunlich groß. Vor allem schwankte die Anzahl der Rückantwort-Silben, die nach längerer Gefangenschaft auch ohne Anwesenheit eines

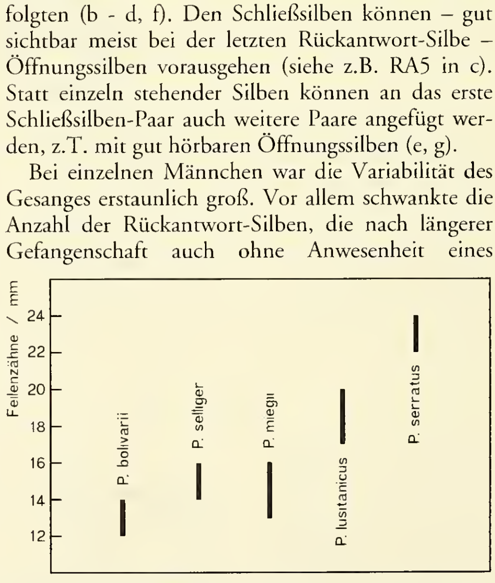


Abb. 8. Zähnchendichte der Feile des ♂ Singapparates bei den Arten von *Platystolus* (*Neocallicrania*). Die Zähne wurden (bei jeweils 3 ♂) in der Feilenmitte gezählt.

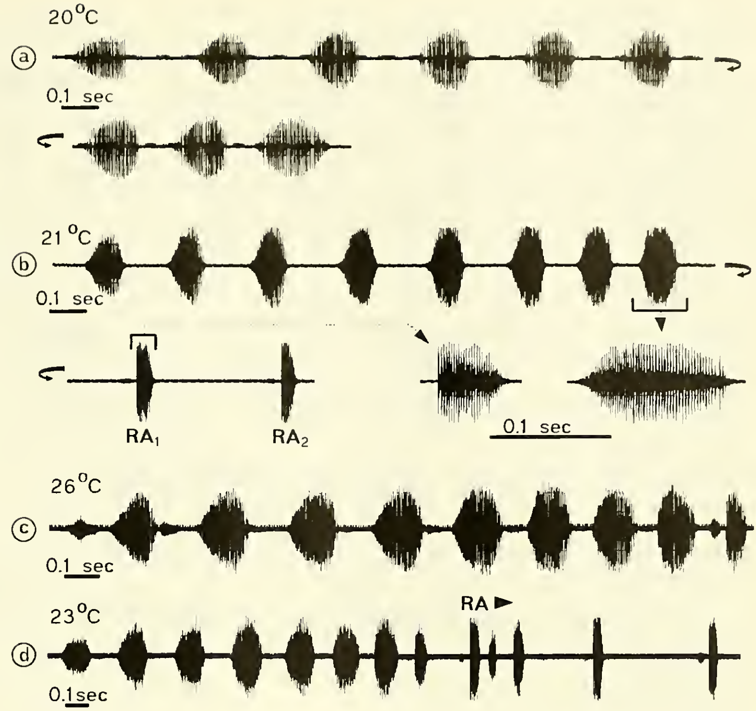


Abb. 9. *Platystolus lusitanicus.* Abkürzungen siehe Abb. 2.

Weibchens dem Initialgesang angefügt wurden, von Vers zu Vers stark (zwischen 0 und 7 Silben); bei Fehlen von Rückantworten waren nach dem Initialgesang manchmal auch stumme Elytrenbewegungen zu beobachten (Alterserscheinung?).

Material. – 20.vi.1987 und 7.vi.1995 Sagres (Süd-Portugal), 5 ♂, 1 ♀; 30.vii.1991 und 6.vi.1995 Milfontes (Süd-Portugal), 3 ♂, 2 ♀; 9.vi.1995 Melides (Süd-Portugal), 1 ♀. Jeweils ganz in der Nähe des Meeres, in einzelstehenden Büschen oder Buschgruppen und im dornigen Unterwuchs von Kiefernwäldern. Sang bei kühler Lufttemperatur und Wind am späten Nachmittag und Abend, an heißen Tagen dagegen nur nachts.

Platystolus (Neocallicrania) lusitanicus **(Aires & Menano, 1916) stat. nov. + comb. nov.**
(Abb. 8-11)

Ephippigera miegi lusitanica Aires & Menano, 1916: 53.

Morphologie. – Maße (Neotypus; in mm): Körper 37; Pronotum-Länge 7.7; Pronotum-Breite (in der Mitte gemessen) 8.6; Elytra 2.3; Hinterfemur 19.8; Hintertibia 21.3. Maße aller drei Männchen (im Vergleich mit *P. serratus* und *P. miegii*) siehe Tabelle 2. Pronotum und Abdomenende des Neotypus siehe Abb. 10 a)-d). Bei dem Männchen des Fundortes El Castillo de las Guardas sind die Seitenkiele des Pronotum deutlich tiefer eingekerbt als bei den Tieren von Fundao und Aviz; die stärkeren Einkerbungen beginnen kurz hinter dem Sulcus und reichen nach vorn bis zum Paranotum-Unterrand. Auch die Pronotum-Oberseite ist bei diesem Tier seitlich, wenig vor dem Sulcus, stachlig. Bei dem Exemplar von Fundao konvergieren die Pronotum-Seitenränder kaudalwärts. Färbung (Neotypus, Aviz): Grundfarbe (Kopf, Paranota, seitliches und ventrales Abdomen, hintere abdominale Tergalränder) hellgrün; Pronotum dorsal, hinter der vorderen Querfurche, graugrün mit schwarzem Fleck zwischen vorderer Querfurche und Sulcus (siehe auch Abb. 10a); auffallendes weiß-gelbliches, hellviolett gesäumtes Band im Pleuralbereich des Abdomen; abdominale Terga II-VII vorn in der Mitte mit je einem schwärzlichen Fleck; Oberseite des Abdomen, Pronotum vor der vorderen Querfurche sowie hinterer dorsaler Kopfbereich mit hellbrauner Färbung; Augen, Elytren, Cerci, Epiproct, Tergum X-Fortsatz und Analklappen braun bis rotbraun; Beine dorsal hellviolett. Die Tiere von Fundao und El Castillo de las Guardas waren insgesamt ähnlich, d.h. überwiegend grün gefärbt (Pronotum jedoch fast einfarbig dunkler grün); in der Mitte der Prozona des Pronotum befand sich ebenfalls ein länglicher schwarzer Fleck; die abdominalen Terga wiesen hinten breite,

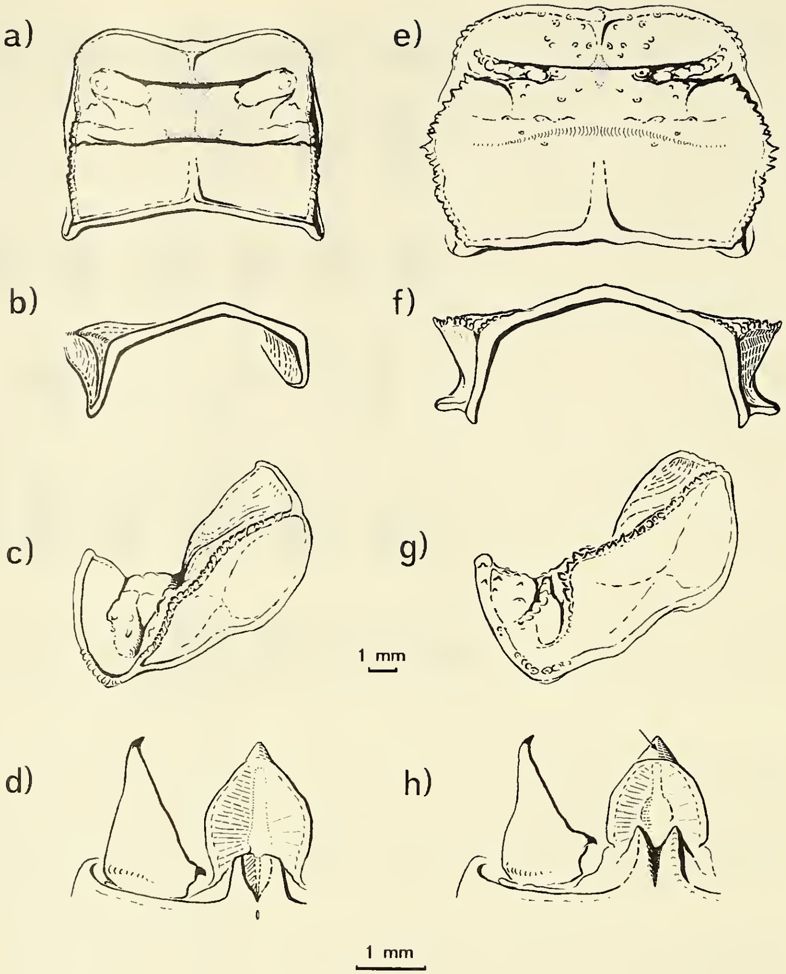


Abb. 10. Merkmale der ♂ von *P. lusitanicus* (a-d; Neotypus, Aviz) und *P. serratus* (e-h; Milfontes); es wurden Tiere etwa gleicher Körpergröße ausgewählt. Das Breiten/Längen-Verhältnis des Pronotum ist in a) und e) bei senkrechter Ansicht von oben nicht korrekt wiedergegeben, da die Metazona perspektivisch stärker verkürzt wird (Maße siehe Tabelle 2). Die feiner punktierten Stellen in a) und e) kennzeichnen schwarze Flecken. In b) (Kaudalansicht des Pronotum) wurde das Pronotum (im Gegensatz zu f) schräg gestellt, um seine nach lateral vorgeschwungenen Kanten, die 'Konkavität des Paranotum-Querschnitts', zu zeigen; diese wurde durch eine optische Schnittlinie durch das Paranotum besonders hervorgehoben.

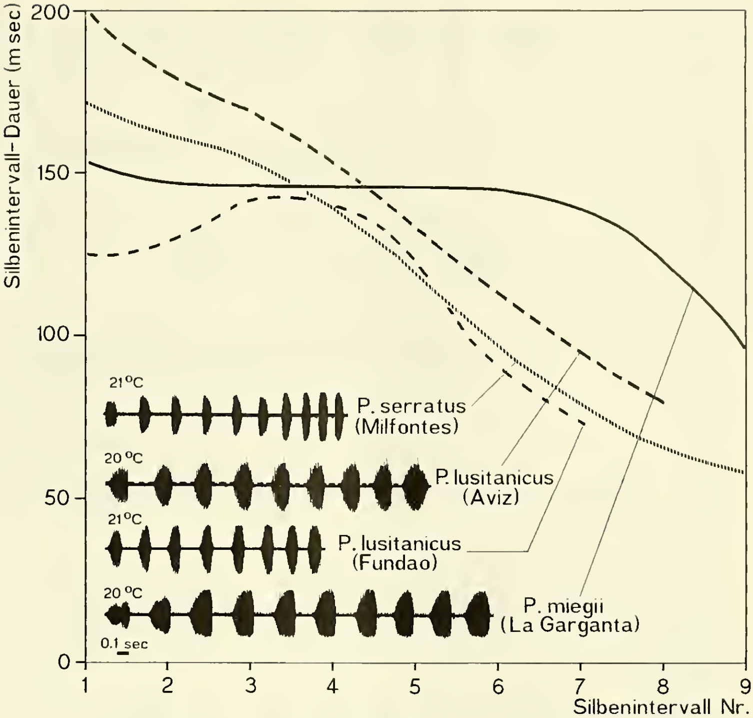
braune Ränder auf; die abdominale Pleuralhaut war unauffälliger (grünlich), die Dorsalseite der Beine blaugrau.

Differentialdiagnose. – Die Männchen der Art unterscheiden sich von *P. miegii*-Männchen durch die geringere Größe, den erheblich leiseren, rhythmischen Initialgesang (vgl. Abb. 11) und die abweichende Form des Pronotum (Breite/Länge 1.0-1.1; vgl. Tabelle 2). Auch im stärker konkaven Querschnitt der Paranota (Abb. 10 b) weicht die Art von *P. miegii*, der einen konvexen Übergang der Paranota in die Metazona des Pronotum zeigt, ab. Gegenüber *P. serratus* existieren v.a. Unterschiede in der Silbenlänge des männlichen Initialgesangs (Abb. 11), im Verlauf der Seitenkiele des Pronotum im vorderen Bereich (Abb. 10 c, g) und im männlichen Abdomenende (Abb. 10 d, h), das dem von *P. miegii* plesiomorph entspricht (siehe auch Beschreibung bei *P. serratus*). Zu Unterschieden in der Zähnchendichte der Feile des männlichen Singapparates siehe Abb. 8.

Bemerkungen. – Während *P. miegii* auch am Tage sang, begann die Gesangsaktivität von *P. lusitanicus* erst mit der Abenddämmerung.

Bei El Castillo de las Guardas fand sich *P. lusitanicus* auf einem Hügel mit Garrigue-artiger Vegetation. Bei Aviz kam die Art syntop mit *Pycnogaster cucullata* (Charpentier, 1825) vor, jedoch weniger einem Bachbett genähert, sondern v.a. in Zistrosen- und Ginsterbüschen, zwischen auf sandigem Boden stehenden Korkeichen (vgl. auch Pfau & Pfau 1995).

Abb. 11. Silbenintervall-Dauer im Verlauf der Initialgesänge von *P. serratus*, *P. lusitanicus* und *P. miegii*. Die abgebildeten Verse, die bei ungefähr gleicher Temperatur aufgenommenen wurden, verdeutlichen auch die unterschiedlichen Silbenlängen.



Bei Fundao wurde *P. lusitanicus* auf einer Kiefernwaldlichtung aufgefunden, syntop mit *P. selliger meridionalis* (genauere Beschreibung des Biotops siehe dort).

Bioakustik. – Der Initialgesang ist deutlich leiser als der Gesang von *P. miegii* und im Freiland schon aus einer Entfernung von ungefähr 5 Metern kaum mehr zu hören. Darin und in der sukzessiven Verkürzung der Silbenpausen im Verlauf des Verses (siehe Abb. 11), die den Gesang rhythmisch klingen läßt, stimmen *P. lusitanicus* und *P. serratus* überein.

Die mittellangen Initialgesänge der Männchen weisen kurze bis mittellange, vor allem am Versanfang crescendierende Schließsilben auf (Abb. 9 a: Aviz; b: Fundao; c, d: El Castillo de las Guardas). Die letzte Silbe wurde bei dem spanischen Männchen (El Castillo de las Guardas: c, d) mehr oder weniger verkürzt. Öffnungssilben können ganz am Anfang des Gesanges, vor der ersten und zweiten Schließsilbe, auftreten; seltener war eine Öffnungssilbe auch vor der letzten Schließsilbe zu erkennen (c).

Bei den Männchen von Aviz und Castillo de las Guardas (a, c, d) waren die Silben des Initialgesanges deutlich länger als bei dem Männchen von Fundao (b; siehe auch Abb. 11). Da sich die Verbreitungsgebiete von *P. lusitanicus* und *P. miegii* in Mittelportugal (Fundao, Guarda) anscheinend überschneiden (vgl. Abb. 22), könnten die besonders kurzen Silben im Initialgesang nördlicher *P. lusitanicus* auf 'character displacement' zurückzuführen sein.

Die sehr kurzen bis kurzen Rückantwort-Schließsilben (b, d) variierten in ihrer Anzahl stark: es wurden 1-7 Silben gezählt. Sie wurden nach längerer Haltung dem Initialgesang ohne weibliche Antworten angehängt, wobei auch bei dieser Art (wie bei *P. serratus* und – seltener – *P. miegii*) die ersten Silben besonders eng stehen können (siehe d). Den Schließsilben der Rückantwort gehen in der Regel sehr leise Öffnungssilben, mit dichterer Impulsstruktur, voraus.

Bis jetzt konnten keine Weibchen gefangen werden; ihre Antworten waren jedoch im Freiland mehrmals gut zu hören und erfolgten - wie bei den anderen Arten - im Zeitraum zwischen dem Initialgesang und den Rückantwortsilben.

Material. – Neotypus ♂: 10.vi.1995; Locus typicus: nordwestlich Aviz (südwestlich Portalegre, Mittelportugal), 200m; hinterlegt im Hessischen Landesmuseum (Darmstadt). Weiteres Material (Sammlung Pfau): 04.viii.1991 (1 ♂), südlich Fundao (Serra da Guardunha, Portugal), 650m; 27.vi.1992 (1 ♂), südlich El Castillo de las Guardas (nordwestlich Sevilla, Provinz Sevilla, Spanien), 250m.

Platystolus (Neocallicrania) miegii (Bolívar, 1873) **comb. nov.**
(Abb. 8, 11, 12)

Ephippigera Miegii Bolívar, 1873: 224.

Morphologie. – Körpermaße der Männchen (im Vergleich mit *P. serratus* und *P. lusitanicus*) siehe Tabelle 2; Zähnchendichte der Feile des männlichen Singapparates siehe Abb. 8. Abgesehen von der unterschiedlichen Form des Pronotum (Breite/Länge <1; vgl. Tabelle 2) weicht der Pronotum-Querschnitt gegenüber *P. lusitanicus* und *P. serratus* ab: er zeigt einen eher konvexen Übergang zwischen den Paranota und der Metazona; dieses Merkmal, die 'fehlende Konkavität des Paranotum-Querschnitts', stellt anscheinend eine Plesiomorphie dar, in der *P. miegii* mit *P. selliger* und *P. bolivarii* weitgehend übereinstimmt.

Bemerkungen. – Bei La Garganta Ende Juli 1991 massenhaft im Ginster; nach einem Regen hunderte von Tieren auf der Straße, an überfahrenen Artgenossen fressend. Mitte Juni 1995 stand das Populationsmaximum offensichtlich noch bevor; darauf wiesen die zahlreichen Larven hin, die sich (abweichend von den Imagines) v.a. im Farn aufhielten. Hauptgesangsaktivität am Tag, zwischen 17 und 19 Uhr; singt jedoch auch nachts. Im Gegensatz zu *P. serratus* und *P. lusitanicus* sehr agile Art, die bei Nachstellung unter Erzeugung einer lauten Abschreckstridulation schnelle Fluchtbewegungen durchführt. Bei La Garganta fand sich am selben Fundort *P. martinezii*; diese Art lebt jedoch anscheinend mehr am Waldrand und im Gebüsch der Lichtungen.

Bioakustik. – Der männliche Initialgesang ist sehr laut. Er ist im Feld noch aus über 50 Metern Entfernung zu hören; da die Weibchen auch kaum hörbar leise vom Tonband abgespielte Gesänge vehement beantworteten, ist zu erwarten, daß sie die Männchen aus noch erheblich größeren Distanzen vernehmen.

Die Verse der Männchen sind kurz bis mittellang und enthalten 5-12 (meist 7 oder 8) mittellange bis lange Schließsilben, die am Versanfang schnell lauter werden (Abb. 12 a-e). Die Silben sind deutlich länger als bei *P. serratus*, jedoch nur wenig länger als bei *P. lusitanicus* (zu *P. lusitanicus* von Fundao siehe weiter oben). Die letzte Silbe kann leiser ausfallen und/oder bis über die Hälfte verkürzt sein (a); sie kann jedoch auch verlängert sein (e). Innerhalb der Silben nimmt die Impulsfrequenz zum Silbenende hin ab (a). Im Unterschied zu *P. serratus* und *P. lusitanicus* nimmt die Lautstärke der Impulse innerhalb der Silben bei *P. miegii* allmählicher zu. Außerdem werden die Pausen zwischen den Silben erst ganz am Versende kürzer, meistens ist nur das letzte Silbenintervall verkürzt (vgl. Abb. 11).

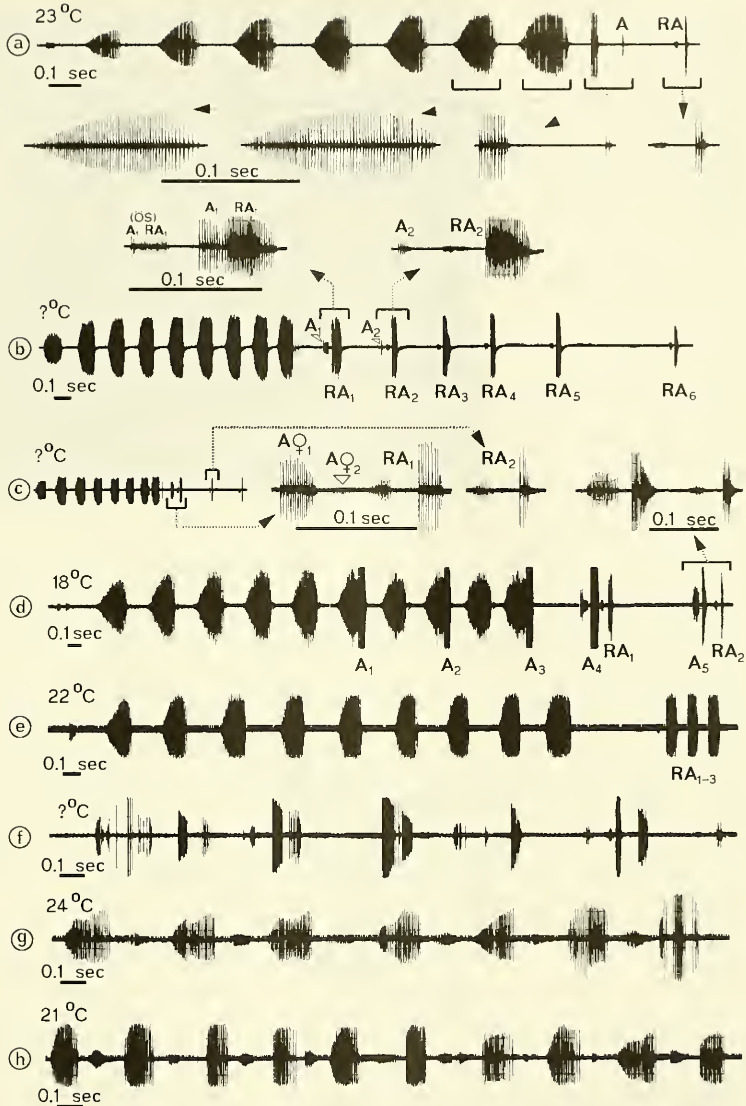
Die Antwort des Weibchens besteht in der Regel aus 1-10 sehr kurzen bis kurzen Schließsilben, denen leise Öffnungssilben vorausgehen (Abb. 12 a-d). Bei längeren Silbenserien waren die Pausen zwischen den Silben oft unterschiedlich lang, d.h. die Antwortstridulation war unregelmäßig. Abb. 12 d) zeigt das Beispiel eines Weibchens, das schon innerhalb des männlichen Initialgesanges mit einer Antwort-Silbenserie begann, wobei die Silbenfrequenz genau halb so groß war wie die des Männchens. Erst nach der letzten Silbe dieser Serie (A4) erfolgte die Rückantwort des Männchens; das Weibchen reagierte daraufhin mit einer weiteren Antwortsilbe (A5), die wiederum eine Rückantwort zur Folge hatte. In diesem Fall war das Tonbandgerät nur für das Männchen gut ausgesteuert, die weiblichen Schließsilben wurden dagegen so stark übersteuert, daß selbst die vorausgehenden Öffnungssilben, die mit den männlichen Schließsilben des Initialgesanges zusammenfielen, die männlichen Silben überragten. Derartige Antworten der Weibchen begannen an ganz verschiedenen Stellen des männlichen Initialgesangs, wobei auffällig war, daß sich die Abstände zwischen den weiblichen Silben erst nach dem Ende des männlichen Gesanges vergrößerten – die Silbenserie des Weibchens wird innerhalb des Initialgesanges anscheinend von den Silben des Männchens 'synchronisiert'. Meistens wurden die letzten Silben der Antwort abrupt verkürzt (d); in einigen Fällen fand dagegen im Ablauf der Antwort eine stetige Zunahme der Silbenlänge statt.

Im Freiland war in der sehr individuenreichen Population von La Garganta bemerkenswert, daß die Weibchen auf männliche Initialgesänge verschieden schnell reagierten: die Antworten kamen als ein sekundenlanges 'Gezwitscher', d.h. mit deutlich unterschiedlichen Zeitabständen zu einem bestimmten Initialgesang, aus allen Richtungen, wobei entfernter sitzende Weibchen (über 10m Abstand) anscheinend besonders spät reagierten (vgl. c).

Einzelne Weibchen erzeugten sehr kurze bis sehr lange (bis über 10 Sekunden andauernde) Spontangesänge, die aus zwei bis weit über 20 Öffnungs- und Schließsilben bestanden – manchmal während des Laufens, z.B. bei der Verfolgung eines Männchens (nicht dargestellt).

Die Männchen antworteten normalerweise auf jede weibliche Antwortsilbe mit einer Rückantwort, sofern die Antwort nicht vom eigenen Gesang maskiert wurde (siehe oben). Für die meist sehr kurzen (bis kurzen; siehe e) Rückantwort-Schließsilben ist typisch, daß sie zu Beginn eines Duetts länger sind und erst gegen Ende stärker verkürzt werden (b - d). Ähnlich wie in den Silben des Initialgesanges nimmt die Impulsfrequenz auch in den Rückantwortsilben am Silbenende ab (b). Im Labor erzeugten (anscheinend

Abb. 12. *Platystolus miegii.* Abkürzungen siehe Abb. 2.

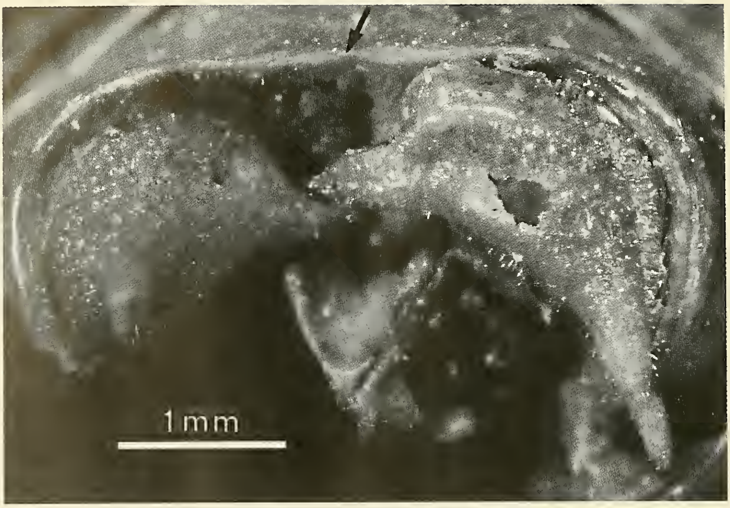


stark motivierte) Männchen nach der Antwort des Weibchens auch ganze Serien von Rückantwortsilben (3-6 Silben), in denen die Silben durch besonders kurze Pausen getrennt waren (e).

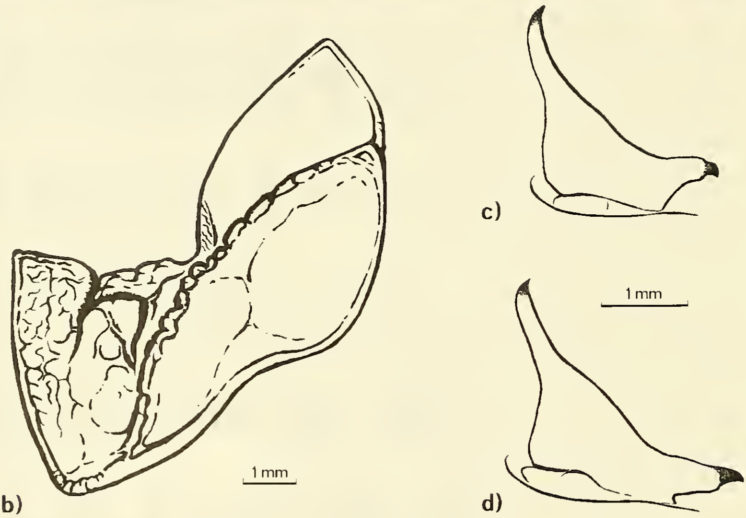
Ähnlich wie bei *P. obvius* und *P. martinezii* (siehe Kapitel der Arten sowie Pfau & Schroeter 1988) kam es auch bei *P. miegii* vor, daß Männchen im Gelände ohne vorherigen Initialgesang auf Spontangesänge von Weibchen – oder auf Antworten von Weibchen, die anderen Männchen galten - mit Rückantworten reagierten. Meist schlossen diese Männchen dann sofort eigene Initialgesänge an.

In Abb. 12 f) ist eine erratische Silbenfolge mit sehr unterschiedlich lauten und langen Silben abgebildet, die kurz vor der Bildung einer Kopula im Gelände zu hören war und anscheinend vom Männchen stammte. Derartige von Initialgesängen abweichende, in unmittelbarer Nähe des Weibchens erzeugte Stridulationen wurden auch bei *Ephippiger perforatus* (de Rossi, 1790) (eigene, nicht veröffentlichte Beobachtungen) und in der Gattung *Pycnogaster* Graells, 1851, bei den Arten der Untergattung *Pycnogaster*, beobachtet ('Nahwerbung'; vgl. Pfau 1988, Pfau & Pfau 1995).

Abb. 13. a), b) Holotypus von *Platystolus selliger selliger*; Abdomenende in Kaudalansicht (a) und Pronotum von lateral (b). Der Pfeil in a) zeigt auf das Gelenk zwischen dem Tergum X und seinem nach unten geklappten kaudalen Fortsatz. c) Rechter Cercus von *P. selliger selliger* (Lindoso, Serra do Gerez, Portugal). d) Rechter Cercus von *P. selliger meridionalis* (Holotypus; Fundao, Serra da Guardunha, Portugal).



(a)



b) c) d)

Während der Kopulation sangen die Männchen v.a. dann Serien von relativ langen Schließsilben (und kürzeren, leisen Öffnungssilben), wenn die Weibchen unruhig wurden und sich von ihnen zu trennen versuchten (g; siehe auch Tabelle 1). Innerhalb oder gegen Ende dieser Serien (siehe letzte Silbe in g) traten auch weitgehend in einzelne Impulsgruppen aufgelöste oder stark verkürzte Silben (ähnlich wie in f dargestellt) auf. Die meisten Silben der 'Kopulationsgesänge' waren deutlich länger als die Silben der männlichen Abschreck-Stridulation (Abb. 12 h; beim Vergleich von g und h ist die verschiedene Temperatur der Aufnahmen, die den Unterschied der Silbenlängen verringert, zu beachten).

Material. – 11.ix.1983, südlich Guarda (Portugal), 1100m. 25.vii.1991 und 16.vi.1995, La Garganta (südlich Bejar, Provinz Caceres, Sierra de Gredos), 1100m. In Hochginsterbeständen (*Retama* sp.).

Platystolus (Neocallicrania) selliger selliger (Charpentier, 1825) comb. nov.
(Abb. 8, 13-15)

Barbitistes selliger Charpentier, 1825: 99. *Ephippiger seoanei* Bolívar, 1877: 269, 279. **Syn. nov.**

Die Merkmale des wiederaufgefundenen Holotypus von '*Callicrania selligera*' sollen hier neu beschrieben werden (vgl. auch 'Bemerkungen zur Systematik').

Tabelle 3. Körpermaße (in mm) von (I) *P. selliger selliger* (11 ♂, 7 ♀), nördlich des Douro, und (II) *P. selliger meridionalis* (9 ♂, 2 ♀), südlich des Douro. Durchschnittswerte in eckigen Klammern.

	Pronotum-länge (a) ♂	Pronotum-länge (a) ♀	Pronotum-breite (b)*) ♂	Pronotum-breite (b)*) ♀	a/b ♂	Postfemur ♂	Postfemur ♀	Posttibia ♂	Posttibia ♀	Ovi-positor	Cercus-breite (c)**) ♂	Cercus-länge (d) ♂	c/d ♂
(I)	7.4-9.5	7.9-9.1	6.1-7.5	6.5-7.8	1.1-1.3 [1.2]	16.4-18.2	16.5-19.9	17.8-21.6	18.0-22.0	19.2-26.0	1.1-1.3	2.0-2.8	0.36-0.55 [0.49]
(II)	9.1-11.5	11,4-11.7	8.4-9.8	9.7-9.9	1.0-1.2 [1.1]	20.0-24.0	24.0-25.0	21.6-26.4	27.8-28.3	32.0-34.0	1.5-1.7	2.3-2.8	0.61-0.74 [0.66]

*) In der Mitte gemessen
**) An der proximalen Nahtlinie gemessen, das heißt ohne Innenzahn

Material. – Holotypus ♂: Exemplar Nr. 1444 (Museum für Naturkunde der Humboldt-Universität, Berlin); älteres Etikett: 'Selligera Charp.*, N., Fisch.*, Lus.'; neueres Etikett: '*Callicrania selligera* (Charp.) ♂, Holotypus, det. K. K. Günther 1995'. Die Beine des Exemplars fehlen bis auf die linke Hintercoxa und -tibia, die Antennen bis auf ihre Basis. Der kaudale Fortsatz des Tergum X ist nach unten geklappt; der rechte Cercus war abgebrochen und wurde (nach ventral gerichtet) wieder angeklebt; beim linken Cercus fehlt die Spitze (vgl. Abb. 13 a). Die Titillatoren fehlen.

Ein weiteres Exemplar – '*Callicrania selligera* (Charp.) ? Paratyp. ♀, det. K. K. Günther 1995' – konnte dagegen als *Steropleurus pseudolus* (Bolívar, 1878) bzw. *Steropleurus andalusius* (Rambur, 1838) bestimmt werden (*Steropleurus pseudolus* und *Steropleurus andalusius* sind möglicherweise zu synonymisieren).

Morphologie. – Maße (Holotypus; in mm): Körper 25; Pronotum-Länge 8; Pronotum-Breite (in der Mitte gemessen) 7.2; Hinterfemur 18; Hintertibia 20; Cercus-Breite 1.2 (an der proximalen Nahtlinie gemessen; vgl. auch Tabelle 3); Cercus-Länge 2.3. Das Pronotum (Seitenansicht siehe Abb. 13 b) ist in der Metazona wenig rugos, d.h. das Netzwerk seiner Oberflächenwülste ist nur wenig erhaben; zwischen und auf den Wülsten ist die Kutikula feiner quer-gerieft, am vorderen Abbruch der Metazona befinden sich deutlichere Querfurchen.

Im Breiten-Längenverhältnis der Cerci, das dem oberen Extrem von *P. selliger selliger* genähert ist (vgl. Tabelle 3), entspricht der Holotypus mehreren in der Serra do Gerez (Nordportugal) gesammelten Männchen (vgl. auch Abb. 13 c: ♂ von Lindoso). Weiter nördlich und v.a. östlich vorkommende *P. selliger selliger*-Männchen weisen dagegen proximal schmalere Cerci auf, deren Breiten-Längenverhältnis bei Exemplaren aus der Sierra de la Demanda dem unteren Extrem genähert ist. Es ist daher zu vermuten, daß die nur ungenau angegebene terra typica ('Lus.' = Lusitanien) auf das nördliche Portugal einzugrenzen ist (zum weiter südlichen Vorkommen von *P. selliger meridionalis* siehe weiter unten). In Nordportugal, in der Region Lindoso – sowie auch weiter nördlich, bei Orense (Spanien) –, fanden sich neben Exemplaren mit einer dem Holotypus sehr ähnlichen Pronotum-Oberflächenstruktur auch einzelne Tiere mit besonders glatter, 'glänzender' Metazona, die darin (und im Fundort) '*Callicrania pellucida* Bolívar, 1885' entsprechen; *Callicrania pellucida* wurde als Synonym von *C. selligera* eingezogen (vgl. z.B. Peinado 1990).

Da *Callicrania seoanei* (Bolívar, 1877) (eigene Funde, auch aus dem Gebiet des locus typicus) morphologisch und bioakustisch nicht von *P. selliger* (Holotypus bzw. Tiere aus der Serra do Gerez; siehe oben) abzugrenzen ist, wird *C. seoanei* als Synonym eingezogen. Zur Variationsbreite der Maße von *P. selliger selliger* (incl. '*C. seoanei*') siehe Tabelle 3 sowie die Angaben bei Harz (1969) zu '*C. selligera*' und '*C. seoanei*'; Harz mußte sich allerdings bei '*C. selligera*' auf Literaturdaten stützen, die sich zum Teil evtl. auf andere Arten beziehen (vgl. 'Bemerkungen zur Systematik'). Die zahlreichen eigenen Fundstellen liegen innerhalb des bisher bekannten Verbreitungsgebietes (von '*C. seoanei*') und werden daher nicht im Einzelnen aufgeführt.

Zur Zähnchendichte der Feile des männlichen Singapparates vgl. Abb. 8.

Bemerkungen. – Im Nordwesten (Galizien) wurde die Art syntop mit *P. bolivarii* aufgefunden; im Norden und Nordosten trat *P. selliger selliger* gemeinsam mit *P. faberi faberi* bzw. *P. faberi demandae* auf (zu der im Südwesten aufzufindenden Unterart *P. selliger meridionalis* siehe unten). Anscheinend ermöglicht der jeweils ziemlich unterschiedliche Initialgesang diese für die Arten von *Platystolus* ungewöhnliche 'Neigung' zur Syntopie.

Für den Zeitabschnitt vor der Paarung ist folgende Freilandbeobachtung (Galizien) interessant: Ein Weibchen reagierte auf den Initialgesang eines in der Nähe sitzenden Männchens, indem es sich auf der Oberseite eines Brombeerblattes so ausrichtete, daß das Abdomenende in Richtung des singenden Männchens zeigte. Das Abdomen wurde steil nach oben gestellt, ca 50-60 Grad gegenüber dem Blatt, und begann heftige Pumpbewegungen (Aus- und Einwärtsbewegungen der Sterna) auszuführen. Die Analklappen des Abdomenendes wurden dabei immer wieder weit gespreizt. Möglicherweise dient dieses Verhalten dem Aussenden von Duftstoffen. Zur Kopulation vgl. Tabelle 1.

Platystolus (*Neocallicrania*) *selliger meridionalis* **subsp. n.**
(Abb. 13-15)

Material. – Holotypus ♂: 24.vi.1992, südlich Fundao (Serra da Guardunha, Portugal), 650 m; hinterlegt im Hessischen Landesmuseum, Darmstadt. Paratypen: 04.viii.1991 und 24.vi.1992 (3 ♂, 2 ♀), selber Fundort wie Holotypus, 300-650 m (Sammlung Pfau; 1 ♀ Hessisches Landesmuseum, Darmstadt); 26.vii.1991 (4 ♂), Candelario (südöstlich Bejar, Provinz Salamanca, Westausläufer der Sierra de Gredos, Spanien), 1100m; 14.vi.1995 (1 ♂), Vouzela (nordwestlich Viseu, Portugal), 550 m.

Nach den bisherigen Funden stellt der Fluß Douro die nördliche Verbreitungsgrenze der Unterart dar.

Morphologie. – Maße (in mm, Tiere Alkohol-konserviert) 9 ♂, Holotypus in Klammern, 2 ♀: Körper ♂ 34-44 (42.0), ♀ 40-42; Pronotum ♂ 9.5-11.5 (11.2), ♀ 11.4-11.7; Postfemur ♂ 20.0-24.0 (24.0), ♀ 24.0-25.0; Posttibia ♂ 21.6-26.4 (26.4), ♀ 27.8-

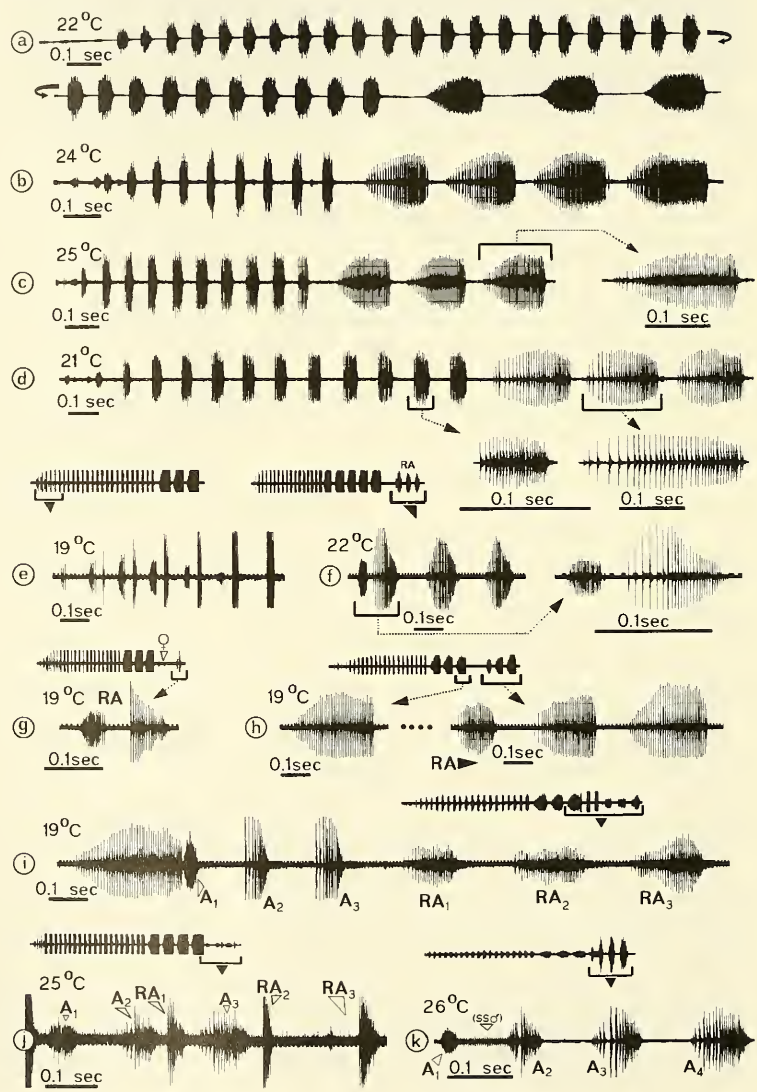
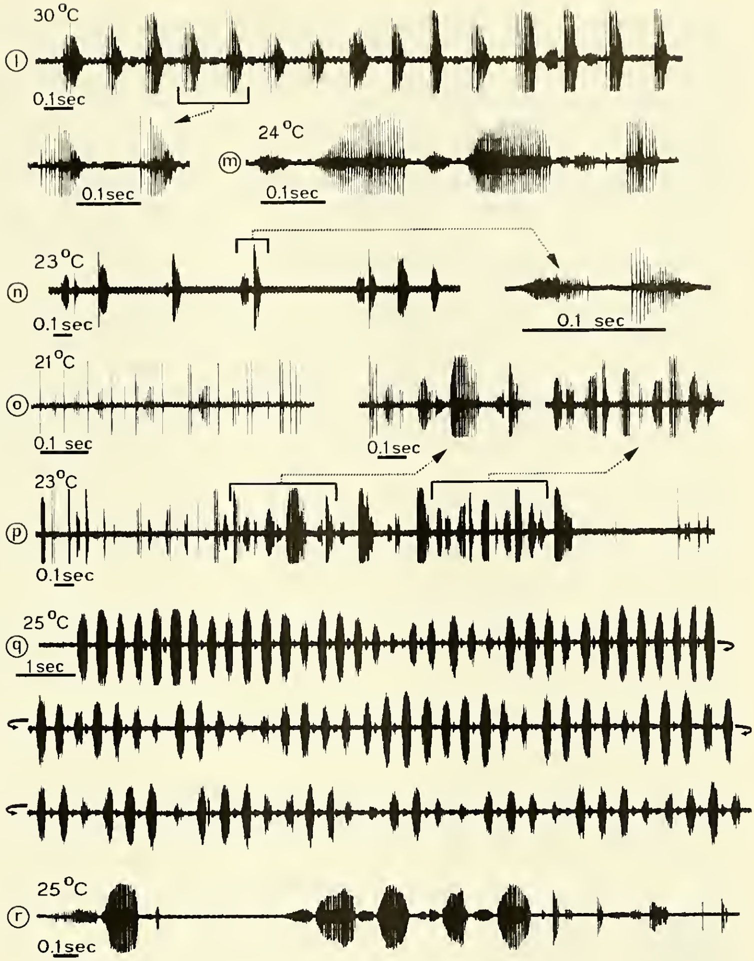


Abb. 14. *Platystolus selliger*. Abkürzungen siehe Abb. 2.

Abb. 15. *Platystolus selliger*. Abkürzungen siehe Abb. 2.



28.3; Elytra ♂ 2-3 (2.5), ♀ 1-1.5; Ovipositor 32.0-34.0. Weitere Maße (im Vergleich mit *P. selliger selliger*) siehe Tabelle 3.

Pronotum ziemlich variabel: in der Metazona mit Netzwerk stärker erhabener Wülste oder relativ glatt, mit ganz wenig erhabenem oder deutlichem Mittelkiel; der Seitenrand ist mäßig stark eingekerbt, im mittleren Bereich und davor jedoch manchmal fast 'stachlig'. Der Ovipositor der Weibchen ist (entsprechend der Körpergröße) sehr lang; er ist relativ schwach und gleichmäßig gebogen.

Färbung: Körperoberseite grün, Unterseite heller gelb-grün; auch die Beine sind auf der Unterseite heller grün als auf der Oberseite. Pronotum hinten seitlich mit hellerer gelbbrauner Zone; Femura distaldorsal graublau; Cerci und Epiproct hellbraun; Legebohrer im basalen Drittel grün, sonst bräunlich. Flankenhaut des Abdomen ganz vorn als satt gelber, schräger Seitenstreif deutlich hervorgehoben. Elytren innen tiefbraun bis schwarz, nach außen folgen ein braungelber Ring und ein grau-brauner Kaudalrand.

Differentialdiagnose: männlicher Cercus proximal deutlich breiter als bei *P. selliger selliger* (vgl. Tabelle 3 sowie Abb. 13 d und c); Pronotum besonders breit (siehe Tabelle 3).

Derivatio nominis: Der Name spielt auf das südliche Vorkommen der Unterart an.

Bemerkungen. – Bei Fundao in 650m Höhe syntop mit *P. lusitanicus*, der im Juni 1992 allerdings nicht zu finden war (evtl. war es für *P. lusitanicus* in dieser Höhenlage noch zu früh im Jahr).

Die Fundorte Fundao und Candelario stellen v.a. mit Ginster und Eichen verbuschende Kiefernwaldlichtungen, in ungefähr nordexponierter Hanglage, dar. Die meisten Tiere saßen (ca 80cm bis 2m hoch) auf jungen Eichen, und zwar oft auf der Oberseite großer Blätter. Auch bei Vouzela fand sich *P. selliger meridionalis* v.a. im jungen Kiefernwald. Der Gesang war erst ab Einbruch der Dunkelheit zu hören, auch bei niedrigen Temperaturen (10 °C).

Zur Kopulation vgl. Tabelle 1. Ähnlich wie bei anderen Arten waren die Männchen nach der Kopulation längere Zeit schweigsam; sie begannen erst nach zwei bis drei Tagen wieder zu singen.

Bioakustik. – Im weiteren werden beide Unterarten gemeinsam behandelt; nur bei bemerkenswerten Unterschieden wird direkt oder indirekt (Fundort) auf die jeweilige Unterart hingewiesen.

Die Männchen von *P. selliger* singen kurze bis sehr lange Verse (Abb. 14 a-d). Diese weisen im Teil I mehr oder weniger zahlreiche sehr kurze bis kurze Schließsilben auf, die bereits nach wenigen Silben ihre volle Lautstärke erreichen. Im Teil II folgen lange bis sehr lange Schließsilben, mit deutlich vergrößerten Impulsabständen, die jedoch gegen Silbenende meist wieder kleiner werden. Gelegentlich wird die letzte Teil II-Silbe etwas verlängert (b), in anderen Fällen (d) war dagegen die erste Teil II-Silbe besonders lang. Die Öffnungsbewegung der Elytren ist in beiden Gesangsteilen stumm; nur ganz am Beginn des Teils I können Öffnungssilben hörbar sein (siehe z.B. e: Fundao).

Die Anzahl der Teil I-Silben variiert stark: Im Südwesten und Westen des Verbreitungsgebietes – bei *P. selliger meridionalis*, und auch bei *P. selliger selliger* aus Nordportugal, Galizien und Asturien – ist der Teil I der Initialgesänge relativ kurz; die Silbenzahl schwankte zwischen 9 und 25, der Durchschnittswert war ungefähr 14 (b: Fundao; c: Serra do Gerez; d: Candelario). Diese relativ kurzen Initialgesänge hören sich zwar im Gelände ähnlich an wie die Gesänge von *P. ramburii*, sind jedoch strukturell gut von ihnen zu unterscheiden. Östliche Tiere, beginnend bereits östlich der Picos de Europa (a: Sierra de la Demanda), sangen dagegen einen etwa doppelt so langen Teil I, mit bis weit über 30 Silben (geschätzter Mittelwert: 25); im Teil II waren die Pausen zwischen den (kürzeren) Silben länger. Ob hier ein Ost-West-Gefälle (cline) vorliegt, oder ob verschiedene Unterarten existieren, muß noch genauer untersucht werden (siehe auch Abschnitt 'Verbreitung und Ausbreitungsgeschichte').

Die Anzahl der Teil II-Silben zeigt ebenfalls eine beträchtliche Variationsbreite. Besonders häufig sind drei Silben, in Einzelfällen 1-2 oder 4-5 Silben (Übersichtsbild f: Fundao). Seltener waren im Freiland bis 7 Silben zu hören, bei einem sehr alten Männchen von *P. selliger meridionalis* in Gefangenschaft sogar bis 11 Silben (dieses Tier variierte auch die Anzahl der Rückantwortsilben von Gesang zu Gesang besonders stark).

Die Antwort der Weibchen erfolgt in der Regel kurz nach der letzten Teil II-Schließsilbe des männlichen Initialgesangs; gelegentlich beginnt sie auch schon innerhalb des Initialgesangs. Sie besteht aus 2-4 sehr kurzen bis kurzen, meist crescendierenden und länger werdenden Schließsilben, die einen typischen, d.h. in der ersten Hälfte lückigen Impulsaufbau zeigen (i-k). Die letzte Silbe wird manchmal stärker von den übrigen Silben abgesetzt.

Bei Riotorto (Galizien) waren im Freiland vor allem zwischen 16 und 18 Uhr auch viele Spontangesänge der Weibchen, bestehend aus ca 2-10 Schließsilben, zu hören; sie regten in der Nähe sitzende Männchen anscheinend zu Initialgesängen an. In Gefangenschaft sang ein Weibchen von *P. selliger meridionalis* bis zu 7 Sekunden lange, relativ laute Spontangesänge.

Die Rückantwort der Männchen, die in der Regel viel leiser ist als der Initialgesang, war meist von der weiblichen Antwort zeitlich deutlich getrennt (i: Fundao). Rückantwort und Antwort konnten aber auch überlappen (j: ♂ Lindoso [Nordportugal], ♀ Fonsagrada [Galizien]). Die Rückantwort besteht aus einem einzelnen Silbenpaar (d.h. einer Öffnungs- + Schließsilbe; g: Fundao) oder aus mehreren einzelnen Schließsilben, wobei meistens nur der ersten Schließsilbe eine Öffnungssilbe vorausgeht (f, h, i: Fundao).

Die Länge der Schließsilben der Rückantwort variierte stark: sehr kurz (j), kurz bis mittellang (f, g, h) bis sehr lang (h). Lange und sehr lange Rückantwortsilben wurden bisher nur bei *P. selliger meridionalis* beobachtet. Bei dieser Unterart kann die Lautstärke und Länge der Silben im Verlauf der Rückantwort zunehmen, so daß sie allmählich (oder auch sprunghaft) den Teil-II-Silben ähnlicher werden (h). Ob es sich hier um konstante Unterschiede zur nördlichen Unterart handelt, ist bei der geringen Individuenzahl untersuchter Tiere noch unklar.

Die Abschreck-Stridulation ist in Abb. 15 l) (♀, Fundao) und m) (♂, Fundao) dargestellt. Bei der weiblichen Abschreck-Stridulation ist die Impulsstruktur auffällig ähnlich wie in Antwortsilben. Die Schließsilben der männlichen Stridulation sind meist deutlich länger als die der Weibchen; in wenigen Fällen waren jedoch beim Männchen auch Serien mit sehr unterschiedlich langen Silben zu hören, die den 'Kopulationsgesängen' (siehe unten) ähnelten.

Den im Labor 'arrangierten' Kopulationen gingen keine Nahwerbungs-Gesänge der Männchen voraus. Es kam dagegen vor, daß das Weibchen im Falle einer Flucht des Männchens dieses verfolgte und stridulierte (n: Fonsagrada).

Während der Kopulation werden vom Männchen erratische Silbenserien mit sehr unterschiedlich langen und lauten Silben erzeugt. Diese Serien variieren in ihrer Länge und ihrem Charakter ständig: Passagen mit stark verkürzten Silben klingen z.B. wie ein schnelles 'Geknister' (o: Fundao); ihnen können jedoch sofort wieder Teile mit ganz anderem Aufbau folgen (p: Fundao). Man hat den Eindruck, daß der Andruck der beiden Elytren gegeneinander häufig verändert wird, und daß es auch öfters zu einem 'Verhaken' zwischen Plectrum und Feile kommt (zur Funktionsmorphologie der Plectrum-Feilen-Andrucksregulierung bei Grillen vgl. Pfau & Koch 1994).

Während der Spermatophorenübergabe waren die Tiere besonders unruhig. Zu Beginn des Austritts der Spermatophore, etwa 25 Minuten nach Bildung der Kopula, wurden die Silbenserien der Männchen länger; sie dauerten während der Anheftung der Spermatophore am Weibchen bis zu 34 Sekunden lang an (q: Lindoso). Auch diese langen Stridulationen konnten Teile mit sehr kurzen 'Silben' (ein Impuls bis nur wenige Impulse lang; r: Lindoso) enthalten.

Im Freiland waren die lauten 'Kopulationsgesänge' so auffällig, daß man die Pärchen gut orten und finden konnte.

Platystolus (Neocallicrania) bolivarii **(Seoane, 1878) comb. nov.**
(Abb. 8, 16)

Ephippiger Bolivarii Seoane, 1878: 71.

Morphologie. – Zur Zähnchendichte der Feile des männlichen Singapparates vgl. Abb. 8.

Bemerkungen. – An fast allen Fundstellen syntop mit *P. selliger selliger*. Der Gesang war morgens und (bei nicht sehr hohen Temperaturen) auch nachmittags zu hören. Die Art fällt durch ihre auffallend glänzende Kutikula auf. Ähnlich wie *P. martinezii* (vgl. Pfau & Schroeter 1988) sind die Tiere besonders wehrhaft und beißlustig.

Bioakustik. – Der Initialgesang der Männchen ist sehr laut. Er besteht aus mittellangen (bis langen) Versen, die einen in der Regel sehr kurzen Crescendo-Teil I aufweisen, der sehr kurze Öffnungs- und Schließsilben zeigt. Darauf folgt ein längerer Teil II, der kurze, scharf klingende Schließsilben, jedoch keine Öffnungssilben enthält (Abb. 16 a, b).

Der Antwort-Gesang des Weibchens besteht aus zahlreichen, meist kurzen Silben (c) oder aus einer einzigen Silbe (d). Die Impulsstruktur der Silben ist typisch, d.h. im Anfangsteil unregelmäßig-lückig. Die Antwort ist deutlich leiser als der männliche Initialgesang: bei gleichem Abstand der Männchen und Weibchen vom Mikrofon ergibt sich als Schätzwert eine Lautstärken-Differenz von 10 dB.

Einzelne kurze Rückantwort-Silben des Männchens können bereits innerhalb der Antwort des Weibchens erzeugt werden (c), oder die Rückantwort bildet eine von der Antwort getrennte, kurze

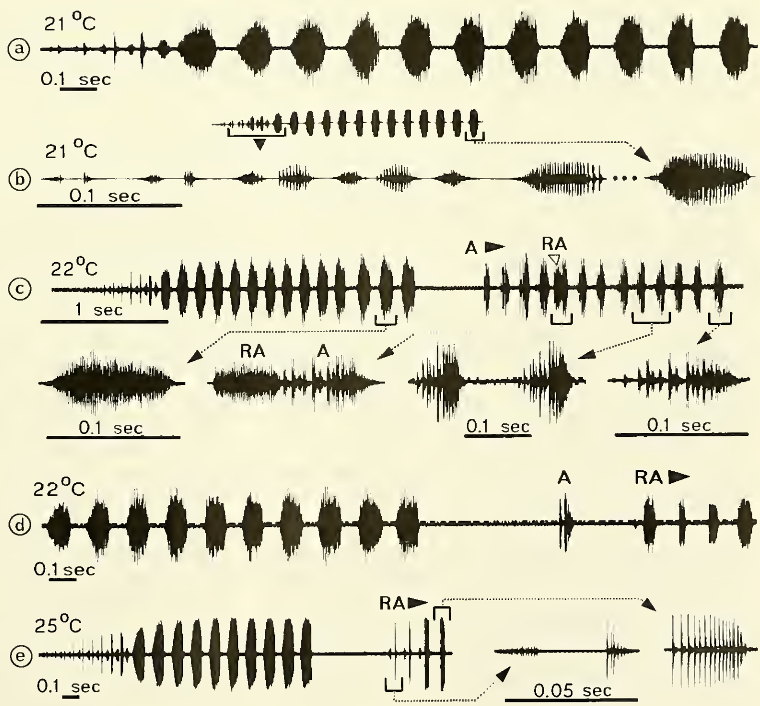


Abb. 16. *Platystolus bolivarii.* Abkürzungen siehe Abb. 2.

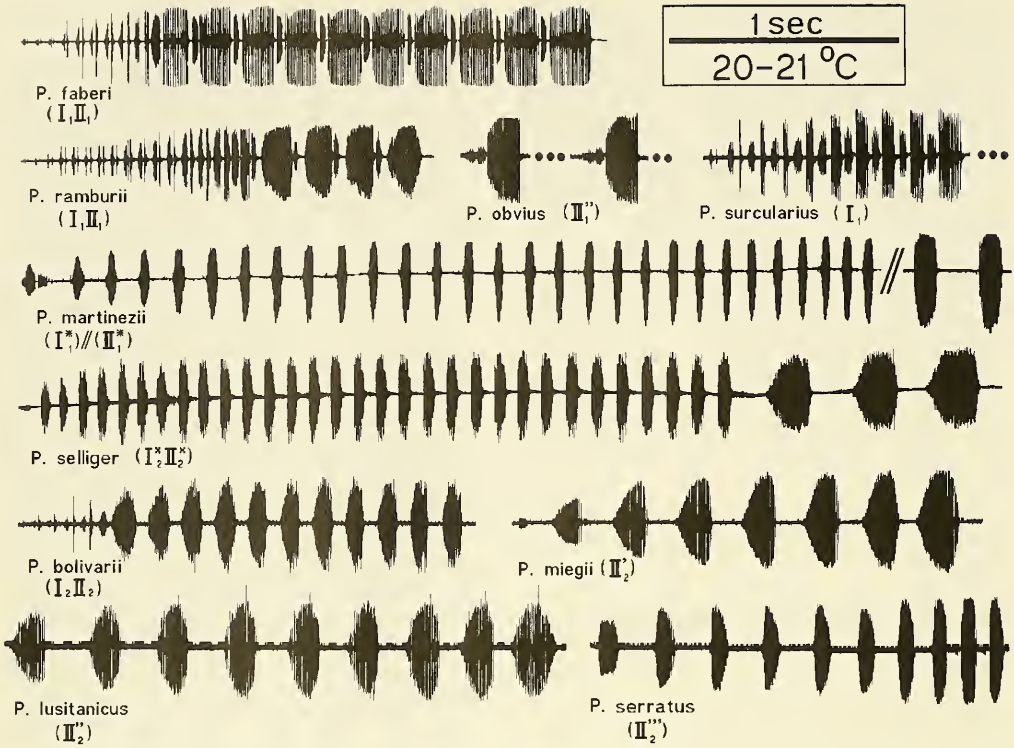


Abb. 17. Gegenüberstellung der Initialgesänge der *Platystolus*-Arten (20-21 °C). Für *P. selliger* wurde ein 'östlicher' Gesang ausgewählt. Nur im Fall von *P. martinezii* wurde auch die Rückantwort (durch // vom Initialgesang abgesetzt) dargestellt (vgl. Text). Die vorhandenen Vers-Teile I bzw. II wurden in Klammern vermerkt, ihr Apomorphie-Grad wurde angedeutet; Index 1 steht für *Platystolus* (*Platystolus*), 2 für *Platystolus* (*Neocallicrania*).

Silbenserie (d). Bei den Rückantwort-Schließsilben ist auffällig, daß sie den Silben des Teils II des Initialgesanges ähnlich sind - sie sind jedoch kürzer.

Bei einer Aufnahme begann die Rückantwort, wie der Initialgesang, mit sehr kurzen Öffnungs- und Schließsilben und endete dann mit längeren, lauteren Schließsilben (e). Diese Rückantwort enthielt anscheinend sowohl den Gesangsteil I als auch den Teil II in stark verkürzter Form. Dies weist darauf hin, daß die Rückantwort als ein verkürzter zweiter Initialgesang zu interpretieren ist (siehe auch *P. faberi* und Abschnitte 'Phylogenie' und 'Funktion und Evolution der Rückantwort'). In anderen Rückantworten war der Teil I dagegen reduziert (d).

Bei Störung wird eine scharfklingende Abschreck-Stridulation erzeugt. Sie kann nur wenige Silben lang sein, wurde aber in einzelnen Fällen über viele Sekunden ausgedehnt.

Material. – Zahlreiche Tiere von verschiedenen Fundstellen im bekannten Verbreitungsgebiet (Galizien, Asturien).

Phylogenie

Hier soll versucht werden, über einen Vergleich der morphologischen und bioakustischen Merkmale der Arten das phylogenetische System zu rekonstruieren (Abb. 18, 19). Den morphologischen Merkmalen (Merkmale [1], 3-[5], 8, 11a, 11b, 12 (part.), 13 (part.), 15, 18, 20, 21) kommt dabei eine größere Bedeutung zu, da es v.a. mit ihrer Hilfe (und funktionsmorphologischen Erwägungen) möglich war, ein phylogenetisches 'Grundgerüst' aufzubauen; dieses war weitgehend die Basis für die Interpretation der bioakustischen Merkmale und die Rekonstruktion ihrer Evolution. Bei fehlender Kenntnis der stammesgeschichtlichen Verwandtschaft der Gruppen der Ephippigerinae (d.h. nur bedingt möglichem Außengruppenvergleich) bleiben die Hypothesen allerdings mit Unsicherheiten behaftet.

Morphologische Merkmale

Vermutlich bilden die beiden Untergattungen *Platystolus* (*Neocallicrania*) und *Platystolus*

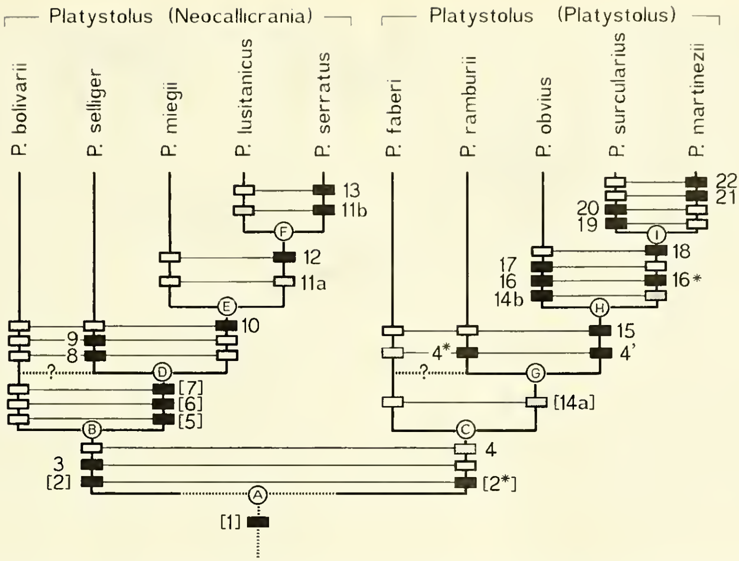


Abb. 18. Kladogramm. Graue Kennzeichnungen verweisen auf intermediäre Apomorphiestufen. Zu den verschiedenen hypothetischen Stammarten 'A'-'I' siehe auch Kapitel 'Verbreitung und Ausbreitungsgeschichte'. Merkmale: Nur die apomorphen Merkmalszustände werden beschrieben; die Plesiomorphien sind daraus abzuleiten oder ergeben sich durch Außengruppen-Vergleich. Die morphologischen Merkmale werden nur zum Teil durch Abbildungen wiedergegeben (siehe z.B. Harz 1969; zu den bioakustischen Merkmalen siehe Abb. 17 und Kapitel der Arten). Stärker hypothetische Bewertungen wurden durch eckige Klammern gekennzeichnet. [1], Hinterrand des Tergum X in der Mitte vorgezogen (Abb. 19a); [2], kürzere Schließsilben im Teil II des Initialgesanges, Öffnungssilben dort reduziert; [2*], längere Schließsilben im Teil II des Initialgesanges; 3, männliche Cerci weit proximal bezahnt (Abb. 19b), Titillatoren charakteristisch; 4, Tergum X des Männchens auf größerer Breite zwei-zipflig nach kaudal vorgezogen (vgl. Abb. 19f); 4*, Zipfel des Tergum X des Männchens nach dorsal abgebogen und vergrößert (vgl. Abb. 19i und Text); 4', Tergum X-Fortsätze des Männchens verlängert und median fast auf ganzer Länge verwachsen (Alternativapomorphie zu Merkmal 4*, vgl. Abb. 19j, k und Text); [5], männliche Cerci basal verbreitert (Abb. 19d, e); [6], Rückantwort verkürzt; [7], Schließsilben im Teil II des Initialgesanges verlängert; 8, Cercus-Innenzahn der Männchen verlängert (vgl. Abb. 13a, c, d und Abb. 19e); 9, Teil I des Initialgesanges abgewandelt (gleichartige Schließsilben, ohne Öffnungssilben), Anzahl langer Teil II-Silben verringert; 10, Teil I des Initialgesangs reduziert; 11a, Zähnchendichte der Feile des männlichen Singapparates erhöht (1. Apomorphiestufe, vgl. auch Abb. 8); 11b, Zähnchendichte der Feile des männlichen Singapparates erhöht (2. Apomorphiestufe, vgl. auch Abb. 8); 12, Pronotum verändert: Breite/Länge = 1 oder >1, Kaudalrand verdickt, Paranotum-Querschnitt konkav (siehe auch Abb. 10a-b, e-f und Text zu den Arten), 'rhythmischer' Initialgesang durch sukzessive Verkürzung der Silbenpausen (siehe auch Abb. 11); 13, dorsaler Seitenkiel des Pronotum vorn nach unten abgeknickt, vor der Unterkante erlöschend (siehe Abb. 10g, weitere Pronotum-Apomorphien siehe Text zu *P. serratus*), männlicher Tergum X-Fortsatz tiefer eingekerbt (siehe Abb. 10h), Epiproct charakteristisch: distal mit längerer, schräger Kante (Pfeil in Abb. 10h), Verkürzung der Teil II-Silben im Initialgesang; [14a], Rückantwort verkürzt (1. Apomorphiestufe, Konvergenz zu Merkmal [6]); 14b, Rückantwort verkürzt, bis auf eine einzige sehr kurze bis kurze Schließsilbe (mit vorausgehender Öffnungssilbe) – 2. Apomorphiestufe; 15, Verlegung des männlichen Cercus-Innenzahns ganz nach distal, männlicher Epiproct charakteristisch abgewandelt: breit-rechteckig bis -spatelförmig (vgl. Abb. 19j, k); 16, Reduktion des Teils I des Initialgesanges (Konvergenz zu Merkmal 10); 16*, Reduktion des Teils II des Initialgesanges (Alternativapomorphie zu Merkmal 16); 17, extreme Verkürzung des (Teils II des) Initialgesanges; 18, männliche Cerci verlängert und distad verjüngt (Abb. 19k), Pronotum verändert: Verkürzung der Metazona, frontad divergierender Seitenkantenverlauf; 19, repetitiver Gesang der Männchen, Reduktion der weiblichen Antwort, Reduktion der Rückantwort; 20, abdominale männliche Terga (VI)-VII-X bedornt; 21, männliche Titillatoren charakteristisch abgewandelt; 22, Teil I des Initialgesanges verändert: stark verlängert, ohne Öffnungssilben, gegen Ende mit kürzer werdenden Silbenpausen.

(*Platystolus*) zusammen eine monophyletische Gruppe (Merkmal [1]). Auch der Gesang der Männchen könnte eine Autapomorphie einer Stammart 'A' der Gattung *Platystolus* darstellen (siehe 'Bioakustische Merkmale').

Während die Monophylie der Untergattung *Platystolus* durch den Besitz des auf breiter Basis stärker vorgezogenen, zwei-zipfligen Tergum X (Merkmal 4) zu begründen ist, macht es größere Schwierigkeiten, für die Arten der Untergattung *Neocallicrania* synapomorphe Merkmale zu finden. Geht man davon aus, daß ungefähr in der Mitte bezahnte Cerci der Männchen – ähnlich den Cerci von *P. faberi* oder *P. ramburii* (und auch etlicher

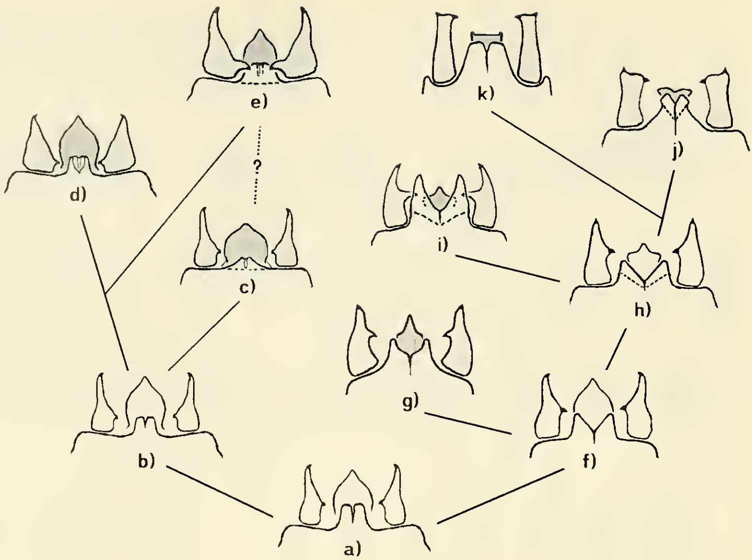


Abb. 19. Evolution einiger Strukturen des männlichen Abdomenendes (die Arten wurden in unterschiedlichen Abbildungsmaßstäben, d.h. 'Größen-normiert' gezeichnet). a)-e) *Platystolus* (*Neocallicrania*): c) *P. bolivarii*, d) *P. lusitanicus* (+ *P. miegii* + *P. serratus*), e) *P. selliger selliger*, f)-k) *Platystolus* (*Platystolus*): g) *P. faberi demandae*, i) *P. ramburii*, j) *P. obvius*, k) *P. martinezii* (+ *P. surcularius*). Hypothetische Ahn- bzw. Zwischenformen nur als Umrißbild. Gestrichelte Linien deuten die Gelenkabgrenzung des Tergum X-Fortsatzes an (c, e) oder kennzeichnen die Stellen, an denen die Zipfel des Tergum X-Fortsatzes nach dorsal 'abknicken' (h-j).

Steropleurus-Arten) – ursprünglich sind (vgl. Abb. 19 a, f-i), so könnten die Cerci der *Neocallicrania*-Arten, deren Innenzahn sich weit proximal der Mitte befindet, eine solche Synapomorphie darstellen (Abb. 19 b-e); eine weitere liegt wohl in den sehr einheitlichen und charakteristischen Titillatoren der Männchen vor. Beide Merkmale wurden als Merkmal 3 zusammengefaßt (siehe Abb. 18).

Der Vergleich der Cerci der Männchen der beiden Untergattungen weist auf eine entgegengesetzte Wanderung des Cercus-Innenzahns innerhalb *Platystolus* (*Neocallicrania*) und *Platystolus* (*Platystolus*) hin: Während der Innenzahn bei allen *Neocallicrania*-Arten weit proximal der Mitte liegt (und die Tendenz aufweist, noch weiter nach proximal zu wandern: Abb. 19 c-e), wurde er innerhalb der Untergattung *Platystolus* weiter nach distal verlegt (Merkmal 15 part.; Abb. 19 j, k). Diese Hypothese einer entgegengesetzten Wanderung des männlichen Cercus-Innenzahns in den beiden Untergattungen bekommt dadurch Gewicht, daß zwischen der Gestalt des Tergum X, das mehr oder weniger weit nach distal vorgezogen ist, und unterschiedlich bezahnten Cerci anscheinend ein funktioneller Zusammenhang existiert:

Auf der *Platystolus* (*Platystolus*)-Seite des Stammbaums ist das Tergum X auffälligerweise dann besonders weit nach kaudal vorgezogen, wenn der Innenzahn der Cerci distal liegt – nur in diesem Fall können sich die Cerci wohl überhaupt am Weibchen verankern.

Eine Ausnahme bildet *P. ramburii* (Abb. 19 i). Hier ist der (gegenüber *P. faberi*; Abb. 19 g) vergrößerte zwei-zipflige Tergum X-Fortsatz jedoch in einem Winkel nach dorsal, über die Schwenkebene der Cerci hinaus, abgeknickt und stellt somit kein Hindernis für die etwa mittig bezahnten Cerci dar. Da diese 'Lösung' des oben angesprochenen Verankerungs-Problems nur für *P. ramburii* zutrifft, kann man folgern, daß die Verlängerungen des Tergum X-Fortsatzes bei *P. ramburii* (Merkmal 4*) und *P. obvius* + *P. surcularius* + *P. martinezii* (Merkmal 4') parallele, d.h. unabhängige Entwicklungen darstellen.

Während die Gruppe *P. obvius* + *P. surcularius* + *P. martinezii* durch die Merkmalskombination 4'+15 gut als eine monophyletische Einheit begründet werden kann, bleibt die Verwandtschaft der (im Hinblick auf diese Merkmale plesiomorphen bzw. alternativ-apomorphen) übrigen Arten der Untergattung etwas fraglich. Die stärkere Zweizipfligkeit des männlichen Tergum X-Fortsatzes bei *P. faberi* und *P. ramburii* (Abb. 19 g, i) könnte zwar zur Begründung eines Schwestergruppenverhältnisses der beiden Arten herangezogen werden; da der Tergum X-Fortsatz bei *P. obvius* und *P. martinezii* jedoch eine längere mediane Nahtlinie (siehe Abb. 19 j, k) aufweist, die auf eine sekundäre Verwachsung zweier großer Zipfel schließen läßt (Merkmal 4'), wird hier davon ausgegangen, daß ein zweizipfliger Tergum X-Fortsatz innerhalb der Untergattung *Platystolus* als plesiomorph zu bewerten ist (für die Stammart 'C' der Untergattung stellt das Merkmal 4 dagegen die Autapomorphie dar, mit der die Monophylie der Untergattung begründet wurde; siehe Abb. 19 f und weiter oben).

P. obvius (Abb. 19 j) zeigt noch eine Andeutung der für *P. ramburii* (Abb. 19 i) beschriebenen Abknickung der Tergum X-Zipfel nach dorsal. Dieses Merkmal könnte somit eine nähere Verwandtschaft von *P. ramburii*, *P. obvius*, *P. martinezii* und *P. surcularius* begründen. Entsprechend dem oben beschriebenen Zusammenhang zwischen Tergum X-Fortsatz-Größe und Cercus-Innenzahn-Lage würde man folgern, daß die Vergrößerung der Zipfel des Tergum X und ihre stärkere Abknickung nach dorsal bei *P. ramburii* (Merkmal 4*; Abb. 19 i) einerseits, und die Verlängerung und Verwachsung der Zipfel bei *P. obvius*, *P. martinezii* und *P. surcularius* (Merkmal 4'; Abb. 19 j, k) andererseits, unabhängige, parallele Entwicklungen darstellen, die von einem intermediären Zustand ausgingen, bei dem die Tergum X-Zipfel nur leicht nach dorsal abgebogen waren (hypothetisches Stadium, Abb. 19 h). Das Merkmal 'schwache Abknickung der Tergum X-Zipfel nach dorsal' ist jedoch mit Unsicherheiten behaftet, da es (siehe *P. martinezii*, Abb. 19 k) zur Reduktion neigt und somit bereits bei der Stammart 'C' der Untergattung vorhanden gewesen sein könnte.

Auf der *Neocallicrania*-Seite des Stammbaums wurde der Cercus-Innenzahn nach proximal verlegt; der Fortsatz des Tergum X wurde möglicherweise im Zusammenhang mit dieser Entwicklung sogar verkleinert, um sie ohne Funktionsverlust zuzulassen. Innerhalb von *Neocallicrania* wurde der Innenzahn des Cercus bei *P. selliger* dann sekundär vergrößert (Merkmal 8, Abb. 19 e; Konvergenz zu *P. ramburii*, Abb. 19 i); dies war jedoch nur im Zusammenhang mit der Ausbildung eines Gelenkes an der Basis des vorgezogenen Bereichs des Tergum X, in welchem der Tergum X-Fortsatz bei Schließung der Cerci nach unten weggeschwenkt werden konnte, möglich (vgl. auch Abb. 13 a und 'Spezieller Teil', 'Bemerkungen zur Systematik').

Im Gegensatz zu *P. miegii*, *P. lusitanicus* und *P. serratus* kann der kaudale Fortsatz des Tergum X auch bei *P. bolivarii* (Abb. 19c) nach unten geklappt werden; auch hier ist der Hinterrand des Tergum X dann 'gerade'. Da in diesem Fall jedoch keine funktionelle Notwendigkeit für eine Beweglichkeit des Tergalfortsatzes ersichtlich ist – die Cercus-Zähne sind (wie bei *P. miegii*, *P. lusitanicus* und *P. serratus*) kurz –, könnte man folgern, daß ein ähnlicher Zustand wie bei *P. bolivarii* als präadaptiver Ausgangspunkt für die autapomorphe Vergrößerung des Cercus-Innenzahns bei *P. selliger* in Frage kommt. Dies wäre ein Argument für ein Schwestergruppenverhältnis von *P. bolivarii* und *P. selliger* (siehe gestrichelte Linie mit '?' in Abb. 18 und 19).

Diese vor allem auf funktionsmorphologischen Erwägungen beruhenden Hypothesen sind sicher nur erste Schritte zur Aufklärung der Evolution der Strukturen des männlichen Abdomenendes. Neben stammesgeschichtlichen Analysen an anderen Gruppen der Ephippigerinae müssen nun genauere Untersuchungen der Funktionsmorphologie der Kopulationsapparate durchgeführt werden (morphologische Vergleiche allein ergeben sicher keine Leserichtungskriterien; vgl. z.B. Pfau 1991). Zu den weiteren zur stammesgeschichtlichen Rekonstruktion herangezogenen morphologischen Merkmalen vgl. Abb. 18.

Bioakustische Merkmale

Initialgesang. – Für die hypothetische gemeinsame Stammart 'A' von *Platystolus* (*Neocallicrania*) + *Platystolus* (*Platystolus*) wird ein längerer zwei-teiliger Initialgesang, mit einem Crescendo-Teil I und einem laute, längere Silben enthaltenden Teil II, angenommen, ähnlich dem Initialgesang von *P. faberi*, *P. ramburii* oder auch *P. bolivarii*. Möglicherweise stellt ein derartiger Initialgesang eine Autapomorphie der Stammart von *Platystolus* dar. Strukturell entsprechende, jedoch kürzere Gesangsverse finden sich innerhalb der Ephippigerinae auch bei Arten anderer Gattungen, etwa bei *Steropleurus stali* (Bolívar, 1877) und *Steropleurus ortegai* (Pantel, 1896) (Hartley et al. 1974, Heller 1988 sowie eigene, unpubl. Beobachtungen), bei welchen allerdings der Teil II bis auf eine Silbe verkürzt wäre, oder bei *Ephippigerida zapatari* (Bolívar, 1877) (Heller 1988; eigene, unpubl. Beobachtungen) und *Uromenus* cf. *robustus* Werner, 1933 (Heller 1988). Diese Arten könnten *Platystolus* nahe stehen.

Möglicherweise wurde der ursprüngliche Initialgesang bereits bei der ersten Art-Aufspaltung – in die Stammart 'B' von *Platystolus* (*Neocallicrania*) und die Stammart 'C' von *Platystolus* (*Platystolus*) – alternativ abgewandelt: die Stammart 'B' verkürzte die Teil II-Silben und reduzierte die Öffnungssilben in diesem Abschnitt (Merkmal [2]; zu finden noch bei *P. bolivarii*), die Stammart 'C' verlängerte dagegen die Teil II-Silben (Merkmal [2*]; erhalten bei *P. faberi* und *P. ramburii*) und behielt die Öffnungssilben plesiomorph bei.

Schon die Aufspaltung der Stammart 'A' von *Platystolus* könnte also sowohl zu abgrenzenden Gesangs-Merkmalen (Fernbereich der Partnerfindung) als auch abgrenzenden Merkmalen der Kopulationsmechanik (eigentliche Paarung; siehe 'Morphologische Merkmale') geführt haben. Die Merkmale [2] und [2*] – wie auch die Merkmale 3 part. und 4 (wenn man von einer parallelen Veränderung des Tergum X-Zipfels bzw. Cercus-Innenzahns ausgeht) – wären demnach als alternativ-apomorphe Merkmale anzusehen.

Der dargestellte Stammbaum (Abb. 18) deutet auf eine komplizierte Evolution des männlichen Initialgesangs innerhalb der beiden Untergattungen hin. Auf der *Neocallicrania*-Seite kann z.B. für die aus der hypothetischen Stammart 'D' hervorgegangenen Arten eine (der Merkmalsausbildung [2*] konvergente) erneute Verlängerung der Teil II-Silben angenommen werden (Merkmal [7]; zu finden bei *P. selliger*, *P. miegii* und, m. E., *P. lusitanicus*). *P. serratus* verkürzte dagegen die Teil II-Silben wieder (Merkmal 13 part.). Derartige Veränderungen der Silbenlänge stellen bei nah-verwandten Arten von Feld- und Laubheuschrecken ein häufig eingesetztes Mittel zur Artabgrenzung dar (vgl. z.B. v. Helversen 1979; Pfau 1988), so daß durchaus vorstellbar ist, daß es, nach räumlichen Trennungen von Gruppen, mehrfach zu alternativen Entwicklungen kommt.

Abgesehen von den beschriebenen Abwandlungen der Versteil II-Silbenlänge fanden innerhalb von *Neocallicrania* noch gravierendere Veränderungen der Gesamtstruktur des Initialgesanges statt. Während der Versteil I bei *P. selliger* beibehalten und (vor allem im Osten; siehe Abschnitt 'Verbreitung und Ausbreitungsgeschichte') autapomorph stärker verändert wurde (Merkmal 9 part.), wurde er bei der Stammart 'E', dem hypothetischen Vorfahren von *P. miegii* und *P. lusitanicus* + *P. serratus*, reduziert (Merkmal 10). Möglicherweise begünstigten diese unterschiedlichen Gesangsdifferenzierungen eine Abgrenzung der aus der Spaltung der Stammart 'D' hervorgegangenen Tochterarten (*P. selliger* - Stammart 'E'). Die Stammart 'F' von *P. lusitanicus* + *P. serratus* differenzierte dann den verbliebenen Teil II des Initialgesangs durch sukzessive Verkürzung der Silbenpausen im Versverlauf (Merkmal 12 part.).

Auf der *Platystolus* (*Platystolus*)-Seite des Stammbaumes wird der Initialgesang der Männchen erst bei der Aufspaltung der Stammart 'H' in *P. obvius* und *P. surcularius* + *P. martinezii* in stärkerem Maße abgewandelt: Bei *P. obvius* wurde der Teil I des Initialgesangs völlig reduziert; durch eine Reduktion der Silbenzahl bis auf eine einzige Silbe ging außerdem der Vers-Charakter des Gesangs verloren (Merkmale 16 und 17). Die Stammart 'I' der Schwestergruppe *P. surcularius* + *P. martinezii* reduzierte dagegen den Teil II des Initialgesangs (Merkmal 16*; der Teil II der Rückantwort blieb dagegen erhalten, siehe weiter unten). Auch die Aufspaltung der Stammart 'H' führte also anscheinend zu alternativ-apomorphen Gesangsmerkmalen, die die Abgrenzung der Tochterarten begünstigt haben könnten. Bei *P. surcularius* behielt der Versteil I weitgehend seine ursprüngliche Form bei; die relativ kurzen Einzelverse wurden zu einem sekundär repetitiven Gesamtgesang gereiht (Merkmal 19 part.). Bei *P. martinezii* wurde der Teil I dagegen stark verlängert und modifiziert (Merkmal 22).

Rückantwort. – Die Initialgesang-ähnlichen Rückantworten von *P. faberi* und (weniger ausgeprägt) *P. bolivarii* deuten darauf hin, daß die Rückantwort an der Basis der Untergattungen *Platystolus* und *Neocallicrania* noch weitgehend einem zweiten Initialgesangsvers, der sofort nach der Antwort des Weibchens gesungen wurde, entsprach. Am *Neocallicrania*-Ast des Stammbaums wurde die Rückantwort wahrscheinlich bereits bei der Stammart 'B' verkürzt und modifiziert. Eine noch weitergehende Reduktion fand dann wohl bei der Stammart 'D' statt (Merkmal [6]). Dieses Merkmal wurde in der Abb. 18 zur Begründung einer Gruppe *P. selliger* + *P. miegii* + *P. lusitanicus* + *P. serratus* herangezogen. Es ist zwar angesichts der allgemeinen Reduktionstendenz der Rückantwort (siehe auch *Platystolus* (*Platystolus*)) etwas fraglich, wird aber durch weitere mögliche Synapomorphien (Merkmale [5], [7]) gestützt. (Zum eventuellen Schwestergruppenverhältnis von *P. bolivarii* und *P. selliger* siehe 'Morphologische Merkmale'.)

Auch innerhalb der Untergattung *Platystolus* neigt die Rückantwort zur Reduktion. Wahrscheinlich waren bereits bei der Stammart 'G' nur einzelne (Teil II-)Silben des ursprünglich längeren Rückantwort-Verses übriggeblieben (Merkmal [14a]). Dieses Merkmal würde die Monophylie einer Gruppe *P. ramburii* + *P. obvius* + *P. martinezii* + *P. surcularius* stützen; die Möglichkeit eines Schwestergruppenverhältnisses zwischen *P. faberi* und *P. ramburii* kann jedoch nicht ausgeschlossen werden (siehe 'Morphologische Merkmale').

Eine noch weitergehende Reduktion der Rückantwort (durch Silben-Verkürzung) fand bei *P. obvius* statt (autapomorphes Merkmal 14b), wohingegen die Stammart 'I' von *P. surcularius* und *P. martinezii* die Rückantwort anscheinend noch in plesiomorpher Ausprägung, d.h. weniger stark reduziert von der Stammart 'H' übernahm. *P. surcularius* reduzierte die Rückantwort dann vollständig (Merkmal 19; siehe dazu auch Abschnitt 'Funktion und Evolution der Rückantwort'). Dagegen behielt *P. martinezii* die langen Teil II-Silben der Rückantwort der Stammart 'I' bei, so daß hier der 'Gesamt-Gesang' des Männchens (Initialgesang + Rückantwort) dem Initialgesang von *P. selliger* äußerlich stark ähnelt (zumal auch bei *P. martinezii* die Öffnungssilben reduziert sind; vgl. Abb. 17). Im Gegensatz zum Gesang von *P. selliger* gehören die Teil II-Silben bei *P. martinezii* aber nicht dem Initialgesang an, sondern stellen Silben dar, die aus einem zweiten Gesangsvers, nämlich der Rückantwort, stammen. Von diesem zweiten Vers war bei der Stammart 'I' (genauer wohl schon seit der Stammart 'G') nur noch der Teil II vorhanden; der Initialgesang der Stammart 'I' war andererseits durch Reduktion des Teils II modifiziert, d.h. in ihm fehlte gerade der andere Versteil zu einem vollständigen Vers (siehe weiter oben). So arrangieren sich die beiden Versteile I und II bei *P. martinezii* nur scheinbar zu einem kompletten, zwei-teiligen Initialgesang – jedoch eben nur dann, wenn ein Weibchen geantwortet hat (*P. selliger* singt dagegen die Rückantworten zusätzlich zu seinem zwei-teiligen Initialgesang).

Obwohl das Merkmal 'Rückantwort' an der Basis beider Untergattungen noch in primitiver Ausprägung zu finden ist, kann es nicht unbedingt als eine die Monophylie der Gattung *Platystolus* stützende Autapomorphie gewertet werden. Die im folgenden beschriebenen Beobachtungen an *Steropleurus* aff. *stali* (Bolívar, 1877) zeigen, daß die Rückantwort möglicherweise bereits bei den Vorfahren von *Platystolus* evoluiert wurde; es könnte sich hier allerdings auch um Konvergenz handeln (vgl. Abschnitt 'Funktion und Evolution der Rückantwort').

Steropleurus aff. *stali* unterscheidet sich nur geringfügig von *Steropleurus stali*: die Titillatoren sind länger und stärker gebogen, der Initialgesang ist kürzer. (Ob hier im Grunde nicht eine eigene, neue Art vorliegt, muß noch näher untersucht werden.) Eine große Population von *Steropleurus* aff. *stali* fand sich bei Candelario (Provinz Salamanca, Westausläufer der Sierra de Gredos; 27.vii.1991) in 1800m Höhe: in einem einzigen Ginsterbusch saßen bis zu ungefähr 100 Tiere. Komplette Wechselgesänge zwischen einem Männchen und einem Weibchen, die Antworten und (stark verkürzte!) Rückantworten enthalten, werden in Abb. 20 e) und g) wiedergegeben. (Zur Kopulation im Labor vgl. Tabelle 1.)

Funktion und Evolution der Rückantwort

Die Frage nach der biologischen Bedeutung der komplexen Duette zwischen Männchen und Weibchen der Gattung *Platystolus* (und weiterer Ephippigerinae; siehe Abschnitt 'Phylogenie') ist sicher nur schwer zu klären (vgl. etwa Robinson et al. 1986 zur Bedeutung der einfacheren Kommunikation bestimmter Phaneropterinae). Dennoch soll hier versucht werden, ihrer möglichen Funktion und

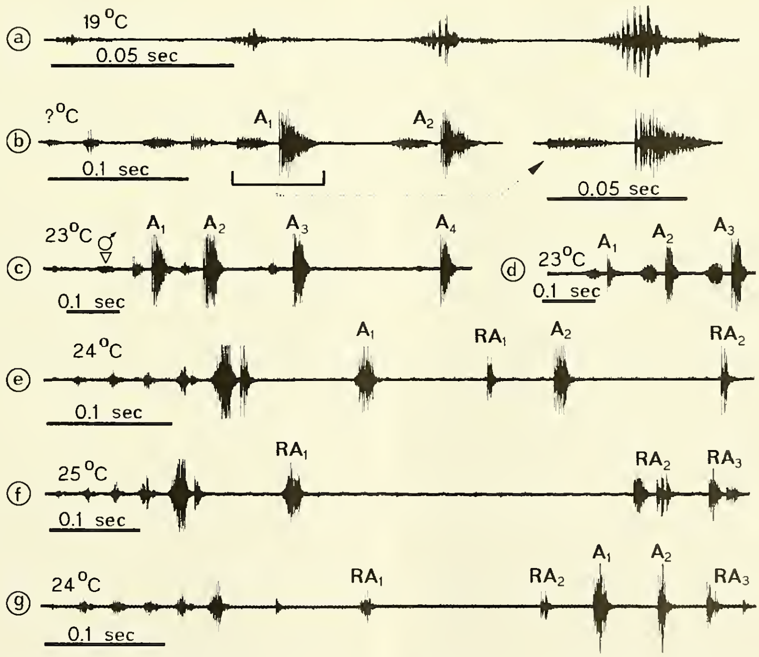
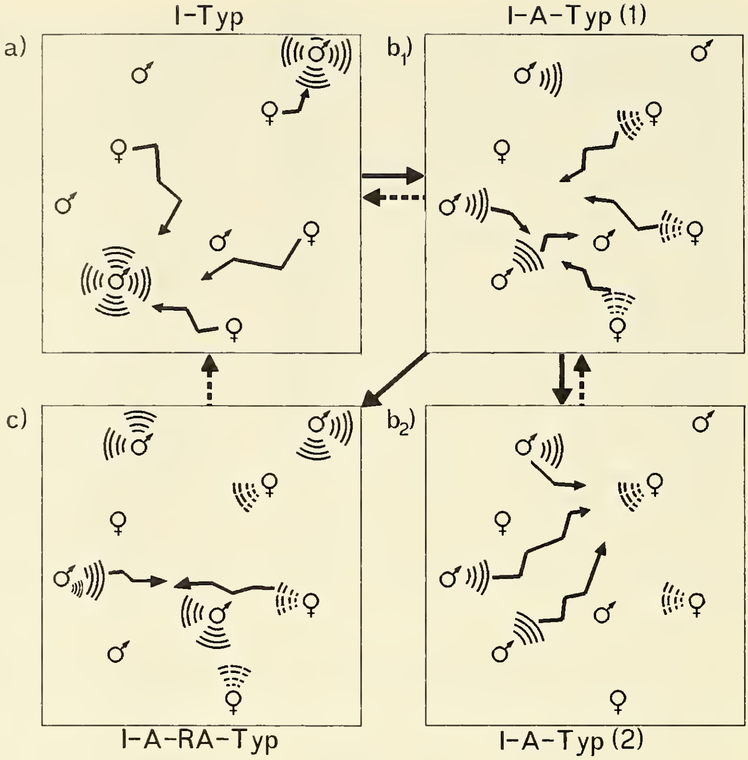


Abb. 20. *Steropleurus* aff. *stali*. Bei dem schon etwas gealterten Pärchen waren die Zeitintervalle zwischen den ♂ Initialgesängen (a) und den ♀ Antworten auffällig unterschiedlich (vgl. b und g). Die Antwort des ♀ bestand aus 1-4 Silben-Paaren (oder einzelnen Schließsilben), die ein deutliches Crescendo aufweisen konnten (d); meistens wurde das letzte Silbenpaar stärker abgesetzt (c). Die Rückantwort – bestehend aus 1-4 Silbenpaaren oder einzelnen, typisch strukturierten Öffnungs- oder Schließsilben – konnte dem Initialgesang auch ohne weibliche Antwort angefügt werden (f). Antwort und Rückantwort überlappten in verschiedener Weise (e, g). Abschreck-Stridulationen der ♂ und ♀ (längere Serien aus bis ca 15 Silbenpaaren) sowie 1-2 Sekunden lange Spontangesänge der ♀ (nicht dargestellt) zeigen, daß das akustische Inventar der Art dem von *Platystolus* entspricht. Abkürzungen siehe Abb. 2.

Abb. 21. Kommunikations-Typen der Orthopteren: a) Initialgesang-Typ (I-Typ); b_1), b_2) Initialgesang-Antwort-Typ (1) und (2) (I-A-Typ (1), (2)); c) Initialgesang - Antwort - Rückantwort-Typ (I-A-RA-Typ). Gestrichelte Pfeile kennzeichnen Rückentwicklungen.



Evolution durch einen Vergleich der verschiedenen Typen der akustischen Kommunikation der Orthopteren näher zu kommen (Abb. 21). Dabei soll das Augenmerk vor allem auf das Risiko singender und/oder sich bewegender Tiere sowie die (damit in Beziehung stehende) Sicherheit und Geschwindigkeit des Zusammenfindens der Männchen und Weibchen gerichtet werden. Außerdem sollen einige Beobachtungen beschrieben werden, die für die hier vorgestellten Hypothesen wesentlich waren oder für zukünftige Bearbeitungen von Bedeutung sein könnten.

Abb. 21 a) zeigt den wahrscheinlich ursprünglichen Typ der akustischen Kommunikation der Orthopteren, bei dem die Männchen stationär singen, während sich die Weibchen ihnen phonotaktisch zur Paarung nähern (Initialgesang-Typ; abgekürzt I-Typ). Dieser Kommunkationstyp findet sich z.B. bei Grillen und Laubheuschrecken (siehe etwa Bailey 1991, Ewing 1989, Huber et al. 1989). Das Feindrisiko der Geschlechter ist geteilt, da sowohl das stationäre Dauersingen der Männchen wie auch die Bewegungen der Weibchen (v.a. wenn sie freies Gelände überqueren müssen) Risiken in sich bergen (vgl. dazu Bailey 1991; Heller 1992 für *Poecilimon veluchianus* (Ramme, 1933)). Nur die Weibchen haben bereits im Vorfeld der Paarbildung eine Wahlmöglichkeit. Die Männchen können dagegen erst wählen, wenn Weibchen bei ihnen ankommen; sie erhalten keine Informationen darüber, wo sich die Weibchen befinden, es sei denn, sie sind bereits sehr nahe. Ein solches System hat den Nachteil, daß u.U. viele Weibchen auf ein einziges Männchen zuwandern.

Abb. 21 b) stellt den zweiten in der Literatur beschriebenen Kommunikationstyp der Orthopteren dar, bei dem die Männchen singen und die Weibchen antworten (Initialgesang-Antwort-Typ; I-A-Typ). Bei diesem Typ, der für viele Phaneropterinae zutrifft, bewegen sich die Männchen und Weibchen im wahrscheinlich ursprünglichen Fall (I-A-Typ (1), Abb. 21 b_1) aufeinander zu (vgl. Zhantiev & Korsunovskaya 1986, Heller 1990). Bei einigen flugfähigen nordamerikanischen Phaneropterinae übernimmt das Männchen nach der Antwort des Weibchens einen ersten Teil der Annäherung und erzeugt dann einen abweichenden Gesang, der das Weibchen zur Überbrückung der restlichen Distanz veranlaßt (Spooner 1968).

Im abgeleiteten Fall des I-A-Typs der Kommunikation (I-A-Typ (2), Abb. 21 b[2]), der ebenfalls für verschiedene Phaneropterinae zutrifft, sind die antwortenden Weibchen stationär und nur die Männchen bewegen sich phonotaktisch (vgl. Heller & v. Helversen 1986, Robinson et al. 1986, Zhantiev & Korsunovskaya 1986).

Auch Vertreter der Ephippigerinae (*Steropleurus asturiensis* (Bolívar, 1898) und *Steropleurus stali* (Bolívar, 1877)) müßte man nach den Befunden von Hartley (1993, p. 166: 'either or both partners moving') dem I-A-Typ (1) bzw. (2) zurechnen. *Steropleurus asturiensis* erzeugt jedoch offensichtlich auch Rückantworten, die Hartley als 'secondary song' bezeichnet; zu *Steropleurus* aff. *stali* siehe Abschnitt 'Phylogenie'.

Beim I-A-Typ der Kommunikation haben die Männchen und die Weibchen im Vorfeld der Paarbildung eine Wahlmöglichkeit: die Weibchen können wählen, welchem Männchen sie antworten (bzw. antworten und sich nähern) wollen, die Männchen, zu welchem antwortenden Weibchen sie sich hinbewegen wollen. Das Risiko der Männchen und Weibchen ist wohl beim I-A-Typ (1) nur geringfügig gegenüber dem I-Typ verschoben. Es erscheint zwar für die sich bewegenden und außerdem durch ihren Gesang auffallenden Männchen größer geworden zu sein, wurde aber gleichzeitig dadurch verringert, daß sie jetzt über die Anwesenheit 'interessierter' Weibchen informiert sind und nicht mehr andauernd singen müssen: sie müssen nur von Zeit zu Zeit (wahrscheinlich abhängig von verschiedenen Faktoren, z.B. der Anzahl vorhandener Weibchen bzw. konkurrierender Männchen, der Habitatstruktur ...) einen Initialgesang erzeugen, um zu prüfen, ob sie dem Weibchen inzwischen nähergekommen sind, die Laufrichtung also noch stimmt. Das Risiko der Weibchen blieb wohl ebenfalls, trotz der hinzugekommenen akustischen Aktivität, relativ unverändert, da der Antwortgesang (in einem artspezifischen Zeitfenster gesungen) nur kurz zu sein braucht, so daß die Weibchen nur wenig auffallen (vgl. dazu auch Heller 1984) – ein Teil der Laufaktivität und des mit ihr verbundenen Risikos wird außerdem von den Männchen übernommen. Im Fall stationärer Weibchen (I-A-Typ (2)) wurde die Risikobalance wohl stärker zu Ungunsten der Männchen verschoben (vgl. Heller 1992 für *Poecilimon affinis* (Frivaldski, 1867)). Dieses Risiko konnte bei manchen Arten anscheinend dadurch vermindert werden, daß das Männchen nach Erhalt der weiblichen Antwort die Lautstärke der weiteren Initialgesänge reduziert (vgl. Spooner 1968 für *Scudderia curvicauda* Brunner).

Das Weibchen erhält bei den beiden Initialgesang-Antwort-Typen der Kommunikation keine sofortige Information darüber, ob seine Antwort von dem speziellen Männchen, dem es geantwortet hat, überhaupt gehört worden ist, und ob sich dieses zu nähern beabsichtigt. Dies zeigt sich erst beim nächsten, aus größerer Nähe kommenden Initialgesang des Männchens. Beim I-A-Typ (1) ist auch für das Männchen ungewiß, welches der antwortenden Weibchen sich in seine Richtung bewegen wird. Die Mobilität beider Geschlechter bedeutet im Grunde, daß sich ein Männchen auf jedes antwortende Weibchen zubewegen könnte, ein Weibchen dagegen auf jedes singende Männchen. Die Antworten bzw. Gesänge anderer Tiere können also für die Männchen und Weibchen bei beiden I-A-Typen leicht zu Änderungen der Orientierung führen, so daß der Rufkontakt abreißen und die Information über das Näherkommen eines bestimmten Weibchens bzw. Männchens verlorengehen kann; für beide Geschlechter können sich komplizierte Zickzack-Kurse und Umwege ergeben.

Der I-A-Typ der Kommunikation kann aus dem ursprünglicheren I-Typ abgeleitet werden (Abb. 21 a-b_1-b_2). Für den Rollentausch der Männchen und Weibchen bei dieser Entwicklung macht Bailey (1991) vor allem eine Erhöhung des Feinddrucks verantwortlich, die zunächst eine Verkürzung des männlichen Gesangs zur Folge hatte und dann – wegen der zunehmenden Schwierigkeit für Weibchen, immer unauffälliger singende Männchen zu finden – zur Evolution der weiblichen Antwort führte. Heller (1990) beschreibt mehrfach-konvergente Entwicklungsumkehrungen bei den Barbitistini, die zeigen, daß es leicht wieder zu einer sekundären Vereinfachung der Kommunikation durch Reduktion der weiblichen Antwort kommen kann (Abb. 21 b_2-b_1-a). Zwischen dem I-A-Typ (1) und dem I-Typ könnte dabei ein weiteres, ebenfalls anscheinend rezent repräsentiertes Übergangsstadium durchlaufen werden, bei dem sich (noch) antwortende Weibchen auf (bereits) stationäre Männchen zubewegen (Gattung *Isophya*; siehe Zhantiev & Korsunovskaya 1986); zur Erklärung dieses (schwer verständlichen) Kommunikationstyps wird angenommen, daß die Antworten der Weibchen eine gesteigerte Singaktivität der Männchen provozieren, wodurch die Suche der Weibchen erleichtert würde (Heller 1990, Robinson 1990). Robinson (1990) betrachtet den Fall als typisch für die Gattungen *Callicrania*, *Platystolus* und *Steropleurus* - allerdings ohne Kenntnis der Rückantwort.

Beim dritten, für Orthopteren neuen Kommunikationstyp (Pfau & Schroeter 1988) wird das Duett durch einen zweiten Gesang des Männchens, die Rückantwort, erweitert (Initialgesang-Antwort-Rückantwort-Typ; I-A-RA-Typ, Abb. 21 c). Dieser Kommunikationstyp kann relativ leicht vom I-A-Typ (1) abgeleitet werden, da sowohl die Fähigkeit der Weibchen zu Antwortgesängen als auch die Mobilität der (nicht mehr repetitiv singenden) Männchen bereits vorhanden sind.

Setzt man bei *Platystolus* die bioakustischen Befunde mit dem stammesgeschichtlichen System (Abb. 18) in Beziehung, so ergibt sich, daß die Rückantwort bei den plesiomorphen Arten *P. faberi* und *P. bolivarii* dem Initialgesang stärker ähnelt; sie ging demnach aus einem zweiten Gesangsvers hervor, der unmittelbar nach der weiblichen Antwort erzeugt wurde. Abgeleitete, jüngere Arten singen dagegen verkürzte Rückantworten, die den Vers-Charakter meist weitgehend verloren haben: nur einzelne Silben, die entweder dem Versteil I oder II 'entliehen' wurden, blieben übrig (siehe Kapitel der Arten sowie Abschnitt 'Phylogenie'). Durch diese Verkürzung der Rückantwort wurde wahrscheinlich das Feindrisiko der durch Initialgesang, Rückantwort und Bewegung besonders auffäligen Männchen verringert.

Dagegen ist bemerkenswert, daß der Initialgesang selbst - abweichend vom I-A-Typ der Phaneropterinae - bei den meisten Arten von *Platystolus* relativ lang ist. Man muß daraus jedoch nicht unbedingt auf eine grundsätzlich von den Phaneropterinae (siehe Bailey 1991 und weiter oben) abweichende Evolution der weiblichen Antwort schließen. Die Antwort des Weibchens wurde zwar innerhalb der Ephippigerinae wahrscheinlich konvergent zu den Phaneropterinae entwickelt, ihre Evolution könnte aber ebenfalls dadurch vorangetrieben worden sein, daß die Initialgesänge der Männchen immer unauffälliger wurden – z.B. durch eine Verlängerung der Pausen zwischen den einzelnen Gesangsversen: bei einigen Arten (*P. selliger*, *P. lusitanicus*, *P. serratus*) sind die Pausen zwischen den einzelnen Initialgesängen so lang (auch bei günstigen Witterungsbedingungen bis über 15 Minuten lang), daß eine Ortung der Tiere im Gelände nur sehr schwer möglich ist.

Auch im Falle des Initialgesang-Antwort-Rückantwort-Typs der Kommunikation bekommen sowohl die Männchen als auch die Weibchen akustische Informationen, die bereits im Vorfeld der Geschlechterfindung eine Wahlmöglichkeit erlauben. In diesem Fall wird jedoch dem Weibchen sofort nach seiner Antwort durch die männliche Rückantwort signalisiert, daß es gehört worden ist. Es muß in diesem Fall keinen weiteren Initialgesang abwarten, um zu erfahren, ob das spezielle Männchen, dem es geantwortet hat, seinerseits 'interessiert' ist; da es mit einer sofortigen Laufaktivität dieses Männchens rechnen kann (siehe weiter unten), verbessert sich seine Erfolgschance. Die Rückantwort stellt anscheinend eine 'Entscheidungshilfe' für das Weibchen dar, und bedeutet umgekehrt auch für das Männchen, daß sich das spezielle Weibchen, dessen Antwort es 'bestätigte', nun mit größerer Wahrscheinlichkeit in Bewegung setzen wird. Die Tiere laufen nicht mehr unbedingt in Richtung irgendeiner Antwort bzw. irgendeines Initialgesangs los, sondern erst nach einer beidseitigen Bestätigung der Ortung. Für beide Geschlechter scheint es im weiteren vor allem darauf anzukommen, sich zur Schall-Erzeugung und -Wahrnehmung immer wieder möglichst gut in Richtung des erwarteten Partners auszurichten. Da der akustische Kontakt durch die Verlängerung (und Differenzierung) des Gesangsduetts besser aufrechterhalten werden kann als bei anderen Kommunikationstypen, wird das Zusammenfinden erleichtert und beschleunigt – es wurde eine qualitativ neue Stufe erreicht.

Diese Hypothesen können durch verschiedene Labor- und Freilandbeobachtungen gestützt und erweitert werden:

Versuche mit *P. obvius* zeigten, daß die Männchen auf Antworten der Weibchen noch bei 15 Metern Entfernung mit Rückantworten reagierten und sich dann sofort genau in Richtung Weibchen in Bewegung setzten.

Bei *P. miegii* ergab sich, daß die Annäherung der Geschlechter bei einer größeren Entfernung der Tiere in Etappen vonstatten gehen muß (entsprechend wie auch beim I-A-Typ; vgl. z.B. Spooner 1964, 1968). Waren die Käfige der Männchen und Weibchen weit voneinander entfernt aufgestellt (ca 15 Meter), sangen die Weibchen zwar Antworten nach dem männlichen Initialgesang (in einzelnen Fällen, bei besonder hoher Motivation, bis zu 10 Einzelsilben in einer bis fünf Sekunden langen Serie), diese wurden jedoch von den Männchen offensichtlich überhaupt nicht gehört – die Antwort ist deutlich leiser als der bei dieser Art besonders laute Initialgesang der Männchen. Das Weibchen muß sich also zuerst allein dem Männchen nähern. Wurde die Distanz durch Verstellen der Käfige auf ca 8 Meter verringert, reagierte das Männchen sofort mit Rückantworten. Wurden beide Tiere jetzt freigelassen, fanden sie innerhalb weniger Sekunden zueinander ; vor allem das Weibchen fiel dabei durch besonders schnelles und zielstrebiges Laufen auf. Während der wechselseitigen Annäherung wurden weiter komplette Duette gesungen; erst bei ca 50 Zentimetern Entfernung verzichtete das Weibchen öfters auf eine Antwort.

Die Männchen und Weibchen von *P. miegii* reagierten interessanterweise je nach der Distanz der Käfige 'abgestuft': Bei ca 8 Metern Entfernung wurde meist nur eine einzige Antwortsilbe und eine einzige Rückantwortsilbe erzeugt. Bei einer plötzlichen Verringerung der Entfernung auf etwa zwei Meter (bis 50 Zentimeter) kam es dagegen fast immer zu Serien-Antworten der Weibchen, die besonders häufig schon innerhalb des Initialgesanges begannen (Abb. 12 d); das Männchen antwortete seinerseits mit einer Serie von Rückantwortsilben, wobei entweder kurz nach jeder Antwortsilbe eine Rückantwortsilbe folgte (Abb. 12 b), oder es wurde (anscheinend bei besonders großer Erregung des Männchens) direkt nach der ersten weiblichen Antwortsilbe eine Serie von drei bis sechs eng stehenden Silben erzeugt (Abb. 12 e).

Im Freiland konnte bei *P. selliger meridionalis*, dessen Gesangsaktivität in einem lichten, jungen Eichenwald bei Fundao nach Einbruch der

Dunkelheit allmählich zunahm, beobachtet werden, daß die Weibchen ganz bestimmte Männchen 'bevorzugten'. Sie konkurrierten anscheinend hinsichtlich dieser Männchen: Gesänge anderer Männchen, die sogar näher saßen, wurden ignoriert; sie hatten keine Antworten zur Folge – diese Männchen sangen daher auch keine Rückantworten. Es kam also zu Wechselgesängen zwischen ganz bestimmten Tieren. Wegen der Dunkelheit war es leider nicht möglich, festzustellen, ob Suchbewegungen durchgeführt wurden. Bevorzugte Rufkontakte zwischen bestimmten Tieren waren auch bei *P. miegii* im Labor zu beobachten. Das erweiterte Duett des I-A-RA-Typs dient also anscheinend auch einer Paarbildung (und wechselseitigen Stimulation?) im Vorfeld.

Die gezielte Annäherung der Geschlechter ist in einem drei-dimensional-komplexen Gelände, mit größeren Sträuchern und Bäumen, sicher problematisch. Die hier notwendigen zahlreichen Umwege bedeuten nicht nur einen Zeit- und Energieaufwand, auf den Wegstrecken könnten außerdem Gefahren lauern. Der I-A-RA-Kommunikationstyp bedeutet in einem derartigen Lebensraum wohl einen besonderen Vorteil. Da auf dem Wege beider Geschlechter immer wieder Kursänderungen vorgenommen werden müssen (Hindernisse, Zwangswege durch Astverläufe etc.), sind von Zeit zu Zeit zwar erneute Rufkontakte zur Korrektur des eingeschlagenen Weges notwendig, die Gefahr unnötiger Umwege erscheint jedoch insgesamt für beide Geschlechter verringert (siehe weiter oben). Die beschriebenen Beobachtungen an *P. selliger meridionalis* und *P. miegii* (Bevorzugung einzelner Männchen, Abstufung der Reaktion) weisen darüberhinaus darauf hin, daß durch die Rückantwort dem Weibchen weitere Informationen, z.B. über die Motivation des Männchens, mitgeteilt werden könnten.

Nur *P. surcularius*, eine junge Art, die einen stärker abgeleiteten Initialgesang der Männchen zeigt (siehe Abschnitt 'Phylogenie'), ist anscheinend sekundär vom I-A-RA-Typ der Kommunikation zum I-Typ 'zurückgekehrt' (Abb. 21 c-a): 1) Die Männchen sind stationär und singen repetitiv; dafür eignen sich ihre verkürzten Gesänge besonders. 2) Die im Labor registrierten Stridulationen der Weibchen waren entweder spontaner Natur (d.h. wurden ohne Anregung durch ein Männchen erzeugt), oder die Weibchen sangen mehr oder weniger zufällig in die männlichen Gesangssequenzen hinein (Abb. 3 c), ohne sie zu unterbrechen. Die Stridulationen der Weibchen stellen also keine Antworten dar; die Versfolgen der Männchen lassen andererseits keine Rückantworten erkennen. 3) Nur die Weibchen bewegten sich phonotaktisch: sie liefen, sowie sie aus ihren Käfigen freigelassen wurden, sehr schnell und zielstrebig auf die singenden Männchen zu, erkletterten Hindernisse, die auf ihrer Strecke lagen, und suchten sie ab (kurioserweise wurde dabei in verschiedene Gegenstände hineingebissen, z.B. in die grünen, glatten Plastikbügel einer Brille). Hörten die Männchen auf zu singen, stellten auch die Weibchen ihr Suchverhalten sofort ein.

Möglicherweise war für die sekundäre Veränderung des Kommunikationstyps bei *P. surcularius* die Besiedlung eines neuen Lebensraumes von besonderer Bedeutung. Während die übrigen Arten der Gattung *Platystolus* in stark verbuschten bis bewaldeten (komplexen!) Habitaten leben, besiedelt *P. surcularius* die steppenartige, d.h. strukturarme und übersichtliche (klimatisch extreme) Offenlandschaft Mittelspaniens – heute allerdings nur noch kleinflächige Graslandreste sowie die Randstreifen der Agrargebiete.

In diesem Lebensraum, in dem *P. surcularius* als weitgehend sekundär-bodenlebend anzusehen ist, ist das Feindrisiko offensichtlich sehr hoch. Zu den zahlreichen tagaktiven Insektenfressern unter den Vögeln kommen in der Dämmerung z.B. Großtrappe, Triel und Steinkauz hinzu, die beiden letzteren auch in der Nacht. *P. surcularius* mußte diesem hohen Druck durch Freßfeinde anscheinend begegnen: 1) Männchen wie Weibchen sind farblich sehr gut getarnt. Am Tag sind sie schweigsam, leben in Verstecken und sind nur schwer zu finden; die wenigen Weibchen, die bis jetzt gefangen wurden, hatten sich kopf-unter tief in die Blattachseln von Pflanzen gedrückt. 2) Die Art ist weitgehend dämmerungs- bis nachtaktiv - im Gegensatz etwa zur Schwesterart *P. martinezii* (siehe Pfau & Schroeter 1988). 3) Bei Gefahr können die Tiere relativ weite Fluchtsprünge – ungewöhnlich bei den Ephippigerinae – ausführen. Beim Ergreifen erbrechen sie sofort ausgiebig Magensaft. Die Männchen zeigen Widerhaken-ähnliche Dornen auf den abdominalen Terga. 4) Außergewöhnlich ist die sehr kurze Dauer der Kopulation (siehe Tabelle 1), bei der nur etwa drei Minuten (!) auf die Abgabe der sehr großen Spermatophore entfallen.

In diesen Zusammenhang ist wohl auch die Veränderung des Kommunikationssystems zu stellen; das I-A-RA-System, bei dem beide Geschlechter sowohl durch Bewegung als auch durch Lautsignale auffallen, war anscheinend in dem neuen Lebensraum nicht mehr 'tragbar': Die Männchen wurden stationär und sangen (aus meist dornigen Pflanzenverstecken heraus) wieder repetitiv. Die Weibchen reduzierten die Antwort, was gleichzeitig automatisch die Reduktion der Rückantwort bei den Männchen bedeutete. Trotz dieser Vereinfachungen der Kommunikation sind die Chancen der Weibchen nicht schlecht, im offenen Gelände die Männchen zu finden, da Distanzen auf dem Boden schneller als im Geäst zu überbrücken sind, und kleinere Pflanzen schneller erklettert und abgesucht werden können.

Pfau & Schroeter (1988) nahmen zunächst – im Gegensatz zu den hier dargestellten Hypothesen – an, daß die Rückantwort von *P. martinezii* innerhalb der Gattungen *Platystolus* und *Callicrania* als ein Ausnahmefall anzusehen ist und dieser Art in ihrem steppenartigen Lebensraum Vorteile bringen könnte. Die späteren Untersuchungen zeigten jedoch, daß der Besitz der Rückantwort die Regel ist und nicht die Ausnahme. *P. martinezii* ist außerdem keineswegs auf Offenlandschaften beschränkt, sondern lebt auch auf verbuschten Waldlichtungen des Berglandes. Die bisherigen Vorstellungen zur Evolution der Rückantwort (Pfau & Schroeter 1988) mußten ebenfalls revidiert werden.

Verbreitung und Ausbreitungsgeschichte

Die Verbreitung der zahlreichen Arten der Ephippigerinae auf der Iberischen Halbinsel ist nur in Umrissen bekannt. In jüngerer Zeit faßten vor allem Peinado & Mateos (1986 a,b) und Peinado (1990) die in der Literatur und in Museen zu ermittelnden Fundortdaten zusammen; Peinado (1990) stellte für die meisten Arten auch Verbreitungskarten dar, wobei die Computerauswertungen die Areale allerdings nur relativ grob wiedergeben (Peinado mündl.). Im Hinblick auf die Arten der Gattungen *Callicrania* und *Platystolus* (bzw. der Untergattungen *Neocallicrania* und *Platystolus*) sind einige Erläuterungen und Korrekturen notwendig (vgl. Abb. 22): 1) Für *P. bolivarii* publizierte Herrera (1979) verschiedene weit im Osten, in der Provinz Navarra, liegende Fundstellen; dieses Gebiet fehlt bei Peinado (1990), wird jedoch 1992 von ihr aufgeführt. Da es mir bisher nicht gelang, *P. bolivarii* an den von Herrera angegebenen Orten in Navarra aufzufinden, und Herrera mir meine Bitte um Überprüfung nicht beantwortete, nehme ich an, daß die Tiere (übrigens durchweg Weibchen!) nicht korrekt bestimmt wurden. 2) Einige der von Peinado (1990) dargestellten Verbreitungsgebiete konnten durch eigene Funde vergrößert werden; es ist zu erwarten, daß die Areale der Arten bei weiteren Erfassungen noch beträchtlich korrigiert werden müssen: a) Das bisher bekannte Gebiet von *P. faberi* konnte durch die Entdeckung eines Vorkommens in der Sierra de la Demanda weit nach Osten vergrößert werden (Schroeter & Pfau 1987); hier liegt allerdings bereits eine von der westlichen Nominat-Unterart (*P. faberi faberi*) gut zu unterscheidende eigene Unterart vor (*P. faberi demandae*). Da es unklar ist, ob *P. faberi* zwischen den beiden extremen Fundstellen noch vorkommt, und wo genau die Grenze zwischen den beiden Unterarten liegt, stellt das in Abb. 22 dargestellte Gesamtgebiet eine stärkere Vereinfachung dar. b) Das Verbreitungsgebiet von *Callicrania selligera* liegt nach Peinado (1990: Fig. 31) aufgrund von Literaturdaten in Mittel- und Nordportugal (im Norden überlappend mit *Callicrania seoanei*); im Text (p. 158) wird aber auch Südportugal (Algarve, Monchique) erwähnt. *P. selliger selliger* (hier neu beschrieben und mit *C. seoanei* synonymisiert; siehe 'Spezieller Teil') konnte jedoch in Portugal nur nördlich des Flusses Douro (in der Serra do Gerez) aufgefunden werden. Zumindest die Angaben für Südportugal beruhen wohl auf Fehlbestimmungen; zum Teil liegen anscheinend Verwechslungen mit *Steropleurus andalusius* (Rambur, 1838) bzw. *S. pseudolus* (Bolívar, 1878) vor (siehe auch 'Spezieller Teil'). Das Verbreitungsgebiet von *P. selliger* reicht mit der neuen Unterart *P. selliger meridionalis* südwärts bis Mittelportugal und Mittelspanien (westliche Sierra de Gredos) und in Nordspanien, mit '*C. seoanei*' = *P. selliger selliger*, ostwärts bis in die Sierra de la Demanda. Für '*C. seoanei*' wurde in der Karte Peinado's (1990: Fig. 32) im Osten noch ein Fundgebiet in der Region der Provinz Lleida eingezeichnet; dies beruht jedoch auf einem Computerfehler (Peinado mündl.). c) Peinado (1990: Fig. 28) sieht das Verbreitungsgebiet von *Callicrania miegii* auf Mittelspanien beschränkt und grenzt '*C. miegi lusitanica*' (Mittelportugal) deutlich davon ab. *P. miegii* konnte jedoch auch in Portugal (Guarda) aufgefunden werden. Ansonsten werden für *P. miegii* in der Literatur nur relativ wenige, weit auseinanderliegende ältere Funde erwähnt, die hier grob zu einem quer durch Mittelspanien bis weit in den Osten reichenden Gesamtareal zusammengefaßt wurden (vgl. Peinado & Mateos 1986 b). d) *P. lusitanicus* ist, wie die neuen Funde in Portugal (Aviz) und v.a. Spanien (El Castillo de las Guardas) zeigen, weiter verbreitet als bei Peinado (1990: '*C. miegi lusitanica*', Fig. 28) dargestellt. Auch bei dieser Art ist offen, ob in den Bereichen zwischen den wenigen, weit auseinanderliegenden Fundstellen noch Vorkommen existieren.

Zur Klärung der Verbreitung von *P. lusitanicus* und *P. serratus* sind weitere Untersuchungen notwendig, da bisher nur einzelne Fundstellen ermittelt werden konnten. Eine besondere Schwierigkeit besteht allerdings darin, daß es selbst bei relativ Individuen-reichen Beständen – wie z.B. bei Aviz oder Sagres – wegen der leisen Gesänge und langen Gesangspausen außerordentlich schwierig ist, die Tiere zu fangen.

Obwohl die Verbreitungsgebiete der *Platystolus*-Arten zur Zeit nur grob-qualitativ umrissen werden können, soll hier geprüft werden, ob sich aus der Artspaltungs-Abfolge (siehe Abschnitt 'Phylogenie'; Abb. 18) und der Verbreitung (Abb. 22) ein kongruentes Bild der Ausbreitungsgeschichte ergibt.

Da *P. faberi* und *P. bolivarii* besonders ursprüngliche Arten darstellen, kann geschlossen werden, daß der Lebensraum der hypothetischen Stammart 'A' beider Untergattungen im Norden Spaniens, wahrscheinlich im westlichen Kantabrischen Gebirge, gelegen hat. Anscheinend wurde bereits bei der ersten Artspaltung eine westliche Art, die Stammart 'B' von

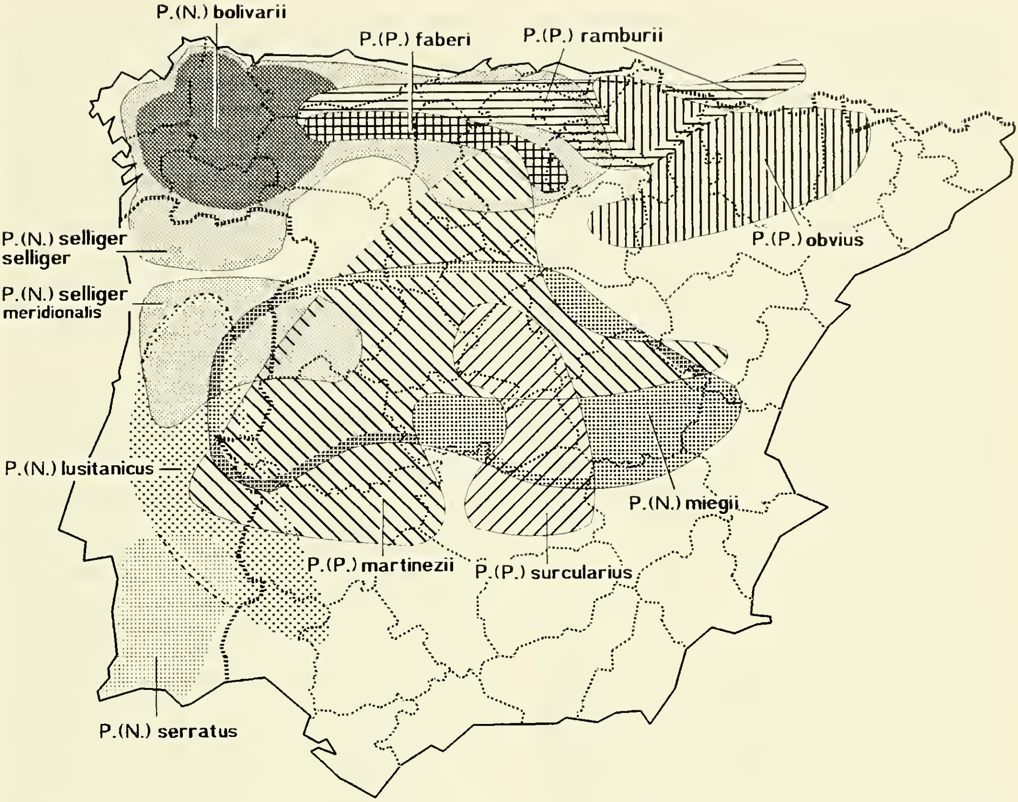


Abb. 22. Verbreitung der Arten von *Platystolus* (*Neocallicrania*) und *Platystolus* (*Platystolus*) auf der Iberischen Halbinsel (nach Peinado & Mateos 1986 a, b, Peinado 1990 und eigenen Funden).

Platystolus (*Neocallicrania*), von einer östlichen Art, der Stammart 'C' von *Platystolus* (*Platystolus*), getrennt.

Im Westen spaltete sich die Stammart 'B' der Untergattung *Neocallicrania* dann zunächst in *P. bolivarii* und die Stammart 'D' auf. Daß *P. selliger*, der Abkömmling der folgenden Spaltung der Stammart 'D', sich möglicherweise erst sekundär nach Osten ausgedehnt hat, geht daraus hervor, daß die Populationen von *P. selliger* im Osten einen stärker abgeleiteten Initialgesang zeigen. Für die Stammart 'D' muß aber ein Initialgesang angenommen werden, der sich sowohl in den Gesang von *P. selliger* als auch den Gesang der Schwesterart 'E' (die den Teil I des Initialgesanges reduzierte) transformieren läßt. Dafür sind Gesänge ähnlich den nord-östlichen Gesängen von *P. selliger* jedoch ungeeignet, da sie einen besonders langen Teil I aufweisen. Initialgesänge ähnlich denen der westlichen *P. selliger*, in welchen der Teil I kurz ist, würden dagegen eine Ableitung zulassen: sie könnten von *P. selliger* (zunächst) weitgehend unverändert übernommen worden sein – wohingegen die Stammart 'E' den (kurzen) Teil I vollends reduzierte. Eine andere Denkmöglichkeit ist, daß die Stammart 'D' einen Gesangs-cline bereits entwickelt hatte – lange Teile I im Nordosten und kürzere nach Westen zu –, und daß die Tochterart 'E' sich im Südwesten 'knospenartig' von dem nun als *P. selliger* zu bezeichnenden Rest abtrennte.

Auch für *P. miegii*, den einen der beiden Abkömmlinge der Stammart 'E', kann man annehmen (in diesem Fall aufgrund der Verbreitung der nah verwandten Arten *P. lusitanicus* und *P. serratus*), daß er wahrscheinlich primär im Westen der Iberischen Halbinsel gelebt hat und sein Gebiet erst sekundär in den Osten ausdehnte. Der zweite Abkömmling der Art 'E', die Stammart 'F', wurde wohl nach Südwesten abgegliedert und spaltete sich dann in eine nördliche Art, *P. lusitanicus*, und eine südliche Art, *P. serratus*, auf. Anscheinend wurden alle Areale nachträglich beträchtlich erweitert, so daß es wieder zu Überschneidungen kam.

Während der westliche Artenkomplex (*Neocallicrania*) eine relativ gut rekonstruierbare Ausbreitungsgeschichte zeigt, liegen die Anfänge der östlichen Arten (Untergattung *Platystolus*) mehr im Dunkeln. Wahrscheinlich hat *P. faberi*, der eine Abkömmling der hypothetischen Stammart 'C' der Untergattung, sein Verbreitungsgebiet im Norden der Iberischen Halbinsel weitgehend beibehalten, während sein Schwestertaxon, die Stammart 'G', eine stärkere Ausdehnungstendenz nach Osten entwickelte. Die Art 'G' wurde dann in die Stammart 'H' und *P. ramburii* (der als einzige Art sogar bis nach Frankreich vordrang) aufgespalten. Die Stammart 'H' gliederte nach Norden *P. obvius* ab, der sich nach Nordosten weiter ausdehnte, und nach Süden die Stammart 'I'. Aufgrund der Verbreitung von *P. obvius* ist es wahrscheinlich, daß die Schwesterart 'I' aus einem relativ weit im Osten liegenden Bereich nach Zentralspanien einwanderte. Das ursprüngliche Areal der Stammart 'I' scheint außerdem bereits relativ weit im Süden gelegen zu haben, da die extremer nördlichen Bereiche wohl erst spät, von *P. martinezii*, besiedelt wurden - also nach der Aufspaltung von 'I' in *P. martinezii* und *P. surcularius*, d.h. nach der Entwicklung autapomorpher Merkmale bei den beiden Tochterarten.

Aus der Verbreitung der Arten und dem phylogenetischen System ergibt sich demnach ein kongruentes Bild des Ablaufes der geographischen Evolution der Gattung *Platystolus*. Es zeigt eine vom nordwestlichen Spanien ausgehende Besiedlung weiter Bereiche der Iberischen Halbinsel. Die Untergattung *Neocallicrania* dehnte sich nach Westen aus und erreichte mit *P. selliger* und *P. miegii* Mittelportugal und das westliche Mittelspanien; *P. selliger* besiedelte Spanien auch im mittleren Norden, *P. lusitanicus* Südportugal und Südwestspanien und *P. serratus* sogar den äußersten Südwesten der Iberischen Halbinsel. Nur mit *P. miegii* drang *Neocallicrania* auch bis weit in den Osten Zentralspaniens vor. Die östliche Untergattung *Platystolus* dehnte sich mit zwei Arten, *P. ramburii* und *P. obvius*, nach Nordosten aus; die beiden jüngsten Arten der Untergattung, *P. martinezii* und *P. surcularius*, besiedelten Zentralspanien und auch (*P. martinezii*) östliche, westliche und nördliche Teile der Iberischen Halbinsel – der Süden Spaniens und Portugals wurde von *Platystolus* (*Platystolus*) nicht erreicht (siehe dagegen die auffallend abweichende Ausbreitungsgeschichte der Gattung *Pycnogaster* Graells, 1851 – genauer ihrer Untergattung *Bradygaster* Bolívar, 1926 – entlang der östlichen und südlichen Gebirgsketten Spaniens; Pfau 1988).

Diskussion

Über den Initialgesang-Antwort-Typ der Kommunikation der Orthopteren (I-A-Typ) existieren neuere experimentelle Untersuchungen an Phaneropterinen (siehe z.B. Heller & v. Helversen 1986; Robinson et al. 1986). Nach Robinson et al. (1986) stellen die besonders schnellen Duette zwischen den Männchen und Weibchen verschiedener Arten dieser Gruppe eine seltene Strategie der Kommunikation dar. Die Weibchen reagieren innerhalb eines sehr engen Zeitfensters (20 - 50 ms) auf den kurzen männlichen Gesang mit einer Antwort; das Intervall zwischen Gesang und Antwort stellt ein wesentliches artspezifisches Charakteristikum dar. Bei Arten mit komplexeren männlichen Stridulationen signalisieren spezielle Zeigersilben ('Marker') das Ende des männlichen Verses (Heller & v. Helversen 1986).

Die bisherigen Untersuchungen an *Platystolus*-Wechselgesängen (I-A-RA-Kommunikationstyp) lassen nicht auf entsprechend enge, konstante Zeitfenster schließen (siehe dazu auch Hartley et al. 1974 für *Steropleurus stali*). Beobachtungen im Freiland deuten auf eine stärkere Abhängigkeit der Reaktionszeiten von der Motivation der Tiere, ihrer Entfernung voneinander (und wohl auch der Körperausrichtung zueinander) und ihrer Körpertemperatur hin. Anscheinend werden am Ende der (meist relativ langen, komplexen!) Initialgesänge keine Markersilben erzeugt, an denen sich das Weibchen orientieren kann. Die Intervalle zwischen Initialgesang und Antwort sind dementsprechend beträchtlich variabel. Möglicherweise reagierten Männchen von *P. ramburii* auf nach besonders großen Zeitabständen erfolgende Antworten von Weibchen deswegen nicht mehr mit Rückantworten, weil in diesen Fällen das Intervall, in dem die Antwort erwartet wurde, überschritten wurde (siehe Abb. 5 c). Daß es auf nicht zu große Intervalle zwischen Initialgesang und Antwort ankommt, zeigt auch eine andere Beobachtung: Ältere Männchen, die sich durch artfremde Gesänge oder künstliche Geräusche (Stuhlknarren, Schlüsselbund-Klirren, Papierknistern etc.) zu Rückantworten anregen ließen, reagierten bei einer Vergrößerung des Zeitabstandes zwischen Initialgesang und künstlicher 'Antwort' ab einem bestimmten Intervall nicht mehr mit Rückantworten.

Bemerkenswert ist, daß die Weibchen und Männchen nach längerer Haltung auch auf artfremde Stridulationen reagierten. So beantwortete ein Weibchen von *P. faberi faberi* regelmäßig den Initialgesang eines *P. bolivarii*-Männchens. Dabei kam es allerdings öfters zu Zeitfehlern – die Antworten erfolgten viel zu früh. Bei älteren Männchen kam es manchmal zu einem Respondieren zwischen verschiedenen Arten, so etwa wieder zwischen *P.* (*P.*) *faberi faberi* und *P.* (*N.*) *bolivarii*, den besonders ursprünglichen Vertretern der beiden Untergattungen.

Den komplizierteren, drei-teiligen Duetten zwischen Männchen und Weibchen bei Orthopteren wurde bisher nur wenig Beachtung geschenkt. Robinson (1990: Fig. 5 c) stellt zwar für *Callicrania monti-*

cola (= *P. ramburii*) einen kompletten Wechselgesang, incl. Rückantwort ('further male call'), dar, geht jedoch nicht näher darauf ein. Hartley (1993: Fig. 4B) dokumentiert ebenfalls eine Rückantwort-ähnliche Stridulation für *Steropleurus asturiensis* ('secondary song'), vermerkt jedoch nur kurz, daß sie aufgrund ihrer zeitlichen Beziehung zur Antwort für die Identifizierung der Männchen durch die Weibchen von Bedeutung sein könnte. Beobachtungen von Spooner (1964: p. 241) an *Scudderia texensis* (Saussure & Pictet, 1897) deuten darauf hin, daß auch bei den Phaneropterinae funktionell der Rückantwort entsprechende akustische Reaktionen der Männchen vorkommen könnten (Serien lauter 'ticks' nach den Antworten der Weibchen); Heller (1990: p. 148) erwähnt etwas ganz Ähnliches für Männchen von *Isophya rossica* Bey-Bienko, 1954 ('isolated pulses ...exactly at the time when the male expects to hear the response of the female').

Auch für andere Insektengruppen mit akustischer Kommunikation existieren Beschreibungen von komplexeren Wechselgesängen, die den Duetten von *Platystolus* in bestimmten Merkmalen entsprechen.

Gogala (1969) berichtet für die Wanze *Tritomegas bicolor* (Cydnidae), daß die Männchen nach dem ersten Werbegesang und der weiblichen Antwort ('Einwilligungsgesang') oft mit einem 'zweiten Werbegesang' reagieren (der lauter ist als der erste – dies steht im Gegensatz zu den meisten hier beschriebenen Rückantworten!). Die Duette dienen nach Gogala der Partner-Erkennung, -Stimulierung und -Koordinierung. Sie entsprechen in ihrer Funktion daher zumindest teilweise den Wechselgesängen von *Platystolus.* Ein wesentlicher Unterschied besteht jedoch darin, daß sie erst bei einer sehr geringen Entfernung zwischen den Männchen und Weibchen vollständig erzeugt werden, oft sogar erst bei direktem körperlichem Kontakt.

Rupprecht (1982) beschreibt für Plecopteren (*Capnia bifrons, Taeniopteryx nebulosa*) einfache Trommelduette (Substratschallerzeugung mit Hilfe des Abdomen), bei denen die Männchen nach einer Antwort des Weibchens mit einem weiteren Trommeln 'rück-antworten'. Die Signale sind untereinander sehr ähnlich. Es wäre interessant zu erfahren, wie sich die Tiere verhalten, ob die Männchen sich z.B. sofort nach ihrem 'Rückantwort-Trommeln' in Bewegung setzen, und ob sich beide Geschlechter aufeinander zubewegen.

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Zusammenfassung

Bioakustik. – Die Männchen und Weibchen nahezu aller Arten der Gattung *Platystolus* (incl. der Arten der Gattung *Callicrania*, die mit *Platystolus* synonymisiert wird) kommunizieren über einen komplexen Wechselgesang: Nach einem Gesangsvers des Männchens (Initialgesang), der im ursprünglichen Fall aus vielen Silben besteht, antwortet das Weibchen. Die Antwort des Weibchens wird vom Männchen mit einem weiteren, kürzeren Gesang 'bestätigt' ('Rückantwort'; Pfau & Schroeter 1988). Nur bei *P. surcularius*, dessen Männchen sekundär repetitiv singen, sind weibliche Antwort und männliche Rückantwort reduziert.

Das akustische Repertoire der Arten von *Platystolus* ist groß. Neben zwei- bis mehrsilbigen Initial- bzw. Spontangesängen (Männchen, Weibchen), und den weiblichen Antworten und männlichen Rückantworten, werden kurzsilbige, leise Nahbalz-Gesänge (Männchen, Weibchen), Abschreck-Stridulationen (Männchen, Weibchen) sowie 'Kopulationsgesänge' erzeugt (letztere sind bei Männchen von *P. selliger* besonders laut und lang).

Systematik, Phylogenie und Gesangsevolution. – Der systematische Status verschiedener Taxa wird revidiert: Die Gattung *Callicrania* wird mit *Platystolus* synonymisiert; der Holotypus von *P. selliger*, der bisher als verschollen galt, wird neu beschrieben; *P. seoanei* wird mit *P. selliger* synonymisiert; *P. selliger meridionalis* subsp. n. wird beschrieben; *P. lusitanicus* wird als gute Art betrachtet und ein Neotypus designiert.

Aufgrund von morphologischen und bioakusti-

schen Merkmalen werden die Stammbäume zweier Untergattungen, *Platystolus* ((((*P. martinezii* & *P. surcularius*) *P. obvius*) *P. ramburii*) *P. faberi*) und *Neocallicrania* subgen. n. ((((*P. serratus* & *P. lusitanicus*) *P. miegii*) *P. selliger*) *P. bolivarii*), rekonstruiert (die Klammern schließen jeweils monophyletische Gruppen ein); die beiden Untergattungen stellen vermutlich Schwestergruppen dar.

Die Analyse der Bioakustik ermöglicht im Vergleich mit dem Kladogramm Rückschlüsse auf die Evolution der Gesänge. Der ursprüngliche Vers des Initialgesangs der Gattung *Platystolus* ist zweigeteilt. Er besteht aus einem kurz-silbigen Crescendo-Abschnitt (Teil I), auf den ein zweiter Abschnitt mit längeren, lauteren Silben folgt (Teil II). Innerhalb beider Untergattungen wurde dieser ursprüngliche Gesangsvers (v.a. durch Reduktion) stark verändert: entweder wurde der Teil I reduziert (*P. obvius*, *P. miegii*, *P. lusitanicus*, *P. serratus*) oder der Teil II (*P. surcularius*, *P. martinezii*); bei *P. obvius* kam es zusätzlich zu einer starken Reduktion der Silbenanzahl.

Die ursprünglichen Arten *P. faberi* und *P. bolivarii* lassen Rückschlüsse auf die Entstehung der Rückantwort zu: Bei beiden Arten ist die Rückantwort dem Initialgesang noch ähnlich; sie kann daher als ein zweiter Gesangsvers interpretiert werden, der ursprünglich noch dem ersten Vers entsprach, bei den meisten Arten jedoch durch Reduktion stark modifiziert wurde. Für *P. martinezii* ergibt sich, daß Gesang und Rückantwort zusammen nur scheinbar einen kompletten, zwei-teiligen 'Vers' bilden, da im Initialgesang der Teil II reduziert ist, in der Rückantwort (die erst nach der Antwort des Weibchens gesungen wird) dagegen der Teil I.

Der Ursprung der Rückantwort liegt möglicherweise unterhalb der Wurzel der Gattung *Platystolus*: *Steropleurus* aff. *stali* zeigt z.B. ebenfalls einen vollständigen drei-teiligen Wechselgesang, der (bei 24 °C) insgesamt nur 0.6 sec lang ist.

Adaptive Bedeutung der Rückantwort. – Drei verschiedene Kommunikationstypen der Orthopteren werden verglichen: Initialgesang-Typ, Initialgesang-Antwort-Typ und Initialgesang-Antwort-Rückantwort-Typ. Der komplexe Initialgesang-Antwort-Rückantwort-Typ hat den Vorteil, daß das Weibchen eine Information darüber erhält, daß seine Antwort von einem Männchen registriert wurde. Da der akustische Kontakt zwischen bestimmten Tieren über die erweiterten Duette wahrscheinlich besser aufrechterhalten werden kann, wird die Annäherung der (sich aufeinander zubewegenden) Geschlechter gesichert und beschleunigt; verglichen mit dem ursprünglicheren Initialgesang-Antwort-Typ der Kommunikation erscheinen Energieaufwand und Risiko vermindert. Die Evolution der Rückantwort wird mit den dreidimensional-komplexen Lebensräumen der Arten in Zusammenhang gebracht. Nur *P. surcularius* ist – mit der Besiedlung strukturarmer Offenlandschaften Mittelspaniens – sekundär wieder zum einfachsten Kommunikationstyp, dem Initialgesang-Typ, zurückgekehrt.

Ausbreitungsgeschichte. – Die Verbreitung der Arten wird mit Hilfe der Literatur und eigener Funde dokumentiert. Die bisher bekannten Verbreitungsareale werden durch die neuen Fundorte zum Teil erheblich erweitert: *P. selliger* z.B. wurde in Mittelportugal und in der westlichen Sierra de Gredos gefunden, wo er eine südliche Unterart, *P. selliger meridionalis* subspec. n. (mit abweichender Cercusform), darstellt; *P. lusitanicus* konnte auch in Spanien, in der westlichen Sierra Morena, nachgewiesen werden.

Die erste Artspaltung, die zur Trennung der Untergattungen *Neocallicrania* und *Platystolus* führte, fand vermutlich im Kantabrischen Gebirge statt. Die Abfolge der folgenden Aufspaltungen zeigt, daß *Neocallicrania* sich im Westen der Iberischen Halbinsel südwärts ausgebreitet hat (und mit *P.* (*N.*) *miegii* auch weit nach Osten vorgedrungen ist), während die Ausdehnung der Untergattung *Platystolus* mehr im Osten stattfand. Die aus den letzten Artspaltungen hervorgegangenen Arten – *P.* (*P.*) *martinezii* und *P.* (*P.*) *surcularius* sowie vor allem *P.* (*N.*) *lusitanicus* und *P.* (*N.*) *serratus* – sind am weitesten in den Süden der Iberischen Halbinsel eingewandert.

Summary

Bioacoustics. – Males and females in nearly all species of *Platystolus* (including the species of *Callicrania* which is placed in synonymy with *Platystolus*) communicate with each other using a complex antiphony (as already described by Pfau & Schroeter 1988 for *P. martinezii*): after a male verse (initial song) consisting in the primitive character state of many syllables, the female responds; this response ('Antwort') is 'confirmed' by the male with a shorter, third type of song, the 'confirmatory response' ('Rückantwort'). Only in *P. surcularius*, songs of which are secondarily reiterative, the female response is reduced, and the male confirmatory response is lost.

The song repertoire is large in the genus *Platystolus*. Besides male and female 'normal' songs, consisting of two to several syllables, and female response and male confirmatory response songs, there are relatively low intensity songs of nearby-display with very short syllables (males, females), deterrent stridulations (males, females) and 'copulation-songs' (which are very loud and extremely long in males of *P. selliger*).

Systematics, phylogeny and evolution of songs. – The systematic status of different taxa is revised: the

genus *Callicrania* is placed in synonymy with *Platystolus*; the holotype of *P. selliger*, so far thought to be lost, is redescribed; *P. seoanei* is synonymized with *P. selliger*; *P. selliger meridionalis* subsp. n. is described; *P. lusitanicus* is raised to specific level and its neotype is designated.

The phylogenetic trees of two subgenera, *Platystolus* ((((*P. martinezii* & *P. surcularius*) *P. obvius*) *P. ramburii*) *P. faberi*) and *Neocallicrania* subgen. n. ((((*P. serratus* & *P. lusitanicus*) *P. miegii*) *P. selliger*) *P. bolivarii*), are reconstructed on account of morphological and bioacoustic characters (parentheses enclose different monophyla); presumably the subgenera represent sister groups.

The analysis of bioacoustics compared with the cladogram allows conclusions on the evolution of songs. The primitive verse of the initial song of the genus *Platystolus* is two-parted. It consists of a crescendo containing short syllables (part I), followed by a second part containing louder and longer syllables (part II). In both subgenera, however, this primitive song structure has been strongly modified (in particular by reduction): in some species part I has been reduced (*P. obvius*, *P. miegii*, *P. lusitanicus*, *P. serratus*), in others part II (*P. surcularius*, *P. martinezii*); additionally, in *P. obvius* the number of syllables has been remarkably reduced.

The structure of the confirmatory response in the primitive species *P. faberi* and *P. bolivarii* allows conclusions on its origin: in both species the confirmatory response is similar to the initial song verse; so the confirmatory response can be traced back to a second song verse, which was originally similar to the first verse, but has been strongly modified by reduction in most species. Accordingly, the combination of initial song and confirmatory response of *P. martinezii* resembles only accidentally a complete (two-parted) 'verse', since in this species in the initial song it is part II which has been reduced, whereas in the confirmatory response (which follows the female response) it is part I.

The origin of the confirmatory response can possibly be traced below the root of the genus *Platystolus*: *Steropleurus* aff. *stali* for instance also shows the existence of a complete antiphony - with a male initial song, female response and male confirmatory response – which lasts as a whole only for about 0.6 seconds (at 24 °C).

Adaptive significance of the confirmatory response. – Three different types of communication in Orthoptera are compared: initial song type, initial song-response type and initial song-response-confirmatory response type. The complex third type has the advantage that the female gets the information that its response has been noticed by a male. Using these extended duets, acoustic contact between distinct animals presumably can be better maintained and approach of sexes (both moving towards each other) is ensured and accelerated. Compared to the precedent initial song-response type, energy expenditure and risks seem to be reduced. The evolution of the confirmatory response presumably correlates with the complex three-dimensional environments of most species. Only *P. surcularius*, living in open landscapes of central Spain which are less complex in structure, has secondarily simplified its communication by transforming it into the initial song type.

History of distribution of species. – The distribution ranges of species are described, using published data and own records. Recent data enlarge the known distribution of different species considerably. *P. selliger*, for instance, was found in mid Portugal and in the west of the Sierra de Gredos; morphological differences (especially in the form of the male cerci) make it possible to describe a southern subspecies, *P. selliger meridionalis* subsp. n. *P. lusitanicus* was discovered in the western part of the Sierra Morena, Spain.

The first splitting of species, which led to the division into the two subgenera *Neocallicrania* and *Platystolus* presumably occurred in the Cantabrian Mountains. The sequence of further splittings indicates a southward expansion of *Neocallicrania* in the western part of the Iberian Peninsula (*P.* (*N.*) *miegii* also spreading far eastwards). In contrast, the subgenus *Platystolus* expanded more in the eastern parts of Spain. The species which have derived from the last phylogenetic dichotomic splittings of species - *P.* (*P.*) *martinezii* + *P.* (*P.*) *surcularius* and, even more, *P.* (*N.*) *lusitanicus* + *P.* (*N.*) *serratus* - have reached the most southern parts on the Iberian Peninsula.

LITERATUR

Aires, B. & H. P. Menano, 1916. Catálogo sinóptico dos Ortópteros de Portugal. – Revista da Universidade de Coimbra, 58 pp.

Bailey, W. J., 1991. Acoustic behaviour of insects. An evolutionary perspective. – Chapman & Hall, London, 225pp.

Bolívar, I., 1873. Ortópteros de España nuevos o poco conocidos. – Anales de la Sociedad Española de Historia Natural 2: 213-237.

Bolívar, I., 1876. Sinópsis de los Ortópteros de España y Portugal. – Anales de la Sociedad Española de Historia Natural 5: 79-372.

Bolívar, I., 1877. Sinópsis de los Ortópteros de España y Portugal. – Anales de la Sociedad Española de Historia Natural 6: 249-348.

Bolívar, I., 1878. Analecta Orthopterologica. – Anales de la Sociedad Española de Historia Natural 7: 423-470.

Bolívar, I., 1885. Diagnoses d'Orthopères nouveaux. – Le Naturaliste 15: 116-117.

Bolívar, I., 1898. Catálogo sinóptico de los Ortópteros de la Fauna Ibérica. – Annaes de Sciencias Naturaes, Porto 5: 1-48, 121-152.

Bolívar, I., 1907. Revision des Ephippigerinae. – Annales des Sciences Naturelles Zoologie Paris (9) 5: 38-59.
Charpentier, T. de, 1825. Horae Entomologicae. – Wratislaviae, 255 pp.
Chopard, L., 1951. Orthoptéroides. Faune de France 56. – P. Lechevalier, Paris, 359pp.
Ewing, A. W., 1989. Arthropod Bioacoustics: Neurobiology and Behaviour. – Edinburgh University Press, Edinburgh, 260pp.
Gogala, M., 1969. Die akustische Kommunikation bei der Wanze *Tritomegas bicolor* (L.) (Heteroptera, Cydnidae). – Zeitschrift für vergleichende Physiologie 63: 379-391.
Hartley, J. C., 1993. Acoustic behaviour and phonotaxis in the duetting ephippigerines, *Steropleurus nobrei* and *Steropleurus stali* (Tettigoniidae). – Zoological Journal of the Linnean Society 107: 155-167.
Hartley, J. C., D. J. Robinson & A. C. Warne, 1974. Female response song in the Ephippigerines *Steropleurus stali* and *P. obvius* (Orthoptera, Tettigoniidae). – Animal Behaviour 22: 382-389.
Harz, K., 1969. Die Orthopteren Europas. Bd. I. – Dr. W. Junk, The Hague, 749 pp.
Harz, K., 1975. Eine neue *Platystolus*-Art aus Spanien. – Articulata 1: 17-18.
Heller, K.-G., 1984. Zur Bioakustik und Phylogenie der Gattung *Poecilimon* (Orthoptera, Tettigoniidae, Phaneropterinae). – Zoologische Jahrbücher, Abteilung Systematik 111: 69-117.
Heller, K.-G., 1988. Bioakustik der europäischen Laubheuschrecken. – Josef Margraf, Weikersheim, 358pp.
Heller, K.-G., 1990. Evolution of song pattern in east mediterranean phaneropterinae: constraints by the communication system. – In: W. J. Bailey & D. C. F. Rentz (eds) The Tettigoniidae: Biology, Systematics and Evolution, Springer Verlag, Berlin. pp. 130-151.
Heller, K.-G., 1992. Risk shift between males and females in the pair-forming behavior of bushcrickets. – Naturwissenschaften 79: 89-91.
Heller, K.-G. & D. v. Helversen, 1986. Acoustic communication in phaneropterid bushcrickets: species-specific delay of female stridulatory response and matching male sensory time window. – Behavioral ecology and sociobiology 18: 189-198.
Helversen, O. v., 1979. Angeborenes Erkennen akustischer Schlüsselreize. – Verhandlungen der Deutschen Zoologischen Gesellschaft 79: 42-59.
Herrera, L., 1979. Ortópteros Ensiferos de la provincia de Navarra. – Boletin de la Real Sociedad Española de Historia Natural (Sección Biológica) 77: 393-408.
Huber, F., T. E. Moore & W. Loher, 1989. Cricket Behavior and Neurobiology. – Cornell University Press, Ithaca, 565pp.
Navas, L., 1904. Notas zoologicas. – Boletin de la Sociedad Aragonesa de Ciencias Naturales 3: 196-206.
Peinado, M. V., 1990. Tettigonioideos españoles (Ephippigerinae). – Tesis Doctoral, Universidad Complutense, Madrid, 411pp.
Peinado, M. V., 1992. Inventario preliminar de los Ephippigerinae paleárticos. Géneros *Baetica* Bol., *Callicrania* Bol., *Ephippiger* Berth., *Ephippigerida* Bol., *Platystolus* Bol., y *Praephippigera* Bol. (Orthoptera, Tettigoniidae). – Boletin de la Real Sociedad Española de Historia Natural (Sección Biológica) 88 (1-4): 49-61.
Peinado, M. V. & J. Mateos, 1986 a. El género *Platystolus* Bolívar en la Península Ibérica (Orthoptera, Ephippigerinae). – Eos 62: 175-186.
Peinado, M. V. & J. Mateos, 1986 b. La colección de efipigerinos del Museo Nacionál de Ciencias Naturales (Orthoptera, Tettigoniidae). I. – Actas VIII Jornadas A e E Sevilla: 342-352.
Pfau, H. K., 1988. Untersuchungen zur Stridulation und Phylogenie der Gattung *Pycnogaster* Graells, 1851 (Orthoptera, Tettigoniidae, Pycnogastrinae). – Mitteilungen der schweizerischen entomologischen Gesellschaft 61: 167-183.
Pfau, H. K., 1991. Contributions of functional morphology to the phylogenetic systematics of Odonata. – Advances in Odonatology 5: 109-141.
Pfau, H. K. & U. T. Koch, 1994. The functional morphology of singing in the cricket. – Journal of experimental Biology 195: 147-167.
Pfau, H. K. & B. Pfau, 1995. Zur Bioakustik und Evolution der Pycnogastrinae (Orthoptera, Tettigoniidae): *Pycnogaster valentini* Pinedo & Llorente, 1986 und *Pycnogaster cucullata* (Charpentier, 1825). – Mitteilungen der schweizerischen entomologischen Gesellschaft 68: 465-478.
Pfau, H. K. & B. Schroeter, 1988. Die akustische Kommunikation von *Platystolus martinezi* (Bolívar) - ein schnelles Antwort-Rückantwort-System (Orthoptera, Tettigoniidae, Ephippigerinae). – Bonner zoologische Beiträge 39: 29-41.
Robinson, D., 1990. Acoustic communication between the sexes in bushcrickets. – In: W. J. Bailey & D. C. F. Rentz (eds) The Tettigoniidae: Biology, Systematics and Evolution, Springer Verlag, Berlin. pp. 112-129.
Robinson, D., J. Rheinlaender & J. C. Hartley, 1986. Temporal parameters of male-female sound communication in *Leptophyes punctatissima*. – Physiological Entomology 11: 317-323.
Rupprecht, R., 1982. Drumming signals of Danish Plecoptera. – Aquatic Insects 4: 93-103.
Schroeter, B. & H. K. Pfau, 1987. Bemerkenswerte Sattelschrecken (Orthoptera, Ephippigerinae) aus Spanien und Portugal. – Articulata 3: 41-50.
Seoane, V. L., 1878. *Ephippiger* du Nord de Espagne. – Annales de la Société entomologique de Belgique 21.
Spooner, J. D., 1964. The Texas bush katydid - its sounds and their significance. – Animal Behaviour 12: 235-244.
Spooner, J. D., 1968. Pair-forming acoustic systems of phaneropterine katydids (Orthoptera, Tettigoniidae). – Animal Behaviour 16: 197-212.
Zhantiev, R. D. & O. S. Korsunovskaya, 1986. Sound communication in bush crickets (Tettigoniidae, Phaneropterinae) of the European part of the USSR. – Zoologicheskij Zhurnal. 65: 1151-1163.

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A NEW GENUS OF MICROVELIINAE FROM TREEHOLES IN KENYA (HETEROPTERA: VELIIDAE)

Polhemus, J. T. & R. S. Copeland, 1996. A new genus of Microveliinae from treeholes in Kenya (Heteroptera: Veliidae). – Tijdschrift voor Entomologie 139: 73-77, figs. 1-10. [ISSN 0040-7496]. Published 15 October 1996.

Cylicovelia kenyana gen. n., sp. n. is described from water-filled treeholes in Kenya.

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Key words. – Heteroptera, Veliidae, *Cylicovelia*, taxonomy, new genus, new species, phytotelmata, Kenya.

Although a number of veliid species are known from container habitats in the New World, few have been recorded from the Old World. Throughout the American tropics terrestrial and arboreal bromeliads with water pockets harbor a guild of veliid species endemic to them (reviewed by Polhemus & Polhemus 1991), belonging to the genera *Paravelia* Breddin and *Microvelia* Westwood. In addition, *Paravelia myersi* (Hungerford) is known from treeholes in Trinidad (Hungerford 1931) and Panama (Polhemus & Yanoviak in prep.), an undescribed species of *Microvelia* from treeholes in Panama (Polhemus & Yanoviak in prep.), and two species of *Microvelia* from crabholes in Costa Rica (Polhemus & Hogue 1972). Of these two genera only *Microvelia* occurs in the Old World. *Microvelia* sp. was reported by Laird (1956: 166) from a treehole on Guadalcanal and one undescribed species of this genus occurs in treeholes in Ceylon (P. B. Karunaratne, personal communication to J. T. Polhemus 1981), the first veliids reported from small container habitats in the Old World. Yang & Kovac (1995) recorded species of *Baptista* and *Lathriovelia* (Microveliinae) from Bamboo internodes in West Malaysia.

The new veliid genus and species described here was discovered by the junior author in the Kakemega Forest in western Kenya, living in treeholes formed by adjoining root buttresses of *Ficus exasperata* Vahl. (see Biology notes below).

Cylicovelia gen. n.
(figs. 1-9)

Description

Size. – Macropterous form, elongate (fig. 1), length of males 4.88 to 5.22 mm, females 4.44 to 4.94 mm, general body characteristics and size not sexually dimorphic, males and females very similar although males average slightly larger in size.

Colour. – Ground colour blackish brown, tinged with orange brown; anterior pronotal lobe brownish yellow on either side of median carina. Each hemelytron blackish brown, with five bright white marks, one basal, four distal, and one sordid yellowish stripe on inner basal cell (fig. 1). Apterous form without light markings.

Structural characters. – Apterous and macropterous forms known. Eyes globose, exserted, just reaching anterolateral pronotal angles, separated by about three times the width of an eye, appressed to anterior pronotal margin, with short ocular setae. Head declivant anteriorly, recessed into pronotum, posterior margin sloping caudo-dorsally, with usual three pairs of facial trichobothria; gular region very short, barely visible, rostral cavity closed posteriorly. Rostrum reaching to middle of mesosternum, segment I short, enclosed in rostral cavity, I and IV subequal in length and about three times longer than II, segment III about 8 times as long as II. Antennae slender, very long, almost 1/2 of body length (fig. 5). Pronotum raised medially, with weak median longitudinal carina, prominent at junction with anterior lobe, absent from latter except in apterous form; collar weakly formed, visible only dorso-laterally, terminating under eyes laterally; anterior and posterior lobes set off by a transverse row of large deep foveae, evanescent medially; both lobes set with short stiff erect dark setae; posterior lobe with numerous small foveae, humeri prominent, but less so in apterous form, broadly rounded posteriorly. Thoracic venter not diagnostic, with weakly formed tubercles on either side of mesosternal midline on posterior margin opposing an unmodified metasternum. Metasternal scent gland opening (omphalium) small but visible, marked by a small tubercle; scent channels prominent, curving slightly anterad to base of metacetabulae.

Abdomen of macropters with prominent paired longitudinal carinae on tergite II (fig. 6), lacking in apterous form. Abdominal sternites set off from laterosternites by hair-free glabrous oval lacunae. Hemelytra and flight wings of macropters fully formed, reaching tip of abdomen, with four closed cells (fig. 1).

Legs stout, of moderate length; anterior femur thickly set beneath with dark setae, unmodified; anterior tibia of both sexes with a very narrow comb of closely set minute black denticles occupying almost entire tibial length in males (fig. 2), basal 7/8 in females; middle and hind femora of both sexes modified, tumid ventrally, set ventrally with short dark setae (figs. 3, 4); all tarsi long, claws moderately long, barely preapical; both up- and down curving arolia large, evident.

Male genital segments moderately large, protruding, not modified (figs. 7, 8); proctiger unmodified; parameres small, elongate, oval (fig. 9).

Female tergite VIII on same plane as VII, truncate posteriorly; first gonocoxae small, barely exposed, plate-like; tergite IX of both sexes rounded, protruding posteriorly.

Type-species. – *Cylicovelia kenyana* sp. n.

Remarks

Comparative notes. – The venation of both fore and hind wing is typical of the Microveliinae (see Andersen 1982, figs. 312, 313). We have compared *Cylicovelia* to all known microveliine genera, and find that it is closest to *Millotella* Poisson. In Andersen's (loc. cit.) key to the genera of Microveliinae, *Cylicovelia* keys to *Millotella* (couplet 7) but is clearly not this genus. Linnavuori (1977) provided the latest revision of African Microveliinae. In his key, *Cylicovelia* fails to resolve at couplet 5, because of the large size, yet short second antennal segment; ignoring size, at couplet 11 *Cylicovelia* is separated from *Millotella* because of the lack of stout black denticles ventrally on the mid-femur, and beyond that is clearly not closely allied to any of the three genera containing only small species, i. e. *Xiphoveloidea*, *Pseudovelia* and *Microvelia*. In comparison to *Millotella* , *Cylicovelia* has only a small distal nub on the fore tibia but with an extremely long tibial comb in both males and females (vs. a pronounced distal fore tibial pad and short comb restricted to males), the mid and hind femora are modified in both males and females (vs. only male mid femur in *Millotella*; *M. fontinalis* Linnavuori is not modified, but this species probably does not belong in *Millotella*), and males lack the bizarre abdominal modifications of *Millotella*. *Cylicovelia* is predominantly macropterous, rarely apterous (vs. predominantly apterous in *Millotella*), the fore wing cells are of a different shape, and have a slightly different pattern of maculation.

Etymology. – The generic name *Cylicovelia* is derived from *kylicos* (Gr.), f., cup, referring to the container habitat, and *Velia*, the nominate genus of the family. Gender feminine.

Distribution. – Kenya.

Cylicovelia kenyana sp. n.
(figs. 1-9)

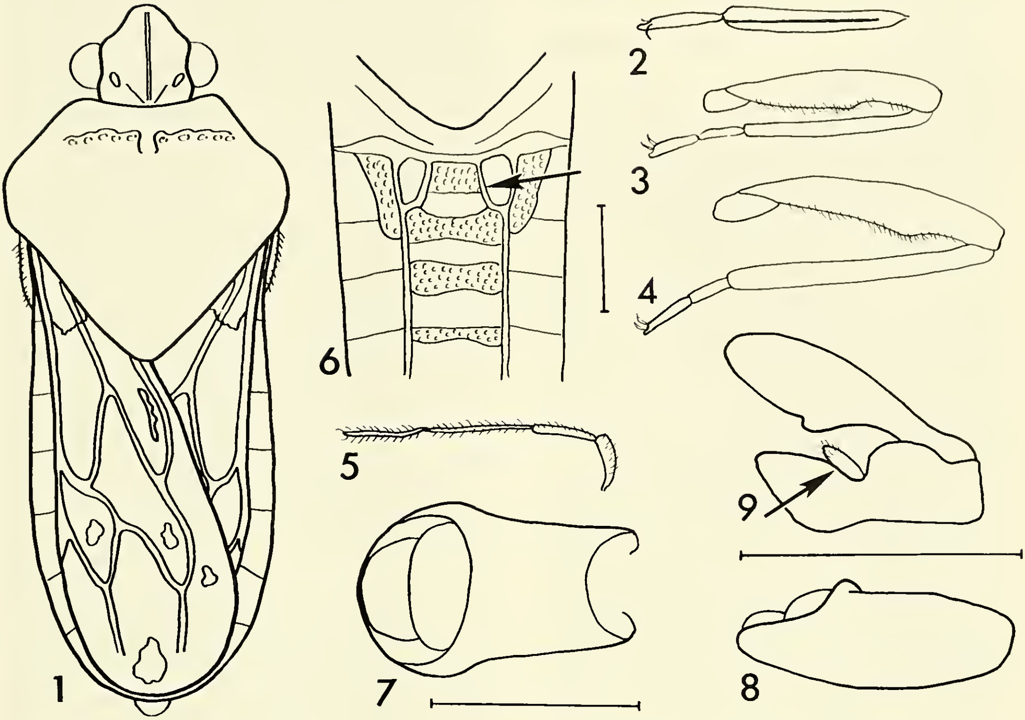
Type material. – Holotype, macropterous male, Kenya: Kakemega Forest, nr. Kakemega Forest Station, 0°14' N, 34°52' E, El. 1676m, treehole KKTH-AM1, height 1.7 m, 29.x.1993, R. Copeland (National Museum of Kenya). – Paratypes: (all macropterous unless noted, all collected by R. Copeland and assistants, all same data as holotype, all in J. T. Polhemus collection, R. S. Copeland collection, U. S. National Museum and National Museum of Kenya, except dates and height of treeholes as follows): KKTH-A, height 3.9 m; 6 females, 5.i.1993. KKTH-AM-1, height 1.7 m; 7 males, 10 females, 29.x.1993; 2 females, 13.x.1992; 1 female, 6.ix.1992; 3 females, 4.xii.1992. KK6TH-A, height 4.3 m; 1 male, 2 females, 6.ix.1992; 1 male, 19.i.1993; 1 female, 28.x.1993. KK6TH-C, height 3.8 m; 1 male, 1 female, 19.i.1993; 1 apterous male, 1.iii.1993. KK6TH-G, height 4.3 m; 1 male, 1 female, 28.viii.1993. KKTH-AV, height 5.3 m; 1 apterous female, 29.x.1993. KKTH-AB, height 0.3 m; 1 male, 3.iii.1993.

Description

Size. – Apterous male, length 4.66 mm (n = 1); width 1.78 mm (n = 1). Apterous female, length 4.66 mm (n = 1); width 1.83 mm (n = 1). Macropterous male, length 4.88 - 5.22 mm (mean = 5.02 mm, n = 10); width 1.78 - 2.05 mm (mean = 1.93 mm, n = 10). Macropterous female, length 4.44 - 4.94 mm (mean = 4.72 mm, n = 10); width 1.78 - 1.94 mm (mean = 1.86 mm, n = 10).

Colour. – Ground colour black, venter, tinged with brown. Head black, often tinged with orange brown, brown ventrally; rostrum luteous on basal three segments, piceous distally. Pronotum with anterior lobe broadly yellowish brown on either side of midline, forming two transverse bands; disc, collar blackish brown. Hemelytra blackish brown, veins lighter, set with bright white markings (fig. 1) and one sordid yellowish streak in inner basal cell. Legs, antennae luteous to brown; antennal segment III lighter, segment IV mostly luteous.

Structural characters. – Macropterous male: Head of moderate length, declivant anteriorly; length 0.61; width of eye/interocular space, 0.18/0.54. Pronotum length : width, 1.62 : 1.80. Abdominal sternites II-VI subequal in length, VII longer.



Figs. 1-9. *Cylicovelia kenyana* gen. n. , sp. n. – 1, Macropterous female, dorsal habitus; 2-4, Male legs; 2, anterior tibia and tarsus, ventral view; 3, middle; 4, hind; 5, antennae; 6, abdominal tergites, macropterous male, showing depressed regions (textured) and carinae on tergite II (arrow); 7-9, male genitalia; 7, ventral view; 8, lateral view; 9, pygophore, proctiger, paramere (arrow). All scale bars = 1/2 mm.

Abdominal venter set with short appressed setae; ventrite VII unmodified, almost straight postero-medially and set with posteriorly directed fringe of long decumbent setae. Legs clothed with short setae, all femora beneath thickly set with very fine moderately long setae; antennae set with short setae and scattered longer setae. Legs unarmed, but slightly modified; all femora tumid on basal 2/3, middle and hind femora abruptly narrowing distally (figs. 3, 4); all tibia straight, anterior tibia with very long ventral comb (fig. 2).

Antennal formula I : II : III : IV; 0.40 : 0.50 : 0.83 : 0.61.

Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2 of fore leg, 1.33 : 1.12 : 0.56 : 0.0; of middle leg, 1.66 : 1.44 : 0.36 : 0.40; of hind leg, 2.09 : 2.09 : 0.36 : 0.40.

Abdominal terminalia as shown in figs. 7-9; first genital segment medially slightly depressed. Paramere small, elongate oval (fig. 9).

Apterous male: Very similar to macropterous male in most respects, but abdominal tergites lacking longitudinal carinae basally, and depressed areas restricted to tergal sutures. Pronotum with humeri less pronounced, median carinae more evident, posterior margin more rounded, feebly angulate, and slightly raised.

Macropterous female: Very similar to male in most respects; fore tibial comb terminating at distal 7/8.

Apterous female: Very similar to apterous male, but slightly more robust.

Remarks

Comparative notes. – See generic description.

Biological and collection notes. – All specimens were collected in treeholes west of the Kakemega Forest Station, mostly formed in the root buttresses of fig trees (*Ficus exasperata* Vahl). All but one treehole (KKTH-AV) are in trees in the stand of forest immediately abutting the Forest Station, and are within 500 m of it. KKTH-AV is located in a stand of forest which is separated from the closer stand by a large area of open field. KKTH-AV is ca 1500 m from the forest sation.

Etymology. – The name *kenyana* refers to Kenya, the country of origin.

Distribution. – Kenya.

Biology and habitat notes

Cylicovelia kenyana was discovered in water-filled treeholes in the Kakemega Forest, western Kenya, by the junior author. All of the treeholes in which veliids were found were within 1500 meters of the Kakemega Forest Station, which is located at 0°14' N, 34°52' E, at an altitude of 1676 m above sea level. Kakemega Forest is the easternmost relic of African equatorial rain forest (Kokwaro 1988), and contains flora and fauna common to West as well as East Africa (Garnham et al. 1946). The first veliids were found in July of 1992 during a search of treeholes for larvae of the libellulid dragonfly, *Hadrothemis camarensis* (Kirby), a common inhabitant of treeholes in this forest (Copeland et al. 1996). The treehole was formed by adjoining root buttresses of *Ficus exasperata*. This type of hole is a pan as defined by Kitching (1971). Thereafter, searches of treeholes for veliids were done on an approximately monthly basis through July 1994. The water surface and inside bark of treeholes were searched with a flashlight , and veliids were captured by aspiration.

Veliids were collected from 9 of 40 different treeholes. Some treeholes were examined more than once, and veliids were found in 22 of the 196 examinations. Adults and immatures were found on the water surface and on the bark above the water. A total of 98 individuals were collected, with numbers in individual collections ranging from 1 to 40, median = 3 (five adults and the immatures are not included in the type material). All treeholes that were positive for veliids, except one, were pans found in *F. exasperata*. The sole exception (KKTH-AB) was a pan formed where a *F. exasperata* grew against a *Trilepisium madagascariense* DC. It appeared that positive treeholes received insolation during the day, or at least were well lighted; veliids were not found in well shaded treeholes.

We examined the effect of treehole height and water volume on veliid distribution. For treeholes for which height was recorded, Veliidae were found in 9 (median = 3.78 m , range 0.3 to 5.3 m) and were absent from 27 (median = 1.35 m , range 0.25 to 6.4 m). Veliids were collected from 39% (n = 18) of treeholes higher than the overall median height (1.76 m) and from 11% (n = 18) of those lower than the median height. This difference was marginally significant ($\chi^2 = 3.70$, $p = 0.054$). Veliid distribution was independent of treehole water volume. For treeholes for which water volume was recorded, veliids were found in 9 (median water volume = 2.68 L; range 0.60 to 24.0 L) and were absent from 12 (median water volume = 2.58 L; range 0.50 to 6.0 L). Veliids were collected from 40% (n = 10) of holes with volumes greater than the overall median (2.68 L), and from 40% (n = 10) of holes with volumes below the overall median ($p = 1.0$; two-tailed Fisher's Exact Test).

The monthly distribution of positive treehole collections is shown in figure 10, along with monthly rainfall at the Kakemega Forest Station. Treehole samples positive for veliids were not distributed uniformly over the sampling period. Treeholes were more likely to contain veliids during the drier months from October to March (19 of 107 samples) than they were during the wet season from April to September (3 of 89 samples) ($\chi^2 = 10.09$, $p < 0.01$).

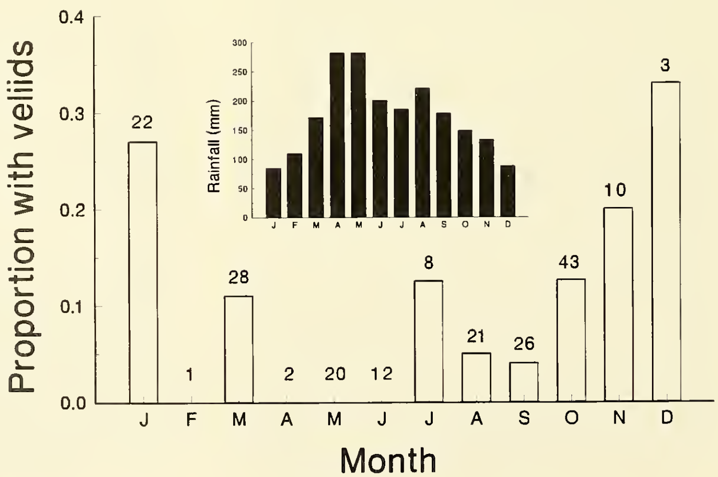


Fig. 10. Monthly proportions of treehole samples which contained veliids during the study period, July 1992-July 1994. The number of monthly samples is indicated above each bar. Fifty-two year mean monthly rainfall for the study site is shown in the inset (Kenya Metereological Department).

The opposite was true for the distribution of treehole samples positive for larvae of the dragonfly, *H. camarensis.* Larvae of this species were significantly more likely to be found in treeholes during the wetter months than during the drier months of the year (Copeland et al. 1996). It is possible that these different temporal distributions are determined in part by biotic interactions between the two predators. Veliids may be important predators on culicid eggs and larvae (Frick 1949; Polhemus & Chapman 1979), and may have significant impact on the density of larval odonate prey in treeholes. Alternatively, veliid distribtution may be influenced by predation by odonate larvae. Abiotic factors may also be important. Veliids may utilize other small bodies of water during the rainy season which become limited during the drier months, forcing a rainfall-related habitat switch into the more permanently wet treeholes. Odonates, on the other hand, may be limited to a range of treehole volumes that are most likely to exist during the rainy season. Odonate distribution was non-uniform with respect to treehole volume, and odonate-positive treeholes contained significantly greater water volumes than negative holes (Copeland et al. 1996).

It is interesting to note that in an intensive study of treehole mosquitoes Garnham et al. (1946) failed to report the presence of either veliids or odonates in treeholes in Kaimosi Forest which, at the time of their study, was contiguous with the Kakamega Forest. It is possible that treeholes of the type found in *F. exasperata* are specific habitats for both taxa. This tree species is near its maximum recorded altitude in the Kakamega Forest (Beentje 1994), and is very common around the Forest Station. It is not recorded by Garnham et al. (1946) as being one of the common species in the Kaimosi Forest, most of which is at a higher elevation than that of the Kakamega Forest. Recent searches in remnant stands of Kaimosi Forest failed to reveal the presence of *F. exasperata* there (M. Rotich, personal communication).

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REFERENCES

Andersen, N. M., 1982. The semiaquatic bugs (Hemiptera, Gerromorpha). Phylogeny, adaptarions, biogeography and classificarion. – Entomonograph 3, 455 pp (Scandinavian Science Press, Klampenborg, Denmark).

Beentje, H. J., 1994. Kenya trees, shrubs, and lianas. – National Museums of Kenya, Nairobi, 722 pp.

Copeland, R. S., W. Okeka & P. S. Corbet, 1996. Treeholes as larval habitat of the dragonfly *Hadrothemis camarensis* (Odonata: Libellulidae) in Kakamega Forest, Kenya. – Aquatic Insects 18, in press.

Frick, K. E., 1949. The biology of *Microvelia capitata* Guerin, 1857, in the Panama Canal Zone and its role as a predator on anopheline larvae (Veliidae: Hemiptera). – Annals of the Entomological Society of America 42: 77-100.

Garnham, P. C. C., J. O. Harper & R. B. Highton, 1946. The mosquitos of the Kaimosi Forest, Kenya Colony, with special reference to yellow fever. – Bulletin of Entomological Research 36 : 473-496.

Hungerford, H. B., 1931. A new *Velia* from Trinidad (Hemiptera, Veliidae). – Annals and Magazine of Natural History (10) 7: 172-175.

Kitching, R. L., 1971. An ecological study of water-filled treeholes and their position in the woodland ecosystem. – Journal of Animal Ecology 40: 281-302.

Kokwaro, J. O., 1988. Conservation status of the Kakamega Forest in Kenya: the easternmost relic of the equatorial rain forests of Africa. – Monographs in Systematic Botany from the Missouri Botanical Garden 25: 471-489.

Laird, M. 1956. Studies of mosquitoes and freshwater ecology in the South Pacific. – Royal Society of New Zealand, Bulletin No. 6: 1-213.

Linnavuori, R. 1977. On the taxonomy of the subfamily Microveliinae (Heteroptera, Veliidae) of West and Central Africa. – Annales Entomologici Fennici 43: 41-61.

Polhemus, J. T. & H. C. Chapman, 1979. Veliidae. p. 49-57. – *In*: A. S. Menke (ed.), The semiaquatic and aquatic Hemiptera of California. – Bulletin of the California Insect Survey 21: 1-166.

Polhemus, J. T. & C. L. Hogue, 1972. Two new *Microvelia* from crabholes in Costa Rica (Hemiptera: Veliidae). – Los Angeles County Museum of Natural History, Contributions in Science, No. 224: 1-6.

Polhemus, J. T. & D. A. Polhemus, 1991. A review of the veliid fauna of bromeliads, with a key and description of a new species (Heteroptera: Veliidae). – Journal of the New York Entomological Society 99: 204-216.

Yang, C. M. & D. Kovac, 1995. A collection of aquatic and semi-aquatic bugs (Insecta: Hemiptera: Gerromorpha and Nepomorpha) from Temengor Forest Reserve, Hulu Perak, Malaysia. – Malayan Nature Journal 48: 287-295.

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CHALASTONEPSIA ORIENTALIS GEN. N., SP. N., A SECOND GENUS IN THE TRIBE METANEPSIINI (DIPTERA, MYCETOPHILIDAE)

Söli, G. E. E., 1996. *Chalastonepsia orientalis* gen. n., sp. n., a second genus in the tribe Metanepsiini (Diptera, Mycetophilidae). – Tijdschrift voor Entomologie 139: 79-83, figs. 1-8. [ISSN 0040-7496]. Published 15 October 1996.

The genus *Chalastonepsia* is erected for a new species from Malaysia, *C. orientalis*. The genus has numerous characters in common with *Metanepsia* Edwards, and the two are likely sister-groups. The new genus differs most markedly from *Metanepsia* in having a complete radial sector, a well developed Sc, and a relatively short stem of the median fork; further, the male terminalia are very different in the two genera. Awaiting a phylogenetic analysis of the family the tribe Metanepsiini is maintained, and an emended diagnosis is given in order to include *Chalastonepsia*. The sistergroup of the tribe is likely to be found among genera in the tribe Gnoristini.

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Key words. – Mycetophilidae, Metanepsiini, new genus, new species, Malaysia.

The Metanepsiini is usually regarded to represent one of five tribes in the subfamily Sciophilinae in the family Mycetophilidae (e.g. Matile 1971, Hutson et al. 1980, Vockeroth 1981). Some authors, however, prefer to rank these tribes at the level of subfamilies (e. g. Tuomikoski 1966, Hennig 1973, Väisänen 1984, 1986, Matile 1989). Metanepsiini hitherto included a single genus, *Metanepsia* Edwards, 1927, erected for the Javanese species, *M. javana* Edwards, 1927. Later seven more species were described from the Afrotropical region (Matile 1971, 1972, 1975, 1980).

In the collection of the Natural History Museum in London a peculiar looking specimen was found among the pinned, unidentified Oriental material of Mycetophilidae. The specimen, a male, had long-stalked, strongly setose flagellomeres, and reduced mouthparts. The species must be attributed to the tribe Metanepsiini, but could not be ascribed to the genus *Metanepsia*.

Methods and terminology

The pinned specimen was cleared and slide mounted in Canada balsam. In addition, slide mounted material of three Afrotropical species of *Metanepsia* was studied. The terminology used in the description follows Vockeroth (1981) and McAlpine (1981).

Chalastonepsia gen. n.

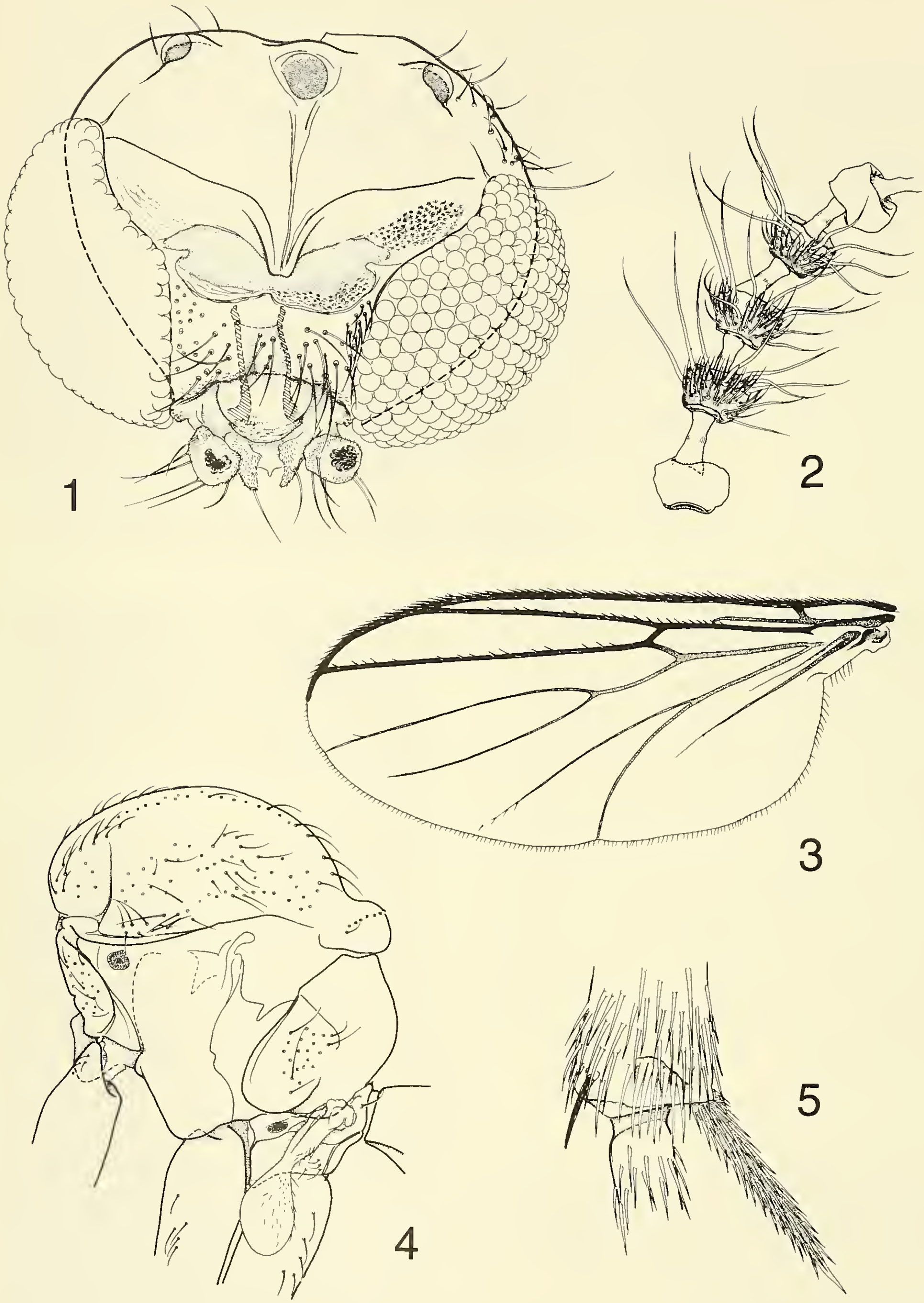
Type species. – *Chalastonepsia orientalis* sp. n., by present designation.

Diagnostic characters. – Reduced mouthparts, one-segmented palpus and bead-like flagellum, each flagellomere bulbous with a long stalk-like apical portion, basal part with numerous long setae.

Etymology. – From Greek, *chalaston*, a chain, referring to the outlining of the male flagellum, and *Metanepsia*, a related genus.

Description

Head. – Antennae inserted below middle of head. Scape and pedicel with numerous small, erect setae. Fourteen flagellomeres, 1-13 with bulbous basal part with circle of very long curved setae and distinctly prolonged, stalk-like apical part; last flagellomere conical. Three ocelli, of equal size, situated along straight transverse line. Lateral ocelli well separated from eye margin. Eyes large, median margin evenly rounded with very shallow incision above antennal socket. Eyes with few small hair-like setae. Back of head with numerous, evenly dispersed setae. Postgenae well developed, with median convexity below occipital foramen. Frons with broad suture between median ocellus and frontal tubercle. Frontal tubercle distinct, bilobate. Face subquadrate, shorter than wide, setose. Clypeus rounded, bare. Cibarial pump well developed. Prementum strongly reduced. Labrum not traceable. Labella small. Stipes weak, apparently fused, bare. Lacinia absent. Palpi strongly reduced, only one visible segment, palpomere 3, with some erect setae, and distinct sensory pit, forming a hollow depression dorsally.



Figs. 1-5. *Chalastonepsia orientalis* gen. n., sp. n.. – 1, head, frontal view; 2, flagellomeres 7-11; 3, wing; 4, thorax (outline of anepisternum uncertain, see text); 5, anteroapical depressed area of fore tibia.

Thorax. – Scutum with rather short acrostichal and dorsocentral setae, and somewhat longer lateral setae; areas in-between bare. Prescutal suture distinct. Scutellum with transverse row of small setae. Antepronotum about twice as large as proepisternum, both setose. Proepimeron large, triangular and bare. Basisternum with some small setae. Anepisternum bare. Katepisternum partly covering basal portion of mid-coxa, bare. Basalare with large, triangular, interior apodeme. Pleural suture complete, curved. Anepimeron well sclerotized with distinct cleft dorsally. Laterotergite ovate, not protruding, setose. Mediotergite bare. Metakatepisternum with some setae.

Wings. – Wing surface on both sides densely clothed with irregularly arranged microtrichia. Costa well produced beyond tip of R_{4+5}. Sc long, bare, apical portion weaker and bent towards R_1. Crossvein Sc-r absent. R_1 and R_{4+5} with dorsal setae only. Rs distinct, oblique. Median and cubital fork both complete, M_2 falling short of wing margin. Point of furcation of CuA slightly before crossvein r-m; CuP short and fold-like. Anal vein well developed.

Legs. – Tibial trichia all irregularly arranged. Some larger apical setae on tibia 1 to 3, and several much smaller setae dispersed along entire length. First tarsomere on mid and hind leg with some distinct setae on ventral half. Fore tibia with anteroapical depressed area very shallow, with some erect trichia. Spurs well developed, shaggy; spur formula 1: 2: 2. Empodium well developed. Tarsal claws with two larger and one smaller ventral tooth.

Abdomen. – Segments 1-8 with well developed sternites and tergites, all setose. Male segment 7 and 8 both reduced, basally narrowed, segment 8 about twice as long as segment 7.

Male terminalia (figs. 6-8). – Tergite 9 very large, entirely covering gonocoxites dorsally, with numerous dorsal and ventral setae. Cerci large, rounded; hypoproct well developed. Gonocoxites small, entirely fused ventrally, each with one long gonocoxal apodeme. Gonostylus small. Aedeagus wide and short. Paramere apparently vestigial.

Remarks. – Due to damage caused by pinning, the exact outline of the anepisternum, anapleural suture and basalares remains uncertain.

Systematics

From the number of shared characters with *Metanepsia*, the two genera are likely sistergroups. Among characters supporting such an arrangement are the reduced mouthparts, the one-segmented palpi and the poorly developed anteroapical depressed area of the fore tibia. In addition the two genera both have a bilobate and distinct frontal tubercle, a nearly bare frons, a costa produced beyond tip of R_{4+5}, and the tibial setae poorly developed. *Chalastonepsia* differs from *Metanepsia* in having a complete radial sector, a well developed Sc, a relatively short stem of the median fork, point of furcation of CuA close to wing base, gonocoxites fused for most of their length, and male tergite 9 very large and covering proctiger.

Chalastonepsia orientalis sp. n.

(figs. 1-8)

Type. – Holotype ♂: Malaysia, Malay peninsula, Pahang, Fraser's Hill, 4000 ft., 29.v.1932, H. M. Pendlebury (BMNH)

Description

Male (n=1). Total length 2.60 mm. Flagellum 1.22 mm, or 1.4 times as long as scutum and scutellum together.

Coloration. – Unicoloured, yellowish brown, wings somewhat lighter.

Head (figs. 1, 2). – Each flagellomere with curved setae longer than entire flagellomere; all trichia and setae situated in small, rounded depressions. Lateral ocelli separated from eye margin for distance about 2.1 times, and from median ocellus by about 2.4 times their diameter. Weak, interrupted suture present between lateral ocellus and eye. Frons with 1 seta in front of median ocellus. Face 0.4 times as long as broad, with 53 setae. Clypeus ovate, about 0.9 times as long as broad.

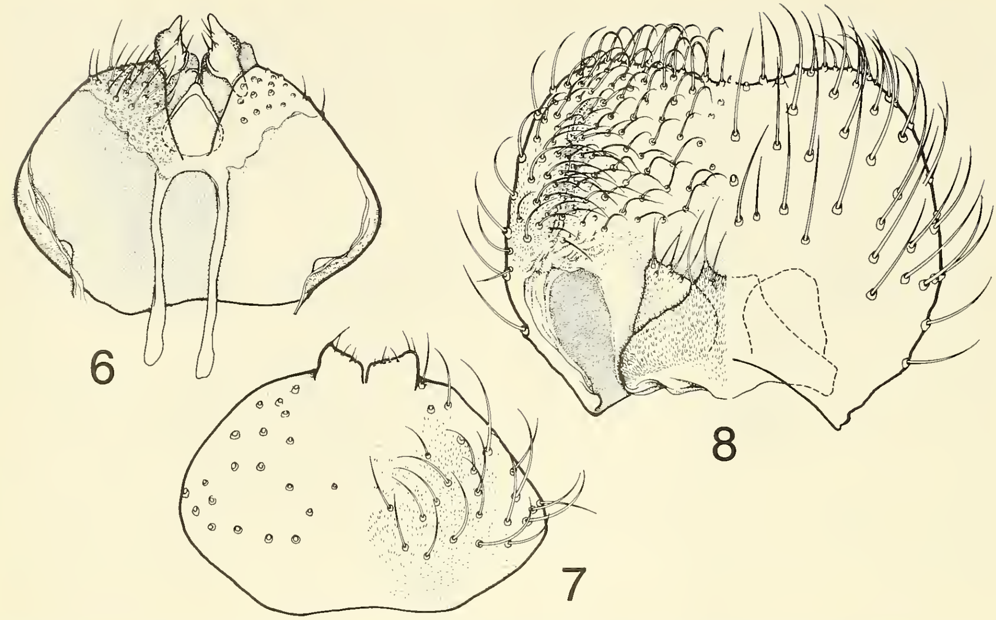
Thorax (fig. 4). – Medially divided basisternum with 5 setae. Scutellum with 14 small setae. Laterotergite with 23 setae. Metakatepisternum with 4-5 setae.

Wings (fig. 3). – Wing length 2.11 mm, measured from distal median plate. Length to width 2.1. Sc 0.24 times wing length. M-petiole 2.7 times as long as r-m. Length of M_1 and M_2 to the length of M-petiole 2.94 and 2.06, respectively. M-basis about as long as CuA-petiole. Length of CuA_1 and CuA_2 to the length of CuA-petiole 1.67 and 1.11, respectively. Anal vein well developed, 1.30 times as long as CuA-petiole. All branches posteriorly of radius bare, except for 0-3 dorsal setae near the wing margin on each of M_1 and CuA_2.

Legs (fig. 5). – Setae on tibiae with weakly developed alveoli. Anteroapical depressed area with 8 erect trichia. Ratio femur to tibia for legs 1 to 3: 0.98; 1.04; 0.88. Ratio tibia to tarsus for legs 1 to 3: 1.71; 1.68; 2.10. Spur lengths in relation to tibial diameter, measured apically: 1.9; 2.1, 2.9; 2.2, 2.7.

Abdomen. – Abdominal sternites 2 and 3 seemingly with two longitudinal fold lines.

Terminalia (figs. 6-8). – Gonocoxites small, entirely fused ventrally, produced in two heavily sclerotized median lobes. Dorsal portion of gonocoxite poorly



Figs. 6-8. Male terminalia of *Chalastonepsia orientalis* gen. n., sp. n. – 6, dorsal view, tergite 9 and proctiger removed; 7, ventral view; 8, tergite 9 and proctiger (left, ventral view; right, dorsal view).

developed, setose. Two very long gonocoxal apodemes, fused by transverse bridge where gonocoxites meet dorsally. Gonostylus small, attached posteriorly, bearing 2-3 small median setae. Aedeagus broad, subtriangular. Tergite 9 very large with several erect setae dorsally, and numerous curved setae ventrally. Proctiger situated ventrobasally of tergite 9 and attached to this by strong membranes. Cercus rounded, with several erect setae apically. Hypoproct more or less triangular with 2 submedian, erect setae.

Discussion

The systematical position of the tribe Metanepsiini in the family Mycetophilidae is uncertain. According to Matile (1971) *Metanepsia* can not be ascribed the tribe Mycomyini as it does not have the tibial trichia arranged in definite lines; neither can it be ascribed the tribe Sciophilini due to the absence of macrotrichia (or setae) on the wing membrane. These characters are commonly regarded as good synapomorphies for the species in each of the two tribes. Furthermore, Matile (1971) rejects the inclusion of *Metanepsia* in the Leiini as it lacks an empodium, and has a reduced seventh abdominal segment, a long R_1 and a very short, and incomplete Rs. Due to the very long stem of the median fork and the reduced Rs, Matile also rejects a possible inclusion in the Gnoristini.

As the new genus invalidates some of the last statements, the possible relationship to the Gnoristini and Leiini demands a closer examination.

Metanepsia and *Chalastonepsia* both feature several other characters found among the Gnoristini, all present in *Palaeodocosia* Meunier, 1904 and *Syntemna* Winnertz, 1863, most of them also in *Dziedzickia* Johannsen, 1909: anepimeron with a distinct cleft, presence of one or more erect setae behind basis of halter, Sc ending in R, frontal tubercle protruding and bilobate, scutum with bare stripes, and metakatepisternum setose. Another character typical for the Gnoristini is the reduction of abdominal segments 7 and 8.

Except for the anepimeral cleft, these characters are also present in some genera outside the Gnoristini, and thus do not form a basis for any conclusive remarks. When present in the Leiini, this often applies to either of the two closely related genera *Ectrepesthoneura* Enderlein 1911 and *Tetragoneura* Winnertz, 1846. These two genera take a rather isolated position within the tribe, and were both tentatively included in the Gnoristini by Väisänen (1986) in his delimitation of the tribe. An additional character indicating a possible relationship between *Chalastonepsia, Ectrepesthoneura* and *Tetragoneura* is the absence of ventral setae on the radial veins.

The discrimination between the Gnoristini and

Leiini is still far from satisfactory, and the monophyly of each of the two tribes are highly questionable. Most likely, the sistergroup of the Metanepsiini will be found among genera included in the Gnoristini, above all indicated by the presence of a distinct and deep anepimeral cleft.

In having several characters in common with the Gnoristini it seems justified to ask whether Metanepsiini should be maintained as a separate tribe, or its two genera should be include in the Gnoristini. In several respects the current classification of the Mycetophilidae is unsatisfactory, and principally based on Holarctic representatives. However, awaiting a more thorough assessment of its phylogeny, including representatives from other biogeographical regions, the tribe Metanepsiini is maintained. In doing so, a revised diagnosis based on Matile (1971) is presented.

Revised diagnosis of the Metanepsiini

Three ocelli. Frons bare or with a few small setae; frontal tubercle weakly or distinctly bilobate. Mouthparts reduced; palpus with one visible segment. Tibia with trichia irregularly arranged, without strong setae except for a few apicals. Anteroapical depressed area of fore tibia absent or weakly developed. Wing membrane without macrotrichia or setae. Sc long, faint towards apex. Rs well developed, about as long as crossvein r-m, or very short and incomplete; R_1 long. Crossvein r-m relatively short, oblique. Petiole of median fork 0.3 to 1.0 times as long as M_1; M_2 reaching wing margin or falling short of this. Point of furcation of cubital fork slightly before crossvein r-m or close to wing margin.

Acknowledgements

My best thanks to Brian Pitkin, Natural History Museum, London, for his assistance during my stay in April 1995, and to Loïc Matile, Muséum national d'Histoire naturelle, Paris; Trond Andersen, Museum of Zoology, Bergen; and to Paul Beuk, Zoölogisch Museum, Amsterdam, for commenting upon the manuscript.

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References

Edwards, F. W., 1927. Diptera Nematocera from the Dutch East Indies (III-IV). – Treubia 9: 352-370.

Hennig, W., 1973. Diptera (Zweiflügler). – Handbuch der Zoologie 4(2) 2/31: 1-337. Berlin.

Hutson, A. M., D. M. Ackland & L. N. Kidd, 1980. Mycetophilidae (Bolitophilinae, Ditomyiinae, Diadocidiinae, Keroplatinae, Sciophilinae and Manotinae). – Handbooks for the Identification of British Insects 11(3): 1-112.

Matile, L., 1971. Une nouvelle tribu de Mycetophilidae: les Metanepsiini (Dipt.). – Bulletin de la Société Entomologique de France 76: 91-97.

Matile, L., 1972. Un *Metanepsia* nouveau du Kénya (Dipt. Mycetophilidae). – Bulletin de la Société Entomologique de France 76: 271-272.

Matile, L., 1975. Deux *Metanepsia* nouveaux d'Afrique orientale (Dipt. Mycetophilidae). – Bulletin de la Société Entomologique de France 79: 216-218.

Matile, L., 1980. Nouvelles données sur les *Metanepsia* afrotropicaux (Diptera, Mycetophilidae). – Revue Française d'Entomologie (N. S.) 2: 119-122.

Matile, L., 1989. Superfamily Sciaroidea. p. 123-145. – *In*: N. L. Evenhuis (ed), Catalog of the Diptera of the Australasian and Oceanian Regions. Honolulu & Leiden.

McAlpine, J. F., 1981. Morphology and terminology. Adults. p. 9-63. – *In*: J. F. McAlpine et al. (eds), Manual of the Nearctic Diptera. Vol. 1. Monograph Research Branch Agriculture Canada. Ottawa. No. 27.

Tuomikoski, R., 1966. On the subfamily Manotinae Edw. (Dipt., Mycetophilidae). – Annales entomologici Fennici 32: 211-223.

Väisänen, R., 1984. A monograph of the genus *Mycomya* Rondani in the Holarctic region (Diptera, Mycetophilidae). – Acta zoologica Fennica 177: 1-346.

Väisänen, R., 1986. The delimitation of the Gnoristinae: criteria for the classification of recent European genera (Diptera, Mycetophilidae). – Annales zoologici Fennici 23: 197-206.

Vockeroth, J. R., 1981. Mycetophilidae. p. 223-246. – *In:* J. F. McAlpine et al. (eds), Manual of the Nearctic Diptera. Vol. 1. Monograph Research Branch Agriculture Canada. Ottawa, Ontario. No. 27.

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BOOK REVIEWS

C. Gielis, 1996. Microlepidoptera of Europe. Volume 1. Pterophoridae. Edited by P. Huemer, O. Karsholt & L. Lyneborg. – Apollo Books Denmark. 222 pp., 16 colour–plates, 287 figs. [ISBN 87–88757–36–6]. Price DKK 350 excl postage; subscribers to the series receive 10% discount. Distributed by Apollo Books, Kirkeby Sand 19, DK–5771–Stenstrup, Denmark. Fax +4562263780.

The Pterophoridae is the first family to be published in the new series: The Microlepidoptera of Europe. This volume covers all the species occurring in Europe (excluding the former Soviet Union) and the Canary Islands.

The introduction briefly discusses the taxonomical history of the family, the characters and their phylogenetic implications, the biology of the adults and larvae. Very useful are the suggestions where and how to collect Pterophoridae. The chapter dealing with the preparation of slides may seem superfluous, but the audience which the editors intend to reach goes beyond the specialists in Lepidoptera. A key to the genera facilitates the identification also provided by the diagnoses, colour–plates and drawings of genitalia. The checklist of the species offers a few new synonymies, but generally confirms the opinion of Arenberger's recent changes in synonymy of this family.

The set–up of the book is practical, offering concise chapters for each species with differential diagnosis, male and female genitalia, and distribution. Also, the biology of the species is worked out. At the end of the book an index to the hostplants is given. This subject tends to be somewhat forgotten by many authors working on Lepidoptera.

The distributional catalogue provides a nice overview of the ranges of the different species, although the layout is rather inconvenient. A major point of criticism is the layout and enlargement of the colour–photographs of the adults. All specimens are shown 2.5 times their natural size. This gives a good indication of the size differences between the species, but makes it impossible to see the diagnostic characters for the smaller species given in the text. Fortunately the descriptions in the text and the figures of the genitalia still make the identification of the species easy.

In conclusion: An important, well printed, nicely hardbacked book, filling the gap between the extensive treatment of species in the series of 'Microlepidoptera Palaearctica' and the regional identification guides. It offers very good value for your money. The next volumes of the series are eagerly awaited for.
[R.T.A. Schouten]

D. T. Goodger & A. Watson, 1995. The Afrotropical Tiger-Moths. An illustrated catalogue, with generic diagnoses and species distribution, of the Afrotropical Arctiinae (Lepidoptera: Arctiidae). – Apollo Books, Denmark. 65 pp, 4 colour-plates, 198 figs. [ISBN 87-88757-32-3]. Price DKK 200 excl postage. Distributed by Apollo Books, Kirkeby Sand 19, DK-5771 Stenstrup, Denmark. Fax +4562263780.

The Afrotropical Arctiinae comprises 411 species, the total number of Afrotropical Arctiidae being 2600. Four superb colour plates illustrate the type species of all Afrotropical genera, except two. For many genera additional species are depicted. The male genitalia are clearly photographed in half-tone.

A list of larval hostplants of 72 species of moths is included, indicating the amount of work still to be done. The catalogue establishes many synonyms, new combinations and also transfers a considerable amount of genera outside the Arctiidae, albeit without much argumentation. The diagnostic characters for each genus are given. For all species label data of the types are presented, but the museums in which the types are kept are not mentioned. The distribution of the species is indicated by citing the countries from which the species have been recorded.

This work provides a very valuable catalogue of the Arctiinae, but it is much more. The plates, the data on distribution and the diagnostic notes for each genus add much value and make it a generic identification guide as well.
[R. T. A. Schouten]

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TWO NEW *CATOXYETHIRA* SPECIES FROM TANZANIA (TRICHOPTERA, HYDROPTILIDAE) AND A REVISED KEY TO TANZANIAN HYDROPTILIDS

Wells, A. & T. Andersen, 1996. Two new *Catoxyethira* species from Tanzania (Trichoptera, Hydroptilidae) and a revised key to Tanzanian hydroptilids. – Tijdschrift voor Entomologie 139: 85-89, figs. 1-5. [ISSN 0040-7496]. Published 15 October 1996.
Catoxyethira giboni sp. n. and *C. stolzei* sp. n. from Tanzania are described and a new record is given for *C. crinita* Wells & Andersen, 1995. Species groups in *Catoxyethira* are discussed briefly, and a revised version of a recently published key to Tanzanian Hydroptilidae is given.
Correspondence: A. Wells, Australian Biological Resources Study, GPO 636, Canberra, ACT 2601, Australia.
Key words. – Trichoptera, Hydroptilidae, *Catoxyethira*, new species, Tanzania.

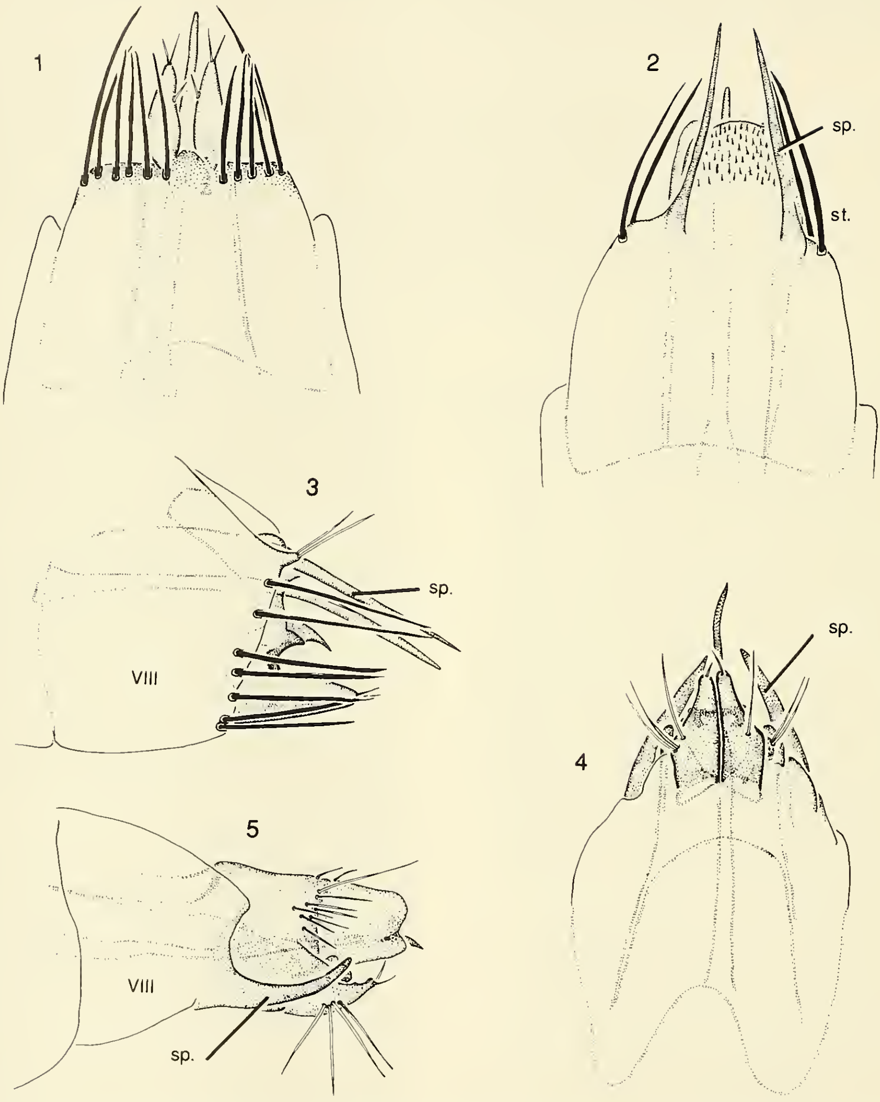
In a recent paper (Wells & Andersen 1995), we described nine species of *Catoxyethira* from Tanzania. Since that study went to press we have recognised two further Tanzanian *Catoxyethira* species amongst newly available material and these are described here. In addition, *C. crinita* Wells & Andersen, 1995 is recorded from the Uzungwa Mountains in southwestern Tanzania.

Catoxyethira is remarkably diverse in the Afrotropical Region, totalling with the two new species described here, 42 species. Indeed, the genus may be endemic to the region, as the identities of the only non-African species, *C. formosae* (Iwata, 1928), from Taiwan and *C. vedonga* Oláh, 1989, from Vietnam, are questionable (see Gibon 1985; Wells & Andersen 1995). At least the Vietnamese species, distinguished by Oláh from species of *Chrysotrichia* Schmid, 1958 mainly on the basis of tibial spur formula, is more probably referable to *Chrysotrichia*, which has been shown to have variable spur formulae (see Wells & Huisman 1993).

Among the Afrotropical *Catoxyethira* species three groups were defined by Gibon (1993), based on male genitalic features, including the shape of abdominal segment VIII and the arrangement of spines. A variety of spiny structures, the nature of which has not always been interpreted accurately either in text or figures, occur in the male genitalia. Some are clearly specialised stout sclerotised setae, since they are socketed, while others appear to be produced from the margins of abdominal sternite VIII and are, therefore, true spines. Only with hindsight, have we fully appreciated the distinctions between the modified setae and true spines of *Catoxyethira* species.

Gibon's *veruta*-group has a ventro-medial structure produced posteriorly from the apical border of sternite VIII, and is accompanied by a pair of lateral spines. The medial structure may be a single sharply tapered spine or be divided to form a pair of such spines. The second group, the *mali*-group, has the distal margin of segment VII unmodified, and has one or more stout, black, (modified) setae distally on sternite VIII, generally at the apico-lateral angles, but no true spines. The *hougardi*-group has the apico-lateral angles or some more medial section of the apical margin of sternite VIII produced into spines which are usually darkly sclerotised and often are accompanied by black setae inserted near the distal border of the sclerite. Gibon was unable to place seven of the 22 species he listed.

Only one of the Tanzanian species, *C. crenulata* Wells & Andersen, 1995 is placed in the *veruta*-group. Two *mali*-group species are known from Tanzania, *C. ruvuensis* Wells & Andersen, 1995, and *C. ocellata* Statzner, 1977. The latter closely resembles *C. pinheyi* Kimmins, 1958 which was not placed in any group by Gibon (1993). If these two species are included in this group, as we believe is appropriate, then the group is probably more properly referred to as the *pinheyi*-group. Most of the Tanzanian species have true spines and are thus members of the *hougardi*-group – *C. apicospinosa* Wells & Andersen, 1995, *C. lanceolata* Wells & Andersen, 1995, *C. elongata* Wells & Andersen, 1995, *C. crinita* Wells & Andersen, 1995



Figs. 1-5. – 1-3. *Catoxyethira giboni* sp. n., male terminalia: 1, ventral view; 2, dorsal view; 3, lateral view. – 4, 5. *Catoxyethira stolzei* sp. n., male terminalia: 4, ventral view; 5, lateral view. – Abbreviations. VIII: abdominal segment VIII; sp.: spine; st.: seta.

and *C. ciliata* Wells & Andersen, 1995, and the two new species, *C. giboni* sp. n. and *C. stolzei* sp. n.

A fourth group of species, here designated the *improcera*-group for Statzner's (1977) species from Zaire, have quite simple genitalia, lacking completely the spiny armature of others. This group also includes *C. incompta* Wells & Andersen, 1995 and *C. bombolensis* Wells & Andersen, 1995 from Tanzania.

At this stage these species groups are simply categories of convenience as they are not all supported by synapomorphies.

Wells & Andersen (1995) listed 29 species of Trichoptera in the Tanzanian Hydroptilidae, 24 newly described. Our key to the hydroptilids of Tanzania included species in *Ugandatrichia* Mosely, 1939, *Hydroptila* Dalman, 1819, *Dhatrichia* Mosely, 1948, *Tangatrichia* Wells & Andersen, 1995, *Orthotrichia* Eaton, 1873, *Stactobia* McLachlan, 1880, *Scelotrichia* Ulmer, 1951, and *Catoxyethira* Ulmer, 1912. Unfortunately, the key was distorted during publication and we therefore include an amended and updated key to the Tanzanian Hydroptilidae in the present paper.

MATERIAL

The material examined in this study forms part of a Trichoptera collection taken in several of the Eastern Arc Mountains in Tanzania by M. Stolze and N. Scharff (see Stolze 1989). Holotypes are lodged in the Zoological Museum, University of Copenhagen, Denmark (ZMUC), and paratypes in ZMUC and in the Museum of Zoology, University of Bergen, Norway (ZMBN).

Catoxyethira giboni sp. n.
(Figs. 1-3)

Type material. – Holotype male, Tanzania, Uluguru Mts, Morogoro River, 600 m, 3.ix.1982, M. Stolze & N. Scharff, ZMUC. Paratypes: 5 males, data as for holotype; 2 males, 3 females (1 male, 1 female on slide), Tanzania, Uzungwa Mts, Mwanihana Forest, Sanje River, 300-400 m, 24.viii.1982, loc. 9, M. Stolze & N. Scharff.

Description

Anterior wing length 2.6-2.7 mm. Terminalia as in figs. 1-3. Sternite VIII with a row of strong black setae apically, the row interupted midventrally; dorsally a pair of straight elongate spines. Tergite X covered with tiny spinules, rounded apically. Inferior appendages more than 2 times as long as wide, more or less conical in ventral view. Subgenital plate not evident in ventral view but possibly represented by the short, curved spiny structures visible in lateral view. Aedeagus simple, straight.

Etymology. – Named for François-Marie Gibon who has described so many *Catoxyethira* species from tropical Africa.

Remarks. – This species most closely resembles *C. cavallyi* Gibon, 1985 from the Ivory Coast, but differs in having more setae posteriorly on segment IX and the spines without serrations on their margins.

Catoxyethira stolzei sp. n.
(Figs. 4-5)

Type material. – Holotype male, Tanzania, Uzungwa Mts, Mwanihana Forest, Sanje River, 300-400 m, 24.viii.1982, loc. 9, M. Stolze & N. Scharff, ZMUC. Paratype, 1 male (on slide), data as for holotype.

Description

Anterior wing length 2.1-2.3 mm. Terminalia as in figs. 4,5. Sternite VIII with a pair of strong dark setae at each apico-lateral angle, a pair of slender straight spines more medially on the dorsum. Segment IX with a pair of short, apically rounded lateral lobes. Tergite X membranous, without spinules. Inferior appendages stout basally, tapered towards apex, a tuft of setae near base. Subgenital plate with a sclerotised band apically. Aedeagus slender, elongate.

Etymology. – Named for M. Stolze who, with N. Scharff, collected the specimens.

Remarks. – In overall form, the genitalia of this species closely resemble those of *C. ciliata* Wells & Andersen, 1995. *Catoxyethira stolzei*, however, is readily distinguished by its shorter, regularly curved spines.

Catoxyethira crinita Wells & Andersen

Catoxyethira crinita Wells & Andersen, 1995

Biology and distribution. – *Catoxyethira crinita* has been collected from beside a large slow-flowing stream, with a sandy and stony substrate. The new record extends the distribution from northeastern Tanzania to the southwestern part of the country.

Remarks. – The two new specimens referred to this species, show some slight differences from the type material. The bundle of dark setae midventrally is denser and the tips of all setae are turned inwards, and the inferior appendages are separated throughout their length.

Material examined. – 2 males (on slides), Tanzania, Uzungwa Mts, Mwanihana Forest, Sanje River, 300-400 m, 24.viii.1982, loc. 9, M. Stolze & N. Scharff, ZMUC.

Key to males of the Tanzanian Hydroptilidae

This is a revised and modified key after Wells & Andersen (1995). Only figures indicated with an asterisk relate to this paper, all other figure numbers, unless otherwise indicated, refer to figures provided by Wells & Andersen (1995).

1. On thorax, mesoscutellum with a transverse suture 2
– On thorax, mesoscutellum without a transverse suture 4
2. Tibial spur formula 1, 3, 4 or 1, 2, 4 3
– Tibial spur formula 0, 3, 4 .... *Scelotrichia glandulosa* Wells & Andersen
3. Tibial spur formula 1, 3, 4 (*Catoxyethira* Ulmer) 8
– Tibial spur formula 1, 2, 4 .... *Stactobia kaputensis* Wells & Andersen
4. On head, ocelli absent 5
– On head, ocelli present 6
5. Forewing with a jugal lobe, tibial spur formula 0,2,4 (*Hydroptila* Dalman) 19
– Forewing without jugal lobe, tibial spur formula 0,3,4 (*Orthotrichia* Eaton) 24
6. Wings slender, attenuate apically, venation reduced (see figs. 4, 32, 51) 7
– Wings broad, forewing rounded apically, venation complete (fig. 26) *Ugandatrichia* Mosely 29
7. On head, antennal flagellar segments with scattered clothing hair; metascutellum triangular, truncate anteriorly (fig. 50) .... *Tangatrichia gracilenta* Wells & Andersen
– Antennal flagellar segments with clothing hair in a basal whorl; on thorax, metascutellum rounded anteriorly (*Dhatrichia* Mosely) 30
8. Abdominal sternite VIII with a pair of true spines or with strong dark setae or both on apical margin (figs. 12-25) 9
– Abdominal sternite VIII with no stout spines or strong setae on apical margin (figs. 8-10) 16
9. Abdominal sternite VIII with 14-16 strong dark setae posteriorly (*figs. 1-3) .... *Catoxyethira giboni* sp.n.
– Abdominal sternite VIII with no more than 4 strong dark setae posteriorly or lacking such setae 10
10. Abdominal sternite VIII with a tuft of long dark setae midventrally .... *Catoxyethira crinita* Wells & Andersen
– Abdominal sternite VIII without a tuft of long dark setae midventrally 11
11. Abdominal segment VIII with a pair of stout spines, or three spines meso-ventrally (figs. 12-21) 12
– Abdominal segment VIII without spines meso-ventrally (figs. 24-25, *fig. 4) 16
12. Abdominal sternite VIII with a shorter third spine between the paired spines (fig. 21) .... *Catoxyethira crenulata* Wells & Andersen
– Abdominal sternite VIII with one pair of spines only 13
13. Paired spines on abdominal sternite VIII about equal in length to inferior appendages (fig. 13) .... *Catoxyethira ruvuensis* Wells & Andersen
– Paired spines on abdominal sternite VIII almost 2×length of inferior appendages, or longer 14
14. Length of paired spines on abdominal sternite VIII 2.5 to 3×length of inferior appendages (fig. 18) .... *Catoxyethira elongata* Wells & Andersen
– Length of paired spines on abdominal sternite VIII no more than 2× length of inferior appendages (e.g. figs. 14, 16) 15
15. Paired spines on abdominal sternite VIII straight in lateral view (fig. 16), curved inwards in ventral view (fig. 17) .... *Catoxyethira lanceolata* Wells & Andersen
– Paired spines on abdominal sternite VIII curved upwards in lateral view (fig. 14), more or less straight in ventral view .... *Catoxyethira apicospinosa* Wells & Andersen
16. Inferior appendages positioned mid-ventrally in a deep excision in abdominal sternite VIII (see Statzner 1977, fig. 24) .... *Catoxyethira ocellata* Statzner
– Abdominal sternite VIII without a deep excision midventrally (fig. 25, *fig. 4) 17
17. Spines on abdominal sternite VIII stout, twisted (fig 25) .... *Catoxyethira ciliata* Wells & Andersen
– Spines on abdominal sternite VIII slender, slightly curved, not twisted (*figs. 4,5) .... *Catoxyethira stolzei* sp. n.
18. Subgenital plate and inferior appendages elongate, subequal in length; inferior appendages cylindrical (figs. 9, 10) .... *Catoxyethira bombolensis* Wells & Andersen
– Subgenital plate about 2× length of inferior appendages; inferior appendages broader basally than distally (fig. 8) .... *Catoxyethira incompta* Wells & Andersen
19. With pair of sclerotised strap-like structures above inferior appendages (fig. 48) 20
– Without pair of strap-like structures above inferior appendages (figs. 39, 42, 43, 46) 21
20. Inferior appendages in ventral view slender, curved, narrowed slightly towards apex, without a black spine apically (see Mosely 1948, fig. 48) .... *Hydroptila cruciata* Ulmer
– Inferior appendages in ventral view stout basally, apically bifid, with strong, black spine ventrally and a pale slender spine dorsally (fig. 48) .... *Hydroptila bumbulensis* Wells & Andersen
21. Inferior appendages short, sub-globose in ventral view, irregular in shape (fig. 46) .... *Hydroptila tannerorum* Wells & Andersen
– Inferior appendages elongate, cylindrical or somewhat sinuous, with length at least 3× width .. 22

22. Aedeagus greatly dilated distally, a single small spine sub-apically (fig. 39) .... *Hydroptila usambarensis* Wells & Andersen
– Aedeagus slender or weakly dilated distally, with one or two spines apically 23
23. Inferior appendages in ventral view dilated in basal half, tapered and out-turned apically; aedeagus with a small spine apically (figs. 41, 42) ....*Hydroptila morogoroensis* Wells & Andersen
– Inferior appendages in ventral view sub-cylindrical; aedeagus divided distally to form a pair of spines in series (figs. 43, 44) .... *Hydroptila mazumbaiensis* Wells & Andersen
24. Abdominal segment IX laterally with paired membranous, digitate processes with 1 or 2 apical setae (e.g. figs. 55-57) 25
– Abdominal segment IX without paired processes laterally (e.g. figs. 58-63) 26
25. Inferior appendages symmetrical (fig. 57) ....*Orthotrichia barnardi* Scott
– Inferior appendages asymmetrical (fig. 55) ....*Orthotrichia bisetula* Wells & Andersen
26. Tibial spurs 0,2,4 .... *Orthotrichia hydroptiloides* Wells & Andersen
– Tibial spurs 0,3,4 27
27. Inferior appendages fused, in ventral view rectangular (fig. 59) .... *Orthotrichia scutellata* Wells & Andersen
– Inferior appendages discrete or partially fused, in form of two unequal lobes 28
28. Inferior appendages rounded, asymmetrical, the left apically with a small sclerotised knob; an elongate process extending distally into a spine at right apico-lateral angle of segment IX (fig. 61) ....*Orthotrichia nigrovillosa* Wells & Andersen
– Inferior appendages tapered distally, the right one twisted; a simple apically rounded process at right apico-lateral angle of segment IX (see Jacquemart 1956, fig. 2) .... *Orthotrichia straeleni* Jacquemart
29. Inferior appendages set into deep excision in abdominal sternite IX, irregular in shape, with small inner spur subapically (fig. 28) .... *Ugandatrichia tanzaniensis* Wells & Andersen
– Abdominal sternite IX with shallow, ventral excision; inferior appendages stout, with inner spur at base (figs. 27, 30) .... *Ugandatrichia dentata* Wells & Andersen
30. Length of inferior appendages in ventral view about 2× width (fig. 35) .... *Dhatrichia divergenta* Wells & Andersen
– Length of inferior appendages in ventral view 3 to 4× width (fig. 37) .... *Dhatrichia cinyra* Wells & Andersen

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References

Dalman, J. W., 1819. Nagra nya insekt-genera, beskrifna. – Kungliga Svenska vetenskapsakedamiens handlingar 40: 117-127.

Eaton, E. A., 1873. On the Hydroptilidae, a family of the Trichoptera. – Transactions of the Entomological Society of London 1873: 141.

Gibon, F.-M., 1985. Recherches sur les Trichoptères d'Afrique occidentale, 2: Stactobiini (Hydroptilidae) de Côte-d'Ivoire. – Revue française d'Entomologie (N.S.) 7: 149-155.

Gibon, F.-M., 1993. Trichoptères du Cameroun. Un nouvel exemple de la richesse des *Catoxyethira* (Hydroptilidae). – Revue Hydrobiologie tropicales 26(3): 199-211.

Iwata, M., 1928. Five new species of trichopterous larvae from Formosa. – Annotationes zoologicae japonenses, Tokyo 11: 341-343.

Kimmins, D. E., 1958. On some Trichoptera from S. Rhodesia and Portuguese East Africa. – Bulletin of the British Museum (Natural History) Entomology Series 7: 559-568.

McLachlan, R., 1880. A monographic revision and synopsis of the Trichoptera of the European Fauna. Part IX, pp. 501-523, with supplement, pp. xiii-lxxxiv. – London.

Mosely, M. E. 1939. Trichoptera. – Ruenzori Expedition 1934-35(3): 1-39.

Mosely, M. E. 1948. Trichoptera. – Expedition to South-West Arabia 1937-38(1): 67-85.

Oláh, J., 1989. Thirty-five new hydroptilid species from Vietnam (Trichoptera: Hydroptilidae). – Acta Zoologica Hungarica 35: 255-293.

Schmid, F., 1958. Trichoptères de Ceylon. – Archiv für Hydrobiologie 54: 1-173.

Starzner, B., 1977. Taxonomische Studien an den Hydroptilidae-Imagines aus dem zentralafrikanischen Bergbach Kalengo. – Deutsche entomologische Zeitschrift, (Neue Folge) 25: 393-405.

Stolze, M., 1989. The Afrotropical caddisfly family Pisuliidae. Systematics, zoogeography, and biology (Trichoptera: Pisuliidae). – Steenstrupia 15(1): 1-49

Ulmer, G., 1912. Trichoptera aus äequatorial-Afrika. – Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika Expedition (1907-08) 4: 81-125.

Ulmer, G., 1951. Köcherfliegen (Trichopteren) von den Sunda-Inseln (Teil I). – Archiv für Hydrobiologie, Supplement 19: 1-528.

Wells, A. & T. Andersen, 1995. Tanzanian micro-caddisflies (Trichoptera: Hydroptilidae). – Tijdschrift voor Entomologie 138: 143-167.

Wells, A. & J. Huisman, 1993. Malaysian and Bruneian micro-caddisflies in the tribes Stactobiini and Orthotrichiini (Trichoptera: Hydroptilidae: Hydroptilinae). – Zoologische Mededelingen, Leiden 67: 91-125.

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LARVAL MITES (ACARI: TROMBIDIIDAE) PARASITIC ON APHIDS IN IRAN: KEY, A NEW SPECIES AND NEW RECORD

Zhang, Z.-Q. & N. Rastegari, 1996. Larval mites (Acari: Trombidiidae) parasitic on aphids in Iran: key, a new species and new record. – Tijdschrift voor Entomologie 139: 91-96, figs. 1-6. [ISSN 0040-7496]. Published 15 October 1996.
A key to larvae of Trombidiidae (Acari: Prostigmata) found ectoparasitic on aphids in Iran is presented. *Allothrombium shirazicum* Zhang sp. n. is described and illustrated from larvae parasitic on *Forda marginata* Koch (Pemphigidae) and unidentified aphids in Shiraz, Iran. *Monotrombium simplicium* Zhang is newly recorded from larvae parasitic on aphids in wheat fields in Shiraz, Iran.
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Key words. – Acari; Trombidiidae; classification; larvae; key; ectoparasites; aphids; Pemphigidae; *Monotrombium*; *Allothrombium*; Iran.

Larvae of the genus *Allothrombium* and *Podothrombium* are common ectoparasites of aphids and are expected to have potential for use as biocontrol agents against aphids (Eickwort 1983, Welbourn 1983, Zhang 1991a, Zhang & Xin 1992). Discovery and accurate description of these parasitic mites are prerequisites for any research toward their potential use in pest control programs (Eickwort 1983, Welbourn 1983).

Recently, H. Norbakhsh of Shahid Chamran University, Ahwaz, Iran sent to the senior author some larval trombidiid mites which were found ectoparasitic on various wheat aphids in Shiraz, Iran. A study of these mites revealed a new species (*Allothrombium shirazicum* Zhang sp. n.) and a new record (*Monotrombium simplicium* Zhang) from Shiraz, Iran. The purpose of this paper is to describe the new species and to present a key to larvae of Trombidiidae parasitic on aphids in Iran.

The terminology and abbreviations used in this paper are adapted from Robaux (1974) and Welbourn & Young (1988). All the measurements of length are in micrometers.

Key to larvae of Trombidiidae parasitic on aphids in Iran

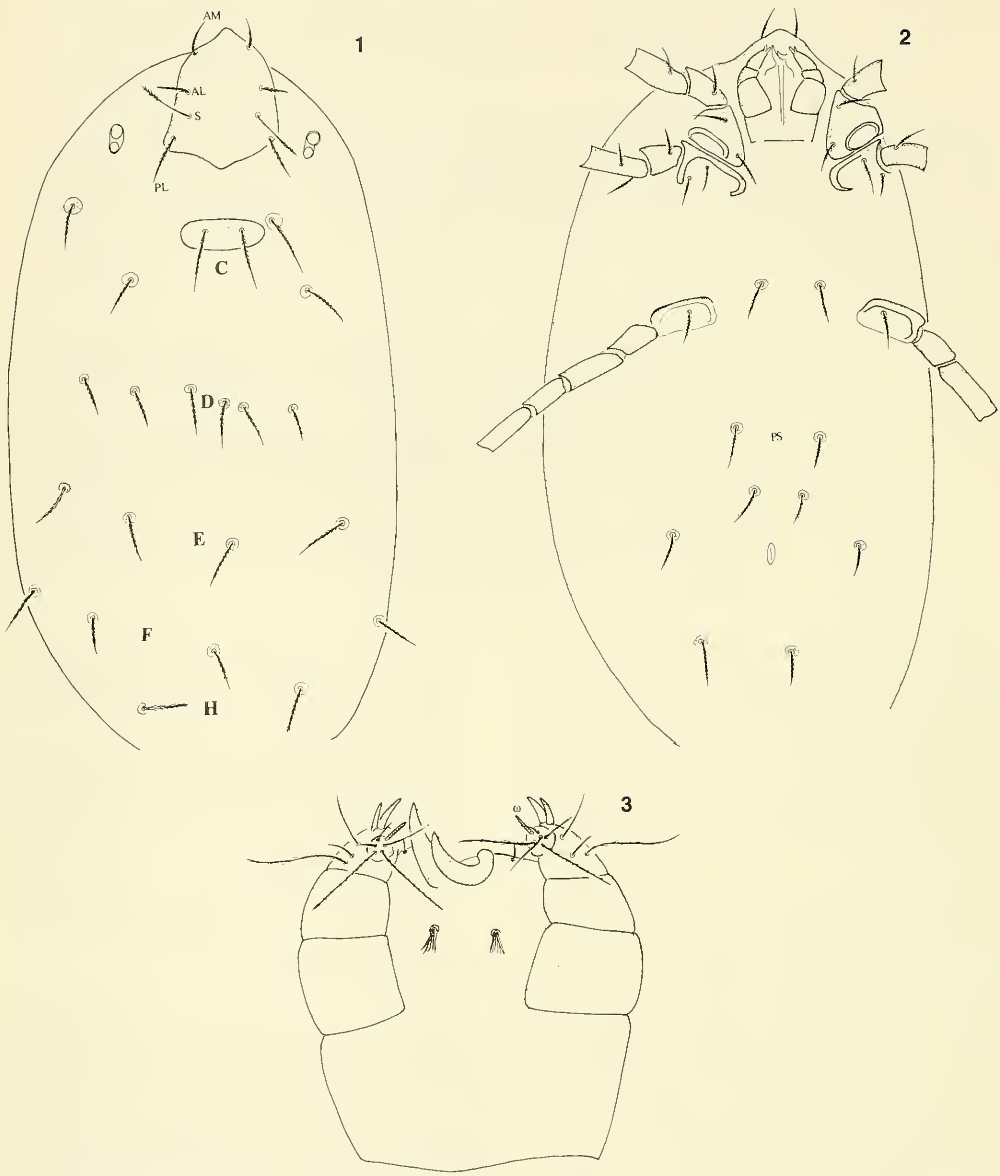
1. Coxa II with one seta; genu II and genu III each with one solenidion .... *Monotrombium* (*M. simplicium* Zhang)
– Coxa II with two setae; genu II and III each with two solennidia (*Allothrombium*) 2
2. Tarsus III with two normal claws and an empodium .... *A. pulvinum* Ewing
– Tarsus III with one normal claw and empodium; inner claw vestigial 3
3. Idiosoma with more than 20 dorsal setae and more than 10 ventral setae .... *A. mossi* Zhang
– Idiosoma with 20 dorsal setae and less than 10 ventral setae 4
4. Legs short; tarsi I-III < 60 μ ... *A. triticium* Zang
– Legs long; tarsi I-III > 90 μ ....*A. shirazicum* Zhang sp. n.

Allothrombium shirazicum Zhang sp. n.
(figs. 1-6)

Type material. – Holotype larva (ZQZ 96-0128-3a) parasitic on an aphid, collected by N. Rastagari (No. 14, 58-19), on 20.iv.1992 in Shiraz, IRAN. – Paratype larva (ZQZ 93-0128-3b), same data as holotype. Paratype larvae (ZQZ 930128-2c, d) parasitic on *Forda marginata* Koch (Pemphigidae), collected by N. R. Nowband (No. 1-19), on 14.vi.1992 in Shiraz, IRAN. All types deposited in the The Natural History Museum (BMNH), London.

Description

Larvae with the following features: fD = 4(+2)-6-4-4-2 = 18(+2); fV = 2-2-2u-2 = 8; fnTr = 1-1-1; fnFe = 5-4-4; fnGe = 4-3-3; fnTi = 5-5-5; fnTa = 17-14-13; fSol = I(0-2-2-1), II(0-2-2-1), III(0-2-0-0); f κ = I(1-1), II(1-0), III(0-0); f ζ = 2-0-0; fϵ = 1-1-0; fPp = 0-0-0-BNN2-BBNNNω; IP = 1298 (1280-1320).



Figs. 1-3. *Allothrombium shirazicum* Zhang sp. n. Holotype larva. – 1, Idiosoma, dorsal view; 2, Idiosoma, ventral view; 3, Gnathosoma.

Larva. – Measurements are means of four specimens, with range in parentheses. Idiosoma engorged, holotype 750 long, 450 wide. Idiosoma dorsally with a scutum, a scutellum, a pair of ocular sclerites, and 24-26 dorsal setae. Scutum pentagonal in shape, widest at postero-lateral angles, with convex posterior side; small punctation on scutum denser on posterior part than on anterior part; AM setae barbed, near antero-lateral angles of scutum; PL setae barbed, at postero-lateral angles; AL setae barbed, between AM and PL setae; S barbed only in distal half, between AL and PL setae. Scutellum with two barbed setae; wider than long, with small punctation throughout. Standard measurements of scutum and scutellum as follows: AM 39 (29-45); AA 60 (53-66); AL 44 (43-47); AW 87 (78-90); MA 42 (41-44); PL 72 (70-73); PW 104 (100-114); AP 46 (38-53); S 84 (79-90); SB 68 (64-70); ASB 94 (90-99); PSB 56 (55-59); SD 151 (145-158); W 124 (119-130); HS 37 (33-38); LSS 86 (79-93); SL 68 (65-72); SS 36 (29-43). Ocular sclerite, 37 (34-40) long, lateral to postero-lateral angles of scutum; with 2 eyes, the anterior eye (13-15 in diameter) larger than the posterior one (9-11 in diameter). All dorsal setae barbed, arising from small setal sclerites; dorsal setal formula fD = 4(+2)-6-4-4-2 = 18(+2).

Idiosoma ventrally with three pairs of coxae, 1 pair of intercoxal setae, eight pairs of ventral setae, and an anus. All setae on ventral idiosoma with barbs. Coxa I 82 (75-88) long, with two barbed setae. Coxa II 84 (81-88) long, with two barbed setae. Coxa III 74 (69-75) long, with a single barbed seta. Intercoxal setae between coxa III. Ventral setae with small setal sclerites; ventral setal formula fV = 2-2-2u-2 = 8.

Gnathosoma truncate posteriorly. Palpal setal formula fPp = 0-0-0-BNN2-BBNNNω. A pair of adoral setae nude, 8 (6-9) long. A pair of subcapitular setae thick, branched distally, 11 (11-12) long, 119 (18-20) apart at base. Cheliceral base 65 (62-68) long; cheliceral blade 26 (23-30) long, curved with a single tooth distally.

Leg segmentation formula fSp = 6-6-6. IP = 1298 (1280-1320). Leg I 448 (431-456); trochanter 53 (50-55), with 1B; femur 83 (80-84), with 5B; genu 49 (47-50), with 4B, two solenidia σ, and a microseta κ; tibia 78 (75-80), with 5B, two solenidia ϕ, and a microseta κ; tarsus 104 (96-108), with 17B, one solenidion ω, one dorsal eupathidum ζ, one terminal eupathidum ζ, one famulus ϵ; claw-like empodium 20 (19-21), two lateral claws 32 (32-34) each. Leg II 414 (406-419); trochanter 52 (49-55), with 1B; femur 74 (71-75), with 4 B; genu 40 (38-42), with 3B, two solenidia σ and one microseta κ; tibia 71 (70-72), with 5B and two solenidia ϕ; tarsus 95 (92-96), with 14B, one solenidion ω, and one famulus ϵ; claw-like empodium 22 (21-23), two lateral claws 31 (25-37) each. Leg III 436 (423-451); trochanter 57 (55-64), with 1B; femur 77 (75-79) with 4B; genu 42 (38-46), with 3B and two solenidia σ; tibia 83 (80-86), with 5B; tarsus 102 (100-107), with 13B; claw-like empodium 26 (25-27), one lateral claw 37 (30-40).

Remarks

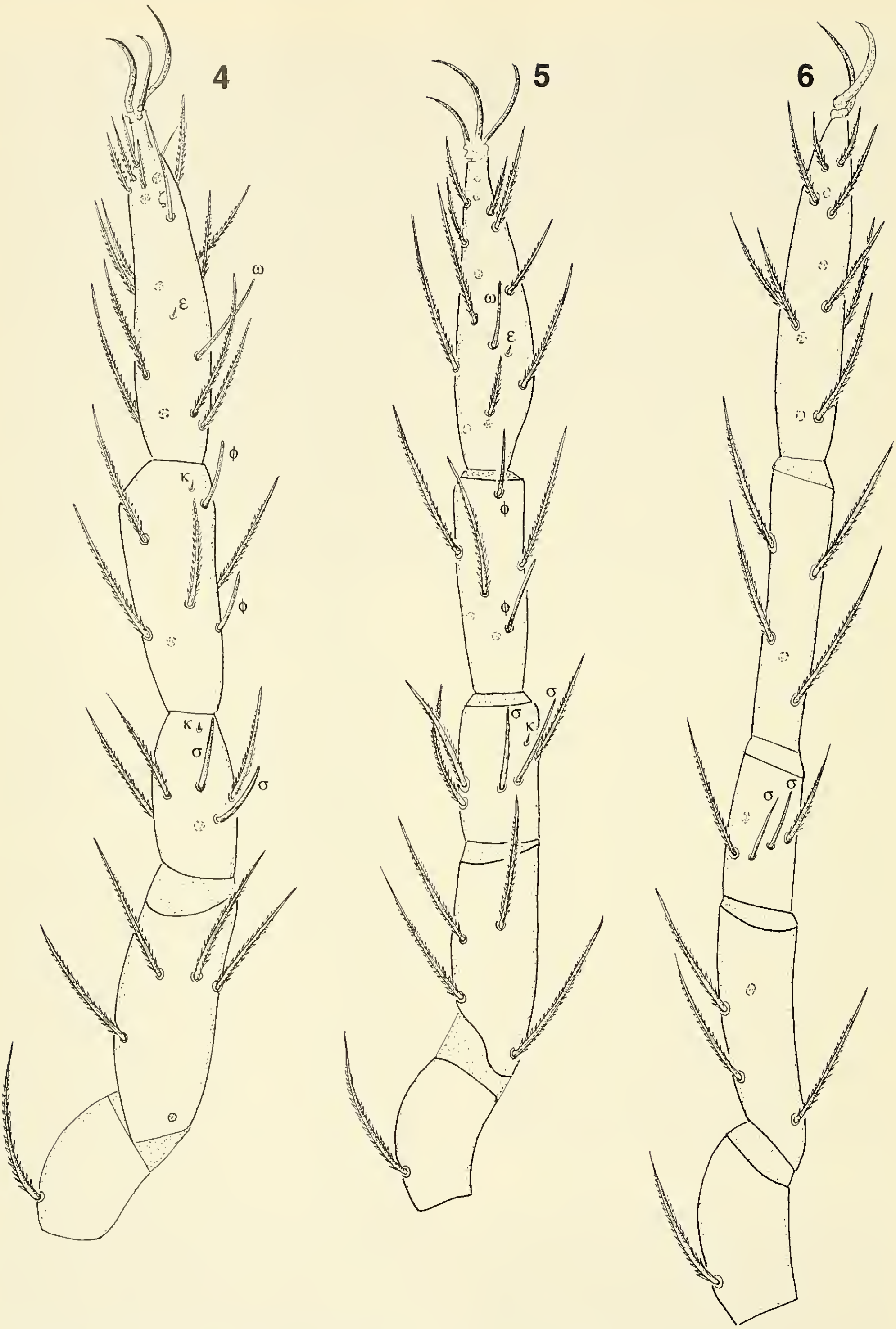
Larvae of 13 *Allothrombium* species have been recognized worldwide (Zhang and Xin 1992; Zhang & Norbakhsh 1995). Four species are known only from Europe: *A. fuliginosum* (Hermann), *A. recki* Feider & Agekian, *A. neapolitanum* Oudemans, and *A. monspessulanum* Robaux & Aeschlimann (Feider 1951, Feider & Agekian 1967, Henking 1882, Hirst 1926, Robaux 1972, 1974, Robaux & Aeschlimann 1987, Oudemans 1910, 1912, Thor & Willmann 1947, Turk & Turk 1952). Six species have been recorded only from Asia: *A. ovatum* Zhang & Xin, *A. kekko* (Southcott), *A. epiphyllus* Shiba, and *A. chanaanense* Feider, *A. triticium* Zhang, and *A. mossi* Zhang (Feider 1977, Shiba 1976, Southcott 1986, Zhang & Xin 1992, Zhang & Norbakhsh 1995). Two species are known only from North America: *A. lerouxi* Moss and *A. mali* (Childers & Vercammen-Grandjean 1980; Moss 1962). *A. pulvinum* Ewing appears to be a cosmopolitan species and has been reported from Europe, Asia (China and Iran), and North America (Howard 1918, Miller 1925, Minks & Harrewijn 1988, Zhang 1988, 1991b, Zhang & Faraji 1994, Zhang & Xin 1989a, b, 1992), although its presence in Europe needs to be confirmed. The new species, *A. shirazicum*, is related to *A. triticium*, but can be distinguished from the latter from its long legs: leg lengths of I-II-III are 448-414-436 for *A. shirazicum*, but 335-328-367 for *A. triticium*.

Monotrombium simplicium Zhang

Description

Larvae with the following features: fD = 2-2-6-4-4-2=20; fV = 2-2-2u-2 = 8; fcx = 2-1-1; fnTr = 1-1-1; fnFe = 5-4-4; fnGe = 4-3-3; fnTi = 5-5-5; fnTa = 17-14-13; fSol = I(0-2-2-1), II(0-1-2-1), III(0-1-0-0); fκ = I(1-1), II(1-0), III(0-0); fζ = 2-0-0; fϵ = 1-1-0; fPp = 0-0-0-BNN2-BBNNNω; IP = 805; tarsus III with reduced inner claw. IP = 785 (754-814).

Larva. – Measurements are means of four specimens, with range in parentheses. Idiosoma 492-530 long, 280-300 wide. Standard measurements of scutum and scutellum as follows: AM 36 (35-38); AA 51 (48-54); AL 33 (25-39); AW 62 (59-65); MA 32 (31-34); PL 47 (45-47); PW 79 (74-83); AP 35 (34-35); S 48 (43-52); SB 50 (49-50); ASB 66 (63-68); PSB 43 (36-49); SD 109 (99-117); W 94 (81-104); HS 32 (25-36); LSS 68 (59-81); SL 42 (39-45); SS 25 (23-26). Ocular sclerite, 23 (22-25) long and 13 (11-13) wide; the anterior eye (diameter 9-11) larger than the posterior one (diameter 5-7). Palpal 52 (51-54) long. Adoral seta 6 long. Subcapitular setae 7 (6-7) long, 12 (11-12) apart at base. Cheliceral base 44 (42-45) long; cheliceral blade 12 (11-14) long. IP = 785 (754-814). Leg I 258 (250-262) long; coxa I 51 (45-57) long; trochanter 33 (32-34) long; femur 48 (47-49) long; genu 29 (27-31) long; tibia 42 (38-47) long; tarsus 57 (51-61) long; claw-like empodium 21 (19-22) long, two lateral claws 15 (13-16) long each. Leg II 253 (243-268) long; coxa II 58 (54-61); trochanter 32 (31-32) long; femur 45 (43-45) long; genu 24 (22-



Figs. 4-6. *Allothrombium shirazicum* Zhang sp. n. Holotype larva. – 4, first leg; 5, second leg; 6, third leg.

25) long; tibia 40 (36-43) long; tarsus 53 (49-58) long; claw-like empodium 23(21-23) long, two lateral claws 16 (14-17) each. Leg III 275 long; coxa III 55 (54-56) long; trochanter 35 (34-36) long; femur 49 (43-52) long; genu 28 (25-31) long; tibia 46 (42-50) long; tarsus 61 (53-68); claw-like empodium 25 (23-28), one lateral claw 17 (16-18).

Material. – Larvae (ZQZ 93-0128-2a, b, and e), IRAN, Shiraz, on wheat aphids,14.iv.1992, N. Rastegari.

Remarks

This species was first decribed from larvae parasitic on aphids in Shahrkord, Iran (Zhang & Norbakhsh 1995). This is a new record of this species from Shiraz, Iran. The Shiraz specimens are almost identical to those from Shahrkord. A minor exception is that the subcapitular setae are longer and more narrowly spaced at base in the former than in the latter; 7 long, 12 apart at base in Shiraz specimens but 5.3 long, 13 apart at base in specimens from Shahrkord.

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References

Childers, C. C. & P. H. Vercammen-Grandjean, 1980. *Aphithrombium mali*, a new genus and species in the family Trombidiidae (Acari: Parasitengonae) parasitic on *Aphis pomi* De Geer. – Journal of the Kansas Entomological Society 53: 720-726.

Eickwort, G. C., 1983. Potential use of mites as biological control agents of leaf-feeding insects. *In* M. A. Hoy, G. L. Cunningham & L. Knutson (eds), Biological control of pests by mites: 41-52. University of California Press/ ANR Publishing Co., Oakland.

Feider, Z., 1951. Un trombidiid dusman al puricilor de plante. – Academia Republicii Populare Romine Filialia Iasi Studii si Cercetari Stiintifice Biologie si Stiinte Agricole 2: 481-497.

Feider, Z., 1977. Contribution à la connaissance des larves d'acariens du bassin oriental de la Mediterranée. – Israel Journal of Zoology 26: 100-113.

Feider, Z. & H. Agekian, 1967. Un nouvel acarien parasite des pucerons. – Travaux de Museum d'Histoire Naturelle 'Grigore Antipa' 7: 71-80.

Henking, H., 1882. Beiträge zur Anatomie, Entwicklungsgeschichte und Biologie von *Trombidium fuliginosum* Hermann. – Zeitschrift für Wissenschaftliche Zoologie 37: 533-663.

Hirst, S., 1926. Note on the development of *Allothrombium fuliginosum* Hermann. — Journal of the Royal Microscopical Society 1926: 274-276.

Howard, C. W., 1918. A preliminary report on the Trombidiidae of Minnesota. – Report State Entomologist of Minnesota 17: 111-144.

Miller, E. A., 1925. An introductory study of the Acarina or mites of Ohio. – Ohio Agricultural Experiment Station Bulletin 386: 82-172.

Minks, A. K. & P. Harrewijn, 1988. Aphids. Their biology, natural enemies and control. Vol. B. – Elsevier, Amsterdam, 364 pp.

Moss. W. W., 1962. The immature stages of the red velvet mite *Allothrombium lerouxi* (Acari: Trombidiidae). – Annals of the Entomological Society of America 55: 295-303.

Oudemans, A. C., 1910. Acarologische aanteekeningen XXXI. – Entomologische Berichten, Amsterdam 3: 47-51.

Oudemans, A. C., 1912. Die bis jetzt bekannte Larven von Trombidiidae und Erythraeidae mit besonderer Berücksichtigung der für den Menschen schädlichen Arten. – Zoologische Jahrbücher (Supplement) 14 (1) 230 pp.

Robaux, P., 1972. Étude des larves de Thrombidiidae; IV. Redescription des larvaires formes d'*Allothrombium neapolitum* Oudemans, 1910, *Neothrombium neglectum* (Bruyant), 1908 et *Microthrombium fasciatum* (Koch), 1836. – Acarologia 14: 612-630.

Robaux, P., 1974. Recherches sur le développement et la biologie des acariens 'Thrombidiidae'. – Memoires du Museum National d'Histoire Naturelle Serie A Zoologie 85: 1-186.

Robaux, P. & J. P. Aeschlimann, 1987. *Allothrombium monspessulanum* nov. spec. (Acari: Trombidiidae), un important enemi naturel des arthropodes inféodés a la luzerne cultivée (*Medicago sativa* Linnaeus) en region mediterranéenne. – Mitteilungen der Schweizerischen Entomologischen Gesellschaft 60: 43-50.

Shiba, M., 1976. Taxonomic investigation on free-living Prostigmata from the Malay Peninsula. – Nature and life in Southeast Asia 7: 83-299.

Southcott, R. V., 1986. Studies on the taxonomy and biology of the subfamily Trombidiidae (Acarina: Trombidiidae) with a critical revision of the genera. – Australian Journal of Zoology (Supplementary Series) No. 123: 1-116.

Thor, S. & C. Willmann, 1947. Acarina. Trombidiidae. – Das Tierreich 71b: 187-541.

Turk, F. A. & S. M. Turk, 1952. Studies on Acari - 7th Series. Records and descriptions of mites new to the British fauna together with short notes on the biology of sundry species. – Annals and Magazine of Natural History (12) 5: 497-500.

Welbourn, W. C., 1983. Potential use of trombidioid and erythraeoid mites as biological control agents of insect pests. *In* M. A. Hoy, G. L. Cunningham & L. Knutson (eds), Biological control of pests by mites. Agricultural Experiment Station. Division of Agriculture and Natural Resources. Special Publication 3304: 103-140. University of California.

Welbourn, W. C. & O. P. Young, 1988. Mites parasitic on spiders, with a description of a new species of *Eutrombidium* (Acari: Eutrombidiidae). – Journal of Arachnology 16: 373-385.

Zhang, Z.-Q., 1988. Two common mites of *Allothrombium* Berlese in China. – Kunchong Zhishi 25: 172-174 [in Chinese].

Zhang, Z.-Q., 1991a. Biology of mites of Allothrombiinae (Acari: Trombidiidae) and their potential role in pest control. *In* F. Dusbabek & V. Bukva (eds), Modern acarology Vol.II.: 513-520. Academia, Prague.
Zhang, Z.-Q., 1991b. Parasitism of *Acyrthosiphon pisum* (Harris) by *Allothrombium pulvinum* Ewing (Acariformes: Trombidiidae): Host attachment site, host size selection, superparasitism, and impact on host. – Experimental and Applied Acarology 11: 137-147.
Zhang, Z.-Q. & F. Faraji, 1994. Notes on *Allothrombium pulvinum* Ewing (Acari: Trombidiidae) new to the fauna of Iran. – Acarologia 35: 357-360.
Zhang, Z.-Q. & H. Norbakhsh, 1995. A new genus and three new species of mites (Acari: Trombidiidae) described from larvae ectoparasitic on aphids from Iran. – European Journal of Entomology 92: 705-718.
Zhang, Z.-Q. & J.-L. Xin, 1989a. Biology of *Allothrombium pulvinum* Ewing (Acari: Trombidiidae), a potential biological agent of aphids in China. – Experimental and Applied Acarology 6: 101-108.
Zhang, Z.-Q. & J.-L. Xin, 1989b. Studies on the morphology and life history of *Allothrombium pulvinum* Ewing (Acariformes: Trombidiidae). – Acta Entomologica Sinica 32: 192-199 [in Chinese with English abstract].
Zhang, Z.-Q. & J.-L. Xin, 1992. A review of larval *Allothrombium* (Acari: Trombidiidae), with description of a new species ectoparasitic on aphids in China. – Journal of Natural History 26: 383-393.

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Giorgio BALDIZZONE

Asti, Italy

A TAXONOMIC REVIEW OF THE COLEOPHORIDAE (LEPIDOPTERA) OF AUSTRALIA

Contribution to the knowledge of the Coleophoridae, LXXXV

Baldizzone, G., 1996. A taxonomic review of the Coleophoridae (Lepidoptera) of Australia. Contribution to the knowledge of the Coleophoridae, LXXXV. – Tijdschrift voor Entomologie 139: 97-144, figs. 1-158. [ISSN 0040-7496]. Published 18 December 1996.

The present taxonomic knowledge of the Coleophoridae of Australia is reviewed. Fifteen species are recorded here, of which nine are described as new: *Corythangela fimbriata, Coleophora leucocephala, C. nielseni, C. horakae, C. fuscosquamata, C. frustrata, C. rustica, C. albiradiata, C. consumpta.* The genitalia of *Corythangela galeata* Meyrick, *Coleophora crypsineura* (Lower), *C. tremefacta* Meyrick, as well as the larval case of *C. seminalis* Meyrick, are illustrated for the first time. Two new synonymies are established: *Plutella ochroneura* Lower, 1897 and *Coleophora pudica* Lower, 1905 are junior subjective synonyms of *C. serinipennella* Christoph, 1872. After examination of the external morphology and the genital structures, the genus *Corythangela* is transferred to the family *Batrachedridae.*

Dr. G.Baldizzone, Via Manzoni, 24, I-14100 Asti, Italy.

Key words. – Coleophoridae; Batrachedridae; Australia; taxonomy; new species.

The present paper is the first in a series of revisions of 'non-palaearctic' Coleophoridae. It will be followed by revisions of species of the Afrotropical region, of South America, and of the Indian subcontinent. As a matter of fact, when studying all the palaearctic species described so far, I have also paid a lot of attention to the species outside the palaearctic region; their number is considerably smaller than those described from the Palaearctic; nevertheless they are essential for my aim to reach a satisfactory systematic organisation in the light of modern methodology. I have not examined the species of North America, a region that is seriously studied by my friend Dr. Jean-François Landry, of Ottawa, but at the moment I can affirm that I have revised all the type series of all the other species of the world. This will enable me to present a complete revision and a general survey of the distribution of the family of Coleophoridae. The present knowledge of Australian Coleophoridae is very poor and based only on publications by Lower (1897, 1905, 1917) and Meyrick (1897, 1921 a and b, 1922). In recent years Common (1970, 1990) has given a survey of what is known up till now. For that reason Dr. Ebbe Schmidt-Nielsen has rearranged all the material that he found in the museums of Australia, i.e. in Canberra and Adelaide, comprising the original material of the Lower collection as well as all the specimens received later on. I have received for study the types kept in the BMNH. All this has enabled me to give a survey of the Australian fauna of Coleophoridae as complete as possible at this moment.

Abbreviations for museums

ANIC: Australian National Insect Collection, Canberra, Australia. – BMNH: Natural History Museum, London, U.K. – RMNH: Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands. – MNHN: Muséum National d'Histoire Naturelle, Paris. – SAMA South Australian Museum, Adelaide, Australia. – USNM: U.S. National Museum of Natural History, Smithsonian Institution, Washington

Checklist of the Coleophoridae of Australia

Corythangela Meyrick, 1897
- *galeata* Meyrick, 1897
- *fimbriata* sp. n.

Coleophora Hübner, 1822
- *serinipennella* Christoph, 1872
- *ochroneura* (Lower, 1897) **syn. n.**
- *pudica* Lower, 1905 **syn. n.**
- *alcyonipennella* (Kollar, 1832)
- *seminalis* Meyrick, 1921
- *leucocephala* **sp. n.**

crypsineura (Lower, 1900)
tremefacta Meyrick, 1921
nielseni sp. n.
horakae sp. n.
fuscosquamata sp. n.
frustrata sp. n.
rustica sp. n.
albiradiata sp. n.
consumpta sp. n.

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I am indebted to Dr. Ebbe Schmidt-Nielsen and to Dr. Marianne Horak (anic), who have entrusted me with all the material found in the collections of Australia, and who have generously helped me with photocopies, information etc. I also express my appreciation to Dr. Klaus Sattler and to Dr. Kevin Tuck (bmnh) for the loan of types, for information and advice, and to an anonymous referee for valuable suggestions to improve this paper. A special word of thanks for my Dutch friends Erik van Nieukerken (rmnh) and Hugo van der Wolf (Nuenen) for help with the realisation of this publication and for the translation into English.

Systematic part

Corythangela galeata Meyrick
(figs. 1, 2, 18, 34-44)

Corythangela galeata Meyrick, 1897: 300. – Lectotype ♀, 'Sydney N.S. Wales, 3/12/84', 'Lectotype ♀, *Corythangela galeata* Meyr., 1897, I.F.B.Common, 1966', '*Corythangela galeata* Meyr., 1/9, E. Meyrick det. in Meyrick Coll.', 'Meyrick Coll., B.M. 1938-290', bmnh [examined].
Corythangella galeata, sensu Capuse, 1973, typographical error.

Material examined. – 1♂ (slide bmnh 24450), Sydney, N.S.Wales, 9.XII.[18]77, paralectotype 4/9 (bmnh); 1♀ (slide bmnh 24463), Sydney, N.S.Wales, bred 3.II.[19]18, paralectotype 6/9 (bmnh); 1♂ (slide anic 2328), Black Mt., ACT, Light Trap, 12. Dec.1963, I. F. B. Common (anic);. 1♂ (slide anic 2317, wing slide), Rous, Richmond River, N.S.W., Sept. 1925, V. J. Robinson (anic).

Description. – The original description is exact and also corresponds to the specimens collected after the type series.

Male genitalia (figs. 34-36, 41-42). – Terminal part of gnathos (fig. 41) two transverse plates with lamellae stellate. Tegumen constricted medially with two short pedunculi. Transtilla broad and short, suboval, joined medially. Valvula weakly delineated. Cucullus short, well sclerotized, narrower at base. Sacculus narrow and long, rather oblique, with heavy lateral margin, with protrusion in form of sclerified wedge directed inwards, extended to base of cucullus; also with extension in distal part in form of wedge, exceeding cucullus in length. Juxta rounded, suboval, shield-like. Aedeagus (fig. 35) attenuate, very long, containing two series of cornuti (fig. 42): one, typical of Coleophoridae, formed by ten needle-like cornuti of varying lengths in long row; the other formed by a great number of very small spines in distal third part of aedeagus.

Structure of abdominal supports (fig. 37). – No posterior lateral struts; transverse strut arched, thicker in middle. Tergal disks (fig. 44) very long and narrow, with short conical spines similar to those of Batrachedridae. Female with less convex transverse strut and shorter tergal disks (fig. 40).

Female genitalia (fig. 38). – Papillae anales long, oval, with short bristles. Apophyses posteriores about 0.3 times length of apophyses anteriores. Sterigma (fig. 39) narrow, rather long, sclerotized, rounded at distal margin, with some bristles. Ostium bursae small, oval. Colliculum chaliced, transparent, except for two reinforcements at margins of extension that connects to ductus bursae. Ductus bursae long, about 12 times longer than sterigma, with lining (fig. 43) of very small rounded spines all along its surface; ductus narrow in distal part, widened progressively in central part and narrowed again in proximal part; bursa copulatrix oval; signum absent.

Biology. – According to the original description, also reported by Common (1990: 241) 'the larvae construct a slender, elongate case from small pieces of the twigs of *Casuarina* (Casuarinaceae) on which they feed.' Unfortunately the original series kept in the bmnh as well as the specimens in anic are without larval cases so that it is impossible to illustrate the cases.

Distribution. – Coast and tablelands of New South Wales.

Corythangela fimbriata sp.n.
(figs. 3, 19, 45-48)

Type material. – Holotype ♂ (slide anic 2341), 15 miles N of Northampton, WA, 18 April 1968, I. F. B. Common & M. S. Upton (anic).

Description. – Wingspan 10 mm. Head (fig. 3) light brown with brilliant sheen, laterally suffused with white. Labial palp white on inner surface and almost completely brown with bronzy sheen on outer surface; second segment almost as long as third. Basal segment of antenna white, dorsally suffused with beige and ventrally with brown, with thick tuft of short brown scales. Flagellum ringed white and very light beige, except for distal segments (about 30)

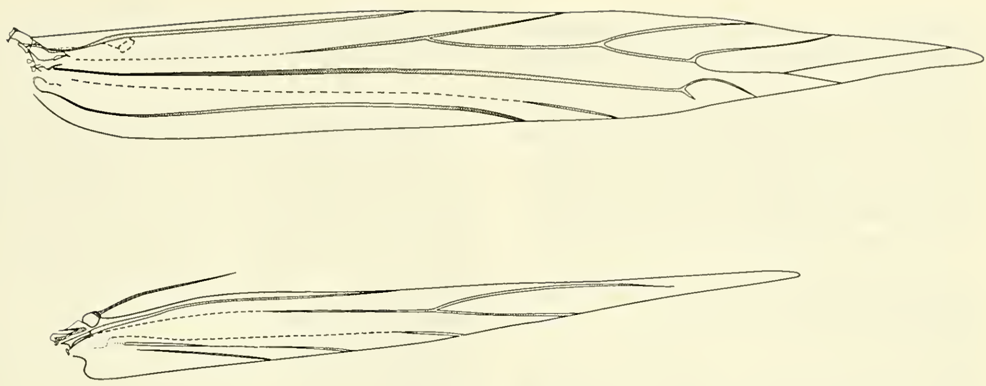

Fig. 1. *Corythangela galeata* Meyrick. Wing venation.

ringed white and dark brown. Thorax light brown with brown tegulae, suffused with white on internal border. Abdomen beige. Forewing with brilliant sheen, white, suffused with beige from costa towards dorsum; bronzy brown narrow streaks along median part, anal vein and dorsum, with incomplete line along internal margin of white costal line. Fringes beige, except for costal portion light brown with white base. Hindwing light brown, with beige fringes.

Male genitalia (fig. 45). – Terminal part of gnathos globular, with long lamellae stellate. Tegumen long, with very short pedunculi. Transtilla sclerotized, subtriangular, little developed. Valvula suboval, heavily sclerotized, poorly delineated. Cucullus short and stout, heavily sclerotized, curved distally. Sacculus very narrow and long, ended in narrow and long point, slightly curved; base with large and rounded protuberance folded towards base of cucullus. Juxta 'V'-shaped. Aedeagus (fig. 46) without cornuti, small and curved, shaped like sharp thorn, with small spines in ventral part of distal half.

Structure of abdominal supports (fig. 48). – Posterior lateral struts only slightly pronounced, transverse strut big, slightly convex, thicker in middle. Tergal disks with short conical spines, resembling those of Coleophoridae more than those of Batrachedridae; disks of third tergite about 4.5 times longer than wide.

Diagnosis. – The new species can easily be distinguished from *C. galeata* by its external habitus as well as by the male genitalia (the female is not known). In the genitalia the most obvious structures are the transtilla and the aedeagus: in *galeata* the transtilla is compact, whereas in *fimbriata* it carries two long extensions; the aedeagus in *galeata* is rather long and straight, with many cornuti, whereas in *fimbriata* it is short and curved, without cornuti.

Biology. – Unknown.

Distribution. – 45 km. north of Geraldton.

Remarks on the genus *Corythangela* Meyrick, 1897. – When examining the two known species of *Corythangela* one is struck first of all by the fact that the antennae are about as long as the forewings, whereas they are much shorter in Coleophoridae. The forewings are slightly narrower and longer than those of Coleophoridae. The head is narrower and longer.

As to the structure of the genitalia it can be said that those of the male generally resemble those of the Coleophoridae, however with obvious differences: the terminal part of the gnathos has thick lamellae arranged in a stellate form, whereas normally in the Coleophoridae the lamellae are thin and short, arranged in transverse rows. The valvula and cucullus have shapes that do not occur in Coleophoridae. The aedeagus is completely different, in *galeata* as well as in *fimbriata*, which also differ completely from each other. In any case, neither of them resembles the intromittent organ of the Coleophoridae, which was the object of study of Razowski (1989, 1990), who introduced the term 'phallotheca' for the organ in Coleophoridae. Moreover, in the two species of the genus *Corythangela* a separate juxta is present, whereas in Coleophoridae the juxta is fused with the aedeagus and has a prolongation in two rods, either separate or joined together (Landry 1993). This juxta configuration causes problems when lifting the 'phallus complex' from the rest of the genitalia during preparation, whereas that operation is rather simple in *Corythangela*. The female genitalia, only known for *galeata*, are similar to those of Batrachedridae.

The structures of abdominal support are similar to those of Batrachedridae in *galeata*, whereas in *fimbriata* they resemble more those of the Coleophoridae:

the tergal disks are shorter and wider than in *galeata*, and the spines are thicker and more firmly attached to the tergal disks.

In spite of the fact that I have not been able to study the larval case of *galeata*, which was not kept with the type series, the biology, as described by Meyrick is typical of Batrachedridae (Hodges 1978).

In view of this I transfer the genus *Corythangela* to the family Batrachedridae.

Coleophora serinipennella Christoph
(figs. 7, 20-23, 49-65)

Coleophora serinipennella Christoph, 1872: 31.
Plutella ochroneura Lower, 1897: 59 syn.n. – Holotype ♂ of *Plutella ochroneura* Lower: 'Semaphore, S.A.', genitalia slide Bldz 9186 (SAMA) [examined].
Corythangela ochroneura, sensu Vives, 1988.
Coleophora stefanii de Joannis, 1899: 331.
Coleophora pudica Lower, 1905: 111, syn.n. Lectotype ♂ (here designated) of *Coleophora pudica* Lower: '3224, Broken Hill' genitalia slide Bldz 9187 (SAMA) [examined]; paralectotypes: 2♂ 'Broken Hill, 4.4.99' (slides Bldz 9188, 9189) (SAMA).
Corythangela pudica, sensu Vives, 1988.
Coleophora novella Chrétien, 1926: 9
Coleophora caliacraella Caradja, 1931: 331.
Coleophora caliacraella lucidella Caradja, 1932: 43
Coleophora jerichoella Amsel, 1935: 306.
Coleophora jordanella Amsel, 1935: 306.
Coleophora sosisperma Meyrick, 1936: 621.
Coleophora deserticola Toll, 1944: 292.
Coleophora soffneri Toll, 1944: 292.

Material examined. – 1♂, Grey Range, 5 miles W of Tickalara, south-west Qld, 14. Nov. 1949, I. F. B. Common; 1♂ (slide ANIC 2300), Mungadal Sation, NSW, 7.iii.1985; 8♂ (slide ANIC 2308), 10 mi NE by E of Iron Knob, SA, 23 Oct. 1968, Britton, Upton, Balderson; 3♂, 6 miles W of Iron Knob, SA, 16 Mar. 1968, I. F. B. Common & M. S. Upton; 11♂, 2 mi. SSE of Ceduna, SA, 30 Oct. 1969, Key & Upton; 6♂, 31.22S 131.47E, 14 km NNW of Yalata Mission, SA, 9 Apr. 1983, 10 May 1983, E. S. Nielsen, E. D. Edwards; 1♂, 40 miles E of Nullarbor, SA, 18 Mar. 1968, I. F. B. Common & M. S. Upton; 2♂, 31.23S 131.24 E, 48 km E by N Nullarbor, SA, 13 Oct. 1981, J. C. Cardale; 3♂, 31.25S 131.07E, 13 mi E of Nullarbor HS, SA, 31 Oct. 1969, Key & Upton; 1♂, 23 mi W of Nullarbor HS, SA, 5 Oct.1968, Key, Upton, Balderson; 4♂ (slide ANIC 2306), 25 miles E of Eucla, WA, 19 Mar. 1968, I. F. B. Common & M. S. Upton; 1♂, 5 miles E of Eucla, WA, 6 Jan. 1967, M. S. Upton; 1♂, 6 mi E of Madura, WA, 15 Oct. 1968, Britton, Upton, Balderson; 2♂, Madura, WA, 20 Mar. 1968, I. F. B. Common & M. S. Upton (slide ANIC 2305); 3♂, Madura, WA, 7 Oct. 1968, Key, Upton, Balderson; 1♂, 7 mi E by N of Balladonia HS, WA, 13 Oct. 1968, Britton, Upton, Balderson; 1♀ (slide ANIC 2307), Kalgoorlie, WA, 19.x.1963, V. J. Robinson; 4♂, Drummond Cove, 11 km N of Geraldton, WA, 13 Apr., 17 Apr., 23 Apr., 26 Apr. 1973, N. McFarland; 1♂ (slide ANIC 2298), 107 miles S of Carnarvon,WA, 21 Apr. 1968, I. F. B. Common & M. S. Upton; 3♂ (slides ANIC 2304, 2297), 8 miles E of Carnarvon, WA, 20 Apr. 1968, I. F. B. Common & M. S. Upton (ANIC).

Male genitalia (fig. 49). – Spinose part of gnathos big, globular. Tegumen constricted medially, with widened subtriangular pedunculi.Transtilla long, triangular, weakly joined in middle. Valvula large, rounded, irregularly sclerotized, covered with short bristles. Cucullus oblique, sometimes narrower medially, rather variable. Sacculus simple, characterized by thick ventral margin and by a process on lateral margin: outline variable (figs. 51-54, 55-62), rounded, conical, subtriangular, or truncate. Phallotheca conical, slightly curved, short, sclerotized only at base and on dorsal surface. Vesica, without cornuti, pronounced along the entire ventral lamina.

Structure of abdominal supports (figs. 50, 65). – Posterior lateral struts 1/3 of length of anterior ones. Transverse strut very thick, in the male convex on distal margin, in the female wider and slightly arched. Tergal disks with many small conical spines; disks of third tergite 5 times longer than wide.

Female genitalia (fig. 63). – Papilles anales small, suboval, with short bristles. Apophyses posteriores about 0.4 longer than anterior ones. Sterigma (fig. 64) trapezoid, weakly sclerotized, with long bristles on distal margin. Ostium bursae narrow, ogival. Colliculum chaliced. Ductus bursae with distal section as long as sterigma, narrow, with two parallel sclerotized bands; anterior section of ductus bursae membranous, gradually widened towards bursa copulatrix. Bursa long, bag-shaped, with a big leaf-like signum, with a long pedunculus.

Diagnosis. – *Coleophora serinipennella* is the only representative species of its group in Australia (the 8th of Toll's system). The variation of the forewing colour pattern occurs scatteringly throughout the wide area of distribution of the species, but reaches its most extreme forms in Australia, particularly the dark form caused by the brown colour of the scales along the veins, which is known only from Australia: that variability has undoubtedly induced Lower to describe the same species twice. Also noteworthy is the variability of the sacculus in the male genitalia: although a common phenomenon in specimens of *serinipennella*, it has reached extreme forms in Australian specimens.

Biology. – The species mines the stems of various species of Chenopodiaceae. Common (1990: 241) writes: 'at least one endemic species produces galls in the stems of Chenopodiaceae in inland New South Wales'.

Distribution. – From Japan to North Africa, and in Europe where it has been collected in Bulgaria, Rumania, Greece, Sicily, southern Italy (Calabria), southern France, Spain (Baldizzone 1994: 55). In

Australia: South-western Queensland, South Australia and arid areas of Western Australia south of Carnarvon.

Coleophora alcyonipennella (Kollar)
(figs. 5, 66-72)

Ornix alcyonipennella Kollar, 1832: 99.
Coleophora cuprariella Zeller, 1847: 36.
Coleophora cuprifulgella Toll, 1962: 652.

Material examined. – 1♂, 27.35S 151.59E, Prince Henry Heights, 620 m, Toowoomba, Q., 4 Jan. 1983, I. F. B. Common; 4♂, N. Tamborine, Q, 23 Aug. 1965, M. S. Upton; 1♂ (slide H 17), Tooloom Scrub, 20.i.36, W. B. Barnard; 1♀ (slide ANIC 2327), 26 mls S of Singleton, NSW, 7 Nov. 1960, I. F. B. Common & M. S. Upton; 1♀, 1 spec., Mt Tomah, NSW, 3000 ft, 18 Dec. 1967, M. S. Upton; 1♂, 1♀ (slide ANIC 2375), Mt Keira, NSW, 23.xii.1963, 8.xii.1972, V. J. Robinson; 1♂, 1♀, 1 spec, CSIRO Experimental Farm Wilton, NSW, 2.i.1973, 29.ix.1980, V. J. Robinson; 1♂, 1♀, George's Basin, NSW, 28 & 30.viii.1965, V. J. Robinson; 1♂, 25 km NNW of Barellan, NSW, 23.ii.1974, E. D. Edwards & M. Story; 1♂, Mittagong, NSW, 28.i.36, [A. J. Turner]; 1 spec. (slide H 52), Goulburn District, NSW, 24.i.1963, R. W. Shelley; 1♂ (slide H 15), Canberra, ACT, 22.ii.1948, I. F. B. Common; 1♂, 1♀ (slide ANIC 2376), Canberra, ACT, 10.xii.1948, 26 Nov. 1948, I. F. B. Common; 11♂ (slide ANIC 2323, wing slide W 56), 1 spec., Black Mt., ACT, Light Trap, 17 Jan. 1961, 30 Feb. 1954, 21 Mar. 1963, 20 Oct. 1959, 15 Nov. 1956, 21 Nov. 1962, 10 Dec. 1963, I. F. B. Common; 3 spec., 2♂ (slide ANIC 2325), Broulee, NSW, 24 Feb. 1962, 13 Oct. 1962, M. S. Upton; 1♂, Mt Dromedary, NSW, 1000 ft., 24 Nov. 1965, I. F. B. Common & M. S. Upton; 5♂ (slide ANIC 2326), Mt Kosciusko, NSW, 5500 ft., 17 Feb. 1968, M. S. Upton; 1♂, 37.43S 145.48E, 10 km ENE of Warburton, Vic., 210 m, 17 Jan. 1979, I. F. B. Common, E. D. Edwards; 1♂, 1 spec., Gisborne, 16.xi.25, 29.xii.23, G. Lyell; 2♂, Little Desert, 13 miles S of Kiata, Vic., 7 Nov. 1966, I. F. B. Common & M. S. Upton; 3♂ (slide H 18), St Helens, Tas., 24.i.38, [A. J. Turner]; 1♂, Cradle Mt., Tas., 3000 ft, 8.iii.24, [A. J. Turner]; 1♂, 1spec., Burnie, Tas., 10.ii.25, [A. J. Turner]; 1♂, Strahan, Tas., 6.ii.25, [A. J. Turner]; 1♀, Wilmot, Tas., 1.ii.25, [A. J. Turner]; 1♂, 8 mls SW Waratah, 1800 ft, T., 16 Feb. 1963, I. F. B. Common & M. S. Upton; 2♂, 1♀ (slide ANIC 2324), Hobart, Tas., 2.ii.36, [A. J. Turner]; 1♀, Mt Wellington, Tas., 2500 ft, 6.ii.36, [A. J. Turner] (ANIC).

Male genitalia (fig. 66). – Spinose part of gnathos narrow, pear-shaped. Tegumen subtriangular, narrower at base of gnathos arms, widened with two long, moderately wide, pedunculi on external lateral margin. Transtilla short, triangular, weakly joined in middle. Valvula big, irregularly oval. Cucullus of average length, narrower at the base. Sacculus curved and thick on lateral margin ended dorsally in short triangular thorn-like process. Phallotheca conical, sclerotized only at base and on dorsum, the latter with a long fold. Cornuti (fig. 68) 6-7 spines of different lengths, united into a curved row.

Structure of abdominal supports (figs. 69, 72). – No posterior lateral struts. Transverse strut with almost straight dorsal margin and biconvex distal one. Tergal disks with short conical spines, almost twice longer than wide (third tergite).

Female genitalia (fig. 70). – Papilles anales pointed, with small needle-like bristles. Apophyses posteriores twice length of anterior ones. Sterigma (fig. 71) trapezoid, curved on distal margin, which has small, needle-like bristles. Ostium bursae small, oval. Colliculum chaliced, traversed by median lamina of ductus bursae, extended to middle of ductus. Ductus with spinose section about half length of ductus with small conical spines. Central part of ductus curved, almost transparent, faintly speckled, anterior part transparent, widened gradually towards bursa copulatrix. The latter bag-shaped with big leaf-like signum.

Diagnosis. – In Australia *C. alcyonipennella* is the only representative of the group of green-metallic Coleophoridae, so there is no possibility of mistaking it for another species. It was imported from Europe with animal fodder and it shows no differences with specimens from the countries of origin.

Biology. – Common (1990: 241, 242) has given a good description of the species, together with some information on the biology, and two drawings of the pupa. He indicates that in Australia *C. alcyonipennella* larvae feed on *Trifolium repens, T. fragiferum* and *Medicago* sp.

Distribution. – Europe, Asia Minor, Irak, Iran, Afghanistan, Pakistan, Japan (Baldizzone 1994:18); the more humid areas of southern Queensland to Tasmania; New Zealand (Common 1990).

Coleophora seminalis Meyrick
(figs. 4, 17, 73-79)

Coleophora seminalis Meyrick, 1921a: 189.
Coleophora immortalis Meyrick, 1922: 556.
Coleophora inmortalis sensu Vives, 1988: 84, typographical error.

Material examined. – 2♂ (slides ANIC 2354, 2353), Bamaga, Cape York, Q., 26 & 28 Mar 1964, I. F. B. Common & M. S. Upton; 1♂ (slide ANIC 2331), 9 miles W of Paluma, 2500 ft., Q., 15 Apr. 1969, I. F. B. Common & M. S. Upton; 1♀ (slide ANIC 2332), Yeppoon, Q, 18 Dec. 1964, I. F. B. Common (ANIC). Type material studied in Baldizzone (1989).

Male genitalia (fig. 73). – (Baldizzone, 1989: 205, figs. 66, 68, 69). Terminal part of gnathos big, oval. Tegumen trapezoid, considerably constricted towards three quarters, with two long pedunculi. Transtilla broad and flattened, irregularly oval. Sacculus broad, characterized by two triangular points at the angles:

the point at the dorso-ventral angle longer than that at the dorso-caudal angle. Phallotheca narrow and long, consisting of two sclerotized bands, one thinner and sharp at apex, the other thicker with a curved tooth at apex. Cornuti (fig. 75) 6-7, of different lengths, united into irregular row.

Structure of abdominal supports (figs. 76, 79). – (Baldizzone 1989: fig. 67) No posterior lateral struts. Transverse strut straight, its proximal edge thicker than distal one. Tergal disks (3rd tergite) about twice longer than broad.

Female genitalia (fig. 77). – (Baldizzone 1989: 205, figs. 70-73). Papilles anales narrow and long. Apophyses posteriores about twice length of anterior ones. Sterigma (fig. 78) trapezoid, distal margin convex with some bristles; with two folds parallel with sides of ostium bursae. Ostium bursae oval, opening at three quarters of sterigma. Colliculum tube-shaped, medially expanded. Ductus bursae with median line in its first half as far as the central curve; spiculate section of ductus about twice length of sterigma. Remainder of ductus almost transparent. Bursa oval, signum a small irregular oval plate with a longitudinal ridge. This signum varies considerably and can also have numerous rounded spines.

Diagnosis. – (Baldizzone 1989: 205). The species belongs to the 30th group of Toll's system and might be placed in the section of *C. glaucicolella* Wood.

Biology. – (Baldizzone 1989: 205). The species lives on various species of *Amaranthus* (*paniculatus* and *viridis*), according to the original description of *C. immortalis* Meyrick. The larval case (fig. 17), looks like that of *C. versurella* Zeller, 1849, which also lives on Amaranthaceae. In the description of *C. immortalis*, Meyrick had placed it near *C. amaranthella* Braun, 1919, a synonym of *C. lineapulvella* Chambers, 1878.

Distribution. – Fiji Islands, Java, eastern China, Australia, New Guinea, Sumatra (Baldizzone 1989: 205). In Australia: moist areas of Queensland north of Yeppoon.

Coleophora leucocephala sp.n.
(figs. 8, 24, 80-90)

Type material. – Holotype: ♂, 31.32S 137.14E, nr Lake Eyre South, SA, 18 Sept. 1978, E. D. Edwards; slide ANIC 2345 (ANIC). Paratypes: 1♀ (slide ANIC 2370), 29.37S 138.06E, The Frome River, 5 km NE of Maree, SA, 15 Sept. 1972, M. S. Upton; 2♂ (slides ANIC 2349, 2340), 1♀ (slide ANIC 2350), 30.04S 138.17E, Farina, 48 km NbyW of Leigh Creek, SA, 17 Sept. 1978, E. D. Edwards; 1♂ (slide ANIC 2346), as holotype (ANIC).

Description. – Wingspan 9-10 mm. Head (fig. 8) white, dorsally suffused with beige. Labial palps white: second segment about 2.5 times longer than third, with wide area of brown scales on external lateral margin. Antennae white, with tuft of short, brown scales at root of the basal segments; flagellum ringed white and beige. Thorax and abdomen beige. Forewings greyish white, sprinkled with long, brown scales, mainly in dorsal half, from anal vein onwards. Fringes grey. Hindwings light beige; fringes grey.

Male genitalia (fig. 80). – Spinose part of gnathos large, globular. Tegumen constricted at base of gnathos arms and reinforced by sclerotized 'Y', with two long and wide pedunculi on external margin. Transtilla irregularly oval, more or less almond-shaped. Valvula small, with narrow and long ventral margin. Cucullus large, ear-shaped, compact. Sacculus narrow, characterized by thick and serrated lateral margin, with rounded tooth at ventral angle and sharper tooth at dorsal angle. Phallotheca formed by two slender and curved rods, one rod slightly longer than the other ended in curved point, other rod sharp. Cornuti about 10 (fig. 82), of different lengths, united into long formation. The male genitalia show a certain amount of variation, as can be seen in figs. 81, 84-87.

Structure of abdominal supports (figs. 83, 90). – No posterior lateral struts; transverse strut with thick and somewhat convex proximal margin, and almost straight distal one, more slender. Tergal disks, covered with conical spines with wide bases, are about 3 times longer than wide. (3rd tergite)

Female genitalia (fig. 88). – Papilles anales narrow and long. Apophyses posteriores about 2.2 times longer than anterior ones. Sterigma (fig. 89) subtrapezoid, with arched proximal margin and convex distal margin with some slender and long bristles. Ostium bursae oval, colliculum chaliced, long, narrowing into ductus bursae. Ductus medial line about 3/5 of length of ductus; spinose part as long as sterigma, covered with very small spines; anterior half of ductus transparent and widened into round bursa copulatrix. Signum a small, oval, sclerotized patch covered with rounded spines.

Diagnosis. – The new species belongs to the 30th group of Toll's system and according to the genitalia structure is close to *C. versurella*, a species so far not known from Australia. The most obvious differences are: in the male genitalia of *leucocephala* the cucullus is shorter and more compact; the sacculus is shorter, and serrated on the lateral margin; the phallotheca rods are more slender, without teeth at the apex as in *versurella*; the cornuti are more numerous, not divided into two sections. In the female genitalia of *leucocephala* both the sterigma and the colliculum are narrower; the spinose part of the ductus is rather shorter; and in the bursa the signum is a single, chitinous patch covered with spines.

Biology. – Unknown.

Distribution. – Dry areas of South Australia.

Coleophora crypsineura (Lower) comb.n.
(figs. 9, 25, 91-106)

Batrachedra crypsineura Lower, 1900: 419. Lectotype ♂ (here designated) 'Broken Hill', slide Bldz 9191 (SAMA) [examined]. Paralectotype ♀ (slide Bldz 9192) same label as lectotype; one specimen without abdomen, same label as lectotype, ♀ (slide Bldz 9190) 'Broken Hill, 19.10.08', 'types 3466' [collected after the name was published] (SAMA).

Material examined. – 1♂, Bourke, NSW, 25 Oct. 1949, I. F. B. Common (slide ANIC 2339); 1♂ (slide ANIC 2329),1♀ (slide ANIC 2315), 149.11E 31.17S, 9 km W of Coonabarabran, NSW, 533 m, 2 Dec. 1974, I. F. B. Common & E. D. Edwards; 1♀, Wyperfeld National Park, Vic., 5 Nov. 1966, I. F. B. Common & M. S. Upton (slide ANIC 2338); 2♂ (slide ANIC 2358), 1♀ (slide ANIC 2359), 6 miles W of Iron Knob, SA, 16 Mar. 1968, I. F. B. Common & M. S. Upton; 1♀, 31.22S 131.47E, 14 km NNW of Yalata Mission, SA, 9 Apr. 1983, E. S. Nielsen, E. D. Edwards (slide ANIC 2369); 1♀, 13 mi. NE by E of Caiguna, WA, 14 Oct. 1968, Britton, Upton, Balderson (slide ANIC 2334)(ANIC).

Redescription. – Wingspan 9-19 mm. Head (fig. 9) white, dorsally suffused with beige. Labial palps white: second segment about 1.5 times longer than third, with brown scales on distal half of lateral margin, third segment white, except for brown ventral margin. Antennae white, basal segment with tuft of short, brown scales on ventral margin; flagellum ringed white and beige. Forewings greyish white, sprinkled with brown and ochreous scales, which form two longitudinal lines, one almost in middle of wing, the other between anal vein and dorsum. Fringes grey-beige. Hindwings and fringes grey-beige.

Male genitalia (fig. 91). – Spinose part of gnathos globular, long. Tegumen strongly constricted at base of gnathos arms, pedunculi arched. Transtilla narrow, long, irregularly oval. Valvula wide, compact, ear-shaped. Sacculus with rounded ventral margin, apical portion dentate. Phallotheca with two slender distally arched rods, longer rod with slightly curved and broadened apex. Cornuti (fig. 92) numerous (more than 20), of different lengths, united into narrow and long formation almost as long as vesica.

The male genitalia show some slight individual variation (figs. 96-99), mainly in the shape of the transtilla, the teeth on the lateral margin of the sacculus, and the apex of the phallotheca.

Structure of abdominal supports (figs. 93, 102). – No posterior lateral struts; transverse strut in male with slender and curved proximal margin, distal margin straighter and more sclerotized at base of disks of 2nd tergite. Tergal disks with short conical spines with wide bases, about 3 times longer than wide (3rd tergite).

Female genitalia (fig. 100). – Papilles anales narrow and long. Apophyses posteriores about twice length of anterior ones. Sterigma subtrapezoid with proximal margin almost straight or slightly arched, distal margin covered with some bristles, also present around ostium bursae. Ostium oval. Colliculum long, chaliced. Ductus bursae with in distal part medial line as long as half the ductus, and small spinose section about as long as half the sterigma; anterior part of ductus transparent, coiled. Bursa copulatrix round, signum a small, elongate patch covered with round spines (fig. 95).

The female genitalia also show some slight individual variation, mainly in the shape of the sterigma and of the colliculum (figs. 101, 103-106).

Diagnosis. – *C. crypsineura* belongs to the 30th group of Toll's system, and is close to *C. leucocephala*, from which it can be distinguished by the following characteristics: in the male of *crypsineura* the ventral margin of the sacculus is more curved, while the lateral margin is wider, oblique and less serrated. The cornuti are more numerous, united into a longer formation. In the female genitalia of *crypsineura* the sterigma is shorter with a wider base, the colliculum is shorter as well as the spinose segment of the ductus bursae, which has a shorter and weaker medial line.

Biology. – Unknown.

Distribution. – Dry and semidry southern Australia from Coonabarabran, New South Wales, to Caiguna, western Australia.

Coleophora tremefacta Meyrick
(figs. 6, 26, 107-113)

Coleophora tremefacta Meyrick, 1921b: 472. Holotype ♂ 'Adelaide, Largs Bay, O.L., 2.20' (SAMA) [not examined]. – Paratype ♀ 'Largs Bay, S.Australia, OL. 2.20', '*tremefacta* Meyr.', 'Paratype *Coleophora tremefacta* Meyr. 1921, det.I.F.B.Common', '*Coleophora tremefacta* Meyr., E.Meyrick det., in Meyrick coll.', 'B.M. Genitalia Slide ♀ 24462' (BMNH) [examined].

Material examined. – 1♂, 'Queensland, T.P.L./95', det. E.Meyrick, (slide BMNH 24466) (BMNH). This specimen was determined by Meyrick after the description of *tremefacta*. The external features resemble those of the paratype ♀ which is kept in the BMNH, but, since both specimens are in poor condition (wings with few scales) characterization of the species is thus tentative.

According to the original description the holotype is in the Lower Collection, which is kept at the SAMA; unfortunately I have not been able to study that specimen, for in the Museum of Adelaide there is, at the moment, no professional lepidopterist who can look for the types among the material in the collection.

Description. – The original description by Meyrick is clear. When examining the two specimens kept in the BMNH I could ascertain that the description fits them well; however, these are worn specimens and better material will be needed for a more comprehensive description.

Male genitalia of the specimen kept in the BMNH (slide BMNH 24466) (fig. 107). – Spinose part of gnathos big, globular. Tegumen constricted at base of gnathos arms, with sclerotized 'Y'; pedunculi long and curved. Transtilla wide and oval. Valvula small, with rounded sclerotized ventral margin. Cucullus large, compact, ear-shaped. Sacculus, curved and oblique, ventrally with narrow lateral margin, apex dentate. Phallotheca with two arched rods, shorter one ended acutely, longer one with small apical tooth. Cornuti (fig. 109) 3-4, of different lengths, one much longer than the others, curved, and almost the full length of the vesica, other cornuti positioned at base of long one.

Structure of abdominal supports (figs. 110, 113). – No posterior lateral struts. Transverse strut slender, somewhat convex. Tergal disks about 3 times longer than wide (3rd tergite) covered with short conical spines.

Female genitalia (fig. 111). –Papilles anales very narrow and long, heavily sclerotized. Apophyses posteriores about twice length of anterior ones. Sterigma (fig. 112) heavily chitinized, subtrapezoid, with both margins concave. Ostium small, ogival. Colliculum narrow, chaliced. Distal part of ductus bursae about twice length of sterigma, almost transparent except for lateral reinforcement; spinose section about 3.5 times longer than sterigma, recurved with medial line extended into coiled portion of ductus, proximal portion of ductus speckled with chitine and coiled. Bursa copulatrix almost rounded, with leaf-shaped signum and smaller suboval signum covered with small spines.

Diagnosis. – *C. tremefacta* belongs to the 30th group of Toll's system in the section of *versurella*. The differences in the genitalia are: in the male of *tremefacta* (specimen BMNH 24466) the transtilla is shorter and more oval, the cucullus is shorter and more compact; the cornuti are different because they are not divided into two formations. In the female the papilles anales are more sclerotized, just like the sterigma, which is much broader; the colliculum is narrower and longer; and the spinose section of the ductus bursae begins closer to the colliculum than in *versurella*.

Biology. – Unknown.

Distribution. – Coastal regions of South Australia, north of Adelaide.

Coleophora nielseni sp. n.
(figs. 15, 30, 114-117)

Type material. – Holotype: ♀ , Brisbane, 3.11.02, [A. J. Turner], slide ANIC 2372 (ANIC). Paratypes 3 specimens, all without abdomen before dissection : 1 ex., Brisbane, 23.ii.02, [A. J. Turner]; 1 ex., Brisbane, 21.xi.02, [A. J. Turner]; 1 ex., Brisbane; *Batrachedra hypoxutha* Meyr. (ANIC).

Note. – All specimens were mixed in the type series of *Batrachedra hypoxutha* Meyrick, 1897 (ANIC), which, according to the original description, consisted of three specimens. Actually the type series of *hypoxutha* comprises two specimens of the true *hypoxutha*, from which Schmidt-Nielsen has selected a lectotype.

Description. – The original description by Meyrick of his *Batrachedra hypoxutha* might have been based upon the specimen that is now the object of the description of *C. nielseni* sp. n., for they correspond very well. In any case I give here a new description. Wingspan 11 mm. Head (fig. 15), thorax and abdomen light ochreous. Head white laterally and dorsally of the eyes. Palpi almost completely covered with ochreous scales, darker at external margin: second segment about 1.5 times longer than third. Antennae: basal segment without scale-tuft, ochreous except for white upper surface, flagellum ringed white and ochreous. Forewings glossy ochreous, gradually variegated from dorsum to costa, the latter white. Fringes grey-beige. Hindwings light grey; fringes beige.

Female genitalia (fig. 114). – Papilles anales oval, very small. Apophyses posteriores about 2.5 times longer than anterior ones. Sterigma narrow (fig. 115), subtrapezoid, anterior margin arched, posterior margin convex, with some short bristles, excavated in middle at ostium bursae. Ostium ogival. Colliculum well sclerotized, in the form of deep cup. Ductus bursae: distal section to colliculum transparent except for two symmetrical reinforcements along external margin, and with medial line extended to half length of ductus. Spinose section about 1.5 times longer than sterigma, section cephalad curved and transparent with medial line; in the central section the ductus is curved, speckled with chitine; bursa copulatrix oval, signum narrow, elongate, covered with triangular spines.

Structure of abdominal supports (fig. 117). – No posterior lateral struts; transverse strut slender, slightly convex. Tergal disks covered with small spines, narrower base. Disks of 3rd tergite about 3.5 times longer than wide.

Diagnosis. – *C. nielseni* belongs to the 30th group of Toll's system, perhaps to the *versurella* section; more precise placement is not possible because the male is unknown. The female genitalia can easily be distinguished from those of *versurella* by the sterigma, which is narrow and long; the spinose section of the ductus bursae, which is shorter; and the signa, because *nielseni* is without a leaf-like signum.

Biology. – Unknown.

Distribution. – Southern Queensland.

Derivation of name. – The species is dedicated to Dr. Ebbe Schmidt-Nielsen, with thanks for the opportunity he has given me to realize this paper.

Coleophora horakae sp.n.
(figs. 11, 31, 118-129)

Type material. – Holotype: ♂, Toowoomba, Q, 1.iv.16, [A. J. Turner]; slide ANIC 2314 (ANIC); Paratypes: 1♀ (slide ANIC 2379), Goodna, Q, 25.i.49, I. F. B. Common; 1♀ (slide ANIC 2373), Glen Innes, NSW, 25.iii.13, [A. J. Turner]; 1♀ (slide ANIC 2319), Black Mt., ACT, Light Trap, 22 Jan. 1961, I. F. B. Common; 1♀ (slide ANIC 2309), 23.38S 133.53E, Todd River, 9 km NbyE of Alice Springs, NT, 10 Oct. 1978 (ANIC).

Description. - Wingspan 10 mm. Head (fig. 11) light brown, except for sides above eyes. Labial palps almost completely white on inside and light brown on outside, except base and dorsal part of second segment white, second segment about 1.5 times shorter than first. Antennae: basal segment uniformly ochreous, without scales tuft; flagellum ringed ochreous and greyish-white. Thorax and abdomen light brown. Forewings pearly ochreous, with slender greyish-white line along costa, gradated, terminated before fringes. Fringes beige. Hindwings light brown; fringes beige.

Male genitalia (fig. 118). – Spinose part of gnathos big, globular. Tegumen constricted at base of gnathos arms, pedunculi laterally prominent. Transtilla short, rounded and dorsally widened. Valvula small, oblique and ventrally long. Cucullus compact, ear-shaped. Sacculus narrow, with external margin rounded and strongly curved, ended apically with two obtuse teeth of irregular shape. Phallotheca rods symmetrical, distally tapered, with apices rounded and curved. About 10 cornuti, of different lengths, united into a cluster about as long as vesica.

Structure of abdominal supports (figs. 121, 125). – No posterior lateral struts. Transverse strut, slightly convex, with complete proximal margin, distal margin not sclerotized in middle. Tergal disks about 4 times longer than wide (3rd tergite) with small conical spines.

Female genitalia (fig. 122). – Papilles anales small, narrow and long. Apophyses posteriores about twice length of anterior ones. Sterigma (figs. 126-129) irregularly trapezoid, with proximal margin almost straight and distal margin convex, with some bristles; distal margin excavated in middle at ostium bursae. Ostium ogival. Colliculum amphora-shaped. Ductus bursae with medial line in distal half, spinose section about as long as sterigma; proximal half of ductus speckled with chitine, and with a few coils. Signum a small elongate plate covered with triangular spines (figs. 123, 124).

Diagnosis. – *C. horakae* belongs to group 30 of Toll's system and may be placed in the section of *C. therinella* Tngstr. The male genitalia can be distinguished mainly by the structure of the lateral margin of the sacculus, which does not end in a big, sharp process as in *therinella*, and by the completely different phallotheca, which is simpler and symmetrical. The female genitalia differ from all others in the group, mainly by the shape of the colliculum, which is amphora-shaped, and by the presence of a single signum, irregular and not of the usual leaf-like shape.

Biology. – Unknown.

Distribution. – Southern Queensland, tablelands of New South Wales to central Australia.

Derivation of name. – The species is dedicated to Dr. Marianne Horak, with thanks for all the help she has given me with the realisation of this paper.

Coleophora fuscosquamata sp.n.
(figs. 10, 28, 130-132)

Type material. - Holotype: ♀, 26.03S 127.14E, 66 km EbyN of Warburton, WA, 15 Nov. 1977, M. S. Upton; slide ANIC 2356 (ANIC). Paratypes: 2♀ (slide ANIC 2357), as holotype; 1♀ (slide ANIC 2348), 24.58S 129.23E, Hull River 33 km ESE of Docker River, NT, 17 Nov. 1977, M. S. Upton (ANIC).

Description. - Wingspan 8-9 mm. Head (fig. 10) white, dorsally covered with ochreous scales. Labial palps white on inner side; second segment about 1.5 times longer than third, outside traversed by brown longitudinal band; third segment ventrally brown. Antennae: basal segment ochreous, dorsally white; flagellum ringed white and brown. Thorax and abdomen ochreous. Forewings ground colour white, with longitudinal streak of ochreous and dark brown scales below costa from base to apex. Fringes beige. Hindwings and fringes beige. It should be noted that the tibiae of this species are unusually coloured for a Coleophoridae: they are white, on the outside traversed by a central longitudinal line, slender, brown.

Female genitalia (fig. 130). – Papilles anales small, oval. Apophyses posteriores about twice length of anterior ones. Sterigma (fig. 131) rather sclerotized, strongly convex on proximal margin and slightly less on distal one; ostium small, oval, little pronounced.

Colliculum large, shaped like elongated funnel. Ductus bursae with medial line along about 2/3rd of its length; distal section of ductus, about 1/3rd of its total length, covered with spines, proximal section, gradually widened into bursa copulatrix. Bursa large, oval, signum a small oval chitinous plate speckled with small spines.

Structure of abdominal supports (fig. 132). – No posterior lateral struts; transverse strut, slightly convex, with complete proximal margin, distal margin more slender in middle part. Tergal disks, with short conical spines, 2.5 times longer than wide (3rd tergite).

Diagnosis. – The species belongs to the 30th group of Toll's system; only the female is known, so presently it is not possible to give a more precise placement in the system. The very characteristic shape of the sterigma enables it to be distinguished easily.

Biology. – Unknown.

Distribution. – Central Australia near border between Western Australia and Northern Territory.

Coleophora frustrata sp. n.
(figs. 13, 32, 133-136)

Type material. – Holotype: ♂, 2.7 km NE of Queanbeyan, NSW, 670 m, 3 Oct. 1972, I. F. B. Common; slide ANIC 2342 (ANIC).

Description. – Wingspan 8 mm. Head (fig. 13), thorax and abdomen ochreous. Labial palps white: second segment about twice length of third, covered with ochreous scales on outer side over much of its surface, third segment ochreous on inner side only. Antennae: basal segment with a short tuft of brown scales brown, except for dorsal side white; flagellum ringed white and brown, except for first basal segments ventrally brown and dorsally white. Forewings pearly ochreous; a thin white line along costa, gradually narrowing. Fringes beige. Hindwings and fringes beige.

Male genitalia (fig. 133). – Spinose part of gnathos big, globular. Tegumen constricted at base of gnathos arms. Transtilla oval, elongated. Valvula small, narrow, teardrop-like shaped. Cucullus ear-shaped, slightly elongated. Sacculus with vertical lateral margin, ended in triangular point at ventral angle, and sharper point at dorsal angle. Phallotheca slightly curved and long, consisting of two rods, longer rod tapered to acute apex, shorter rod 2/3rd of length of other with wider beak-like apex. About ten needle-like cornuti, united into long cluster (fig. 135).

Structure of abdominal supports (fig. 136). – No posterior lateral struts; transverse strut with curved proximal margin, distal margin straight, not sclerotized in middle. Tergal disks with small conical spines, about 2.5 times longer than wide (3rd tergite).

Diagnosis. – The new species belongs to the 30th group of Toll's system; however, the female is unknown, so it is difficult to relate it to another species. In coloration it resembles *C. horakae* sp. n. very much, but the male genitalia are markedly different.

Biology. – Unknown.

Distribution. – Southern tablelands of New South Wales.

Coleophora rustica sp. n.
(figs. 12, 33, 137-140)

Type material. – Holotype: ♂, 23.59S 133.56E, 32 km SbyE of Alice Springs, NT, 23 Sept. 1978, E. D. Edwards; slide ANIC 2351 (ANIC).

Description. – Wingspan 11 mm. Head (fig. 12), thorax and abdomen pearly ochreous. Labial palps ochreous; ventral part of second segment about twice length of third. Antennae: basal segment without scales tuft ochreous, dorsal surface white; flagellum ringed white and ochreous, except for basal segments entirely ochreous. Forewing almost uniformly ochreous, slightly variegated, with brilliant sheen, with some brown scales. Fringes greyish ochreous. Hindwings greyish beige; fringes beige.

Male genitalia (fig. 137). – Spinose part of gnathos globular. Tegumen constricted medially, with wide and rounded pedunculi. Transtilla elongated, oval. Valvula narrow, elongated, teardrop-shaped, oblique on external margin. Valva compact, ear-shaped. Sacculus rounded on ventral margin, ended in subtriangular, obtuse point at ventral angle; lateral margin straight, ended in acute tooth at dorsal angle. Phallotheca slightly arched and long, with two rods, longer rod curved, acute at apex, beak-shaped, shorter rod ended in triangular point. Cornuti 4-5 (fig. 139), needle-like, of different lengths, united into long cluster.

Structure of abdominal supports (fig. 140). – No posterior lateral struts; transverse strut characterized by convex proximal margin, thicker in middle, distal margin almost straight. Tergal disks with short, conical spines on wide base, about 3 times longer than wide (3rd tergite).

Diagnosis. – *C. rustica* belongs to the 30th group of Toll's system, and as the female is not known it is difficult to give a more precise placement in the system. As far as the Australian fauna is concerned, it is close to *C. frustrata*, from which it can be distinguished by the following characteristics of the male genitalia: in *rustica* the pedunculi as well as the cucullus are wider; the ventral margin of the sacculus is more curved, while the lateral margin is not concave, but slightly convex; the processes at the two angles are different;

the phallotheca rods are wider and the longer one ends in a beak, which is absent in *C. frustrata.*

Biology. – Unknown.

Distribution. – Central Australia.

Coleophora albiradiata **sp. n.**
(figs. 16, 27, 141-154)

Coleophora ochroneura.– sensu Common 1990.

Type material. – Holotype: ♂ (slide ANIC 2363), Black Mt, ACT, Light Trap, 17 Jan. 1961, I. F. B. Common (ANIC). Paratypes: 1♂ (slide ANIC 8769) same label as holotype, 2. Nov.1959 [the photograph of this specimen was reproduced in the volume by Common 1990, with the name of *C. ochroneura* Lower] ; 1♀ (slide ANIC 2343), Rockhampton, 2.5.48, I. F. B. Common; 1♂ (slide H 53), Brisbane, 7.iv.10, [A. J. Turner].1♀ (slide ANIC 2355), Brisbane, 10.iii.16; 1♂ (slide ANIC 2333), Warwick, Q, Oct.; 1♀ (slide ANIC 2310), Milmerran, Q., 20.ix.31; 1♂ (slide ANIC 2336), 85 miles W of Wanaaring, NSW, emg. 5 Nov. 1949, I. F. B. Common; Larva on *Rutidosis helichrysoides* [Asteraceae]; 2♂ (slide ANIC 2361), 1♀ (slide ANIC 2362), Depot Beach, 10 miles NE of Bateman's Bay, NSW, 13 Mar 1970, 21 Mar. 1969, I. F. B. Common; 1♀ (slide ANIC 2335), 2.7 km NE of Queanbeyan, NSW, 670 m, 18 Apr.1974, I. F. B. Common; 6♂ (slides ANIC 2371, 2322, 2321, 2365, 2318), 3♀ (slides ANIC 2366, 2320, 2364), as holotype but 9 Apr. 1963, 29 Oct. 1959, 6 Nov. 1959, 3 Apr. 1963, 18 Jan. 1961, 2 Nov. 1959, 17 Dec. 1963, 18 Oct. 1959, 18 Sept. 1963; 1♂ (slide ANIC 2337), 1 km SSE of Srivener Dam, ACT, 13.iii.1985, E. D. Edwards; 1♀ (slide ANIC 2330), 24.15S 133.26E, James Ranges, NT, 22 Sept. 1978, E. D. Edwards; 2♀ (slides ANIC 2312, 2311), 24.11S 134.01E, 56 km SbyE of Alice Springs, NT, 3 Oct. 1978, E. D. Edwards; 1♂ (slide ANIC 2352), 23.41S 134.15E, 39 km E of Alice Springs, NT, 25 Sept. 1978, E. D. Edwards (ANIC).

Description. – Wingspan 9.5-10.5 mm. Head (fig. 16) light brown. Labial palps white; second segment, about twice length of third, almost completely brown on outer side, third segment brown only on ventral side. Antennae: basal segment brown with scale tuft; flagellum ringed white and brown. Thorax brown with white and brown tegulae. Abdomen beige. Forewings ochreous with white streaks along costa, dorsum and main veins. Fringes beige. Hindwings and fringes beige. The colour of the wings and the width of the streaks is variable, and in the female the colour is usually lighter.

Male genitalia (fig. 141). – Spinose part of gnathos oval. Tegumen constricted medially, pedunculi of average length. Transtilla narrow, elongated, rounded at apex. Valvula small, subtriangular, covered with bristles. Cucullus big, compact, ear-shaped. Sacculus with curved ventral margin, with long process in shape of curved and sharp horn at dorsal angle extended to middle of cucullus. Phallotheca with two long and symmetrical rods, rounded at apex, more sclerotized on dorsal side. Cornuti 2-3 (fig. 139) rather small, united into needle-like cluster.

Structure of abdominal supports (figs. 140, 154). – No posterior lateral struts; transverse strut with proximal margin thicker than distal one. Tergal disks with small conical spines; those of 3rd tergite about 6 times longer than wide.

Female genitalia (fig. 150). – Papilles anales small, oval, speckled with chitine. Apophyses posteriores about 2.5 times longer than anterior ones. Sterigma (fig. 151) irregularly trapezoid, uniformly sclerotized, with convex proximal margin and curved distal margin, with some bristles, excavated medially at ostium bursae. Ostium small, ogival. Colliculum chaliced, completely transparent, except for well-sclerotized section lining ostium bursae. Ductus bursae entirely transparent, except for sclerotized disk with small spines (figs. 152, 153) at insertion of ductus seminalis. Bursa copulatrix small, oval, without signa.

Diagnosis. – *C. albiradiata* belongs to the 30th group of Toll's system, and according to its genital structures could be placed in the section of *C. chrysanthemi* Hofmann (fig. 149), together with *C. absinthivora* Baldizzone, *C. kurokoi* Oku (fig. 148) and *C. yomogiella* Oku (fig. 147), species that use Asteraceae for hostplants. The most closely related species is *C. yomogiella* Oku, distributed in Japan, China and Korea. The most obvious differences in the genitalia are: in the male of *albiradiata* the cucullus is wider, the sacculus ends in the dorsal angle in a more acute process without a tooth at the base. In the female genitalia of *albiradiata* the distal margin of the sterigma is more rounded; the ductus bursae is shorter, completely transparent, also without the medial line which is present in *yomogiella*; the bursa has no signum, while *yomogiella* has a small one.

Note. – Common (1990) treated this species under the name of *C. ochroneura* (Lower), also presenting a photograph of a specimen (fig. 24.10) and a drawing of the male genitalia (fig. 83.3, 4). Evidently he had not studied the type of *ochroneura.*

Biology. – One of the specimens that I studied had been bred from *Rutidosis helychrysoides* DC: this species belongs to an endemic genus in the tribe *Inuleae* of the *Asteraceae. Rutidosis* is a plant of drier habitats. Unfortunately the larval case has not been preserved and there is no other biological information associated with the specimen. It should be noted that owing to the fact that the species has also been collected in Java it must also live on another plant species.

Distribution. – Southern Queensland, coastal New South Wales to central Australia.

Coleophora consumpta sp. n.
(figs. 14, 29, 155-158)

Type material. – Holotype: 1♂, 31.22S 131.47E, 14 km NNW of Yalata Mission, SA, 9 Apr. 1983, E. S. Nielsen, E. D. Edwards; slide ANIC 2360 (ANIC).

Description. – Wingspan 9 mm. Head (fig. 14), thorax and abdomen beige. Labial palps white: second segment about twice length of third, with wide brown band on outer side, third variegated white and beige. Forewings weakly and uniformly ochreous, with some brown scales. Fringes beige. Hindwings light brown; fringes beige.

Male genitalia (fig. 155). – Spinose part of gnathos globular. Tegumen constricted at base of gnathos arms, pedunculi widened laterally. Transtilla narrow and elongate, slightly widened and rounded at apex. Valvula irregularly shaped, rounded on ventral margin. Cucullus shaped like elongate ear, not extended beyond sacculus. Sacculus narrow, elongate, with long and rounded process laterally, ended dorsal angle with triangular tooth. Phallotheca long and almost straight with two rods, apex of longer rod slightly curved and sharp, beak-like, apex of shorter rod divided into two asymmetrical sharp points. Two needle-like cornuti of different lengths (fig. 157).

Structure of abdominal supports (fig. 158). – No posterior lateral struts; transverse strut almost straight, proximal margin thicker. Tergal disks with short conical spines, about 2.5 times longer than wide (3rd tergite).

Diagnosis. – *C. consumpta* belongs to the 30th group of Toll's system; its precise placement is uncertain, as the female is not known. The male genitalia show no resemblance to any Australian species.

Biology. – Unknown.

Distribution. – East of Nullarbor Plain.

Conclusions

The study of the Coleophoridae of Australia has resulted in rather interesting information, and above all, it can give indications leading to an understanding of the evolution of this extensive family; so far no cladistic work has been produced on this family. First of all one is struck by the small number of specimens in Australia, compared with what we know of the Palaearctic region (more than 1000 species, of which about 400 for Europe (Baldizzone 1995). The genus *Corythangela* is transferred from the family Coleophoridae to the Batrachedridae.

Of the 14 Australian species of the genus *Coleophora* only *C. alcyonipennella* can be considered a species introduced by man. *C. serinipennella* was thought to be an indigenous species (Common 1990), however, its very wide distribution can only be explained by accepting accidental transport. The phenotypical variation of this species that occurs in Australia (a form with brown streaks) could be explained by a very rapid reaction to the environment. *C. serinipennella* is the only representative of its group (Toll's 8th) in Australia, while the other species (except *alcyonipennella*) belong to Toll's 30th group: *C. seminalis*, *C. leucocephala*, *C. crypsineura*, *C. tremefacta*, *C. nielseni*, *C. horakae*, *C. fuscosquamata*, *C. frustrata*, *C. rustica*, *C. consumpta*, *C. albiradiata*. When examining the habitus of these species, the uniformity of their dimensions is striking, for all specimens have a wingspan of 8 to 11 mm.; a similar uniformity can be found in the colour of the forewings, which is always limited to ochreous, white, brown etc. Based on the wing markings the species can be divided into two groups: one characterized by almost uniformly ochreous forewings, with an indistinct white line along the costa and sometimes some brown scales (*C. nielseni*, *C. horakae*, *C. rustica*, *C. frustrata*, *C. consumpta*, *C. tremefacta*); the other with white or beige wings, streaked more or less regularly with brown or ochre (*C. seminalis*, *C. albiradiata*, *C. leucocephala*, *C. crypsineura*, *C. fuscosquamata*). Another very interesting feature in species whose female is known is the absence of a leaf-like or anchor-shaped signum, so characteristic for Coleophoridae. Only *C. tremefacta* has one, small, leaf-like signum, together with another signum which is elongate, irregular, speckled with small spines; that signum is also present in *C. leucocephala*, *C. nielseni*, *C. horakae*, *C. fuscosquamata*, whereas *C. albiradiata* has no signa. This signum is typical of a group of species that includes, for example, *C. versurella*, which in addition has a typical Coleophorid signum. Another interesting feature is the structure of the phallus complex, which is, in all species except *C. serinipennella*, characterized by two 'juxta rods', according to the nomenclature of Landry (1993); the presence of two rods might represent a primitive characteristic (Landry in litt.), while the fusion of the rods, which can be observed in numerous Palaearctic species (also in *alcyonipennella*), could represent an advanced feature. The structure of the genitalia of most of the species, all belonging to the group of *C. versurella* (which is not known from Australia) could indicate that *C versurella* and the Australian species have a common ancestor, which has given rise to a significant subdivision in Australia. Moreover, the phallotheca of *C. serinipennella* is rather simple and the 'juxta rods' are very different: one rod is almost atrophic, while the other shows all the chitinous reinforcement of the 'phallus complex'; this could indicate a different line of evolution. If the view that this species has been imported accidentally into Australia is accepted, the consequence is that all indigenous Australian species so far known have two juxta rods.

REFERENCES

Amsel, H. G., 1935. Neue palästinensische Lepidopteren. – Mitteilungen aus dem Zoologischen Museum in Berlin 20: 271-319.

Baldizzone, G., 1989. A taxonomic review of the Coleophoridae (Lepidoptera) of China. Contribution to the knowledge of the Coleophoridae, LIII. – Tijdschrift voor Entomologie 132: 199-240.

Baldizzone, G., 1994. Contribuzioni alla conoscenza dei Coleophoridae. LXXV. Coleophoridae dell'Area Irano-Anatolica e regioni limitrofe (Lepidoptera). – Memorie Associazione Naturalistica Piemontese 3: 424 pp.

Baldizzone G., L. Gozmany, P. Huemer, O. Karsholt, A. Lvovsky, U. Parenti, P. Passerin d'Entreves, T. Riedl, P. G. Varalda & S. Zangheri, 1995. Lepidoptera Gelechioidea. – In: A. Minelli, S. Ruffo & S. La Posta (eds), Checklist delle specie della fauna italiana 83. Calderini, Bologna.

Braun, A. F., 1919. Descriptions of new species of *Coleophora*. – Entomological News 30: 108-131.

Capuse, I., 1973. Sur la taxonomie de la famille des Coleophoridae. (Clés de détermination des taxa superspecifiques). – Bucarest: 1-24.

Caradja, A., 1931. Beiträge zur Lepidopterenfauna Grossrumäniens für das Jahr 1930. – Memoriile Sectiunii stiintifice. Academia Romana (3), 7 (8): 1-52.

Caradja, A., 1932. Beiträge zur Lepidopteren-Fauna Grossrumäniens für das Jahr 1931. – Bulletin de la Section scientifique de l'Académie roumaine 15: 35-46.

Chrétien, P., 1926. *Coleophora novella* n. sp. – Amateur de Papillons 3 (1): 4-11.

Christoph, H., 1872. Neue Lepidoptera des Europäischen Faunengebietes. – Horae Societatis Entomologicae Rossicae 9: 3-39.

Common, I. F. B., 1970. Lepidoptera (Moths and butterflies). – In Mackerras, I. M. (ed.). The Insects of Australia: xii + 1029 pp. 8 pls. Univ. Press., Carlton, Melbourne.

Common, I. F. B., 1990. Moths of Australia. – Melbourne University Press, 535 pp.

Dugdale, J.S., 1988. Lepidoptera – annotated catalogue, and keys to family group taxa. – Fauna of New Zealand 14: 262 pp.

Hodges, R. W., 1978. Gelechioidea, Cosmopterigidae. – In R. B. Dominick, R.B. et. al. The moths of America north of Mexico 6 (1). E. W. Classey, London.

Joannis, J. de, 1899. Note sur une espèce nouvelle de *Coleophora* provenant de Sicilie. – Bulletin de la Société Entomologique de France 1899: 331.

Kollar, V., 1832. Systematisches Verzeichnis der Schmetterlinge im Erzherzogthum Österreich. – Beitrag zur Landeskunde Oesterreichs unter der Enns 2: 1-101.

Landry, J. –F., 1993. Systematics of the nearctic species of metallic-green *Coleophora* (Lepidoptera: Coleophoridae). – Canadian Entomologist 125: 549-618.

Lower, O.B., 1897. Descriptions of new species of Australian Lepidoptera with notes on synonymi. – Proceedings of the Linnean Society of New South Wales 22: 10-32.

Lower, O.B., 1900. Descriptions of new Australian Lepidoptera. – Proceedings of the Linnean Society of New South Wales 25: 29-51, 403-423.

Lower, O.B., 1905. New Australian Lepidoptera, no. 22. – Transactions of the Royal Society of South Australia 29: 103-115.

Lower, O.B., 1917. Lepidoptera of Broken Hill. Pt. 3. Adelaide. – Transactions of the Royal Society of South Australia 41: 369-377.

Meyrick, E., 1897. Descriptions of Australian Microlepidoptera, XVII, Elachistidae. – Proceedings of the Linnean Society of New South Wales 22: 297-435.

Meyrick, E., 1921a. New Microlepidoptera. – Zoölogische Mededeelingen, Leiden 6:145-202.

Meyrick, E., 1921b. Exotic Microlepidoptera 2 (13/15): 385-480.

Meyrick, E., 1922. Exotic Microlepidoptera, 2 (16/19): 481-608.

Meyrick, E., 1936. Exotic Microlepidoptera 4 (20): 609-642.

Razowski, J., 1989. Genitalia terminology in the Coleophoridae. – Nota lepidopterologica 12: 192-197.

Razowski, J., 1990. Morphology of the intromittent organ and distal male genital duct in Coleophoridae (Lepidoptera, Gelechioidea). – Nota lepidopterologica 13 (4): 221-228.

Suire, J., 1961. Contribution à l'étude des premiers états du genre *Eupista*. – Annales de l'Ecole Nationale d'Agriculture de Montpellier 30: 1-186.

Toll, S., 1944. Studien über die Genitalien einiger Coleophoriden VI. – Zeitschrift der Wiener Entomologischen Gesellschaft 29: 242-247; 268- 275.

Toll, S., 1962. Materialien zur Kenntnis der paläarktischen Arten der Familie Coleophoridae (Lepidoptera). – Acta zoologica Cracoviensia 7 (16): 577-720.

Vives Moreno, A., 1988. Catalogo mundial sistematico y de distribucion de la Familia Coleophoridae Hübner, [1825] (Insecta, Lepidoptera). – Boletin de Sanidad Vegetal 12: 196 pp.

Zeller, P. C., 1847. Bemerkungen über die auf einer Reise nach Italien und Sicilien gesammelten Schmetterlingsarten. – Isis von Öken 1847: 881-914.

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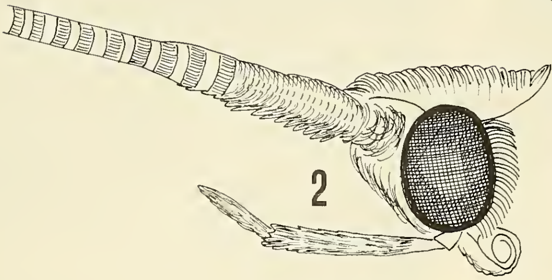

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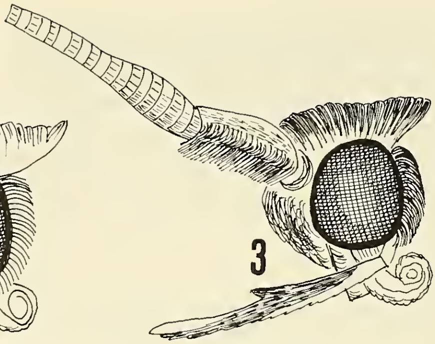

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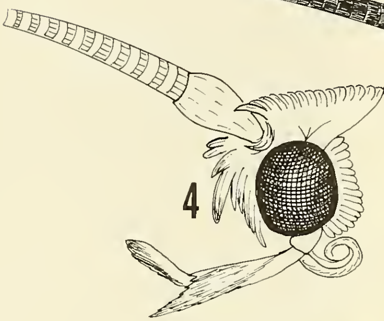

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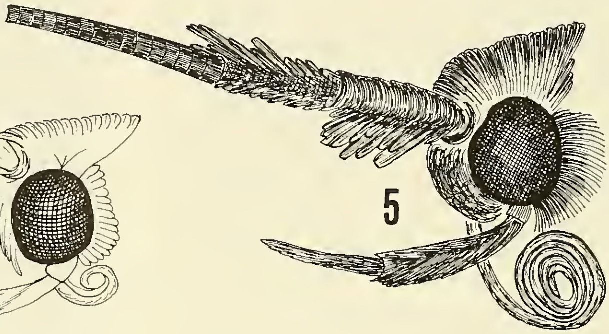

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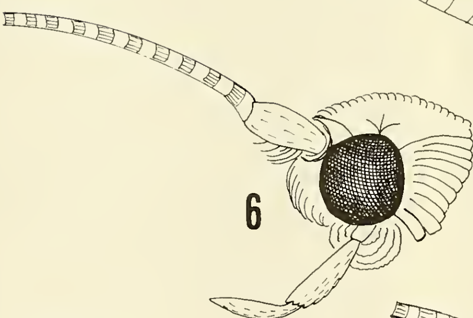

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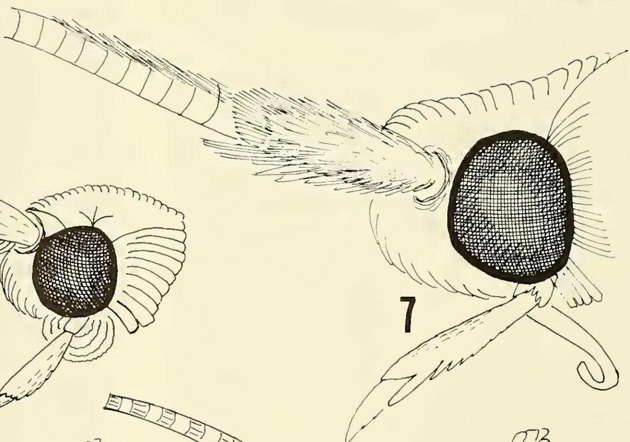

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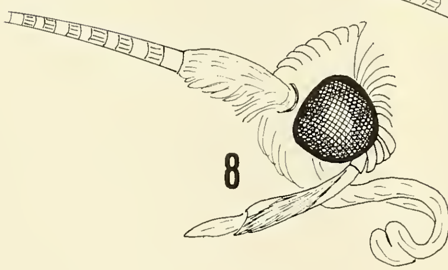

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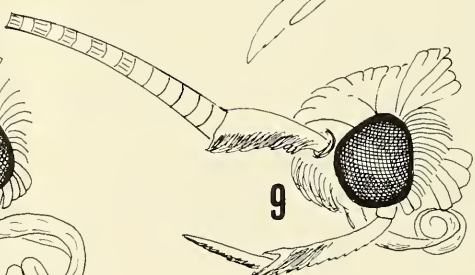

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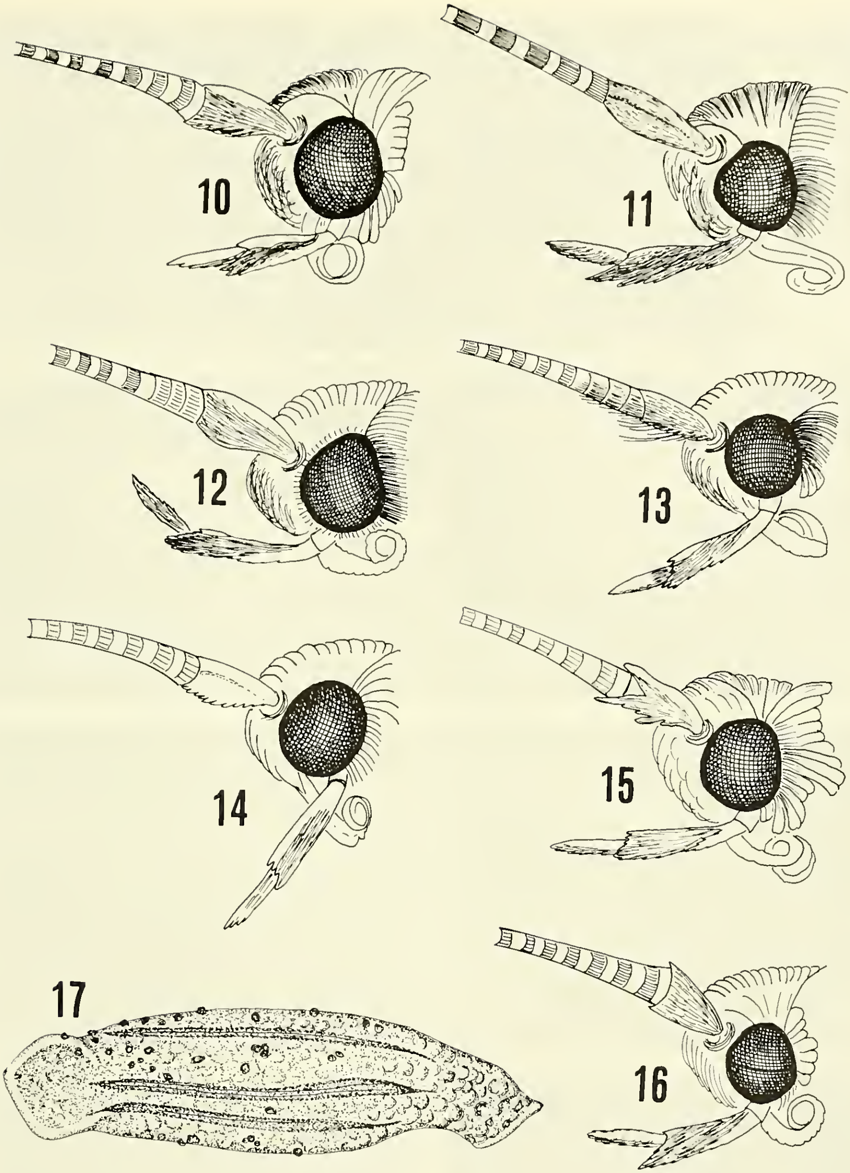
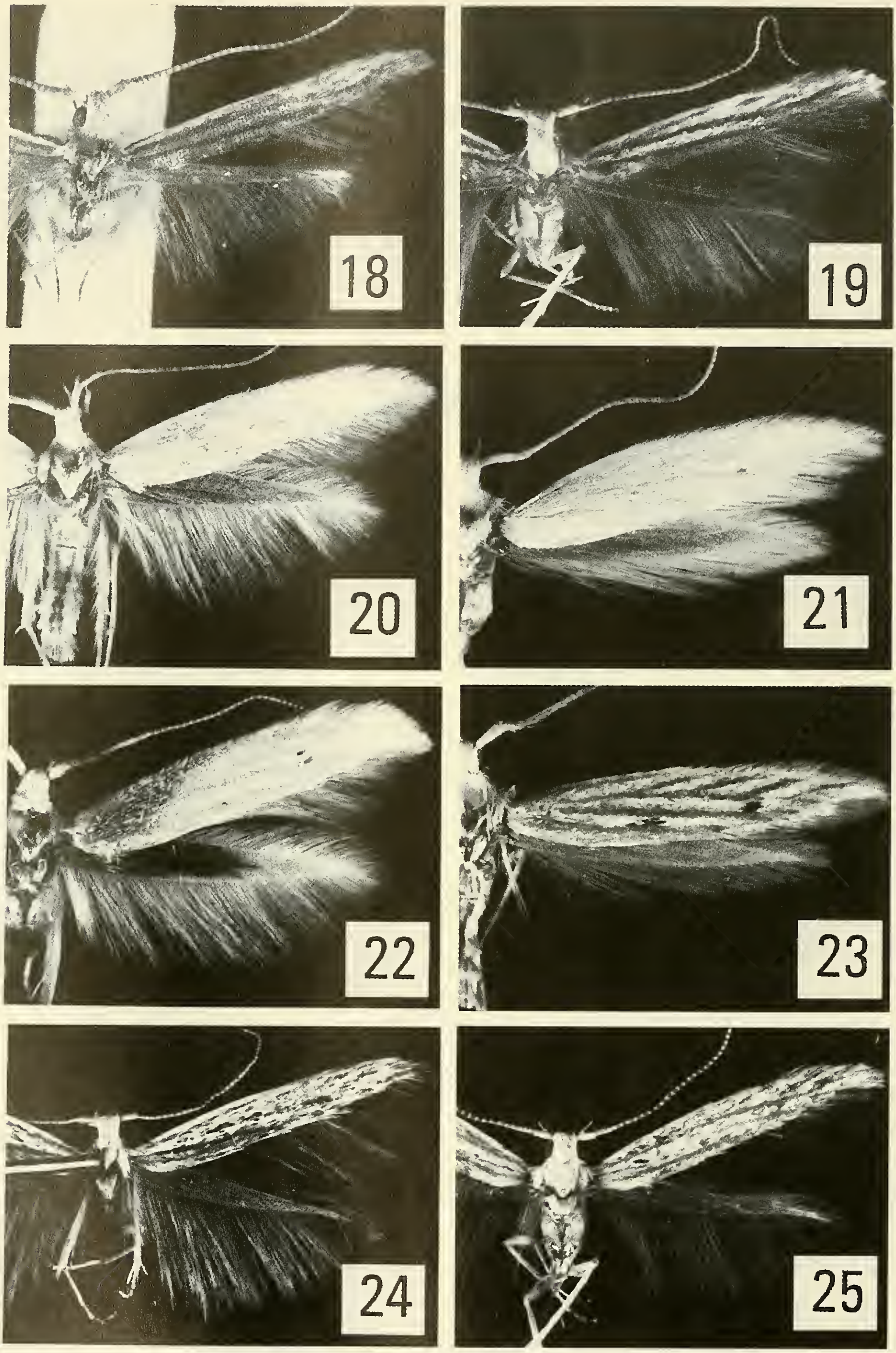
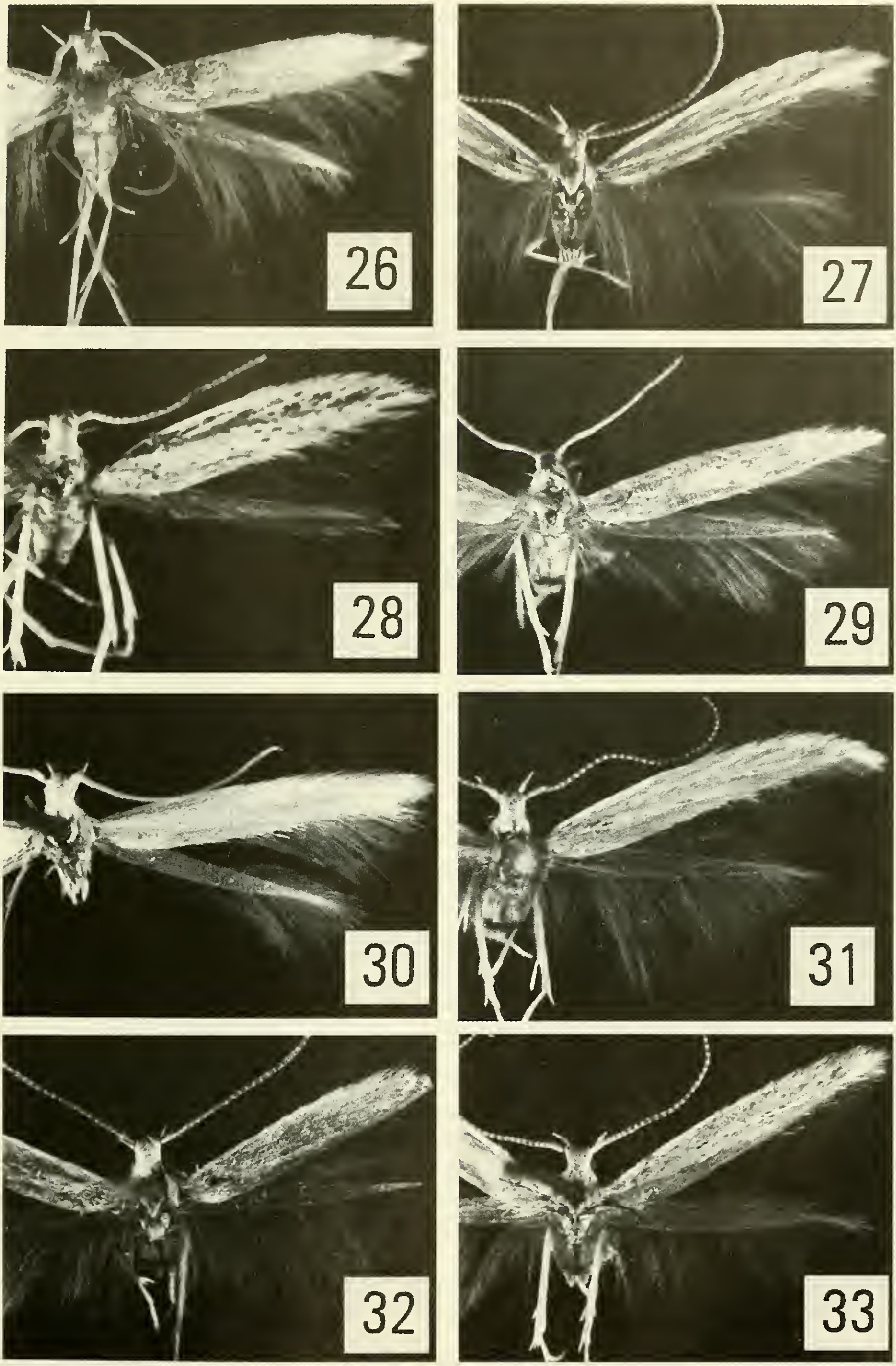


Figs. 10-16. Heads of *Coleophora*. 10, *C. fuscosquamata* sp. n., 11, *C. horakae* sp. n., 12, *C. rustica* sp. n., 13, *C. frustrata* sp. n., 14, *C. consumpta* sp. n., 15, *C. nielseni* sp. n., 16, *C. albiradiata* sp. n. – Fig. 17. Larval case of *C. seminalis* Meyrick.

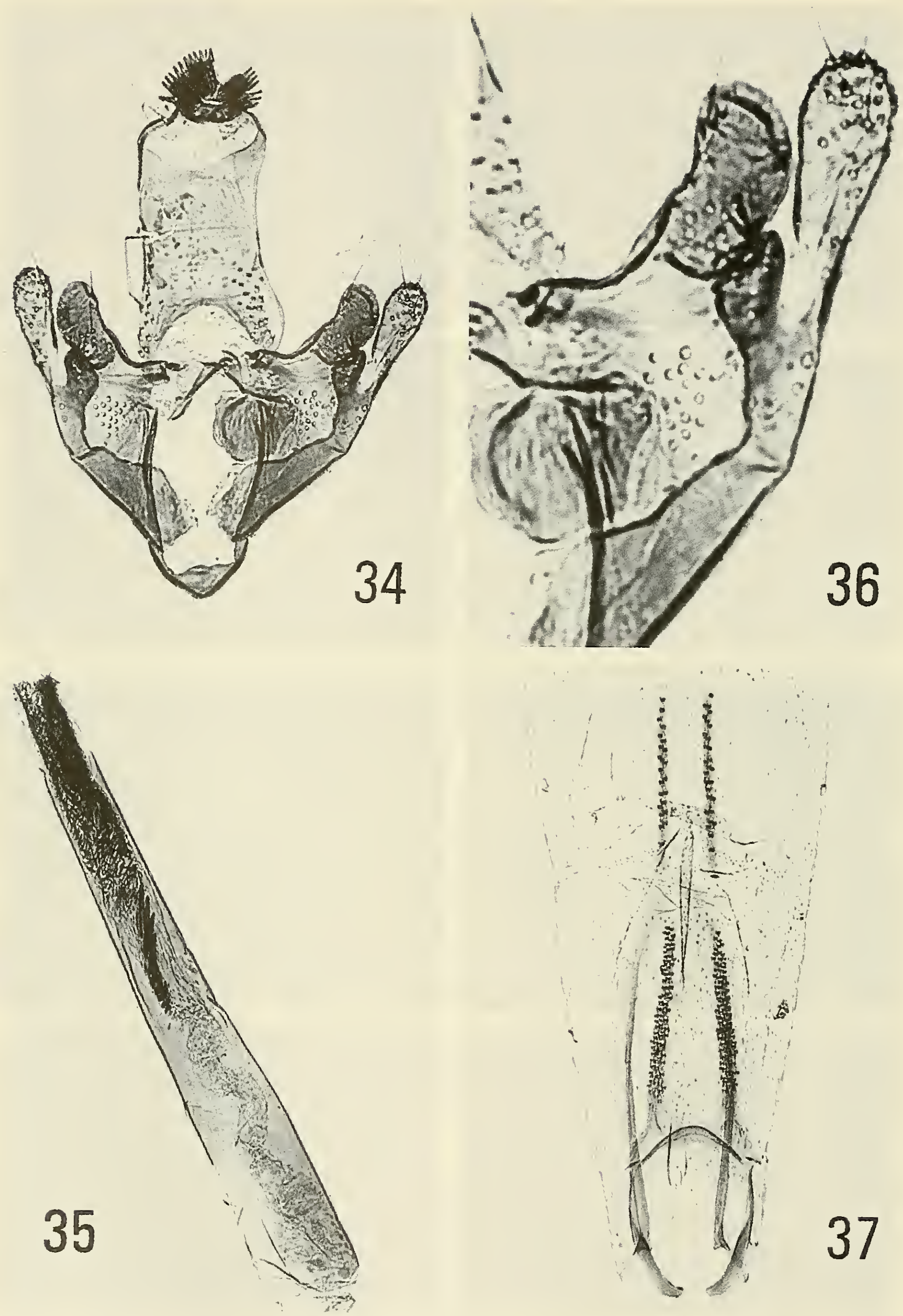
Left
Figs. 2-3. Heads of *Corythangela*. 2, *C. galeata* Meyrick, 3, *C. fimbriata* sp. n. – Figs. 4-9. Heads of *Coleophora*. 4, *C. seminalis* Meyrick, 5, *C. alcyonipennella* (Kollar), 6, *C. tremefacta* Meyrick, 7, *C. serinipennella* Christoph, 8, *C. leucocephala* sp. n., 9, *C. crypsineura* (Lower).



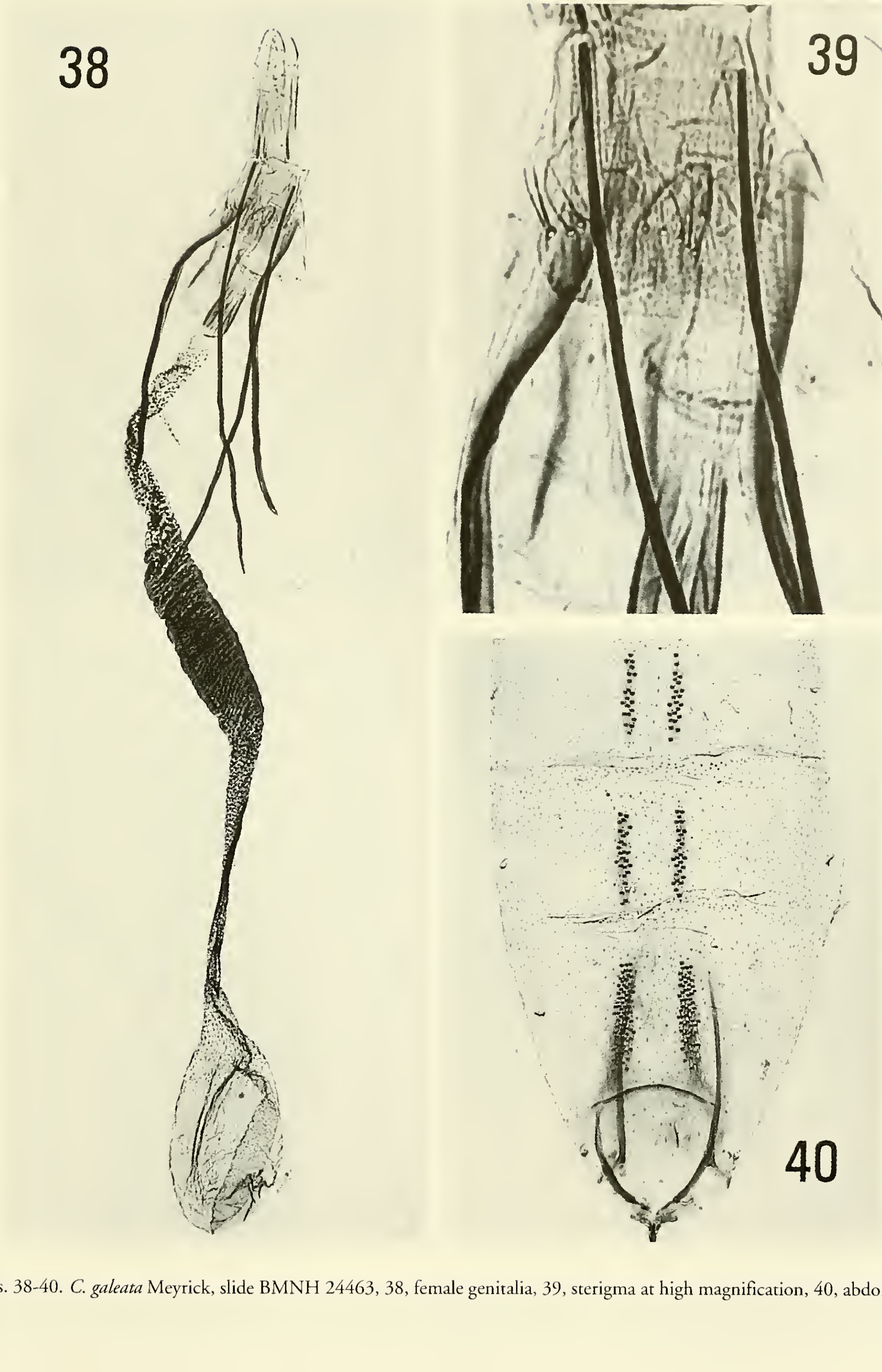
Figs. 18-19. *Corythangela* spp. 18, *C. galeata* Meyrick, 'Sydney, N.S.Wales, 9/12/77', Paralectotype 4/9, 19, *C. fimbriata* sp. n., holotype. – Figs. 20-25. *Coleophora* spp. 20, *C. serinipennella* Christoph, 'Australia, 25 miles E of Eucla, W.A., 19 Mar.1968, I.F.B.Common & M.S.Upton', 21, idem, '10 mi. NE by E of Iron Knob, S.A., 23 Oct.1968, Britton, Upton, Balderson', 22, idem, 'Madura, W.A., 20 Mar. 1968, I.F.B.Common & M.S.Upton', 23, idem, 'Australia, Drummond Cove, 11 km N of Geraldton, W.A., 26 Apr.1973, N.Mc Farland', 24, *C. leucocephala* sp. n., holotype, 25, *C. crypsineura* (Lower).



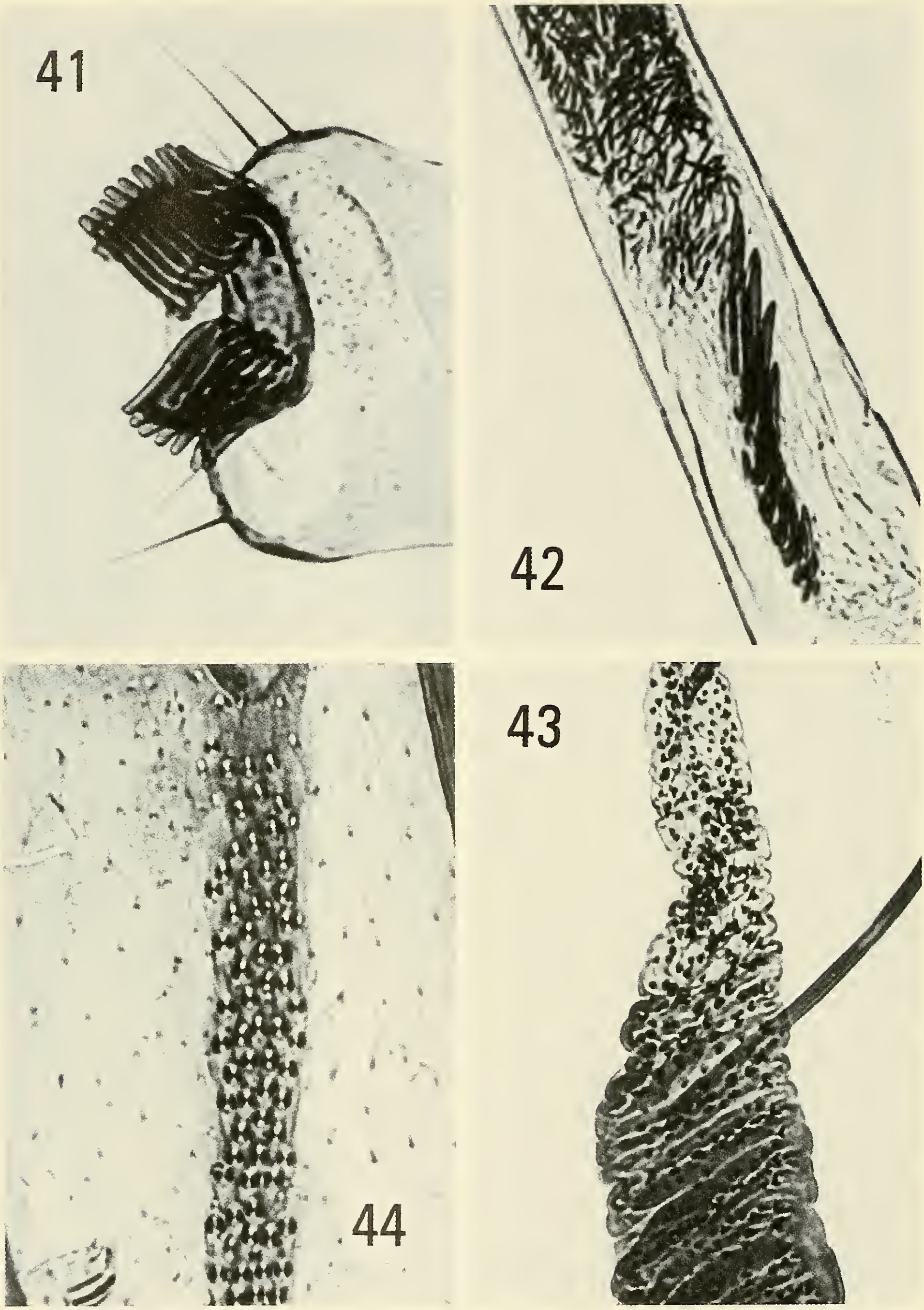
Figs. 26-33. *Coleophora* spp. 26, *C. tremefacta* Meyrick, paratype,27, *C. albiradiata* sp. n., holotype, 28, *C. fuscosquamata* sp. n., paratype, 29, *C. consumpta* sp. n., holotype, 30, *C. nielseni* sp. n., holotype, 31, *C. horakae* sp. n., paratype, 32, *C. frustrata* n. sp., holotype, 33, *C. rustica* n. sp., holotype.



Figs. 34-37. *Corythangela galeata* Meyrick, slide ANIC 2317. 34, male genitalia, 35, aedeagus, 36, detail of genitalia at high magnification, 37, abdomen.

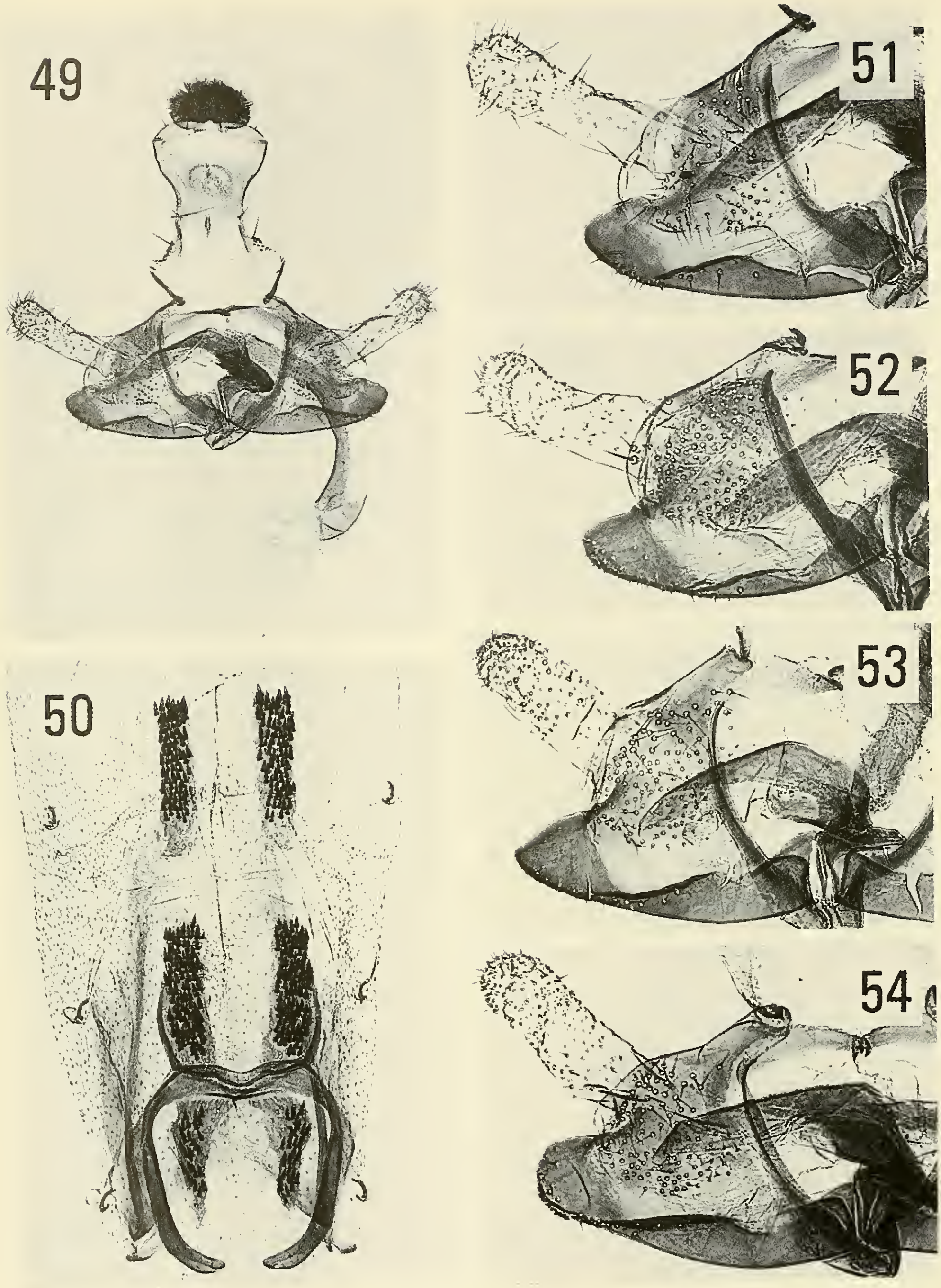


Figs. 38-40. *C. galeata* Meyrick, slide BMNH 24463, 38, female genitalia, 39, sterigma at high magnification, 40, abdomen.

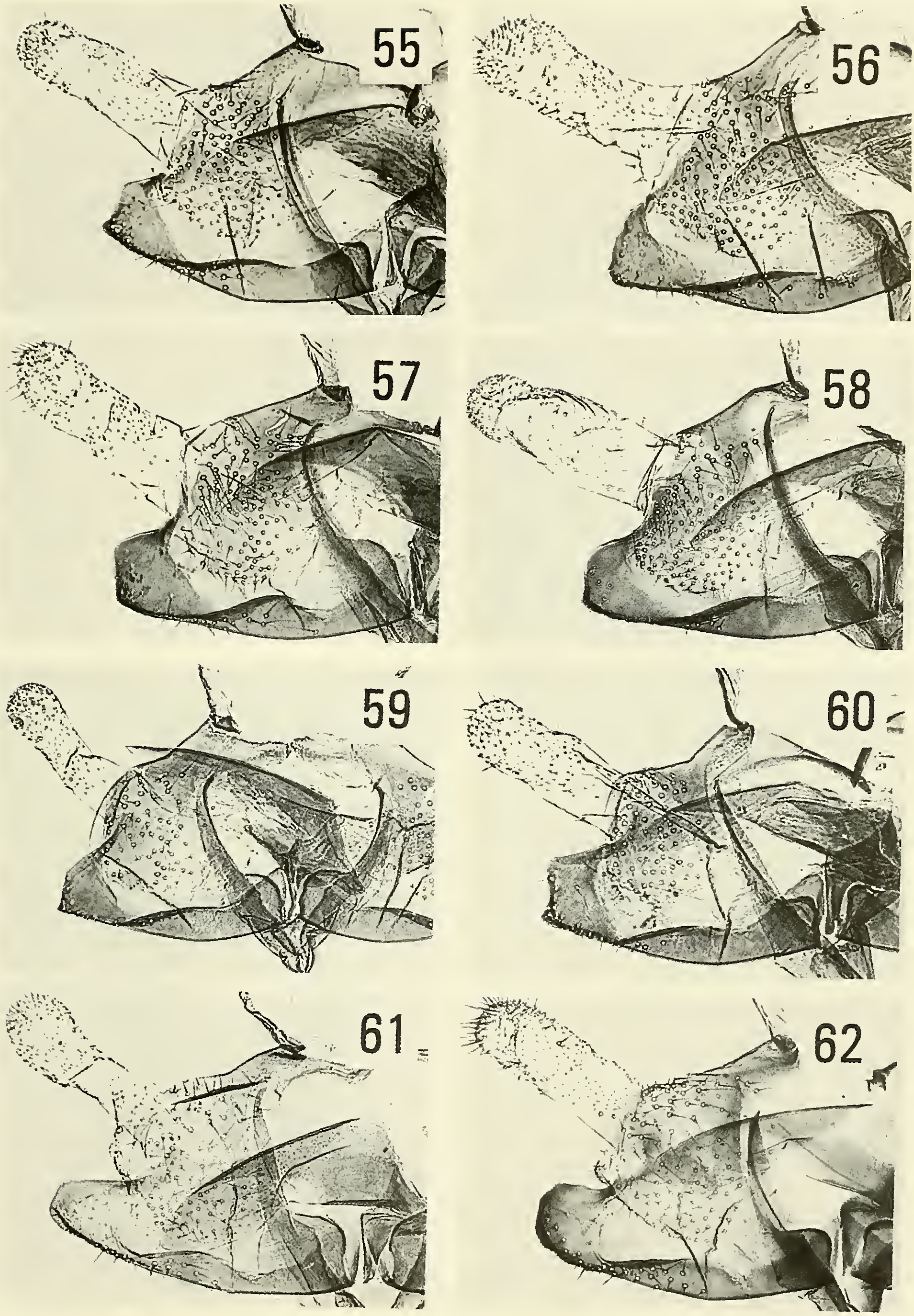


Figs. 41-44. *C.galeata* Meyrick, 41, male genitalia, detail of distal part of the gnathos, at high magnification, slide BMNH 24450, 42, male genitalia, detail of cornuti at high magnification, slide ANIC 2317, 43, female genitalia, detail of ductus bursae at high magnification, slide BMNH 24463, 44, abdomen, detail at high magnification of tergal disk, slide BMNH 24450.

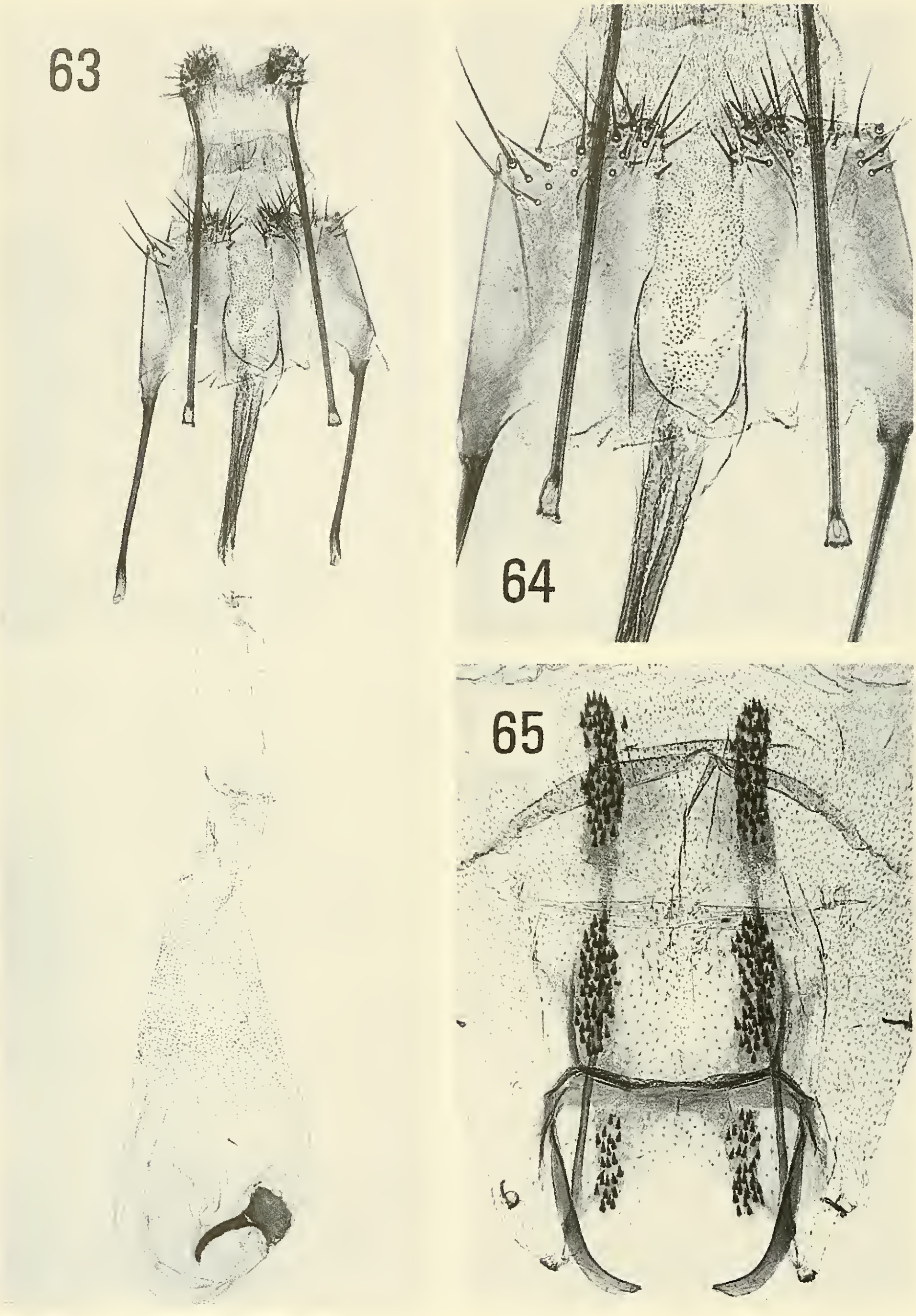
Figs. 45-48. *C. fimbriata* sp. n., holotype, slide ANIC 2341, 45, male genitalia, 46, aedeagus, 47, detail of genitalia at high magnification, 48, abdomen.



Figs. 49-54. *C.serinipennella* Cristoph, male genitalia, 49, slide ANIC 2296, 50, abdomen, 51, detail of genitalia at high magnification, 52, detail, slide ANIC 2304, 53, detail, slide ANIC 2306, 54 slide Bldz 9187, lectotype of *C. pudica* Lower.

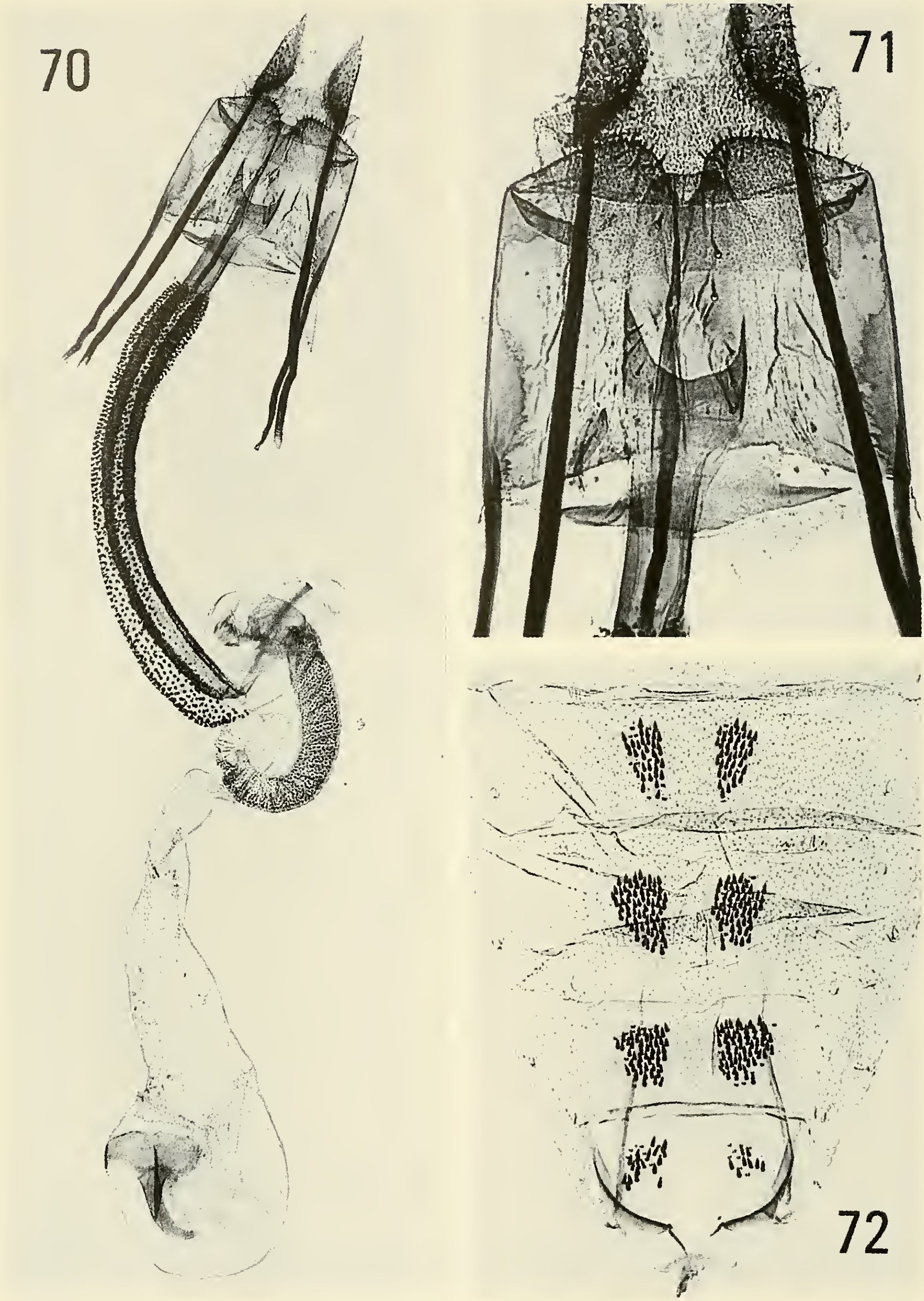


Figs. 55-62. *C. serinipennella* Christoph, male genitalia, detail at high magnification, 55, slide ANIC 2300, 56, slide ANIC 2308, 57, slide Bldz 9186, holotype of *C.ochroneura* Lower, 58, slide ANIC 2297, 59, slide Bldz 9188, paralectotype of *C. pudica* Lower, 60, slide Bldz 9189, paralectotype of *C. pudica* Lower, 61, slide Bldz 6811 'Japan, Kyûshû-Wakamatsu (Chikuzen), 20.VI.1932, I. Tateishi', coll. USNM, 62, slide Bldz 1837 'Algeria, Biskra, 29.V.1907, leg. Chrétien', coll. MNHN.

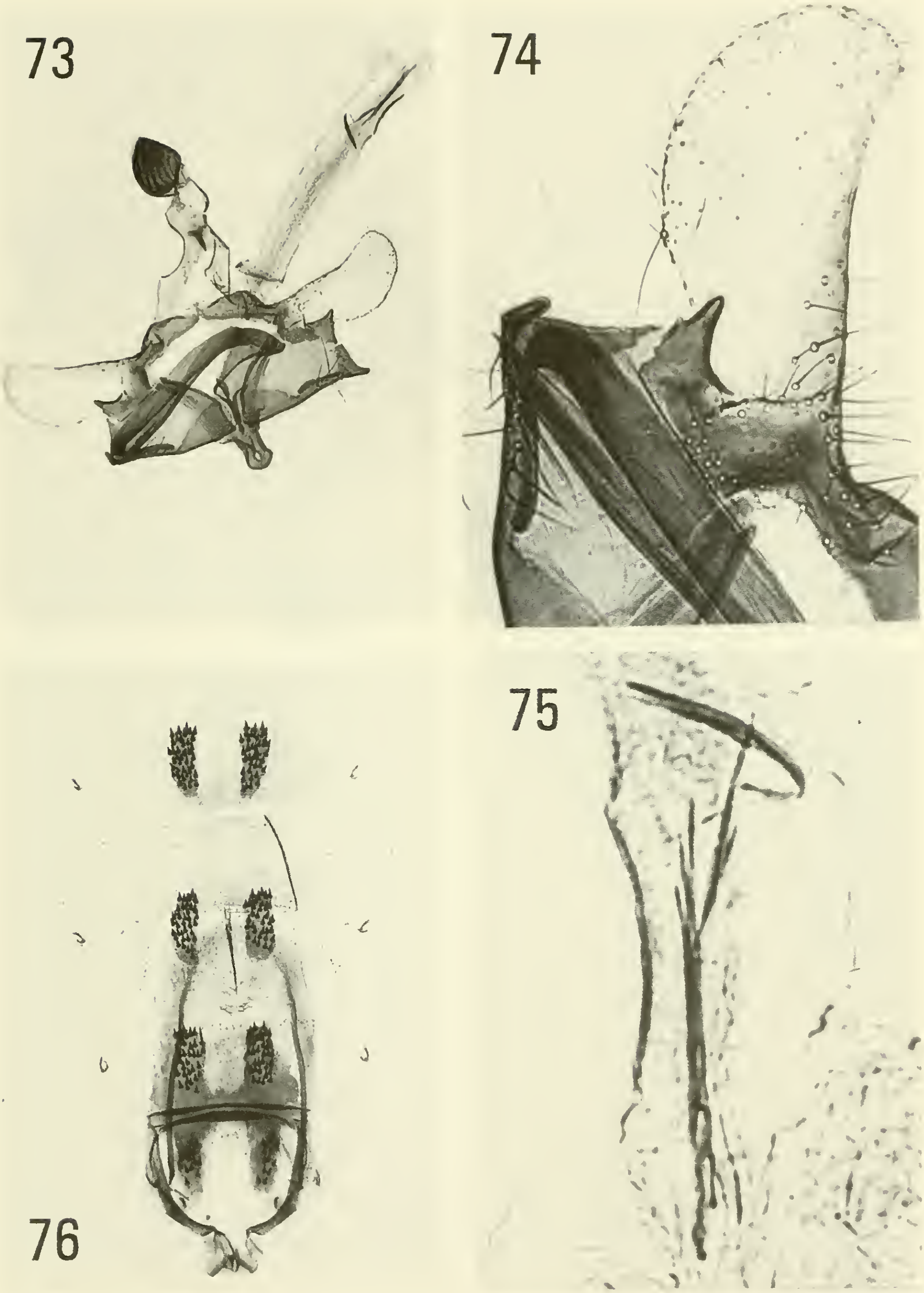


Figs. 63-65. *C. serinipennella* Christoph, slide ANIC 2298, 63, female genitalia, 64, sterigma at high magnification, 65, abdomen.

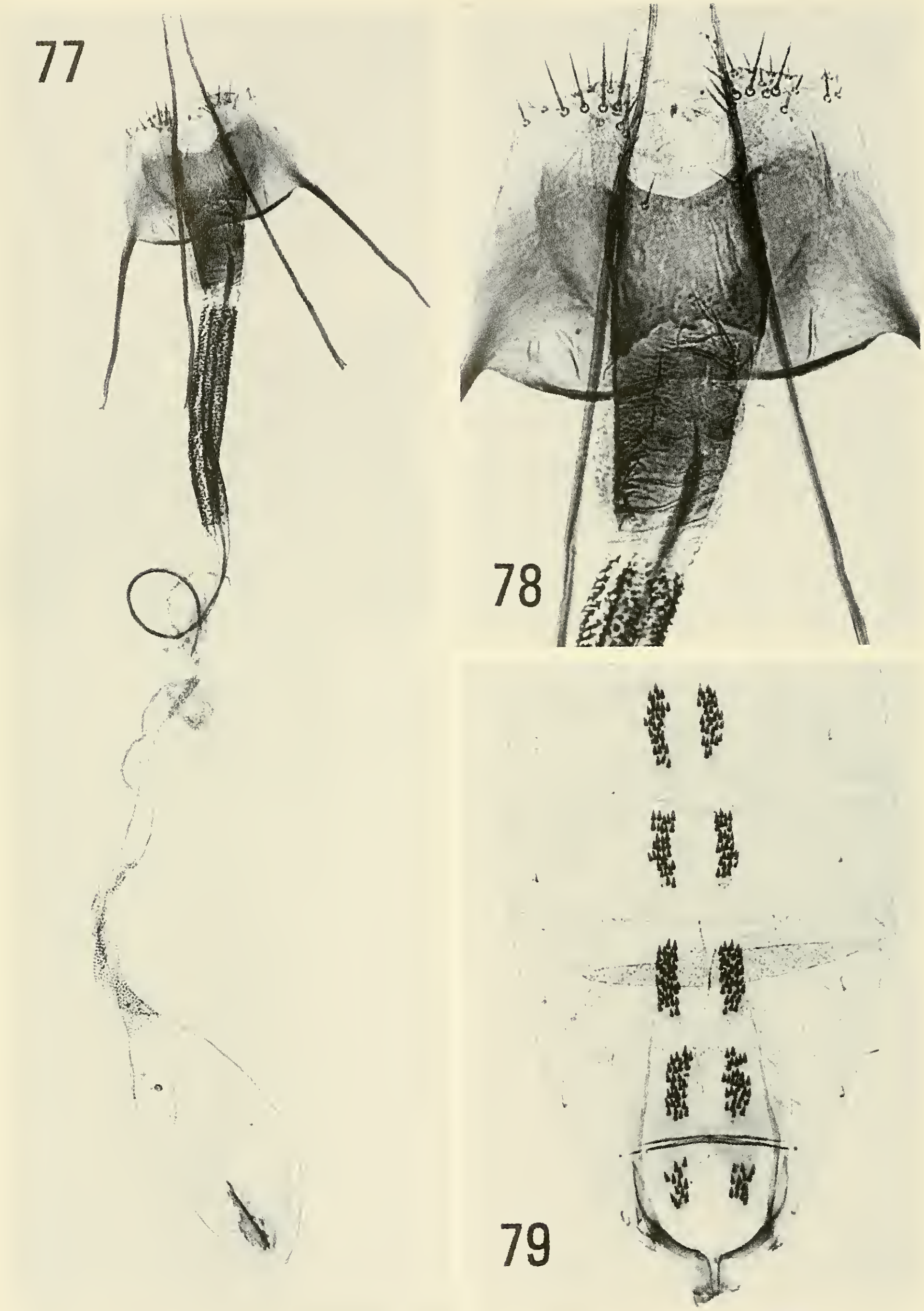
Figs. 66-69. *C. alcyonipennella* (Kollar), slide ANIC 2325, 66, male genitalia, 67, detail of genitalia at high magnification, 68, cornuti at high magnification, 69, abdomen.



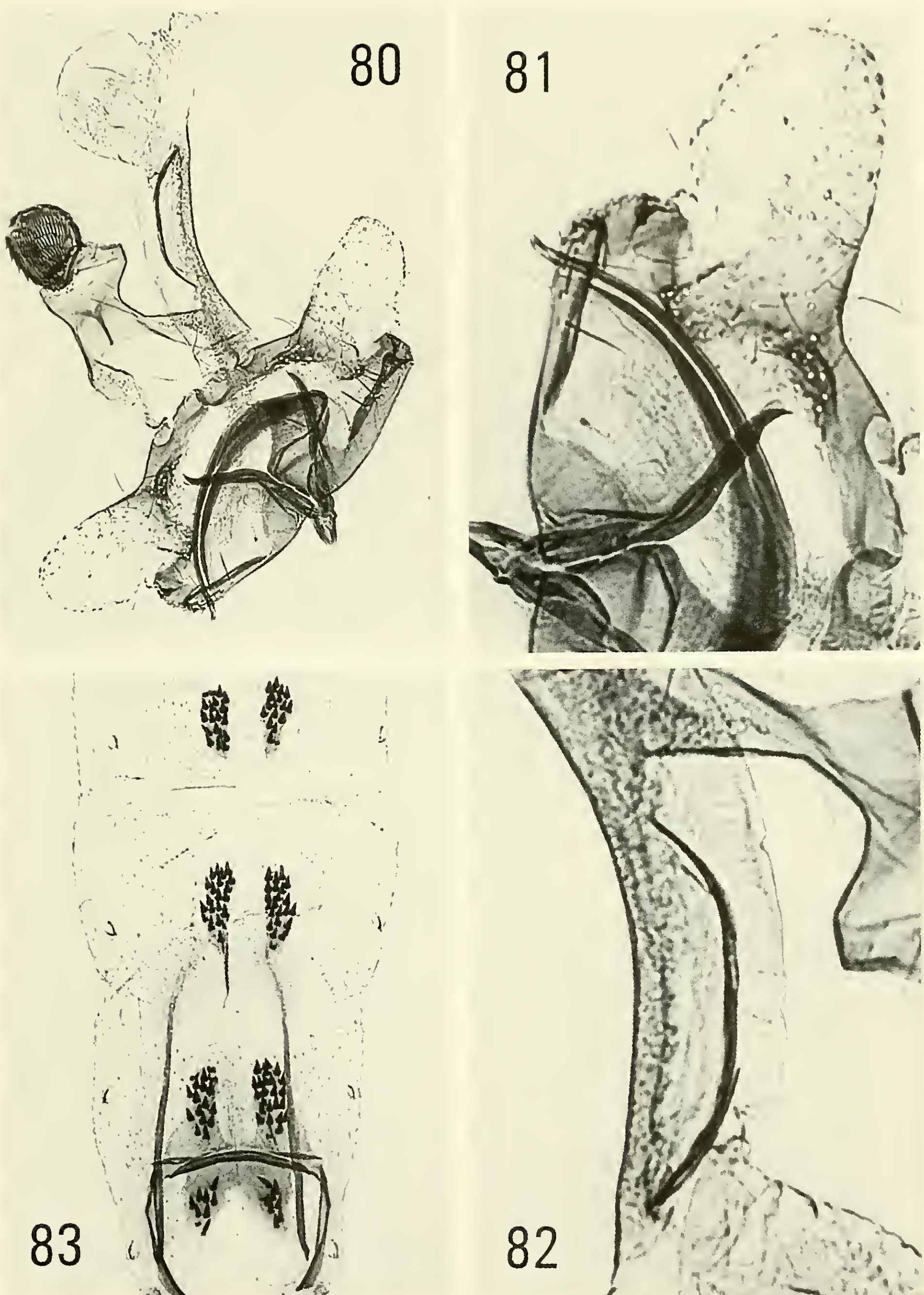
Figs. 70-72. *C. alcyonipennella* (Kollar), slide ANIC 2376, 70, female genitalia, 71, sterigma at high magnification, 72, abdomen.



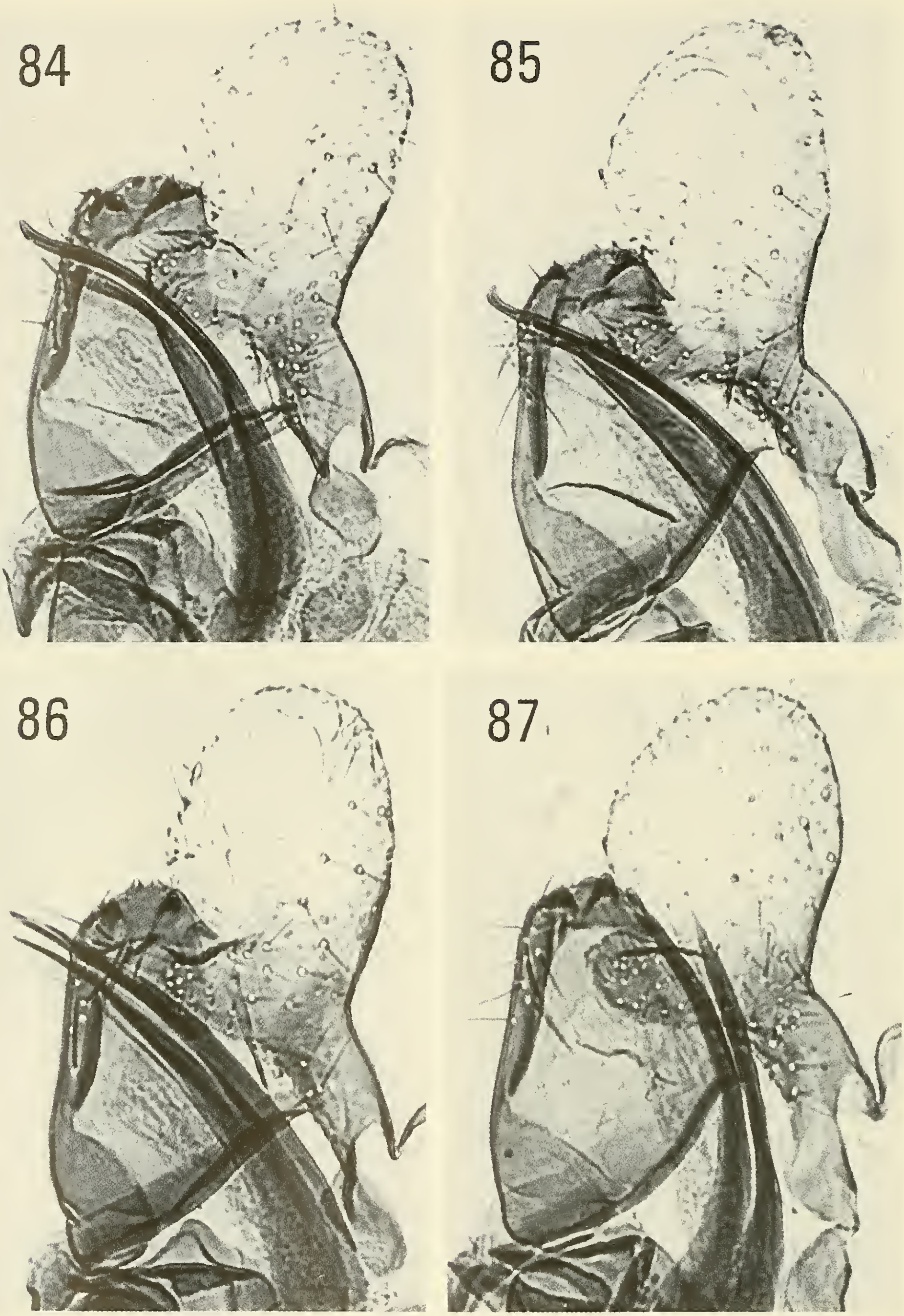
Figs. 73-76. *C. seminalis* Meyrick, slide ANIC 2331, 73, male genitalia, 74, detail of genitalia at high magnification, 75, cornuti at high magnification, 76, abdomen.



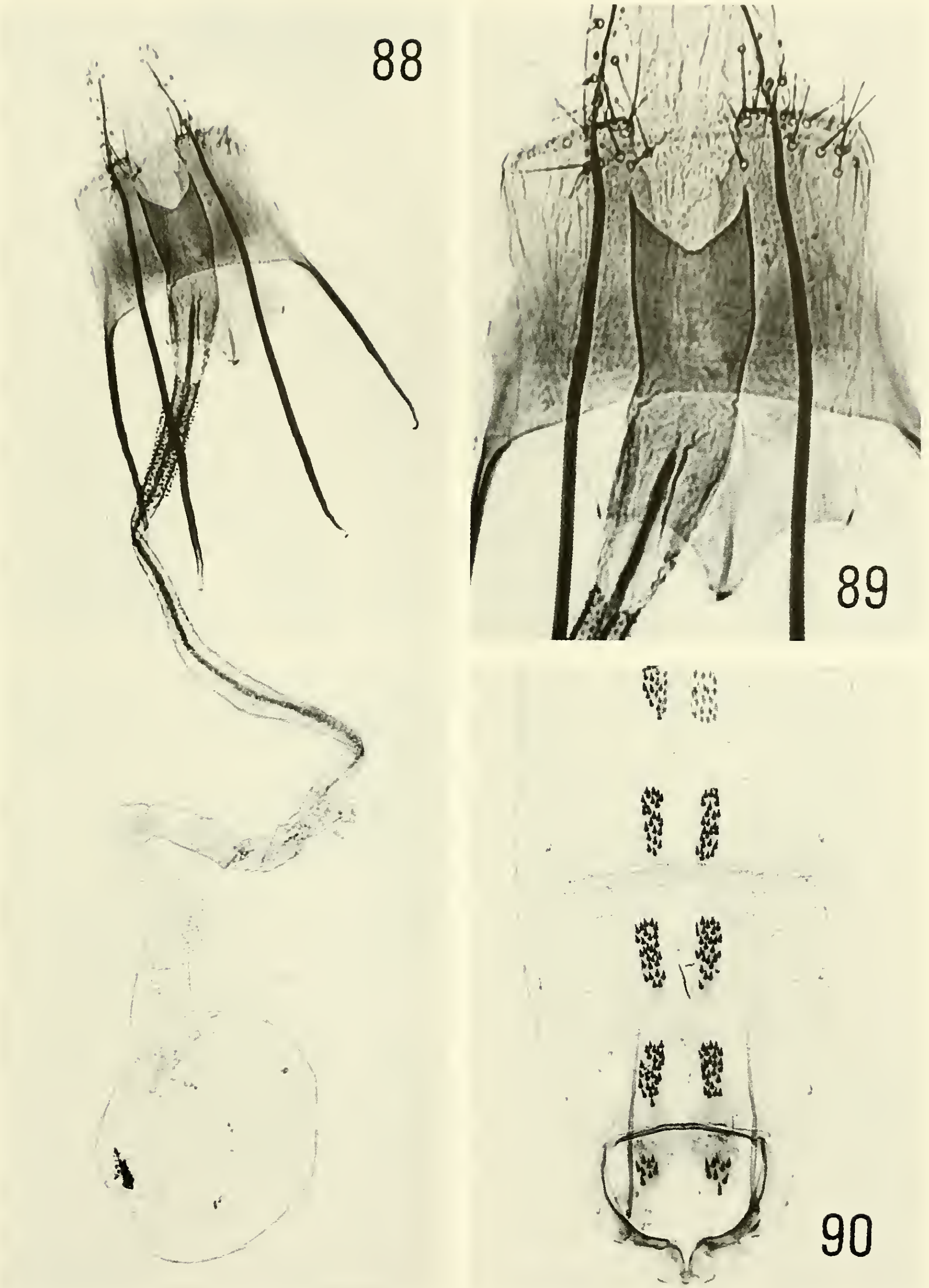
Figs. 77-79. *C. seminalis* Meyrick, slide ANIC 2332, 77, female genitalia, 78, sterigma at high magnification, 79, abdomen.



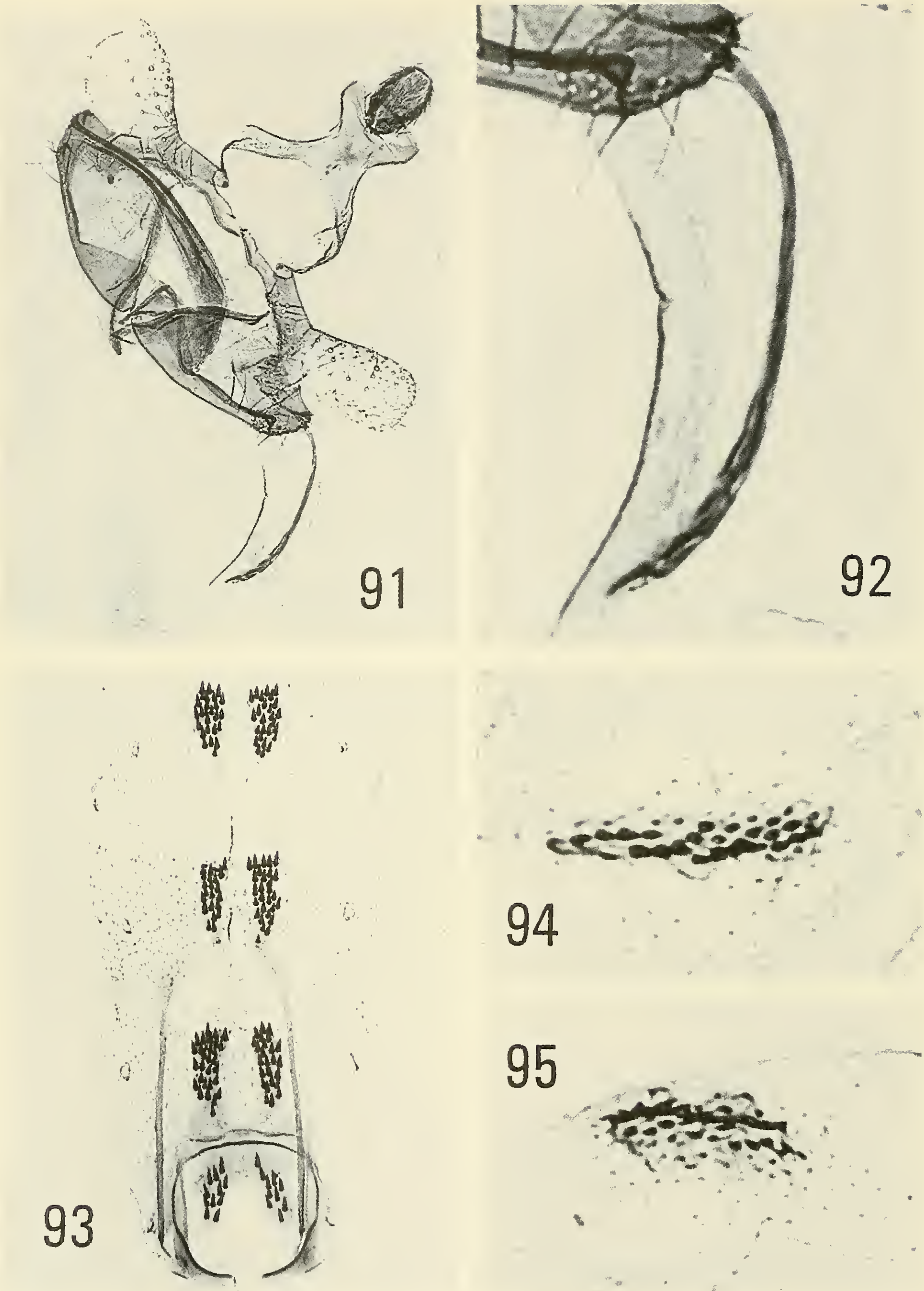
Figs. 80-83. *C. leucocephala* sp. n., slide ANIC 2346, 80, male genitalia, 81, detail of genitalia at high magnification, 82, cornuti at high magnification, 83, abdomen.



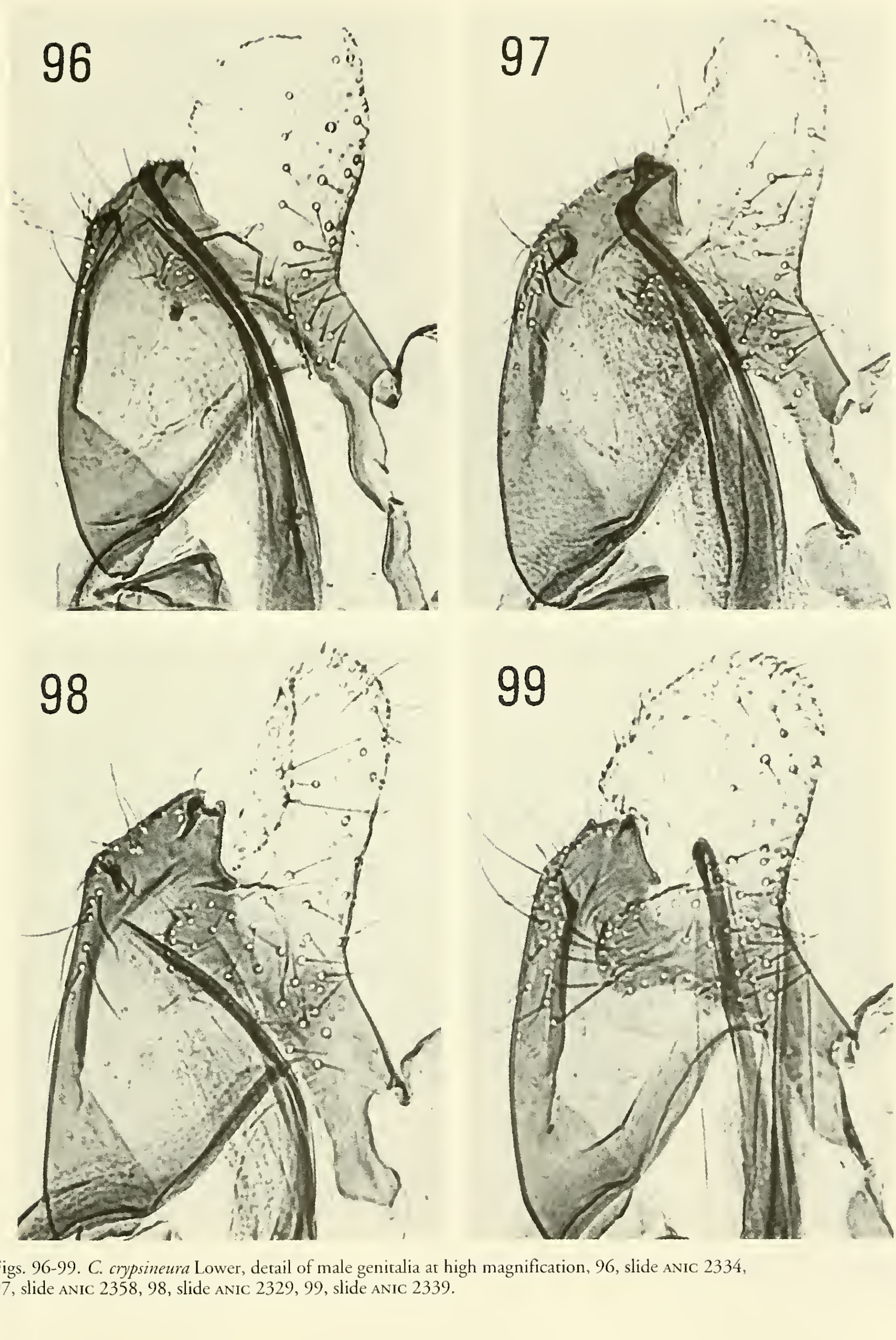
Figs. 84-87. *C. leucocephala* sp. n., detail of male genitalia at high magnification, 84, slide ANIC 2370, 85, slide ANIC 2349, 86, slide ANIC 2345, 87, slide ANIC 2340.



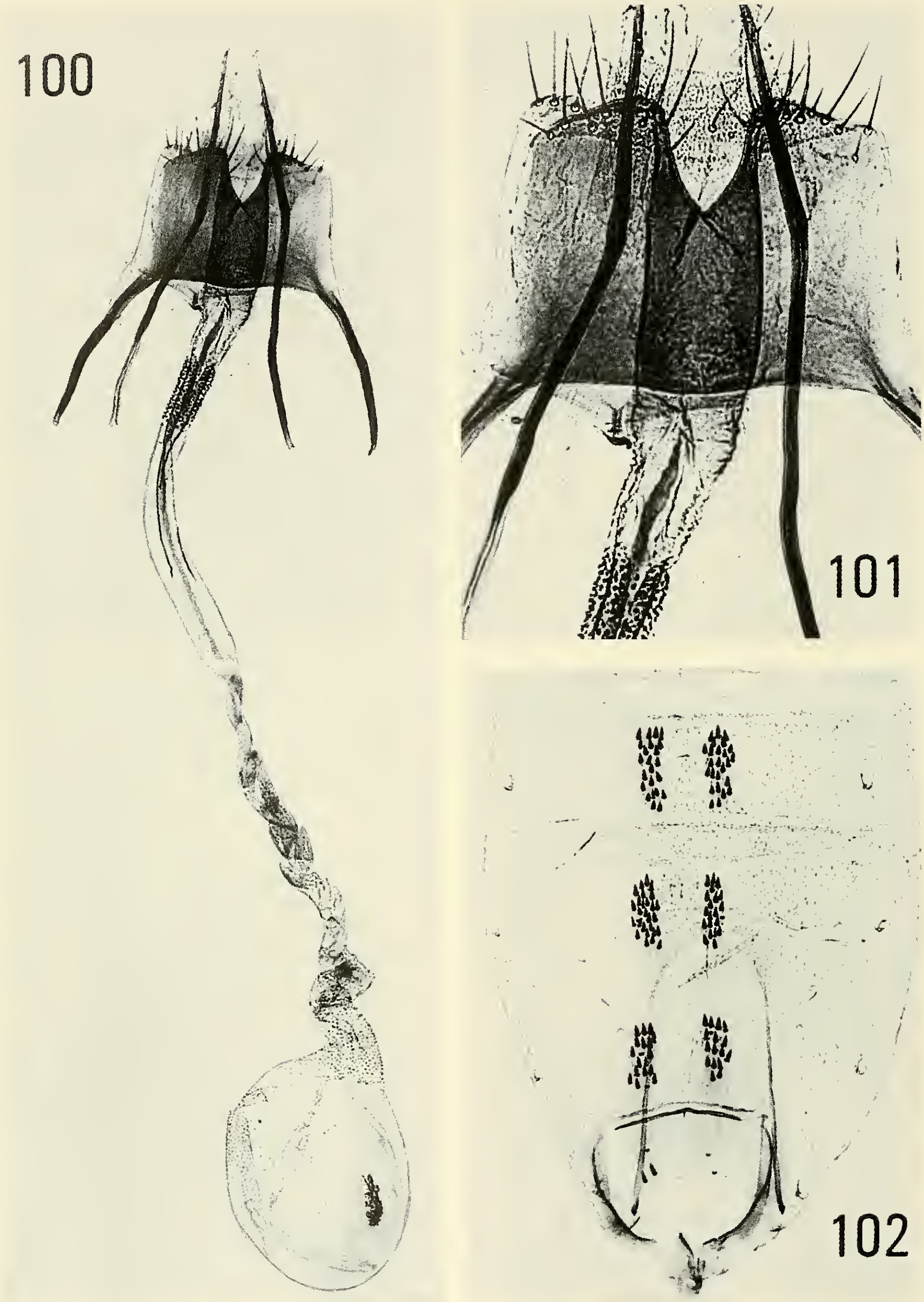
Figs. 88-90. *C. leucocephala* sp. n., slide ANIC 2350, 88, female genitalia, 89, sterigma at high magnification, 90, abdomen.



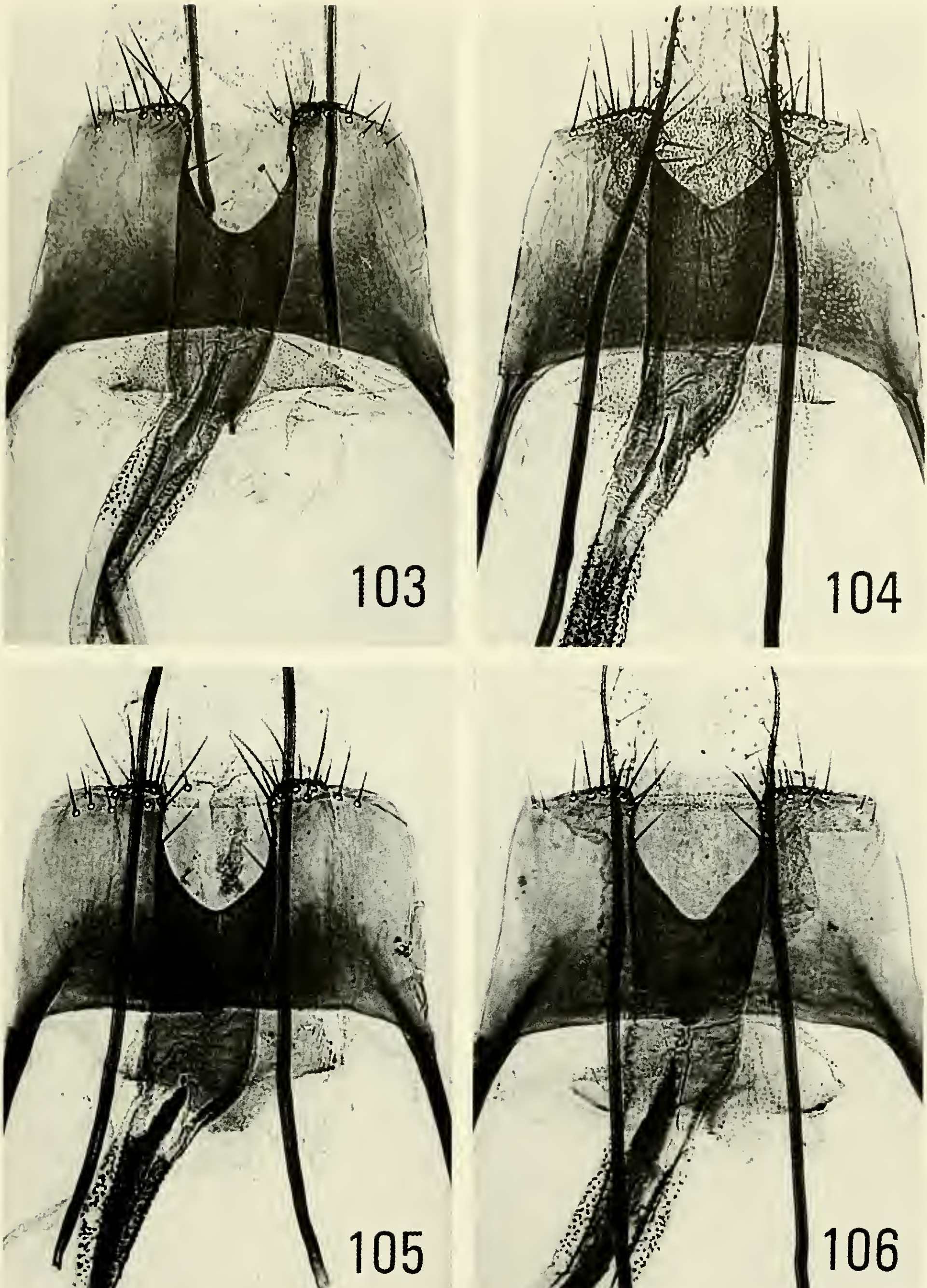
Figs. 91-93. *C. crypsineura* Lower, slide ANIC 2334, 91, male genitalia, 92, cornuti at high magnification , 93, abdomen. Figs. 94-95. *C. crypsineura* Lower, female genitalia, 94, slide Bldz 9190, lectotype, signum at high magnification, 95, slide Bldz 9192, paralectotype, signum at high magnification.



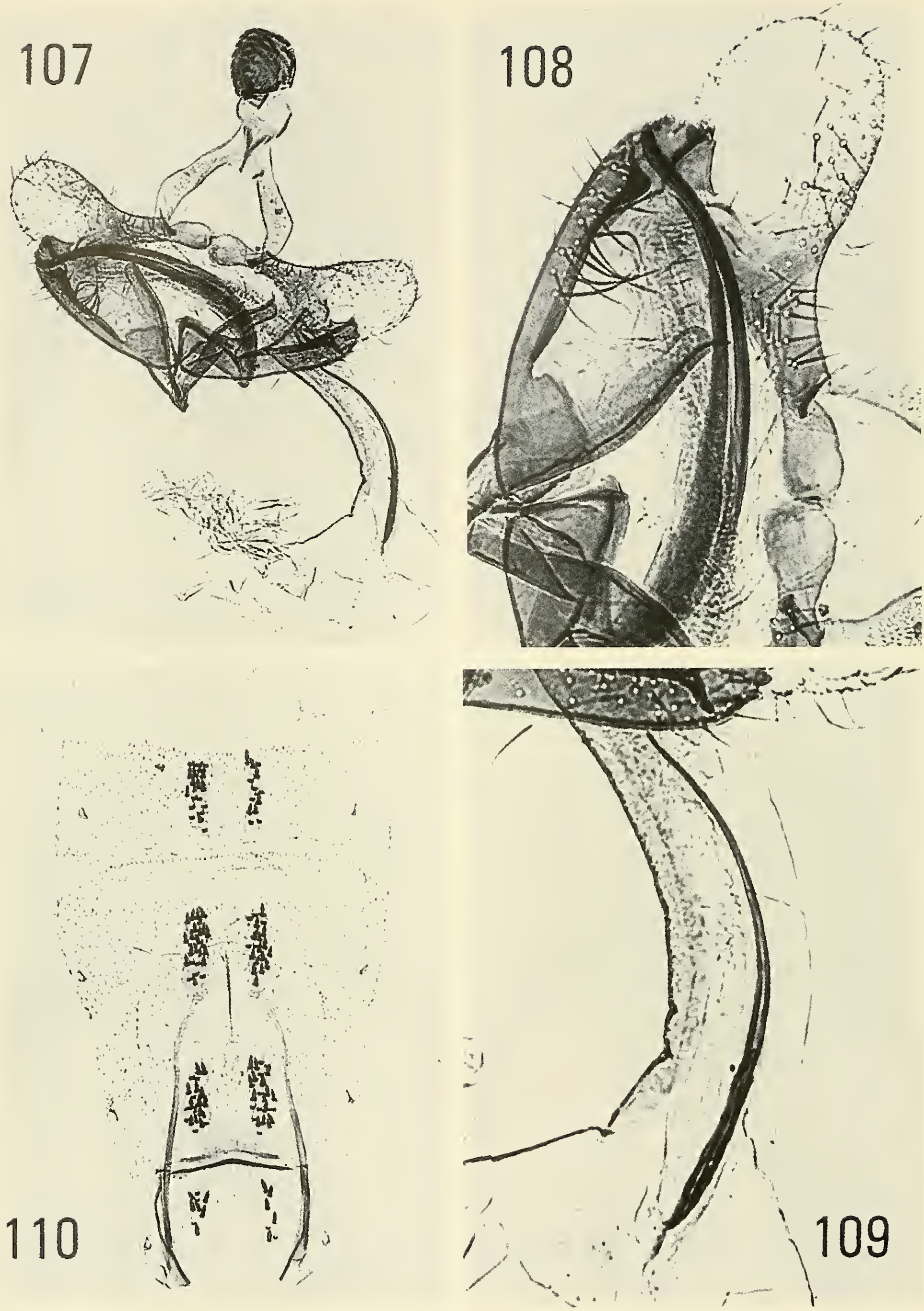
Figs. 96-99. *C. crypsineura* Lower, detail of male genitalia at high magnification, 96, slide ANIC 2334, 97, slide ANIC 2358, 98, slide ANIC 2329, 99, slide ANIC 2339.



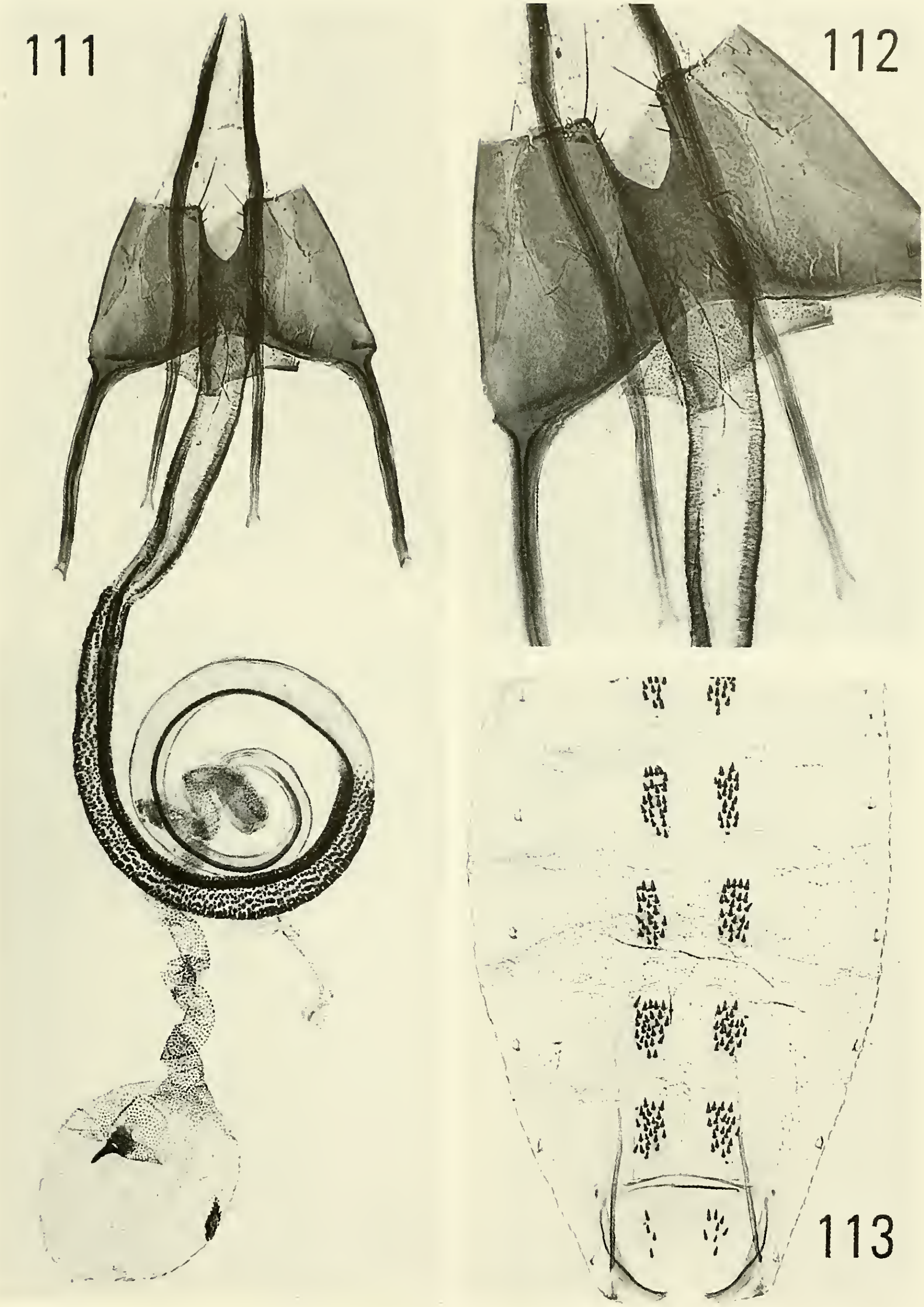
Figs. 100-102. *C. crypsineura* Lower, slide ANIC 2359, 100, female genitalia, 101, sterigma at high magnification, 102, abdomen.



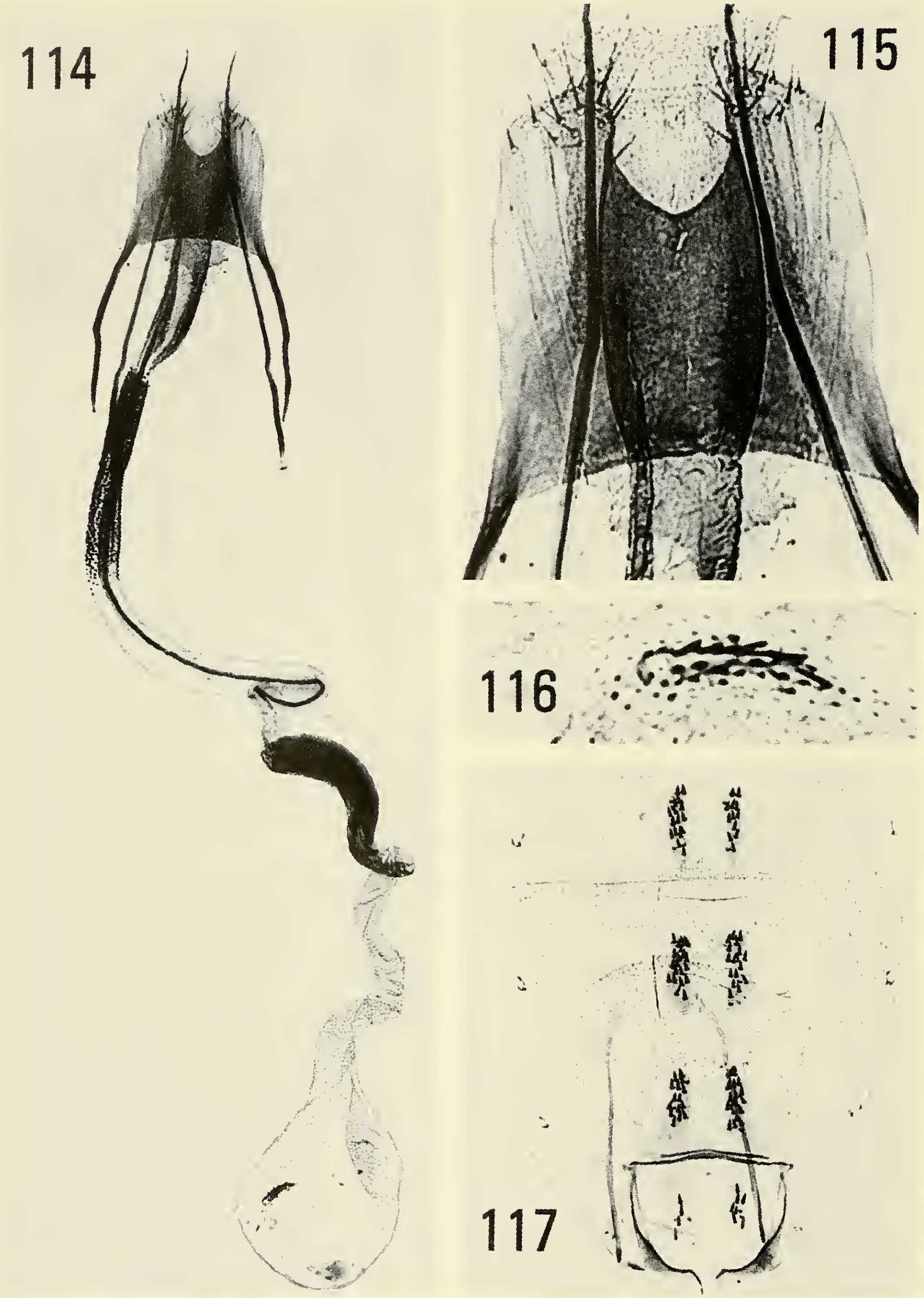
Figs. 103-106. *C. crypsineura* Lower, female genitalia, sterigma at high magnification, 103, slide Bldz 9190, 104, slide ANIC 2369, 105, slide ANIC 2315, 106, slide ANIC 2338.



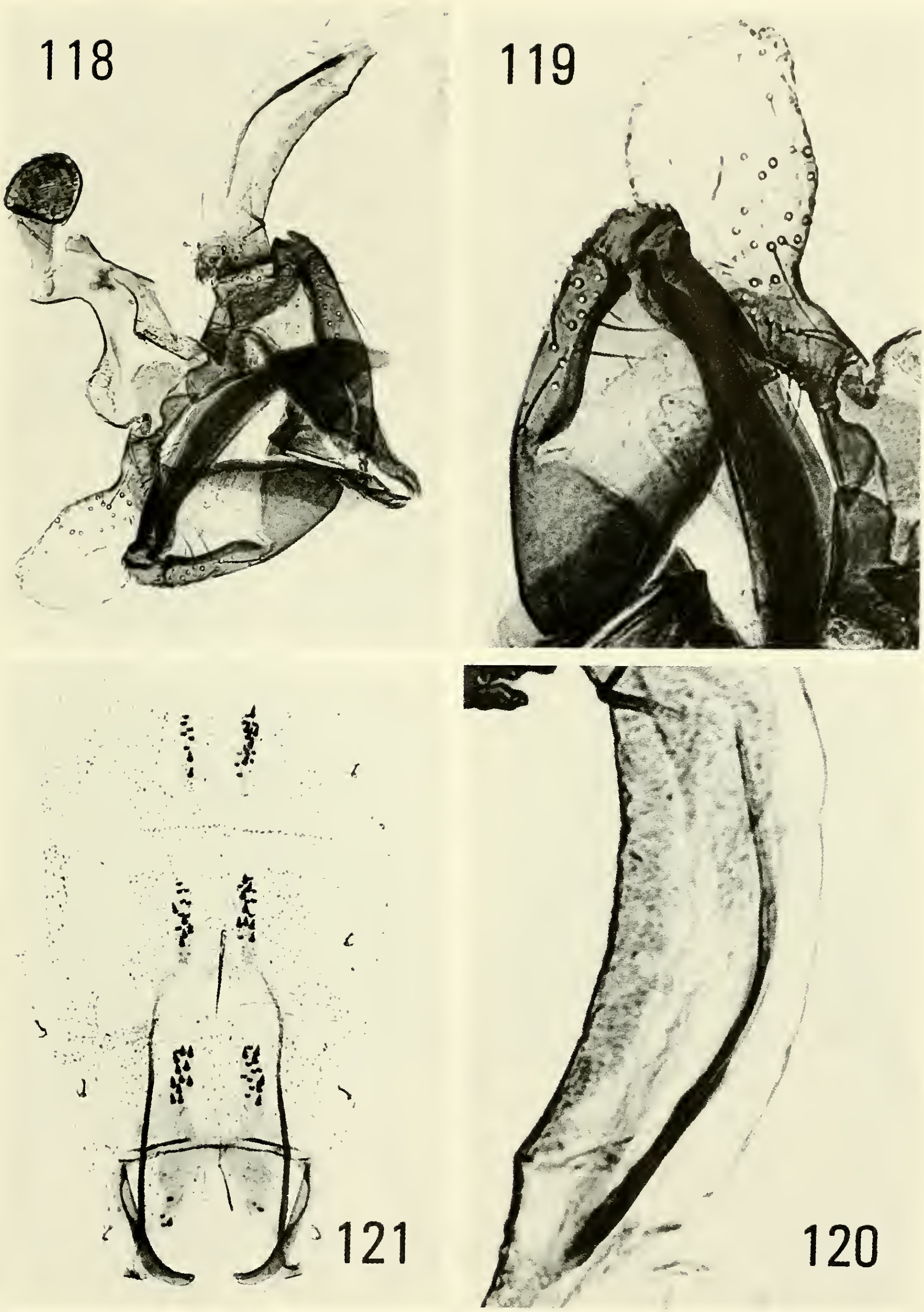
Figs. 107-110. *C. tremefacta* Meyrick ?, slide BMNH 24466 'Queensland, T.P.L./95', coll. BMNH, 107, male genitalia, 108, detail of male genitalia at high magnification, 109, cornuti at high magnification, 110, abdomen.



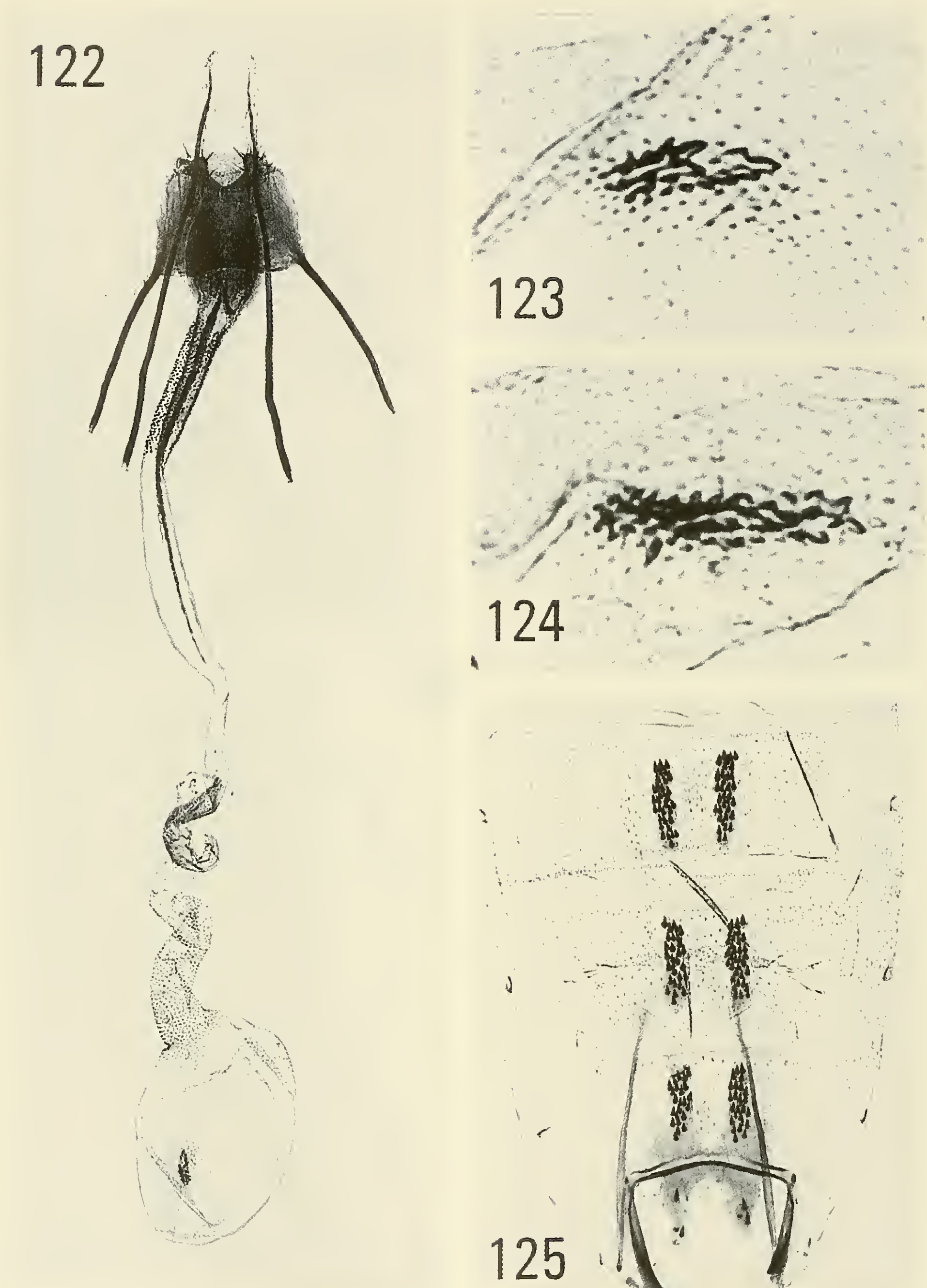
Figs. 111-113. *C. tremefacta* Meyrick, slide BMNH 24462, 111, female genitalia, 112, sterigma at high magnification, 113, abdomen.



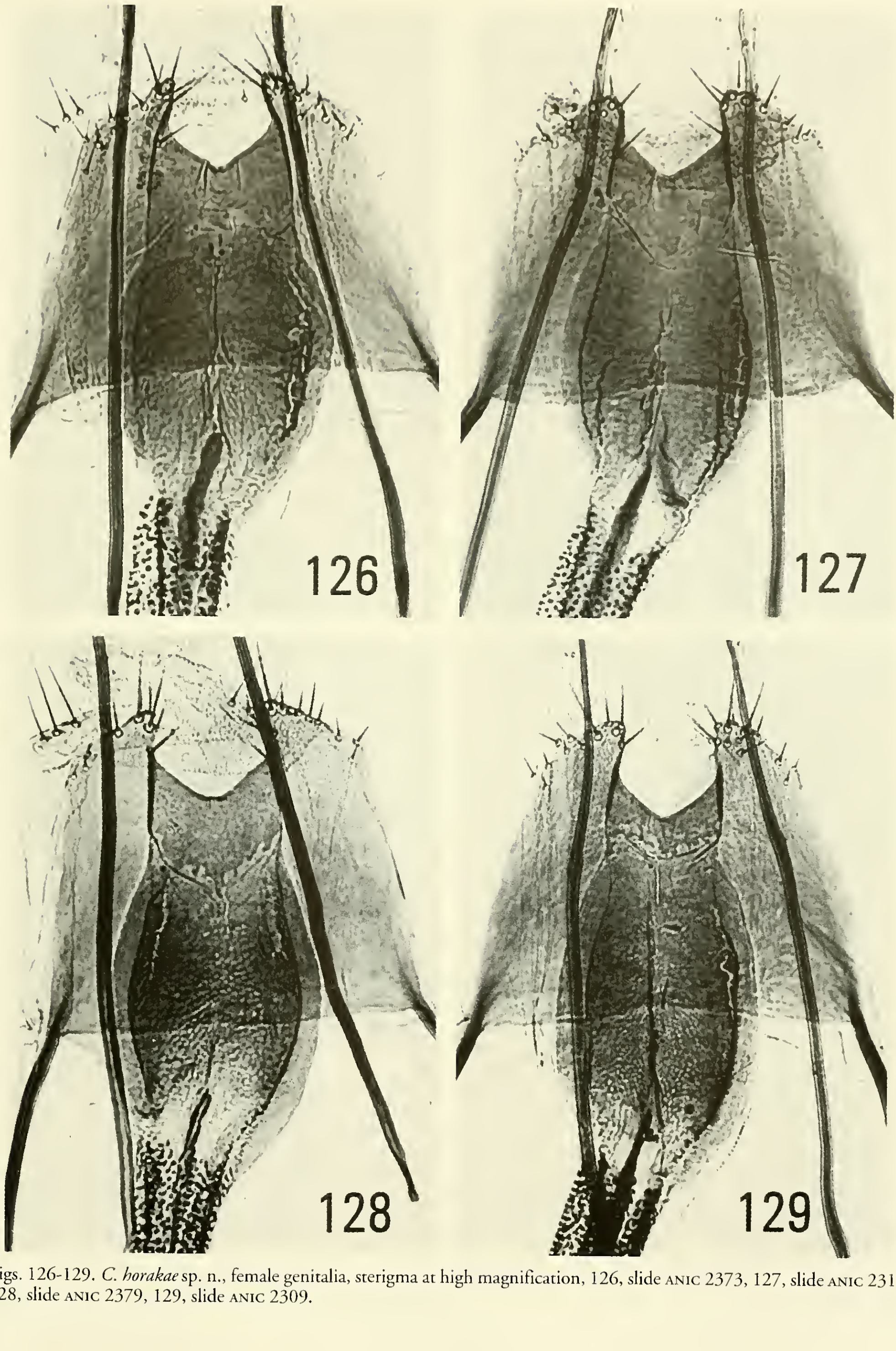
Figs. 114-117. *C. nielseni* sp. n., slide ANIC 2372, holotype, 114, female genitalia, 115, sterigma at high magnification, 116, signum at high magnification, 117, abdomen.



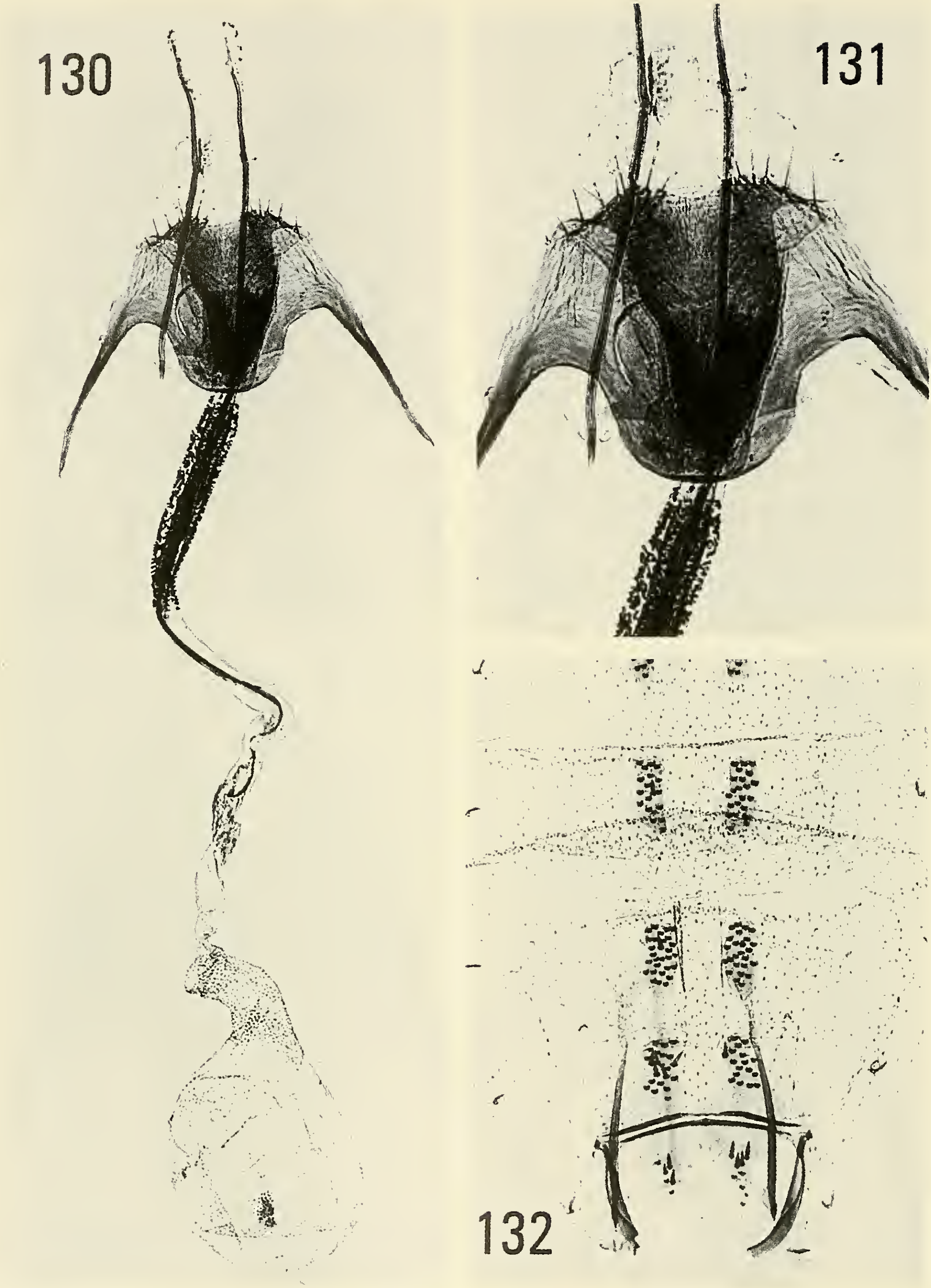
Figs. 118-121. *C. horakae* sp. n., slide ANIC 2314, holotype, 118, male genitalia, 119, detail of male genitalia at high magnification, 120, detail of cornuti at high magnification, 121, abdomen.



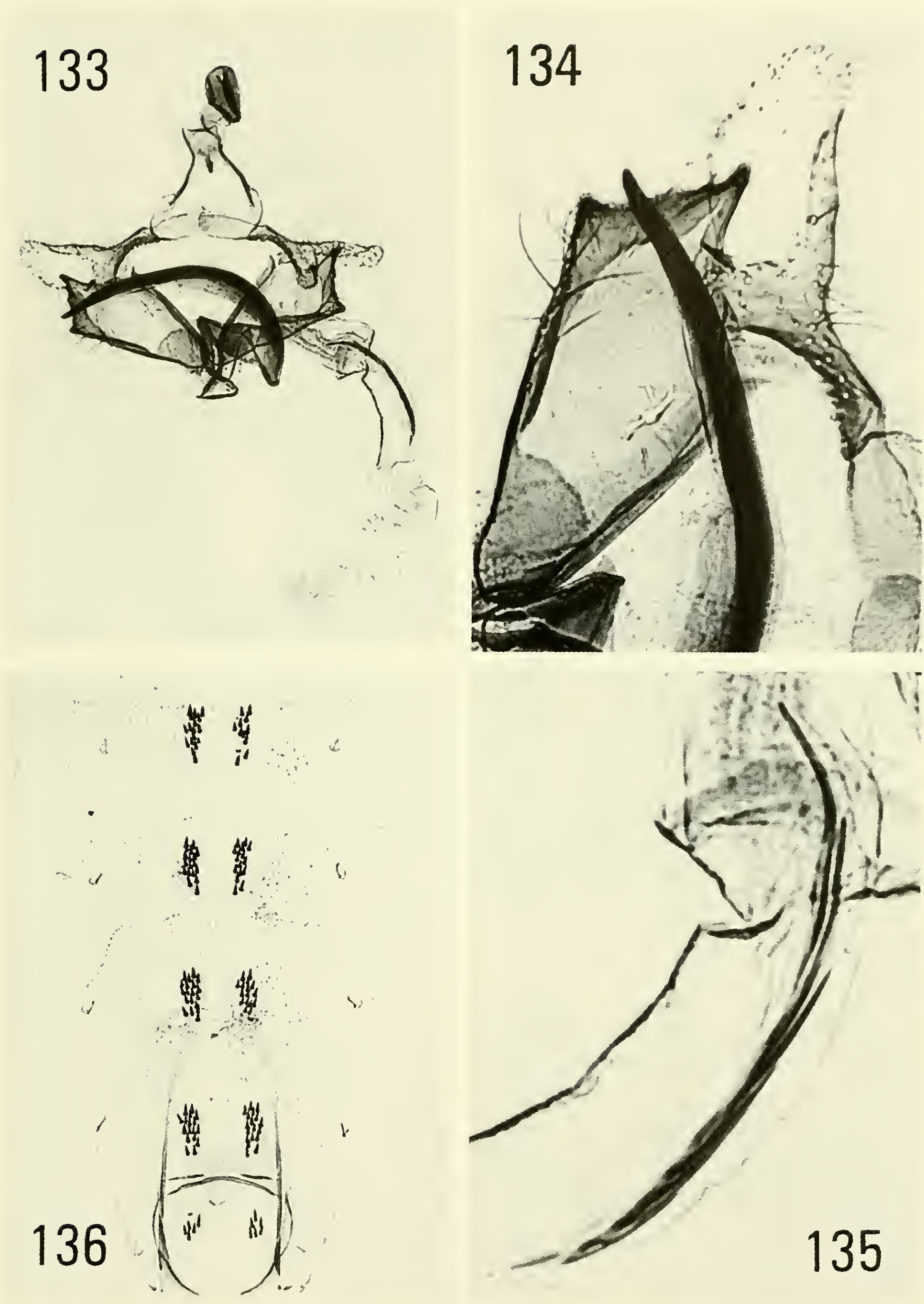
Figs. 122-125. *C. horakae* sp. n., slide ANIC 2319, 122, female genitalia, 123, signum at high magnification, 124, signum at high magnification, slide ANIC 2309, 125, abdomen.



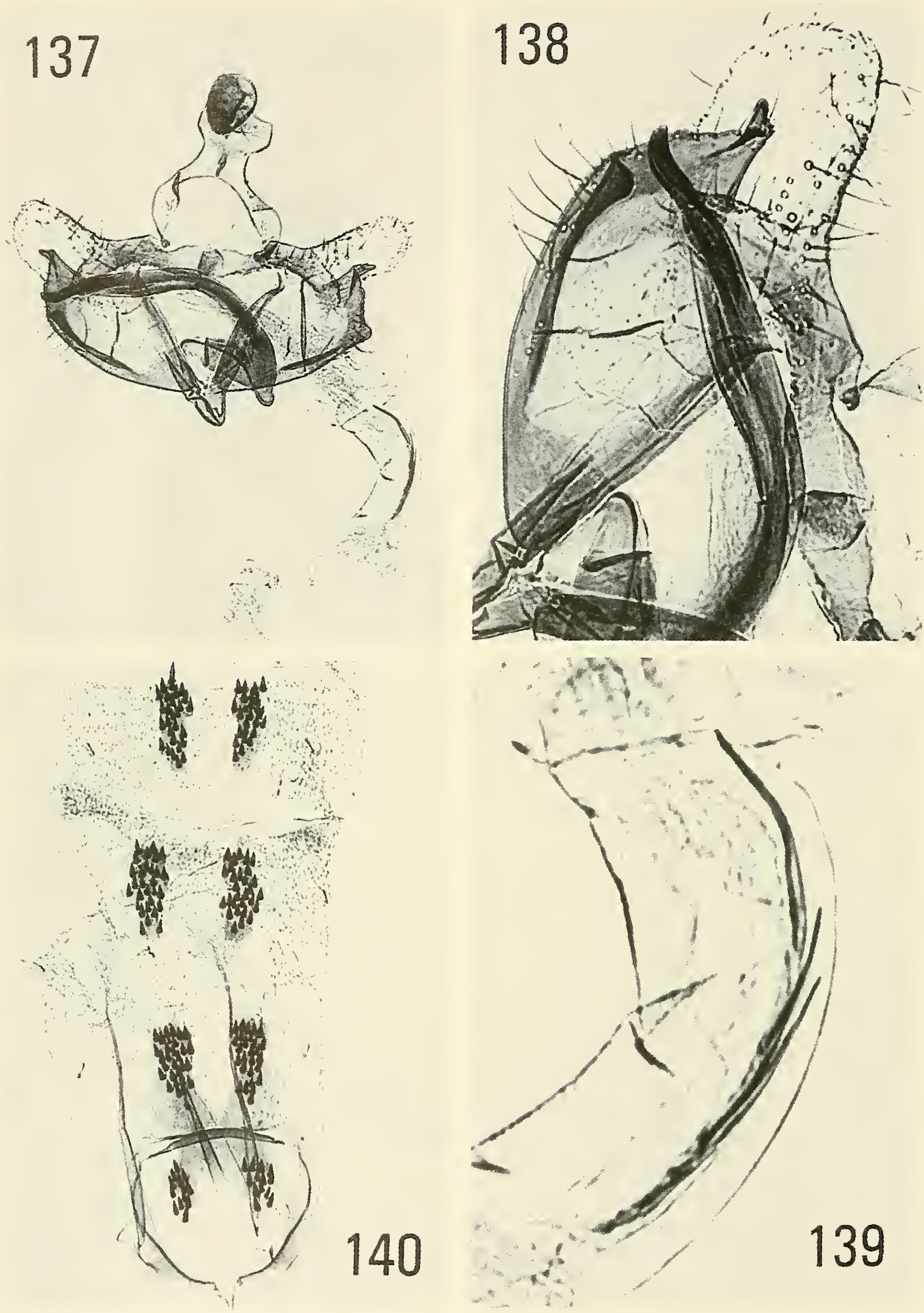
Figs. 126-129. *C. horakae* sp. n., female genitalia, sterigma at high magnification, 126, slide ANIC 2373, 127, slide ANIC 2319, 128, slide ANIC 2379, 129, slide ANIC 2309.



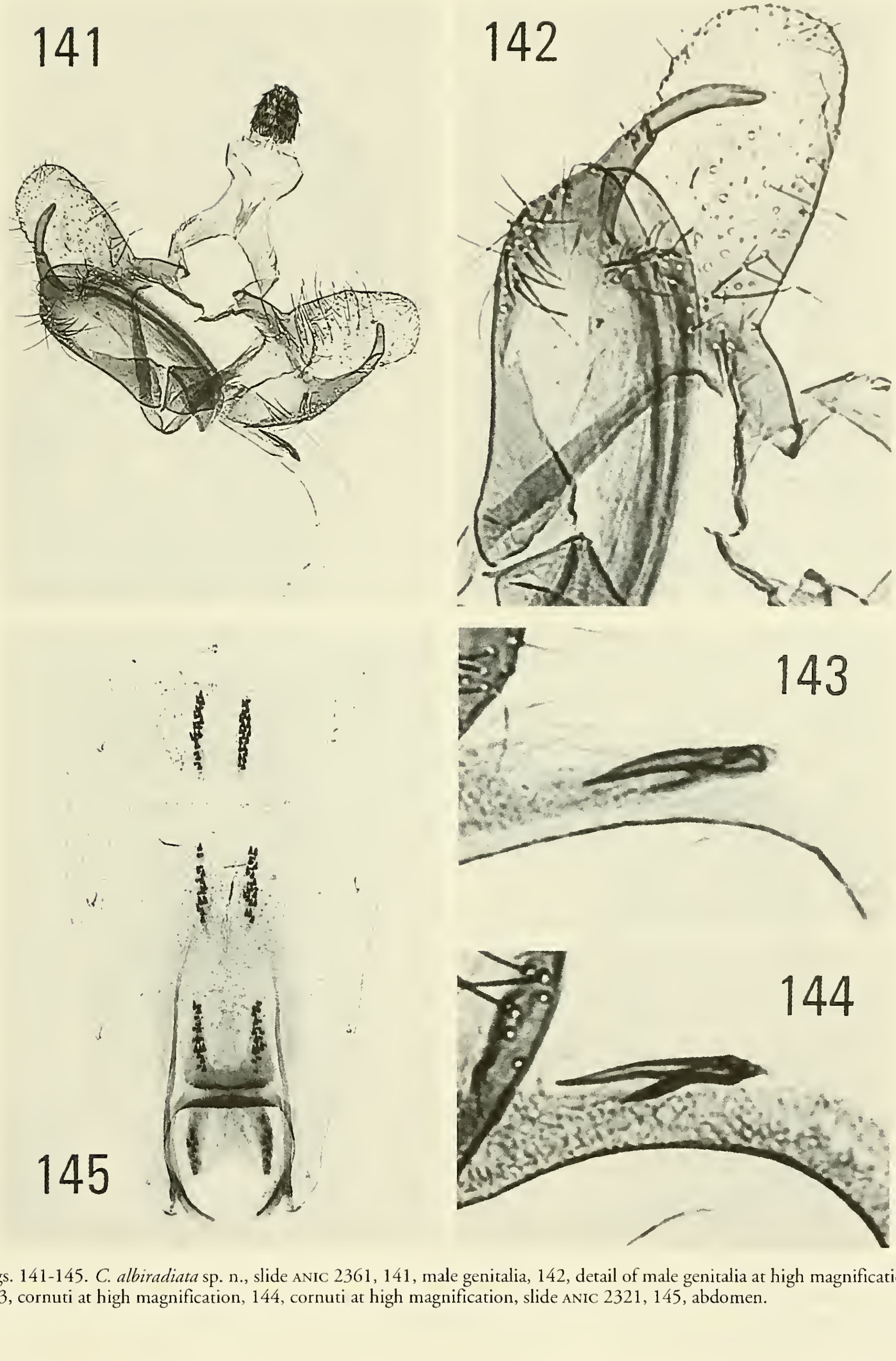
Figs. 130-132. *C. fuscosquamata* sp. n., slide ANIC 2356, holotype, 130, female genitalia, 131, sterigma at high magnification, 132, abdomen.



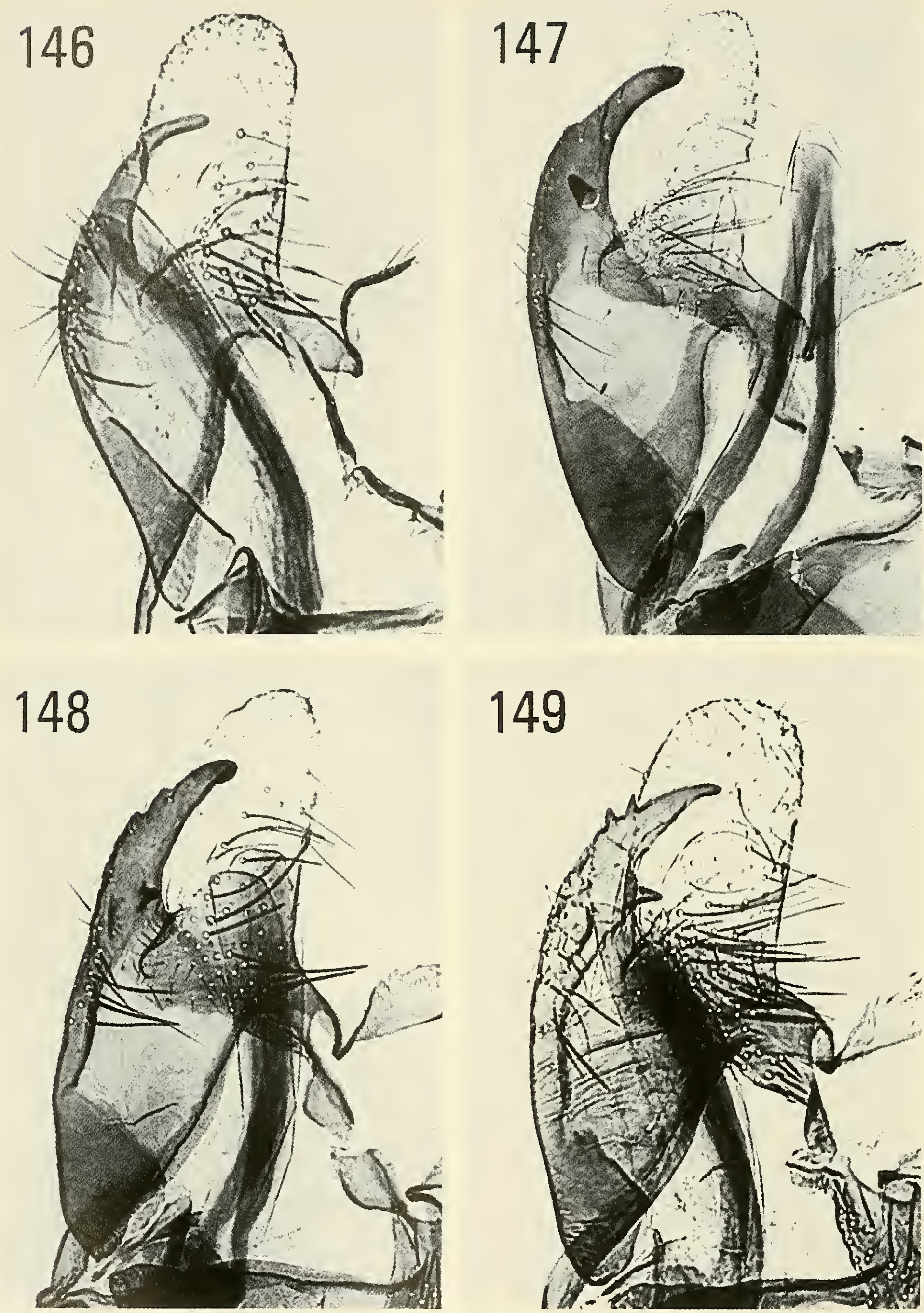
Figs. 133-136. *C. frustrata* sp. n., slide ANIC 2342, holotype, 133, male genitalia, 134, detail of male genitalia at high magnification, 135, cornuti at high magnification, 136, abdomen.



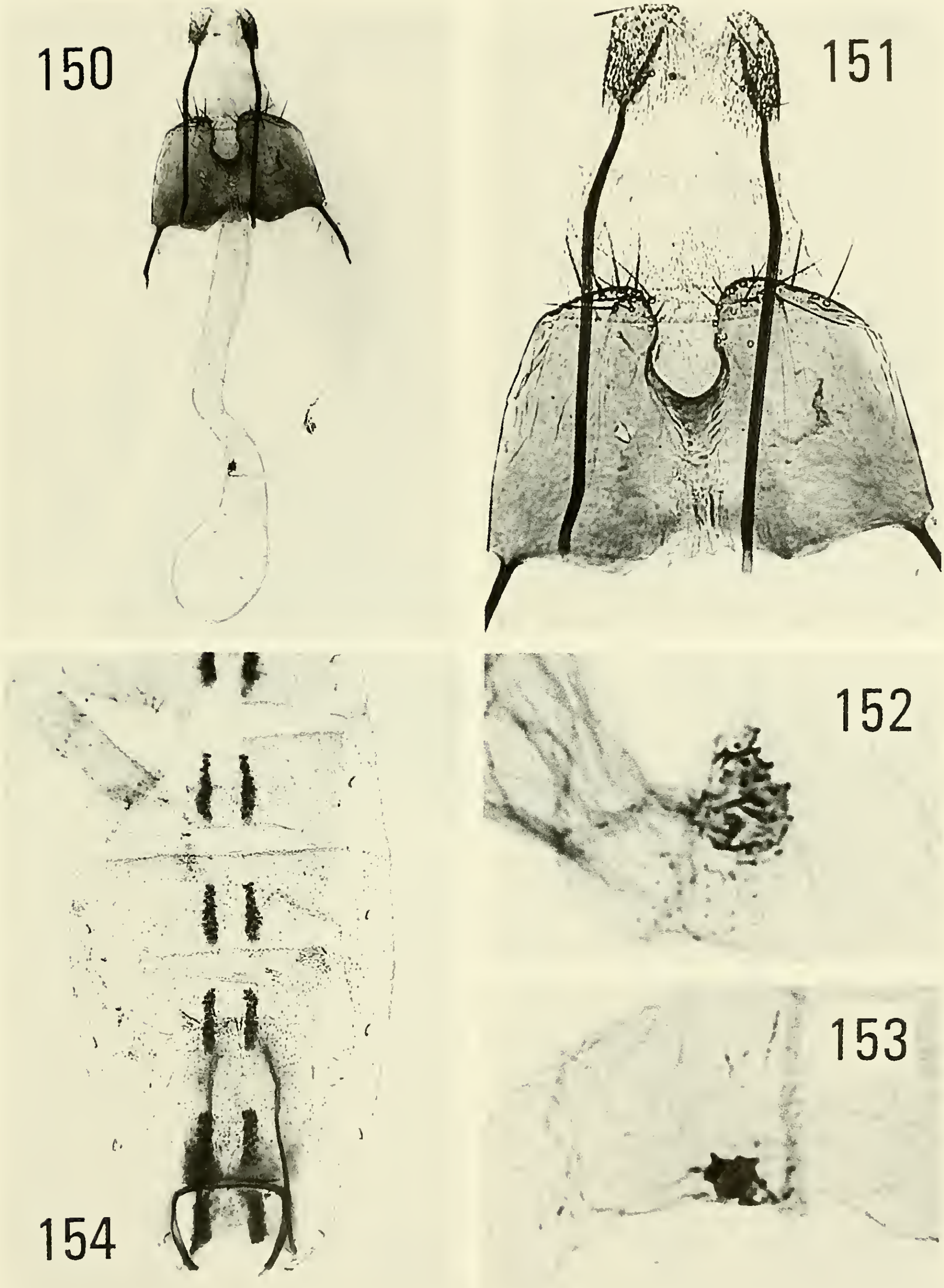
Figs. 137-140. *C. rustica* sp. n., slide 2351, holotype, 137, male genitalia, 138, detail of male genitalia at high magnification, 139, cornuti at high magnification, 140, abdomen.



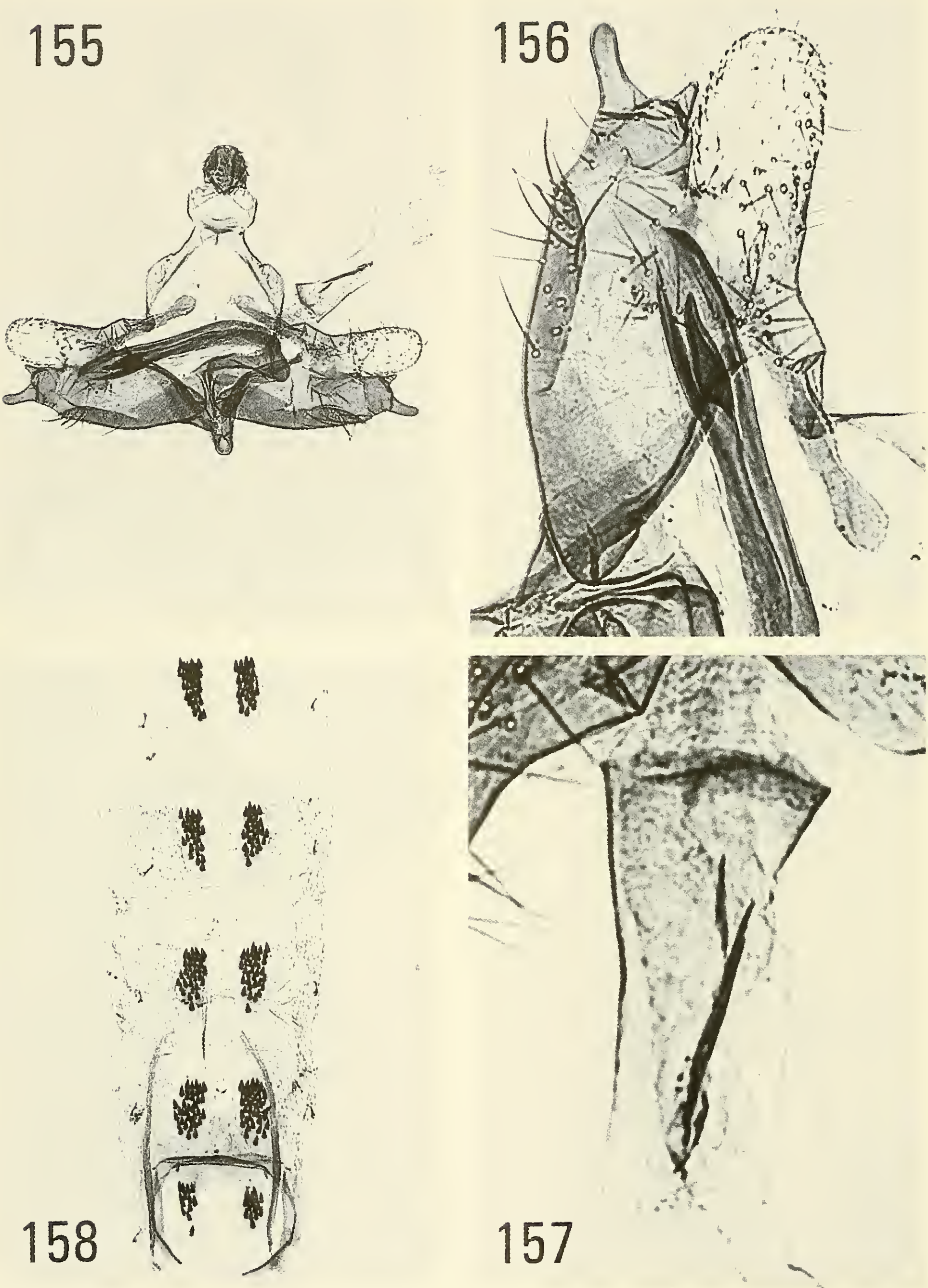
Figs. 141-145. *C. albiradiata* sp. n., slide ANIC 2361, 141, male genitalia, 142, detail of male genitalia at high magnification, 143, cornuti at high magnification, 144, cornuti at high magnification, slide ANIC 2321, 145, abdomen.



Figs. 146-149. *Coleophora* spp., detail of male genitalia at high magnification, 146, *C. albiradiata* sp. n., slide ANIC 2337, 147, *C. yomogiella* Oku, slide Bldz 6923, paratype 'Japan, Morioka, Iwate, Honshu, 21.VI.1973, e.l. *Artemisia princeps*, leg. Oku', coll. Baldizzone, 148, *C. kurokoi* Oku, slide Bldz 6920, paratype 'Japan, Sakai, 24. –30.V.1971, V. Arita leg.', coll. Baldizzone, 149, *C. chrysanthemi* Hofman, slide Bldz 5937 'Italia, Piemonte, Asti, Boschi di Valmanera, 15.V.1982, leg. Baldizzone', coll.Baldizzone.



Figs. 150-154. *C. albiradiata* sp. n., slide ANIC 2335, 150, female genitalia, 151, sterigma at high magnification, 152, detail of ductus bursae at high magnification, slide ANIC 2320, 153, same detail, slide ANIC 2335, 154, abdomen.



Figs. 155-158. *C. consumpta* sp. n., slide ANIC 2360, holotype, 155, male genitalia, 156, detail of male genitalia at high magnification, 157, cornuti at high magnification, 158, abdomen.

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NEW SPECIES OF *BAYADERA* SELYS AND *SCHMIDTIPHAEA* ASAHINA FROM CHINA (ODONATA, EUPHAEIDAE)

Davies, D. A. L. & B. Yang,1996. New species of *Bayadera* Selys and *Schmidtiphaea* Asahina from China (Odonata, Euphaeidae). –Tijdschrift voor Entomologie 139: 145-155, figs.1-32, tab. 1. [ISSN 0040-7496]. Published 18 December 1996.
Three new species of *Bayadera*, *B. serrata* (holotype male: Dali, Yunnan, 4 July 1991), *B. strigata* (holotype male, allotype female: Dali, Yunnan, 4 July 1991) and *B. nephelopennis* (holotype male, allotype female: Omeishan, Sichuan, 8 June 1992) are described. A new species of *Schmidtiphaea*, *S. yunnanensis* is described (holotype male, allotype female: Jiangcheng, S. Yunnan, 26 May 1993) and first description of the female of *S. schmidi* Asahina (Doi Suthep, NW Thailand, 28 June 1990) is presented. A key and a guide to the literature is provided for the 13 species and 2 subspecies now known in *Bayadera*.
Correspondence: D. A. L. Davies, 23 Cedar Court, Hills Road, Cambridge, CB2 2QJ, England.
Key words. – *Bayadera*; *Schmidtiphaea*; key; new species.

Bayadera Selys 1853, was established for *B. indica*, which was originally described by de Selys Longchamps (1853) in the same paper as *Euphaea* (*Epallage*) *indica*. This species is not uncommon in north India and Nepal and in this paper we give data for its distribution as far east as Yunnan. All other species (now 13 species and two subspecies) are in this geographic range with extension to east and south to accommodate species or subspecies in Vietnam and the SE Asia offshore islands Taiwan and the Ryukyus. These damselflies are medium sized, slim, blackish, retiring insects. The principal characters are wings petiolated only to about half way from base to arc and to the level of the first antenodal nervure; Rii in contact with R+M at its origin and for some distance; nodus slightly distal to centre of wing; only one cubital nervure in all wings; Riii not in line with subnodus; abdomen longer than wings; terminal appendages considerably longer than segment 10. The appendages are very similar in style throughout the genus and figures given by early authors are inadequate in detail. References are given here for adequate figures of all species other than those depicted in this paper.

The closely related genus *Schmidtiphaea* Asahina known only by a male from Burma and males from NW Thailand of *S. schmidi* Asahina is included here for description of its hitherto unknown female and of a new species from Yunnan.

SYSTEMATIC PART

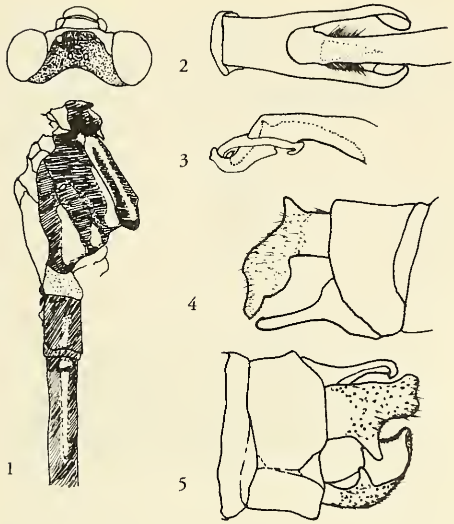
Descriptions of new species

Bayadera serrata sp. n.
(figs. 1-5).

Type material. – Holotype 1 male, Dali, Yunnan, 4 July 1991, leg. YB. (in IZAS).

Male. – Abdomen plus appendages 44.0 mm; hindwing 39.0 mm.

Head. – Labium black with the lateral lobes bluish-yellow; this bright colour on the labrum extending upward over the anterior quarter of frons and laterally along the inner margin of each eye to the level of the lateral ocelli; the frons not projecting, so that when seen from above, the surface of frons almost on the level of surface of genae, the frons sparsely beset with pale yellow hairs; vertex and occiput matt black, the latter with its ridge straight and turned forwards so that its rear can be seen in dorsal view, the rear black with a small geminate yellow spot at the center



Figs. 1-5. *Bayadera serrata* sp. n., male. 1, markings of head, thorax and basal abdominal segments; 2-3, penile organ; 4-5, anal appendages.

behind the ridge. Eyes dark brown above, lower half olivaceous.

Thorax. – Prothorax black with a tiny pale yellow spot and a moderate blue spot on each side of anterior and median lobe respectively. Thorax matt black with two bright bluish-yellow stripes, one antehumeral and another diagonally across the humeral suture, confluent below forming a U-shaped mark on each side in front; laterally a small wedge-shaped blue spot at the antero-dorsal angle of the metepisternum; interpleural suture pruinose; greater part of metepimeron bluish yellow; a large pale yellow area beneath the metathorax. Beneath prothorax, thorax and coxae pruinose, as also dorsum and wingbase of thorax. Wings entirely hyaline; pterostigma dark brown, covering 4-5 cells, Riii begins 1 to 2 cells distal to the subnodus, nodal index forewing 16 : 20 | 20 : 15, hind wing 16 : 16 | 17 : 15. Legs black, femora pruinose internally.

Abdomen. – Black, segment 1 pruinose, segment 2 only dorsally so, marked with blue as follows: segment 2 with a lateral stripe; 3-6 with a baso-lateral spot and a lateral stripe, the latter diminishing posteriorly, almost obsolete in 6; 7-8 with only the baso-lateral spot; 9-10 unmarked. Anal appendages black, the superiors curling strongly downwards, about the length of segment 9 and twice the length of segment 10; interiorly near base a robust spine directed mesad and upward, projecting about 0.5 mm; in dorsal view the area between the dorsal and latero-ventral ridge convex (save the apical expansion), studded basally with minute tubercles, apically with small teeth; the area between the dorsal and internal ridge slightly concave, smooth; in lateral view the apex expanded with the inferior margin minutely serrate and posterior margin smooth, these two margins curling inwards apically. Inferior appendages in lateral view nearly reaching to the tips of superiors, subcylindrical, tapered, the pointed apices directed slightly mesad and dorsad. Penile organ as shown in figs 2-3.

Female. – Unknown.

Differential diagnosis. – Pterothoracic pattern (fig. 1) very different from that of *B. strigata* (fig. 6) and from that of *B. nephelopennis* (fig. 12); the pattern is also different in style from that which is most characteristic of the Euphaeidae (see Discussion). The male abdominal appendages (figs. 4-5) are very different in shape from those of *B. strigata* (fig. 7-8) and those of *B. nephelopennis* (figs. 13-15).

Etymology. – serrata, Latin serrule = a saw, adjective serrated, referring to the inferior margins of the apices of the superior anal appendages. 'The serrated *Bayadera*'.

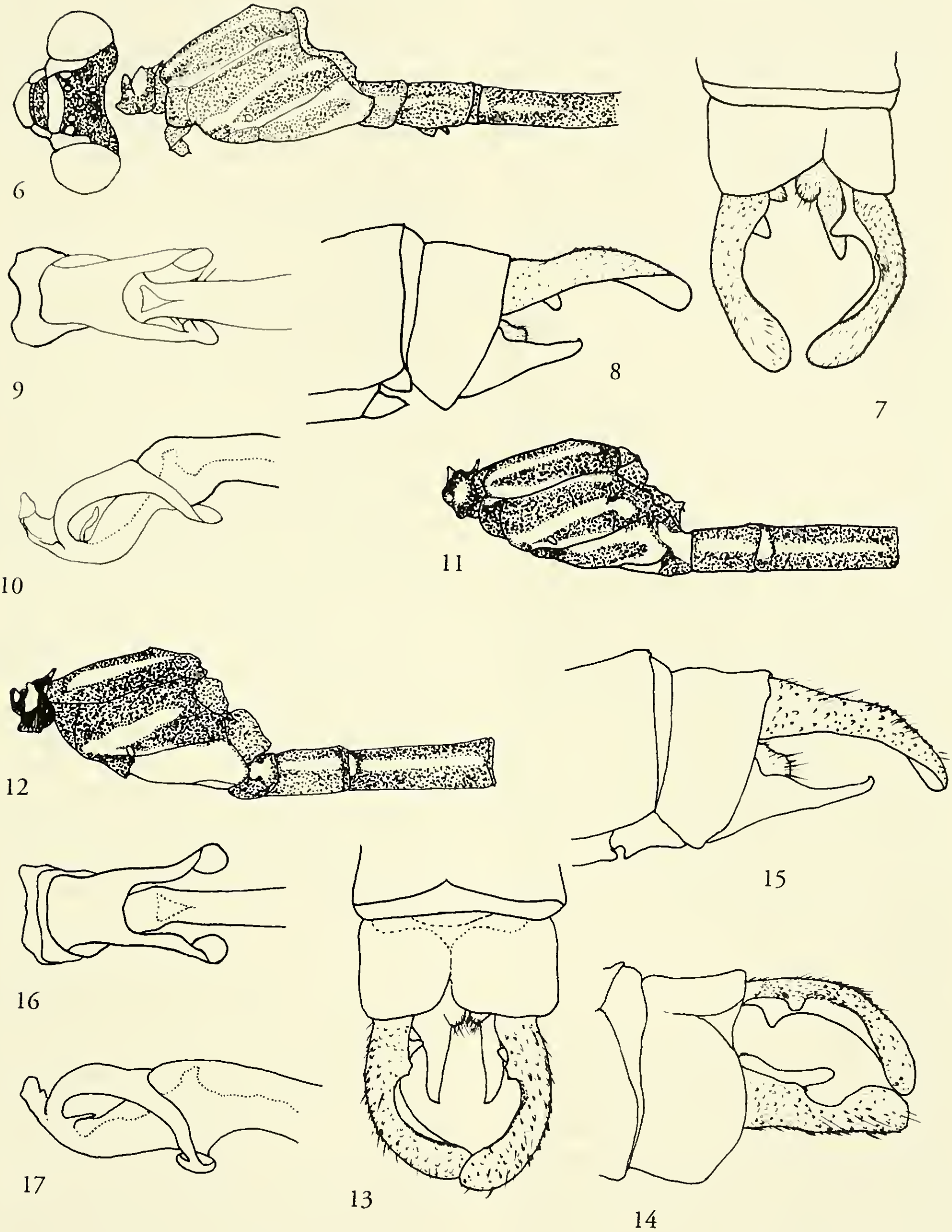
Bayadera strigata sp. n.
(figs. 6-11).

Type material. – Holotype male, 4 July 1991, DALD leg. (in IZAS); allotype female, 4 July 1991, YB leg.; paratypes, 18 males and 10 females, 4-7 July 1991, DALD & YB leg., all from Dali, Yunnan.

Male. – Abdomen plus appendages 42 mm; hw. 35 mm.

Head. – Labium black, pruinose in the middle, bright yellow on the sides with anterior tips black; labrum, bases of mandibles and genae pale blue, this colour expanding upward along the inner margins of the eyes to about the level of the lateral ocelli; anteclypeus black, postclypeus black with a blue spot in the middle; frons black, slightly protruding and beset with a tuft of black hairs on each side; vertex black with a small blue spot on each side against the base of antenna which is black; occiput entirely black. Eyes dark brown above, lower half olivaceous.

Thorax. – Prothorax black, marked with brownish-yellow as follows: a twin spot in the mid-dorsum and a small ventro-lateral spot on each side of the anterior lobe; a large lateral spot beset with silvery hairs on each side of the middle lobe and a tiny spot on each side and one in the centre of the posterior lobe. Pterothorax black, marked with pale yellow as follows: – a fine antehumeral stripe curving out above and below; a similar but broad stripe diagonally across the humeral (mesopleural) suture curving for-



Figs. 6-11. *Bayadera strigata* sp. n. – male: 6, markings of head, thorax and basal abdominal segments; 7-8, anal appendages; 9-10, penile organ; female: 11, markings of head, thorax and basal segments of abdomen.
Figs. 12-17. *Bayadera nephelopennis* sp. n. – female: 12, markings of head, thorax and basal abdominal segments; male: 13-15, anal appendages; 16-17, penile organ.

ward below and nearly in touch with the antehumeral stripe; laterally three broad stripes, one on each suture (interpleural and metapleural), the third over the greater part of the metepimeron, the first and second confluent below, the latter and the third confluent above; a large area beneath the metathorax. Beneath, prothorax, thorax, coxae, basal segments of abdomen and dorsum of thorax including wingbase, pruinose. Legs black, femora pruinose interiorly, the anterior femora with a baso-inner pale yellow band, this band longer posteriorly, almost the whole length of the posterior femora. Wings hyaline, a faint tinge of reddish-brown at base and extending as far as the distal end of the quadrilateral and along the costal area to the nodus; Riii slightly proximal to the subnodus; pterostigma black, covering 5-7 cells; nodal index forewing 16 : 20 | 20 : 15, hind wing 16 : 16 | 17 : 15.

Abdomen black, segment 1 with large lateral spot on each side; segments 2-3 with a lateral streak; segments 3-7 with a small blue baso-lateral spot on each side; segments 3-4 with a weakly metallic reflection on dorsum; segments 2-10 with obscure mid-dorsal line, obvious at each end on segments 2-6 and clear to see on segments 7-8. Appendages black, the superiors forcipate, about the length of segment 9, twice the length of segment 10, interiorly a robust spine near base and directed mesad and ventrad beyond the internal margin, the anterior margin continuing from the spine as an internal concave ridge running into the dorsal ridge at its apex. Posterior and exterior to the spine, a vertical tubercle continuing as a ridge which ends as a minutely serrated anterior margin of the apex; the apex slightly dilated, flattened and somewhat hollowed out beneath. Inferiors from lateral view not reaching half the length of the superiors, subcylindrical, tapered, the pointed apices directed slightly mesad and dorsad. Penile organ as shown in figs. 9-10.

Female. – Abdomen plus appendages 38.4 mm; hindwing 37.6 mm.

Head almost the same as that of the male but brownish yellow. These coloured markings on the prothorax and thorax a little more developed than in the male, with antehumeral and humeral stripes confluent below. Wings as in the male. The same colour makes a fine mid-dorsal line on the abdomen from segments 3-8, more substantial than in the male, with a larger lateral spot on segment 1, lateral stripe on 2, a basal spot and lateral stripe on 3-6, only basal spot on 7, a large latero-apical oval spot on segment 9, 10 unmarked. Anal appendages conical, acutely pointed, slightly longer than segment 10.

Differential diagnosis. – Pterothorax with 5 stripes in the pattern of the style of *Bayadera* (and many Euphaeidae) forming ellipses (fig. 6); especially different from the patterns of *B. serrata* (fig. 1) and of *B. nephelopennis* (fig 12). Anal appendages distinctive (figs. 7-8, 4-5 and 13-15).

Etymology. – Latin, strigus = a furrow or stripe, hence strigata, = striped; adjective describing the striped pattern of the pterothorax as seen laterally (fig, 6); especially different from that of *B. serrata* (fig. 1) and *B. nephelopennis* (fig. 12). Anal appendages distinctive (figs. 7-8); 'The striped *Bayadera*'.

Bayadera nephelopennis sp. n.
(figs. 12-17).

Type material. – Holotype male, allotype female, 8 June 1992, in IZAS; paratypes 1 male and 2 females, 8 June 1993, 4 males and 3 females, 8 June 1992, YB leg., all taken at Omeishan, Sichuan.

Male. – Abdomen plus appendages 43.2 mm; hindwing 36.0 mm.

Head. – Labium black; labrum, bases of mandibles and genae pale blue, and the colour extending upward along the inner margin of the eyes to the top of the head; the rest of the head matt black; frons slightly projecting and beset with a tuft of black hairs on each side; eyes dark brown.

Thorax. – Prothorax entirely black, the pleuron and the greater part of the median lobe laterally pruinose. Pterothorax black, interpleural and metapleural suture pruinose, greater part of metepimeron obscurely brownish yellow. Beneath, prothorax, pterothorax and coxae, as also dorsum and wingbase of pterothorax pruinose. Legs black, femora pruinose internally. Wings with about distal one third hyaline, basal two thirds cloudy light brown; stigma dark, covering 6-7 cells; Riii slightly proximal to subnodus; nodal index forewing 17 : 19 | 20 : 17, hindwing 17 : 19 | 16 : 18.

Abdomen entirely black; segment 1 pruinose, 2 dorsally so and beset with silvery hairs laterally at basal two-thirds; segment 3 with basal two-thirds and 4 with only one-third metallic reflections dorsally. Anal appendages black, the superiors forcipate, about the length of segment 9 and twice the length of segment 10, interiorly near base a robust spine directed mesad and ventrad; beyond the internal margin, the anterior margin continuing from the spine as an internal concave ridge running into the dorsal ridge before the apex; slightly posterior and exterior to the spine is a dorso-mesal tubercle, with its apex flattened and somewhat hollowed out beneath but not dilated. Inferior appendage small, in lateral views reaching over half the length of the superiors, subcylindrical, tapered, the pointed apices directed slightly mesad and dorsad. Penile organ as shown in Figs. 16-17.

Female. – Abdomen plus appendages 37.8 mm; hindwing 38.0 mm.

Head. – Almost the same as that of the male but the colour is brownish-yellow.

Thorax. – Prothorax black, marked with pale yellow as follows: a tiny spot on each side of and one on the centre of the posterior lobe; a large lateral spot beset with silvery hairs on each side of the median lobe; a spot on each side of the anterior lobe. Pterothorax black, marked with pale yellow as follows: a fine antehumeral streak gradually widening below and tapered above, anterior border of this streak curving outwards; laterally one stripe on the interpleural suture, tapered above and confluent below with the area covering the lower part of the metapleural suture and metepimeron; a broad bar beneath the thorax of which the hinder area is broadly black. Beneath, prothorax, thorax, coxae and basal segments of abdomen pruinose. Legs black, femora pruinose internally. Wings similarly patterned to that of the male.

Abdomen. – Black, marked with pale yellow as follows: – a large lateral spot and dorsal spot on segment 1; a fine mid-dorsal line on 3-8 but that on 8 obscure, a lateral streak on segment 2; a baso-lateral spot and lateral stripe on 3-6, the lateral stripe on 6 obscure, 7 with baso-lateral spot only; a large mid-lateral spot on each side of segment 9, segment 10 unmarked. Anal appendages black, conical, acutely pointed, twice the length of segment 10.

Differential diagnosis. – Unique in *Bayadera* in having most of the wing opaque, light brown in males, slightly darker in females, but the wing-tip area hyaline in both sexes. An unusual and characteristic pterothoracic pattern with no humeral stripe but metepimeron wholly yellow (fig. 12). Anal appendages distinct and characteristic (figs. 13-15).

Etymology. – Greek, nephelos = a cloud; Latin, penne = a wing; adjectival description of the most obvious features, 'the cloudy-winged *Bayadera*'.

Schmidtiphaea yunnanensis sp. n.
(figs. 18-23)

Type material. – Holotype 1 male, allotype 1 female, 26 May 1993; paratypes, 1 male and 3 females, 26 May 1993, all from Jiangcheng Co., Yunnan, YB leg. (in IZAS).

Male. – Abdomen plus appendages 47 mm; hindwing 33 mm; body very slender and fragile when compared with its relatively robust congener *S. schmidi* Asahina and coloured brownish-black.

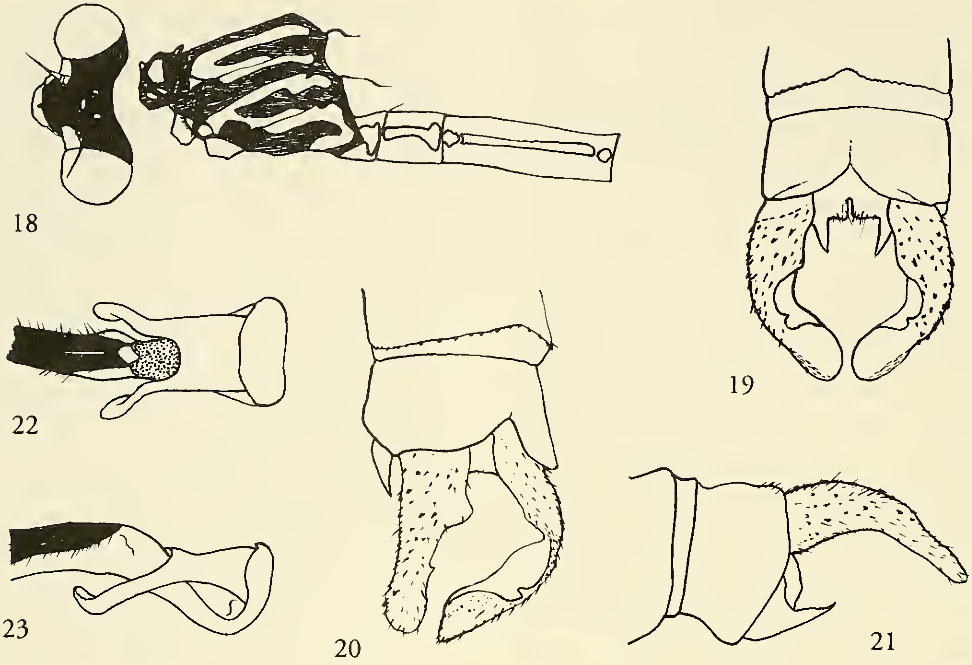
Head. – Relatively large and wide; labium pale yellow with the median lobe and tips of lateral lobes dark brown; mandibles dark brown (probably bluish-brown when teneral); anteclypeus dark brown, postclypeus protruding and finely, transversely wrinkled, brownish-black; frons shining with blue lustre; vertex matt black but shiny over area alongside the eyes.

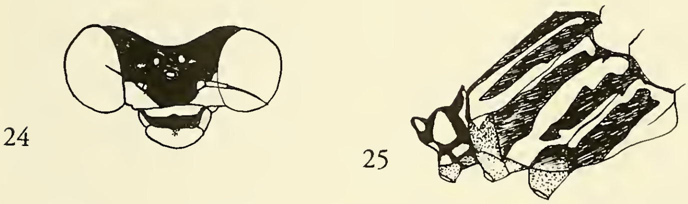
Thorax. – Prothorax brownish-black, the anterior lobe with a small bluish-yellow spot on each side, middle lobe with a large wedge-shaped bluish-yellow spot on each side. Pterothorax brownish-black, striped as shown in fig. 18 and pale coloured as follows: two olivaceous stripes, one antehumeral diverging above and the other diagonally across the humeral suture, confluent below; three moderately broad lateral stripes, one on each suture (interpleural and metapleural), the third over the metepimeron, the first and second confluent below, the second and third confluent above, a large pale yellow area beneath the metathorax. Legs rather short, brownish-black, coxae pale coloured and slightly pruinose, the anterior aspect of the trochanters also pale. Wings very narrow, maximum width of hindwing 5.8 mm, hyaline but slightly enfumed, veins black, pterostigma reddish-brown, covering 4-5 cells in the forewing, 3-4 in the hindwing; nodal index forewing 20 : 17 | 17 : 19, hindwing 20 : 16 | 15 : 17. Riii arising 2 cells distal to subnodus in all wings; IA running parallel to the posterior wing margin; 4 and 3-5 cross veins in the cubital space of fore- and hindwings respectively.

Abdomen. – Long and slender, ratio of head + thorax to abdomen 9:47; only very slightly inflated at segments 1-2 and 8-10; brownish-black, but paler than head and thorax; segments 3-6 with middle part brown, segment 1 with a large pale spot on each side; segments 2-3 each with a lateral pale stripe and a very fine mid-dorsal pale line along segments 2-6, three terminal segments slightly pruinose. Anal appendages black, the superiors about the length of segment 9 and twice the length of segment 10, with distal half strongly bent inwards and downwards; superiors in dorsal view with solid straight base and rather deep depression on inner side causing a sharp ridge dorsally with a small inwardly directed tubercle; distal quarter dorso-ventrally compressed with apices slightly dilated and flattened; ventral side somewhat hollow as continuation of a hollow underside starting at base; inferiors very short, in ventral view triangular, acute above. Penis as shown in figs. 22-23.

Female. – Abdomen plus appendages 34.8 mm, hindwing 32.5 mm.

Head almost the same as that of the male but the colour markedly bluish-yellow; labrum, mandibles and genae bluish-yellow, this colour extending upwards past the eyes and antennae. Thorax marked with yellow as in the male but the pattern much more distinct. wings similar to those of the male, 3-6 cross-veins in the cubital space; Riii arising 2-3 cells beyond the subnodus, nodal index forewing 18 : 14 | 13 : 17, hindwing 18 : 12 | 13 : 18. The abdomen more distinctly marked with bluish-yellow, lateral stripes and the fine mid-dorsal line visible through the length of





Figs. 18-23. *Schmidtiphaea yunnanensis* sp. n. – female: 18, markings of head, thorax and basal abdominal segments; male: 19-21, anal appendages; 22-23, penile organ.
Figs. 24-25. *Schmidtiphaea schmidi* Asahina. Undescribed female. – 24, markings of head; 25, prothorax-thorax, lateral aspect.

segments 2-7; ventro-lateral margins of segments 3-7 pale brown; segments 8-10 unmarked. Anal appendages slightly longer than segment 10, conical and acutely pointed.

Differential diagnosis. – Our specimens fit well in the hitherto monotypic genus *Schmidtiphaea* Asahina 1978. This new species is much smaller and more delicate than its congener (and genotype) *S. schmidi* Asahina but with a similar ratio of abdomen to wingspan (1.4 to 1.5) while *Bayadera* are in the range of 1.1 to 1.2, except *B. vietnamensis* (see below). Rest of frons shiny black, note yellow stripe here in *S. schmidi.* Pterostigma subtending 3(half) to 4(half) cells.

Etymology. – Latin, ensis = adjectival suffix meaning 'from'; thus 'the *Schmidtiphaea* from Yunnan'.

Schmidtiphaea schmidi Asahina
(figs. 24-25)

Material examined. – Unique specimen of female, Doi Suthep, NW Thailand, 24 June 1990, DALD leg. Type locality in Burma but redescription of the male (from the same Thai locality as our female) by Asahina (1987).

Female. – Description of the female: abdomen plus appendages 38.8 mm, hindwing 35.6 mm.

Head. – Relatively large and wide; labium pale bluish-yellow with tips black; labrum, mandibles and genae brownish-yellow, this colour extending upward along the inner margins of the eyes; clypeus shiny black, anteclypeus very narrow and postclypeus protruding; frons glossy black, its crest traversed yellow; vertex matt black, but area under antennae and along eyes shiny; antenna black except brownish on anterior side of first and second segments; a small pale spot against each lateral ocellus outside; occiput matt black, its rear with a yellow 'dumbell' shaped spot at centre.

Thorax. – Prothorax black, marked with brownish-yellow as follow: – a small spot on each side of anterior lobe; a large wedge-shaped mark on each side of median lobe and most of posterior lobe. Pterothoax marked with bluish yellow as follows: antehumeral stripe diverging above and gradually dilating posteriorly below with anterior in dorsal view almost parallel with carina, a similar stripe diagonally across the humeral (mesopleural) suture, diverging above and curving forward to touch the antehumeral stripe below; lateral three broad stripes, one on each suture (interpleural and metapleural), the third over the metepimeron; the first and second confluent below, the second and third confluent above; beneath tergite pale yellow. Wings narrow, the greatest width of hw. 6.0 mm; wings hyaline, veins black, stigma dark brown and situated apically, covering 5 cells; Riii arising 3-4 cells beyond subnodus; nodal index forwing 24 : 20 | 18 : 24, hindwing 18 : 16 | 17 : 20; 4-5 cross veins in cubital space; IA running parallel to the posterior margin of the wing. Legs brownish-black, coxae, trochanters and other sides of femora pale yellowish.

Abdomen. – Dark brown, marked with pale brownish-yellow as follows: sides of segment 1 and apical ring; lateral stripe and a fine mid-dorsal line through the whole length of segments 2-7, ventro-lateral margins of segments 3-7; segments 8-10 unmarked. Anal appendages slightly longer than segment 10, conical and acutely pointed.

Differential diagnosis. – A robust, strong-flying species, approx. 1 cm greater in length and span than *S. yunnanensis.* Crest of frons having a horizontal yellow stripe. Pterostigma subtending 5-5½ cells. Pterothoracic pattern in same style as *S. yunnanensis* but antehumeral stripe narrower than humeral stripe (the reverse in *S. yunnanensis*) and the yellow area between the eyes much greater than in the latter species.

Bayadera species new to China

Bayadera indica (Selys, 1853)
(figs. 26-28)

Material examined. – 1 male, 27 July 1991, Jiangcheng Co., Yunnan, YB leg..

The present specimen, one of several seen but the only one caught, agrees with the description by Fraser (1934) and can easily be recognized by the apical dark patch on all wings and strongly dilated apex of the superior appendages in the male. This species, the type species of the genus, seems also to be the most widespread and would not have been predicted to occur as far east as China.

Other Chinese *Bayadera* species relevant to this paper

There is a degree of confusion within the genus due to the inadequate diagrams, especially of the terminal appendages, as provided by early authors, when the need for fine detail had not become apparent. *B. bidentata* and *B. melanopteryx* are treated in this context for discussion below.

Bayadera bidentata Needham, 1930
(figs. 29-30)

Material examined. – The type was kindly loaned to us from Cornell University and from this the drawings of the appendages as now depicted were made, to provide detail beyond that of Neednam (1930); subsequently a male specimen was studied, found as follows: 1 male, Hefeng Co. (29.8°N, 110°E), Hubei, at altitude 855 m, 28 July 1989, Zhong Nin leg..

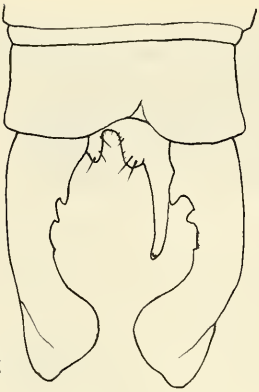
Bayadera melanopteryx Ris, 1912
(figs. 31-32)

Material examined. – 1 male, 26 July 1989, Xiao N. –l. leg.; 2 males, 26 July 1989, Dong D. –z. leg.; 1 male, 28 July 1989, Li Y. –k. leg.; 1 female, 27 July 1989, Lian X. –c. leg.; all from Hefeng Co.,Hubei, at 870 m altitude.

A guide to the genus *Bayadera*

Many early authors relied on minutely detailed descriptions (in their respective languages) of their newly found species and often provided no figures or bad ones. The artistic authors / photographers are giving us much less trouble now. We apologise for not providing our figures by scanning electron microscope photographs.

In the table 1 we list the species of *Bayadera*, with authors, type depository, approximate known geographical area (Type locality in the case of unique specimens) and a reference to what, in our opinion, is a good (the best?) figure of the male terminal appendages. The species list is from Davies & Tobin (1984), with the addition of the three new species described here and one recently described from Vietnam by van Tol & Rozendaal (1995). There are now 13 species plus two subspecies of *B. brevicauda.* For *B. bidentata* a drawing is provided, newly made from the holotype. There was confusion over *B. bre-*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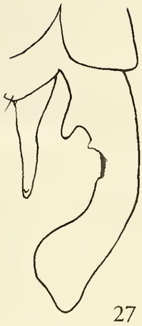
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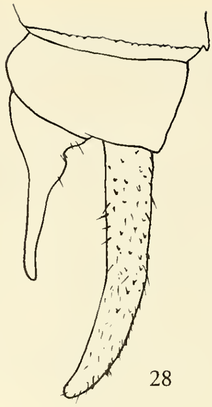
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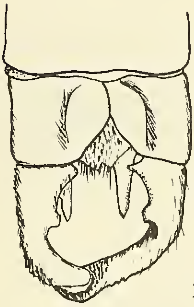
Figs. 26-28. *Bayadera indica* Selys. Anal appendages of male specimen. Jiangcheng Co., Yunnan.

Figs. 29-30. *Bayadera bidentata* Needham. Anal appendages of male holotype.

Figs. 31-32. *Bayadera melanopteryx* Ris. Anal appendages of male. Hefeng Co., Hubei.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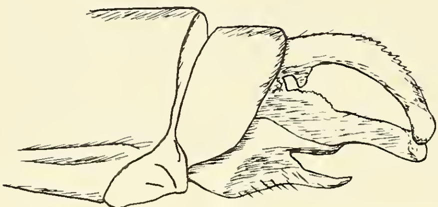
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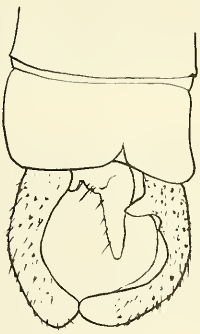
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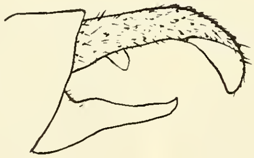
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vicauda because Ris (1912) figured this species, undescribed at the time, under *B. hyalina* Selys. The error was recognised by Fraser, who provided the new name *B. brevicauda* Fraser,1928. No type specimens have been designated. It was, perhaps, unfortunate that Sjöstedt (1932) chose to name his species *B. fasciata* at all from a single female and with poor figures; it is frequently found among dragonflies in many other taxa that females are often marked, e.g. banded (latin, fasciata = banded) when the males are hyaline; identifying a male of this species, when found, may be difficult. Ris's (1912) *B. melanopteryx* bas been redrawn from new specimens for this paper. *B. melania* Navas, 1934 is assumed to be *B. melanopteryx* (see Asahina 1956). *Caliphaea nitens* Navas 1934 was synonymised with *B. melanopteryx* by Chao 1962, but this is likely to be due to a printing error in the numbering of some of the figures in Chao's paper and the intention was to synonymise *Caliphaea nitens* with *Caliphaea consimilis* McLachlan. We are grateful to

Dr Matti Hämälainen for pointing out this interesting anomaly to us.

Summary key

1. Head with yellow face (at least anterior to frons) or two broad transverse yellow bands 2
– Head with labrum, bases of mandibles and genae marked with yellow or blue 4
2. (1) Head in front obviously with two broad transverse streaks against eyes, one over frons and the other across vetex behind lateral ocelli; thorax with an antehumeral stripe, a stripe on interpleural suture and a large spot on metepimeron (only female known) . *fasciata*
– Head in front with labrum, base of mandible, genae and episome, or even frons, marked with yellow, thorax with an additional stripe diagonally across the humeral suture, markings on interpleural suture small or absent (only males known) 3
3. (2) Thorax with a U-shaped yellow marking on each side in front, and laterally with a wedge-shaped blue spot on the metepisternum, a large yellow spot on the metepimeron; segments 3-6 of abdomen with lateral streak in addition to baso-lateral spot. 7-8 with a baso-lateral spot only; superior allendages with only one spine .... *serrata* sp. n.
– The two yellow stripes on each side of thorax in front, not confluent below, latetally with only a large yellow spot on metepimeron; abd. with lateral streak on segment 2-4; spot only on 5-6; superior app. with ventral spine and a median tubercle .... *forcipata*
4. (1) Wings cloudy basically or apically 5
– Wings clear 7
5. (4) Wings with basal two-thirds brown; male with thorax black; mesothorax of female with antehumeral stripe only, metathorax with marking in interpleural suture and metepimeron connected below .... *nephelopennis* sp. n.
– Wings with apices dark brown; male with thorax marked with yellow; mesothorax of female with antehumeral and humeral stripes, metathorax with two or three stripes not connected below 6
6. (5) Wings with about apical one-third dark brown; apex of superior appendages of male not dilated, with a ventral spine and no median tubercle .... *melanopteryx*
– Wings with apices blackish-brown only to midde of stigma; apex of superior app. dilated, with a long ventral spine and a median tubercle .... *indica*
7. (4) Superior appendage of male short and simple, without spine internally 8
– Superior appendage of male two or three times the length of last segment and with one ventral spine or an additional tubercle internally 9
8. (7) Body-size very small with hind-wing only 23-25 mm; two metathoracic stripes forming a V-shaped marking .... *brevicauda ishigakiana*
– Body size larger with hind wing more than 28 mm; two metathoracic stripes forming a V-shaped marking .....*brevicauda brevicauda*
– Body size larger with hind wing more than 28 mm; metepisternal marking interrupted, the upper connected with marking on metepimeron .....*brevicauda continentalis*
9. (7) Superior appendages of male with only one ventral spine or only one triangular tubercle 10
– Superior appendage of male with one ventral spine and one tubercle 11
10(9) Superior app. of male with only one ventral spine, wing with only one cross vein in cubital space .... *hyalina*
– Superior app. of male with only a sharp inwardly directed triangular tubercle at distal quarter; wing with 4-6 cross veins in the cubital space .... *vietnamensis*
11(9) Male with ventral spine of superior app. vestigial, but median tubercle robust ....*longicauda*
– Ventral spine robust, tubercle vestigial or small 12
12(11) Body size small with hind wing 26.5 mm; thorax black, apex of superior app. dilated (only male known) .... *kali*
– Hind wing 32-35 mm; male with apex of superior app. not dilated 13
13(12)Thorax and abdomen of male black; metathorax of female marked with yellow stripe on 2nd and 3rd suture .... *bidentata*
– Thorax and abdomen of male marked with yellow; metathorax of female with three irregular yellow stripes, the former two connected below and the latter two connected above .. .. *strigata* sp. n.

Discussion

Bayadera and *Schmidtiphaea* are two small, poorly known genera and not often encountered. They belong to a 'group' of a dozen or more small, zygopterid genera with similar or overlapping ranges from India to the SE Asia offshore islands. These genera are forest stream dwellers (e.g. *Bayadera*, *Schmidtiphaea*, *Anisopleura*, *Megalestes*, *Rhipidolestes*, *Philosina*, *Archineura*, *Caliphaea*, *Devadatta*, *Philoganga*, plus others among the Argiolestinae). Most species of *Bayadera* are in China, but Burma and Indochina may be their centre. Unfortunately this area has been closed to us since the time of the prewar explorers; Assam is split into unfriendly factions; Burma is dangerous; Bhutan is dubious; Cambodia is in strife and Vietnam only just emerging from terrible disasters. For lack of peaceful access this particularly rich area has not benefited from the recent advances of air-travel and four-wheel-drive vehicles which have provided a 'filling in' phase for species in many parts of the world as we would wish for conservation purposes.

The recently described species *Bayadera vietnamensis* van Tol & Rozendaal 1995, has the facies of a *Schmidtiphaea* with their characteristic length to span ratio, but has several cubital cross veins, perhaps an intermediate position, as the authors commented upon. Annectant species and higher taxa must, of course, occur; only with the failure of a species in the struggle for survival do genera become distinct.

The distribution of large, highly successful and widespread genera such as *Erythrodiplax* and *Argia* in the New World and *Orthetrum* and *Pseudagrion* in the Old World poses the question as to what their success is due. Equally interesting is the question as to whether the small genera already mentioned with limited distribution are budding competitors for dominance in a future world or, more likely, remnants of diminishing groups. Losing or gaining ground is where man has grossly interfered and the many small genera might have given us a different impression when the whole enormous area of south and south-east Asia was forested. We have done them a great dis-service but provided for the former 'successful' group huge paddy-field, gravel pits, fish-farms and reservoirs. Or are the small genera each using a different, unique little niche that none of the others can use?

There is a characteristic and widespread pterothoracic pattern in Euphaeidae where more or less biel-liptical dark areas are formed between the antehumeral and humeral stripes, also between the two laterial thoracic stripes when present and again between these two pairs of stripes. There is much variation between species in the extent to which these are 'closed' or 'open' at their dorsal and ventral meeting points. This pattern is a feature of all the species mentioned in this paper except, curiously, *B. serrata* and *B. nephelopennis*. These features are useful as species characters and are presumably recognition patterns; they are not indicators of relationships however, as seen in the closely similar species *Anisopleura lestoides* and *A. subplatystyla* where the latter has the pattern described for *Bayadera* above while the former species has simple straight stripes which are a feature of the majority of both Anisoptera and Zygoptera. Almost all the eleven genera of Euphaeidae show the theme pattern; when the thorax is all black, the theme pattern can be seen in the females as, for example in the common *Dysphaea dimidiata*. It is food for thought that the pattern also occurs in the Polythoridae in the New World; at least some Polythorid genera occupy ecological niches similar to those chosen by some Euphaeidae.

Larvae of Euphaeidae have lateral abdominal gills (all, so far as they have been studied) and it will be interesting to discover why this primitive feature has been retained, in terms of larval life-style. There is a likely report for *Bayadera*, a 'supposition' specimen (Needham, 1911) of *Bayadera indica*, with lateral abdominal gills but more recently a description of a larva of the same species by Kumar (1973). *Schmidtiphaea* larvae have not yet been found. Does this character provide for better access to the already high oxygen tension in streams and waterfalls? In many waterfall dwellers the terminal appendages have been adapted for use as anchorage devices, e.g. in many Argiolestinae. And why are the lovely, lake lovers living so 'happily' at such low oxygen tension?

Bayadera generally favours small rivers, sometimes filled with boulders and with almost negligible aquatic vegetation, but also smaller streams. By contrast, the related *Anisopleura* favours steep seepages and streamlets. *Schmidtiphaea* will fly in sunshine but also 'happily' in rain and about shady overhangs by forest waterfalls (where the unique female of *S. schmidi* described here turned up in steady rain after a 3-day vigil at the spot where a few males had previously been seen).

Acknowledgements

We wish to thank the Directors of the Kunming Institute of Zoology, Academia Sinica, for facilities made available to the authors to travel in SW China in pursuance of this work. We are also grateful to the Management at the Dept. of Entomology, Comstock Hall, Cornell University, Ithaca, New York, for the loan of the Type (C.U. Type No. 959) of *Bayadera bidentata* Needham.

References

Asahina, S., 1956. Dragonflies from west Tien-Mu-shan, central China. – Entomologiske Meddelelser (Copenhagen) 27 (4-5): 204-228.

Asahina, S., 1964. New and little known dragonflies from the Ryukyus (Odonata). – Kontyû 32 (1-8):1-8.

Asahina, S., 1973. Notes on chinese Odonata IV. D.C. Graham collection from Szechuan and T.H.Cheng collection from Fukien. – Kontyû 41 (4): 446-460.

Asahina, S., 1978. A remarkable new damselfly allied to

Table 1. The species of *Bayadera*.

Species	Author(s)	Date: page	Type dep.	Distribution	Apps depicted
B. bidentata	Needham	1930: 218	CUIC	Zhejiang, Guangxi	This paper
B. b. brevicauda	Fraser	1928: 51	No type	Taiwan	Asahina 1973: 456
B. b. continentalis	Asahina	1973: 455	USNM	Fujian	Asahina 1973: 456
B. B. ishigakiana	Asahina	1964: 1	Asahina	Ryukyu Is.	Asahina 1973: 457
B. fasciata	Sjoestedt	1933: 14	NHRS	Szechuan	Male unknown
B. forcipata	Needham	1930: 217	USNM	Szechuan	Author's paper
B. hyalina	Selys	1879: 373	IRSN	Assam	Fraser 1928: plate 1
B. indica	Selys	1853: 49	IRSN	Nepal to Yunnan	Fraser 1934: 80
B. kali (male only)	Cowley	1936: 477	BMNH	Assam	Author's paper: 479
B. longicauda	Fraser	1928: 53	BMNH	Sikkim	Asahina 1985: 20
B. melanopteryx	Ris	1912: 49	Koningsburg	Szechuan, Guandong	This paper
B. nephelopennis	Davies & Yang	1996	IZAS	Szechuan	This paper
B. serrata	Davies & Yang	1996	IZAS	Yunnan	This paper
B. strigata	Davies & Yang	1996	IZAS	Yunnan	This paper
B. vietnamensis	Van Tol & Rz.	1994	RMNH	Vietnam	Authors' paper

Bayadera (Odonata, Euphaeidae). – Proceedings of the Japanese Society of Systematic Zoology 14: 43-46.

Asahina, S., 1985. A list of the Odonata recorded from Thailand. Part XI, Euphaeidae. –Chô Chô (The Rhopalocerist's Magazine of Japan) 8 (12):18-38.

Asahina, S., 1987. A revised description of *Schmidtiphaea schmidi* (Odonata, Euphaeidae). – Proceedings of the Japanese Society of Systematic Zoology 36: 34-37

Chao, H-f., 1962. A study of Navasian types of chinese dragonflies (Odonata) I. – Acta Entomologica Sinica 11 (Supplement): 25-31.

Cowley, J., 1936. A new species of *Bayadera* (Odonata). – Annals of Natural History (London) (Series 10) 18 (xlvi): 477-482.

Davies, D. A. L. & P. Tobin, 1984. The Dragonflies of the World: A systematic list of the extant species of Odonata vol. 1, Zygoptera, Anisozygoptera. – Societas Internationalis Odonatologica Rapid Communications (Supplements) No. 3: 9 + 127 pp (*Bayadera* on pp 22-23).

Fraser, F.C., 1928. Indian dragonflies Part 31. – Journal of the Bombay Natural History Society 33 (1): 47-59.

Fraser, F.C., 1934. The Fauna of British India, including Ceylon and Burma. Odonata, vol. II, London: Taylor & Francis. (*Bayadera* on pp 78-84).

Kumar, A., 1973. Descriptions of the last instar larvae of Odonata from the Dehra Dun Valley (India) with notes on Biology I Suborder Zygoptera. – Oriental Insects 7(1): 83-118.

Navas, R. P. Longinos, 1934. Névropteres et Insects voisines. Chine et pays environnés, 7^{e} series. – Notes d'entomologie chinoise 2 (1): 1-6.

Needham, J. G., 1911. Descriptions of dragonfly nymphs of the subfamily Calopteryginae. – Entomological News 22 (4): 145-154.

Needham, J. G.,1930. A manual of the Dragonflies of China. –The Fan Memorial Institute of Biology, Peiping, China.

Ris, F., 1912. Neue Libellen von Formosa, Sudchina, Tonkin und den Philippinen. – Supplementa entomologica (Berlin) 1: 44-85.

Selys-Longchamps, E. de, 1853. Synopsis des Caloptérygines. –Bulletin de l'Académie royale de Belgique 20 (annexe): 1-73.

Selys-Longchamps, E. de, 1879. Quatrièmes additions au Synopsis des Caloptérygines. – Bulletin de l'Academie royale de Belgique (2) 47: 349-409.

Sjöstedt, Y., 1932. Schwedisch-chinesische wissenschaftliche Expedition den nordwestlichen Provinzen Chinas. –Archiv för Zoologi (Stockholm) 25A (5):1-22, (3 pls excl).

Tol, J. van & F. G. Rozendaal, 1995. Records of Calopterygoidea from Vietnam, with descriptions of two new species (Zygoptera: Amphipterygidae, Calopterygidae, Chlorocyphidae, Euphaeidae). – Odonatologica 24 (1): 89-107.

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BOOK REVIEW

A.T. Barrion & J.A. Litsinger, 1995. Riceland spiders of South and Southeast Asia. - CAB International, Wallingford U.K., Tucson USA, etc. 736 pp, 16 colour-plates, 412 figs., 336 maps. [ISBN 0-85198-967-5]. Price £ 125 excl postage outside UK (USD 225, USA only). To be ordered from CAB International, Wallingford, Oxon OX10 8DE, UK. Fax +44-1491-833508.

Barrion and Litsinger studied the spiders of ricelands at the International Rice Research Institute in the Philippines for many years. In this large expensive book they have brought together the taxonomy of all the encountered 342 species (134 genera, 26 families), of which 258 are new to science. Only seven new species are from outside the Philippines. In only 32 out of the new 258 new species both sexes are described. The majority of the new species is based on single specimens only, indicating that SE Asian arachnology has still a long way to go.

A general introduction of less than twenty pages covers the historical background of the study of Philippine spiders, morphology, life history and material and methods. The rest of the book is devoted to taxonomy, with keys to families, genera and species, extensive species descriptions, frequently accompanied by drawings of the habitus, male and female genitalia, as well as other details.

Tagalog is the standard language for the new scientific names. Although nothing is said about this in the introduction, the use of Tagalog for this purpose is taken for granted in some new species whose etymology does not mention the Tagalog origin. Also in the case of new species from outside the Philippines, if not named after a person or locality, the new name is derived from Tagalog (*Misumena tapyasuka* n.sp. from Central Java). The use of Tagalog for numbers in scientific names seems to contravene the International Code of Zoological Nomenclature (article 32b, ed. 1985). Exceptionally a latinized English is used for new names, like in *liplikeum.*

There are contradictions between specific and generic descriptions. Some characters used in the genus diagnosis are repeated in every species description of that genus. A comparison with the most related species, which they are likely to be confused with, is lacking in the descriptions. The extensive use of absolute instead of relative measurements is not so practical when comparing own specimens.

Some newly described species appear to be well-known SE Asian species, although in some cases, however, placed in the wrong genus. *Phrurolithus ulopatulisus* n.sp., for example, is a member of the very characteristic genus *Oedignatha* and probably a synonym of *O. scrobiculata.* In several cases, specimens clearly belonging to one species and collected from one locality, are described under several new names, to judge from the descriptions and illustrations (e.g. in *Clubiona* and *Clubionoides*). On the other hand, the sexes of some species may turn out to belong to different species, e.g. in *Cheiracanthium ligawsolanum* n.sp., where the male is 80% larger as the female.

The keys are of limited use. They abound in objectionable unreliable couplets, like the length ratio of carapax to abdomen or subtle size differences (6.05 versus 6.45mm) derived from the only one or two specimens seen by the authors.

One would expect a book of this size to survey all available literature of the encountered species, but the authors prefer to stick precisely to their own material. When they found only one sex of a well-known widespread species, they do not describe or illustrate the other sex. Quite a number of preys have been documented for a common and conspicuous species like *Nephila maculata,* including small birds, but Barrion & Litsinger mention only the two insect species found by them.

On the other hand the authors do not stick completely to the habitat riceland. Spiders from bordering higher vegetation are incorporated on a large scale, and sometimes from other crops (coffee, cotton) or habitats (even secondary dipterocarp forest). Moreover, a rather diverse array of riceland habitats is dealt with. The spider fauna of inundated ricefields will undoubtedly be more similar to that of marshes than to that of dry upland rice.

The 92 colour photographs of 34 species are often not sharp and usually anesthetized specimens have been used. The drawings are of higher quality, but it is difficult to get a clear idea of the structure of more complicated male palps. The artist should have used the technique of surrounding overlying structures with a thin white line. Now is it difficult to judge where a long embolus ends, because the embolus and the border of the alveolus are drawn as one fused line. Not all male palps are drawn in a uniform manner, some in an expanded condition, making a comparison difficult. The drawings of genitalia should have been accompanied by scale-bars.

Many useful writings on SE Asian spiders are lacking in the references, even those of Simon, although he is mentioned in the introduction.

Despite all criticism: thanks to all new species and its drawings this book will remain a standard in SE Asian arachnology. Despite its ambiguities, it can provide SE Asian ecological research with a stimulating taxonomical foundation.

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DENISIA CURLETTII SP. N. FROM TUNISIA (LEPIDOPTERA: OECOPHORIDAE)

Lvovsky, A.L. & J.C. Koster, 1996. *Denisia curlettii* spec. nov. from Tunisia (Lepidoptera: Oecophoridae). – Tijdschrift voor Entomologie 139: 157-160, figs. 1-7. [ISSN 0040-7496]. Published 18 December 1996.
A new species of Oecophoridae is described from Tunisia: *Denisia curlettii* sp. n. The external characters and genitalia are figured, and the biology is briefly discussed.
Correspondence: A. L. Lvovsky, Zoological Institute, Academy of Sciences, Universitetskaja N 1, 199034 St. Petersburg, Russia.
Key words. – Lepidoptera, Oecophoridae, Denisia, Tunisia, new species.

In the genus *Denisia* Hübner, 1825 (Oecophoridae), 18 species are currently recognized. The genus has its main distribution in Europe, but several species occur in the Near-East. There are two species known from North and Central Asia and one species from North America. Below we describe the first species from Africa.

Last year the junior author received three specimens of an unknown Microlepidoptera species from Mr. Traugott-Olsen, (Marbella, Spain). Mr. Traugott-Olsen concluded on the basis of wing venation and genitalia that it could possibly belong to the Momphidae. The scaling of the head and the structure of the male genitalia in combination with the venation identify the moths as belonging to the Oecophoridae. Both families belong to the large and very diverse superfamily of the Gelechioidea.

Leraut (1984) described the monotypic genus *Buvatina* based on a single male specimen, *Buvatina tineiformis*. *Buvatina* is distinguished from *Denisia* by the following characters: forewing with veins R4 and R5 completely merged; the short and porrect labial palpae and the long saccus. The species described here has the upper margin of the valvae concave like in *Buvatina*, but the venation of the forewing (fig. 5) shows a forked position of R4 and R5. This in combination with the long and upcurved labial palpae and the short saccus led us to place the new species in *Denisia*.

Checklist of *Denisia* Hübner, 1825

This is a provisional list compiled from literature, since we did not have the opportunity to examine all the species.
Type species: *Phalaena Tinea stipella* Linnaeus, 1758

1. *Denisia albimaculea* (Haworth, 1828)
2. *Denisia aragonella* (Chrétien, 1903)
3. *Denisia augustella* (Hübner, 1796)
4. *Denisia coeruleopicta* (Christoph, 1888)
5. *Denisia curlettii* **sp. n.**
6. *Denisia fiduciella* (Rebel, 1935)
7. *Denisia graslinella* (Staudinger, 1871)
8. *Denisia luctuosella* (Duponchel, 1840)
9. *Denisia luticiliella* (Erschoff, 1877)
10. *Denisia muellerrutzi* (Amsel, 1939)
11. *Denisia nubilosella* (Herrich-Schäffer, 1854)
12. *Denisia osthelderi* (Rebel in Osthelder, 1936)
13. *Denisia pyrenaica* Leraut, 1989
14. *Denisia ragonotella* (Constant, 1885)
15. *Denisia rhaetica* (Frey, 1856)
16. *Denisia similella* (Hübner, 1796)
17. *Denisia stipella* (Linnaeus, 1758)
18. *Denisia subaquilea* (Stainton, 1849)

Denisia curlettii sp. n.

Type material. – Holotype ♂: Tunisia, Bou Hedma, 18.v.1990, Curletti leg. Gen. prep. A.23.10.92 E. Traugott-Olsen (RMNH). – Paratypes 2♀: Same date and locality as holotype. Gen. prep. B.21.10.92 and B.23.10.92. E. Traugott-Olsen. Wing prep. A.26.10.92 E. Traugott-Olsen. (coll. Baldizzone).

Diagnosis

D. curlettii differs from all other species in *Denisia* by the shape of the valva which has the upper margin concave. In the other species the upper margin is straight or convex (Leraut, 1989). Externally the species resembles *Denisia osthelderi* (Rebel, 1936), but it differs from it by the white basal fascia on the forewing that does not reach the costal margin of the wing. In *D. osthelderi* this fascia is complete. Further by the dorsal and subcostal spot in the middle, in *D. osthelderi* these two spots are united into one large spot. The light yellow hindwing with the greyish-brown apical third, is completely greyish-brown in *D. osthelderi.* The light yellow hindwing of the new species distinguishes it from all other species in the genus. Unfortunately the holotype of *D. osthelderi*, the only specimen known of this species, lacks the abdomen, thus making a comparison of the genitalia impossible.

Description

Male (fig. 1). – Wingspan 8,5-9,5 mm. Head: frons white; vertex shining brown, irrorated white; collar shining dark brown; palpae first segment one-third of the length of the second, white, ventrally with apical dark brown spot, second segment one-fifth longer than third, white, ventrally mottled dark brown and somewhat rough-scaled beneath, third segment dark brown with white irroration dorsally; Scape irrorated white dorsally; ventrally shining light grey; antennae with distinct white annulations, ciliate. Thorax and tegulae shining dark brown. Legs: shining dark brown, tibiae with a white medial and apical ring, tarsi white at joints. Forewing dark brown, densely irrorated by yellow scales, an irrigular white fascia before one-third, perpendicular on dorsum, narrowing towards costa and not reaching it, on dorsum, between base and fascia, a white spot, a triangular white spot on dorsum at halfway, a smaller subcostal white spot just beyond the dorsal spot, almost forming an interrupted outward oblique fascia, a large white costal spot at three-fourth, a small white spot on tornus, inwardly of the costal spot, on costa, dorsum and in the fold, also as some edging of the fascia and the spots; cilia dark grey, mixed ochreous, yellowish at tornal spot. Hindwing shining light yellow with some greyish-brown irroration, especially at base, the apical third shining greyish-brown, cilia greyish-brown around apex, light yellow from tornus to base. Underside: forewing shining greyish-brown, shining yellowish on dorsum; hindwing shining yellowish, irrorated greyish-brown at base and along costa, apical third shining greyish-brown. Abdomen not examined.

Male genitalia (fig. 3). – Uncus triangular, elongated distally, apex flat, slightly indented; tegumen almost parallel-sided, dorso-basal incision with sclerotized rims; gnathos broad, slightly tapering distally with a sharp downwards bent, hook-like apex; saccus rounded; juxta broad, juxta lobes long, narrow, tapering distally into a sharp, upwards bent, apex. Valva short, broad at base, tapering into a rounded, upwards bent and strongly setose cucullus, costa convex, ampulla warty. Aedeagus tubular, both ends bent downwards laterally, dorso-distally broadened subapically, without cornuti.

Female (fig. 2). – Scape dorsally shining dark brown with white apical spot, antennae shining dark brown, annulated white ventrally. Forewing with some scattered yellow scales, strongest in the basal half, the triangular white spot on dorsum at one-half and the smaller subcostal white spot just beyond the dorsal spot smaller and less pronounced.

Female genitalia (fig. 4).– Apophyses posteriores almost twice as long as apophyses anteriores. Tergite VIII almost square, slightly narrowing basally, weakly sclerotized. Antrum upper part bowl-shaped, lower part funnel-shaped, gradually tapering into colliculum, ventral margin almost straight, distal part sclerotized, dorsal wall of ostium bursae strongly spined. Corpus bursae not visible.

Biology

The three specimens have been collected 18 May 1990 by Mr G. Curletti during his visit to Tunisia in order to collect larvae and adults of Buprestidae (Coleoptera). Unfortunately Mr Curletti cannot remember how he collected the specimens. That day he searched for larvae of Buprestidae, which live under the bark of dead trees and shrubs. Perhaps he accidentely reared the moths from these samples of wood. However he also collected at light (u.v. lamp) that night. The moths were collected at the foot of Djebel Bou Hedma (Djebel = hill). This hill, with an altitude of 790 meter, is situated south of the road P 14, halfway between the cities Gafsa and Sfax, several kilometres West of Maknassy.

The collecting site has a desert-like or steppe-like vegetation, characterized by the absence of trees and the presence of small shrubs of *Limoniastrum* sp. and *Tamarix* sp. (fig. 6). The smaller herbs, however, consist of many species and are difficult to identify, mainly belonging to the Chenopodiaceae (Salsolaceae), but also some Graminaceae are found (e.g. *Aristida pungens*). These plants belong to the salty habitat of a 'chott', a depression in the landscape with a salt soil.

Figs 3-4. Genitalia of *Denisia curlettii*. – 3, male genitalia, ventro-caudal aspect, valvae spread, aedaeagus separated, top dorsal aspect, bottom lateral aspect. Scale bar 0.25 mm; 4, female genitalia, ventral aspect, corpus bursae omitted. Scale bar 0.5 mm.


Fig. 1 (left). *Denisia curlettii*, male. – Fig. 2 (right). *Denisia curlettii*, female.

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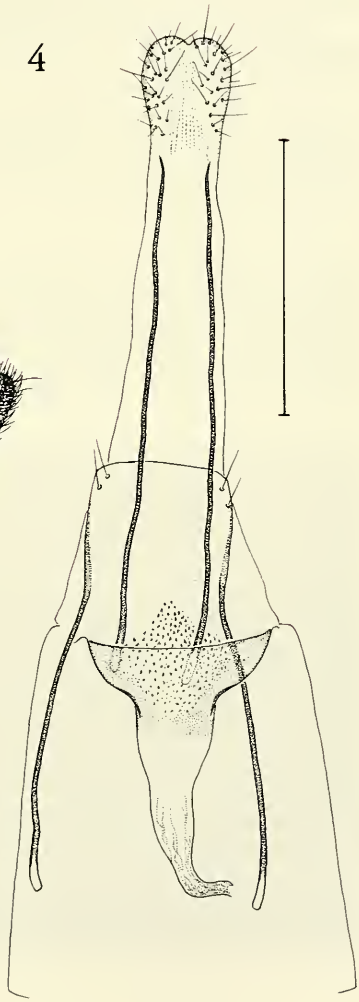

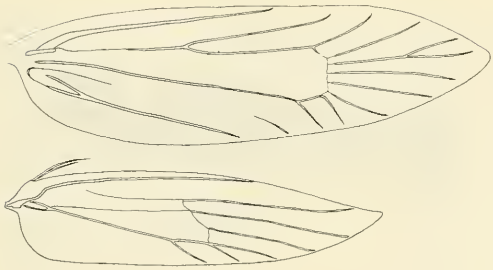

Fig. 5. Wing venation of *Denisia curlettii*.

First stages unknown. Larvae possibly under the bark of *Limoniastrum* sp. or *Tamarix* sp. The species of the genus *Denisia* are reported to feed on decaying wood under dead bark of various trees and shrubs.

Distribution

Only known from the type locality.

Etymology

The species is named after its collector Mr. G. Curletti, Carmagnola, Italy.

Acknowledgements

We would like to express our thanks to the following persons: Dr. G. Baldizzone, Asti, Italy, for the loan of the material and the permission to deposit the holotype in the National Museum of Natural History, Leiden, The Netherlands (RMNH); Mr. E.C. Traugott-Olsen, Marbella, Spain, who brought this species under the attention of the junior author; Mr. G. Curletti, Carmagnola, Italy, who provided us with extensive information on the collection site; Dr. S.Yu. Sinev, St. Petersburg, Russia, for examining the holotype of *Denisia osthelderi*.

The Uyttenboogaart-Eliasen Foundation made the publication of the colour plates possible.

References

Leraut, P., 1984. *Buvatina tineiformis*, espèce et genre nouveaux pour la science decouverts en France (Lep. Oecophoridae, Oecophorinae). – Entomologica gallica, 1(3): 151-153.

Leraut, P., 1989. Contribution à l'étude des Oecophoridae (s.l.). I. Révision de quelques types d'espèces traditionellement associées aux genres *Borhausenia* Hübner et *Schiffermuelleria* Hübner, et description d'une espèce et de deux genres nouveaux. – Alexanor 16: 95-113.

Rebel, 1936. In: L. Osthelder, Lepidopteren-Fauna von Marasch in Türkisch Nordsyrien. – Mitteilungen Münchner Entomologischen Gesellschaft 25 (3): 67-90.

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Fig. 6. Habitat of *Denisia curlettii*. Tunisia: Bou Hedma.

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SIX NEW TAXA OF NEPOMORPHA FROM SULAWESI AND MINDANAO

Notes on Malesian aquatic and semiaquatic bugs (Heteroptera), VI.

Nieser, N. & Chen, P. P., 1996. Six new taxa of Nepomorpha from Sulawesi and Mindanao. Notes on Malesian aquatic and semiaquatic bugs (Heteroptera), VI. - Tijdschrift voor Entomologie 139: 161-174. figs. 1-32. [ISSN 0040-7496]. Published 18 December 1996.
Five new species: *Aphelocheirus geros* (Aphelocheiridae), *Enithares charakia, E. ektakta, E. margarethae* and *E. stansae* (Notonectidae) from Sulawesi and a new subspecies: *Ranatra sulawesii sebui* (Nepidae) from Mindanao are described and an earlier paper on the Sulawesi fauna of these families of Nepomorpha is updated.
Correspondence: Dr. N. Nieser, Htg. Eduardstr. 16, 4001 RG Tiel, The Netherlands.
Key words. – Sulawesi (Indonesia), Mindanao (Philippines), Nepomorpha, new species, key *Enithares*, additional records.

Studying additional water bugs from Sulawesi collected by staff members of the National Museum of Natural History (Leiden), the Zoological Museum (Amsterdam), and the first author, several undescribed species of *Enithares* and one of *Aphelocheirus* were encountered. In addition an undescribed form of *Ranatra* was collected on Mindanao. As the final paper with additions and corrections on the series of Malesian aquatic Heteroptera is planned for the more distant future, it seems useful to describe these species here as an update to part I of the series (Nieser & Chen 1991, 1995).

The present study, in combination with some additions and corrections, results in the following list of twelve species of *Enithares* known from Sulawesi.

Checklist of *Enithares* Spinola, 1837 known from Sulawesi

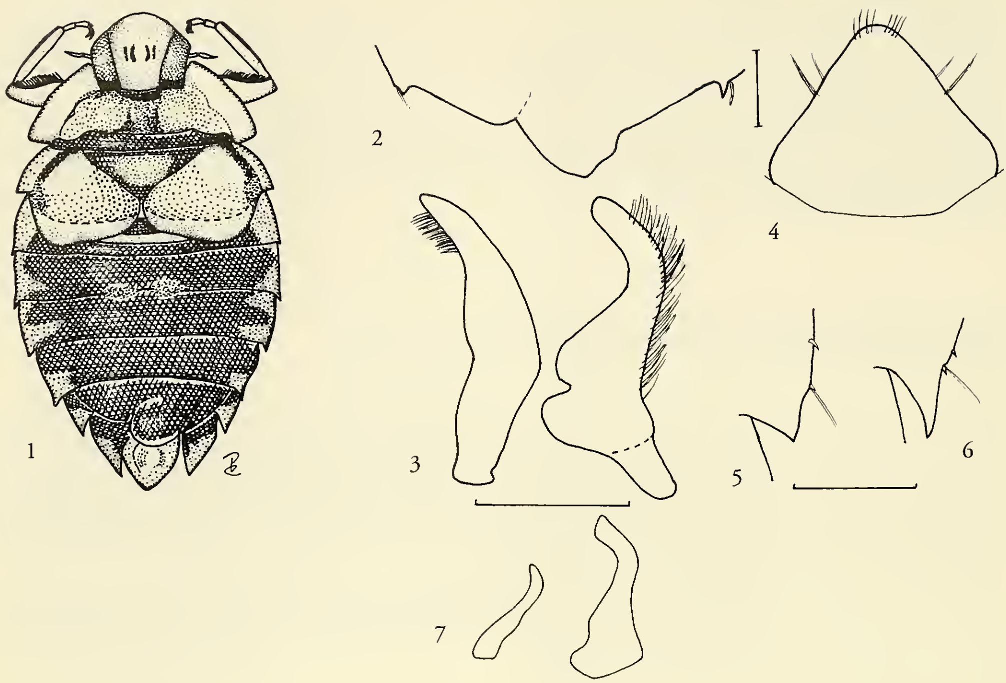
E. bakeri Brooks, 1948. – E. Indonesia, N. Borneo, Mindanao.
E. caesaries Nieser & Chen, 1991. – Sulawesi Tengah.
E. charakia sp. n. – Sulawesi Selatan.
E. ektakta **sp. n.** – Pulau Sangihe.
E. lansburyi Nieser & Chen, 1991. – Sulawesi Tenggara.
E. margarethae **sp. n.** – Sulawesi Selatan.
E. paramegalops Lansbury, 1968. – Sulawesi Tengah, Maluku, Irian Jaya.
E. phenakismos Nieser & Chen, 1991. – Sulawesi Tengah.
E. producta Lansbury, 1968. – Northern part of Sulawesi.
E. skutalis Nieser & Chen, 1991. – Pulau Buton.
E. stansae **sp. n.** – Sulawesi Selatan.
E. sp. near *timorensis.* – Eastern part of Sulawesi.

One additional species of *Aphelocheirus* brings the number of Sulawesi species to four.

Checklist of *Aphelocheirus* Westwood, 1833 known from Sulawesi

A. *celebensis* Polhemus & Polhemus, 1988. – Sulawesi Selatan.
A. geros sp. n. – Western part of Sulawesi.
A. lorelindu Polhemus & Polhemus, 1988. – Sulawesi Tengah.
A. robustus Nieser & Chen, 1991. – Sulawesi Tenggara.

Finally an undescribed form of *Ranatra* was collected.



Figs. 1-7. *Aphelocheirus* spp. – 1-4, *A. geros* sp. n., paratypes, scale 1 mm; 1, dorsal view of male; 2, posterior margin of abdominal tergite 5, male; 3, parameres; 4, genital operculum, female. – 5-6, *Aphelocheirus* spp., lateroposterior spines of connexivum 5, scale 0.5 mm; 5, *A. celebensis*; 6, *A. geros*. – 7, *A. lorelindu*, parameres (redrawn after D. & J. Polhemus 1988).

Material and methods

Measurements are in mm and are based on five specimens of each sex taken from the sample containing the holotype (if available). Length and width refer to the maximum value of the specified body part oriented horizontally, if not specified they refer to body length and width. Length is measured from anterior margin of vertex to apex of hemielytra in *Enithares*, and from anterior margin of vertex to apex of abdomen in *Aphelocheirus* and *Ranatra*.

Short winged *Aphelocheirus* are called brachypterous or micropterous depending on author. Within Naucoroidea there are two main forms with reduced wings. Specimens with hemielytra slightly reduced (mostly the membrane and embolium) and the hind wings usually strongly reduced. We propose to indicate this form, which is common in Naucoridae, by brachypterous. Less often there are specimens with strongly reduced hemielytra, leaving most of abdomen uncovered. This form is predominant in Aphelocheiridae and occurs in some Naucoridae notably the S. American Cryphocricinae. We propose to indicate this form by micropterous.

The areas in Sulawesi and Mindanao used with the localities agree with the administrative provinces. Pulau Sangihe is a spice island belonging to Sulawesi Utara province. As it lies some 200 km N. of the northern point of 'mainland' Sulawesi it is not on the map used in this paper (fig. 30). Remarks between square brackets with the data on localities contain additional information not found on the labels.

Specimens have been deposited in the following collections registered according to Arnett, Samuelson & Nishida (1993): BPBM (Honolulu, U.S.A.); JTPC (Englewood, Co. U.S.A.); MBBJ (Bogor, Indonesia); MUDH (The Hague, The Netherlands); NHMW (Vienna, Austria); NMSC (Singapore); RMNH (Leiden, The Netherlands; SEMC (Lawrence Ka. U.S.A.); USCP (Cebu City, Philippines); ZMAN (Amsterdam, The Netherlands). Unlisted collection: N. Nieser collection, Tiel, The Netherlands (NCTN); G. Zimmermann collection, Marburg, Federal Republic of Germany (ZC). Specimens not specified are in NCTN.

During an early phase of preparing this paper, a number of type specimens have been distributed with labels giving Nieser as sole author, this should be changed in Nieser & Chen.

ACKNOWLEDGEMENTS

Thanks are due to Drs J. van Tol (RMNH), J. P. Duffels (ZMAN), G. M. Nishida, D. A. Polhemus and D.J. Preston (BPBM), J. T. Polhemus (JTPC) H. Zettel (NHMW) and G. Zimmermann (ZC) for the loan of specimens and additional data on localities.

SYSTEMATIC PART

Aphelocheiridae

Aphelocheirus geros sp. n.
(figs. 1-4)

Type material. – Holotype micropterous male (RMNH), INDONESIA: Sulawesi Selatan, Mamasa, river flowing through village, 2°56'S 119°22'E, c. 1050 asl., cultivated area, rather fast flowing stream, bottom boulders with some coarse sand, 8 Apr. 1991, leg. J. van Tol, sample 91JvT02. – Paratypes, same data as holotype, 9♂ 10♀ distributed as follows: 4♂ 6♀ (including allotype and 1 macr.) RMNH; 3♂ (1 macr.) 2♀ NC; 1♂ 1♀ MBBJ; 1♂ 1♀ JTPC. Additional paratypes: Sulawesi Tengah, Sul. 28, S. Anow, 24. Oct. 1993 1♀ macr.; Sul. 53, M. 17. Nov. 1993 2♀ macr., leg. J. P. Duffels (ZMAN). Micropterous unless otherwise indicated.

Description. – Micropterous form (fig. 1); a large species for this genus. Dimensions, length ♂ 9.9 - 10.5, ♀ 9.5 - 10.2; width of head ♂ 1.15-1.25, ♀ 1.12-1.26; width of pronotum ♂ 4.9-5.1, ♀ 5.0-5.1; maximal width (across abdomen) ♂ 5.9-6.1, ♀ 6.0-6.1.

Colour, medium to dark castaneous, eyes shining black. Interoculus, lateral parts of pronotum, hemielytra, lateral angles of connexiva and genital capsule of male usually lighter than remainder. Legs paler than most of ventral side.

Structural characteristics. Head polished, shining, with a few punctures, not or slightly rugulose along midline, produced ahead of eyes for a distance equal to 0.4× the length of an eye; anterior/posterior interoculus 1.6/1.0. Eyes length/width 1.0/0.45, outer margin sinuate due to weakly developed anterolateral flange. Pronotum rugose, shining, lateral part with inconspicuous, short appressed brown setae, width/median length 5.1/1.2, width/length through anterolateral angles 5.1/2.0; lateral margin bearing c. 10 stout minute erect setae. Scutellum glabrous, rugose, width/length 2.5/1.1, lateral margin hardly sinuate, shallow transverse sulcus present along anterior margin. Hemielytra touching medially, reaching posteriorly to or just beyond base of abdominal tergite 3, rugose, bare, somewhat more dull than interoculus and pronotum, embolar margin evenly curving anteriorly, bluntly terminated posteriorly, with inconspicuous, short, appressed brown setae. Abdomen rugose, covered with sparse, fine, rather short, appressed whitish setae, segments 2-7 exposed, paired glandular openings present medially on posterior margin of tergite 3. Lateral margin of all segments with short stout setae, posterolateral angles of segments 3-7 spinose, with a few rather short pale setae, which are rubbed off in several specimens, at base of spines. Length of antennal segments 1 to 4: 0.11, 0.20, 0.35 and 0.48. Labrum glabrous, shiny, apically roundly pointed. Rostrum glabrous, shiny, length 3.2-3.5, reaching middle coxae. Prosternum with weak median carina, propleura with inner projections notched; mesosternum glabrous except for pilose median carina which is strongly tumescent posteriorly; metasternum glabrous, metaxiphus short and narrowly pointed. Abdominal sternites glabrous except for the pruinose genital operculum in female, posterior margins of sternites 4 and 5 with 4-6 backwardly directed stout short setae medially. Legs very sparsely set with fine golden setae. Fore and middle trochanter, femur, tibia and tarsus with thick hair pads on inner surface. Coxae with combs of long pale setae on distal margins. Middle femur and tibia sparsely set with short stout reddish spines, femur bearing 5-8 long erect setae on posterior margin, tibia bearing 3-4 long setae basally on anterior margin and one row of red spines apically. Hind leg, femur sparsely set with short stout reddish spines, tibia with some reddish spines, most densely placed dorsally, tibia and tarsus with long swimming hairs on ventral surface.

Male. Posterior margin of tergite 5 asymmetrical, with a medioposterior hump-like projection, which is delimited more clearly on the left than on the right (fig. 2). Genital capsule yellowish, shiny. Right paramere longest, widened at base, left paramere somewhat narrowed at apex (fig. 3).

Female. Genital operculum (fig. 4) somewhat domed, triangular with a rounded tip. A pair of narrow tufts of long setae along lateral margin, scattered short setae at apex.

Macropterous form. – As micropterous except: Length 11.0, pronotum well developed, its width 4.9-5.1. Scutellum larger and somewhat inflated, mesosternum inflated with a dark, low median carina. Hemielytra pale brown, membranes smoky hyaline, reaching beyond apex of abdomen (broken off in female), leaving connexiva 2-5 uncovered.

Etymology. – *Geros*, Greek adjective meaning solid, referring to the large size of species within genus.

Comparative notes. – *A. geros* differs from *A. celebensis* D. & J. Polhemus by having the lateroposterior spines of connexiva 4-5 longer (figs. 5, 6, older specimens can have the tips of these spines worn off). *A. robustus* Nieser & Chen differs in male by having left paramere with a broad hooked apex, the female has genital operculum short and broad with convex caudolateral angles (Nieser & Chen 1991: 50, figs. 3, 5). The difference with *A. lorelindu* D. & J. Polhemus is summarised in following couplet to be added to the 'Key to *Aphelocheirus* of Sulawesi' by Nieser & Chen (1991):

3. Blackish brown species with strongly contrasting pale yellowish legs. Male: Left paramere distinctly hooked apically, right paramere with a wide and shallow incision at base (fig. 7). Genital operculum of female elongate .... *A. lorelindu* D. & J. Polhemus
– Medium brown species with yellowish brown legs. Male: Left paramere only faintly hooked, right paramere with a narrower deeper incision basally (fig. 3). Female: Genital operculum triangular (fig. 4) (Sulawesi Selatan and S. Tengah) ... . *A. geros* sp. n.

Remarks. – This species belongs to the *celebensis*-group, to which apart from all Sulawesi species also belong *A. australicus* Usinger and *A. pallens* Horváth, which are the only species known from Australia and New Guinea respectively (D. & J. Polhemus 1988: 191). So it seems there exists a geographically separated, morphologically recognisable species group in the area.

Notonectidae

Enithares charakia sp. n.
(figs. 8, 12-15, 30)

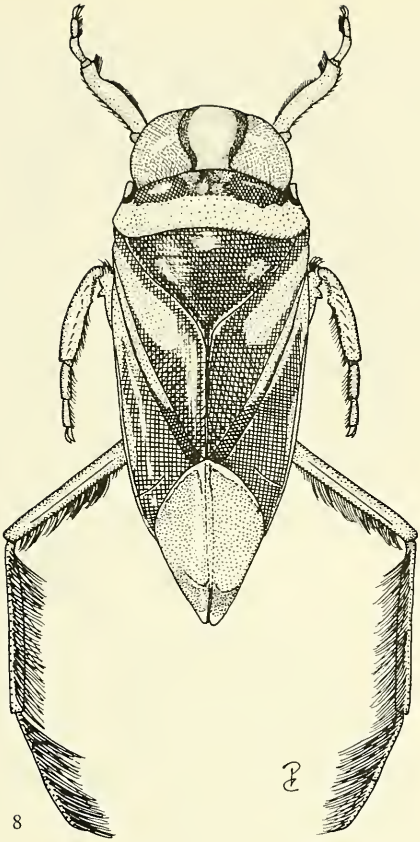
Type material. – Holotype male (pale form): Indonesia, Sulawesi Selatan, S. Anowah, 41 km N of Wotu [± 20 km S of D. Poso] 24. Oct. 1993, narrow streams above water fall in undisturbed rain forest, 650 m asl., leg. J. P. & M. J. Duffels (ZMAN), allotype female same data as holotype (ZMAN). Additional paratypes: Sulawesi Tengah, Salope, near [a few hundred m from N. shore] Danau Poso, waterfall [550m asl.], 29. Jan. 1995, Seifert & Greindl (46), 3♂ 3♀ (2♂ 2♀ NHMW, 1♂ 1♀ NCTN).

Description. – Shape (fig. 8), a rather large relatively broad species, greatest width across hemielytra about 1.5 mm caudally of humeral angles of pronotum. Dimensions, length ♂ 11.7-12.8, ♀ 11.9-12.2; width ♂ 4.70-4.86, ♀ 4.62-4.82; humeral width of pronotum ♂ 4.45-4.70, ♀ 4.40-4.60; width of head ♂ 3.90-4.08, ♀ 3.90-4.00; anterior width of vertex ♂ 1.20-1.28, ♀ 1.20-1.31; synthlipsis ♂ 0.79-0.88 ♀ 0.80-0.88.

Colour. Pale form, sordid white to pale yellowish, eyes, band in pronotal fovea, apex of rostrum and hairs on abdominal venter dark brown to blackish. Legs and venter with diffuse medium brown markings. Hemielytra hyaline with embolium and short posthumeral stripe blackish. Hind wings with smoky patches which in folded condition form an arrow-shape like patch along claval suture, in addition a less distinct stripe at apex of hind wings. Scutellum and anterior part of pronotum in male, some small patches medially on abdomen in female, brownish. Dark form, dorsally generally shining blackish; interocular space, anterior part of pronotum, posterolateral margins of scutellum, large V-shaped spot basally on hemielytra and legs pale yellowish. Pale markings on scutellum and hemielytra variable. Labrum and rostrum partly medium brown, venter pale. Hemielytra hyaline in dark form with extensive dark brown to blackish smoky markings; hind wings largely light smoky brown.

Structural characteristics. Anterior margin of head transverse with vertex hardly protruding, width of head twice its median length (4.0/1.8). Median length of head about one and a half times the anterior width of vertex (1.8/1.25) and slightly larger than median length of pronotum (1.8/1.6). Humeral width of pronotum two and a half times its length (4.55/1.8), lateral margins diverging posteriorly, hind margin gently sinuate to nearly straight. Dorsal margin of pronotal fovea clearly diverging behind eyes, with a distinct ridge which in female is expanded laterally so that the fovea is not or hardly visible in dorsal view, in male fovea at least narrowly visible in dorsal view. Embolium only slightly expanded anteriorly. Length of nodal furrow and its distance to membranal suture subequal (about 0.65). Fore trochanter narrow posteriorly, without ventral nodule; mesotrochanter obtusely angulate posteriorly. Pilosity and spinosity of legs approximately as in related species. Sides of metaxiphus basally nearly straight, strongly converging, apex of xiphus narrow, elongate and acute, needle like. Connexiva of segments 1-3 with black denticles, not ridged.

Figs. 8-12. Habitus of *Enithares* males. – 8, *E. charakia*, paratype; 9, *E. stansae* (paratype); 10, *E. producta*; 11, *E. ektakta* (paratype).



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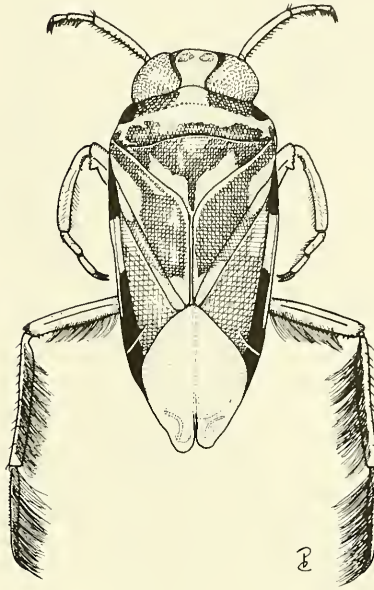

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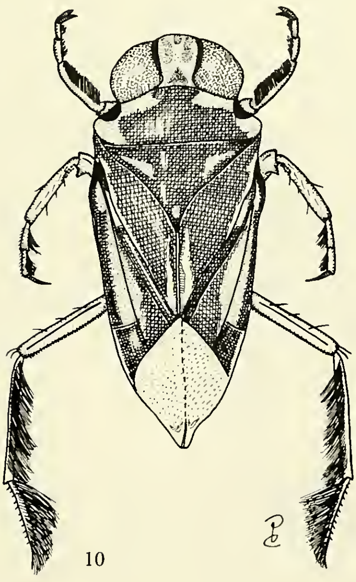

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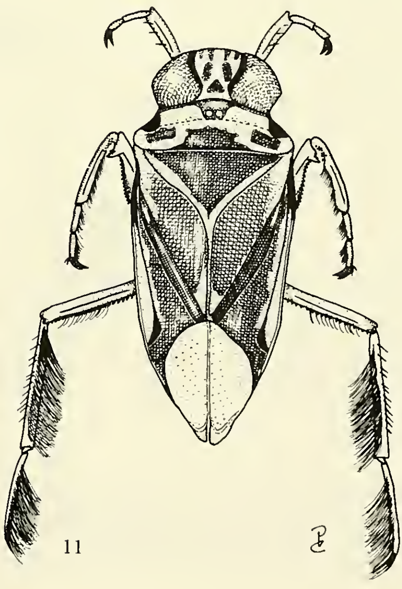

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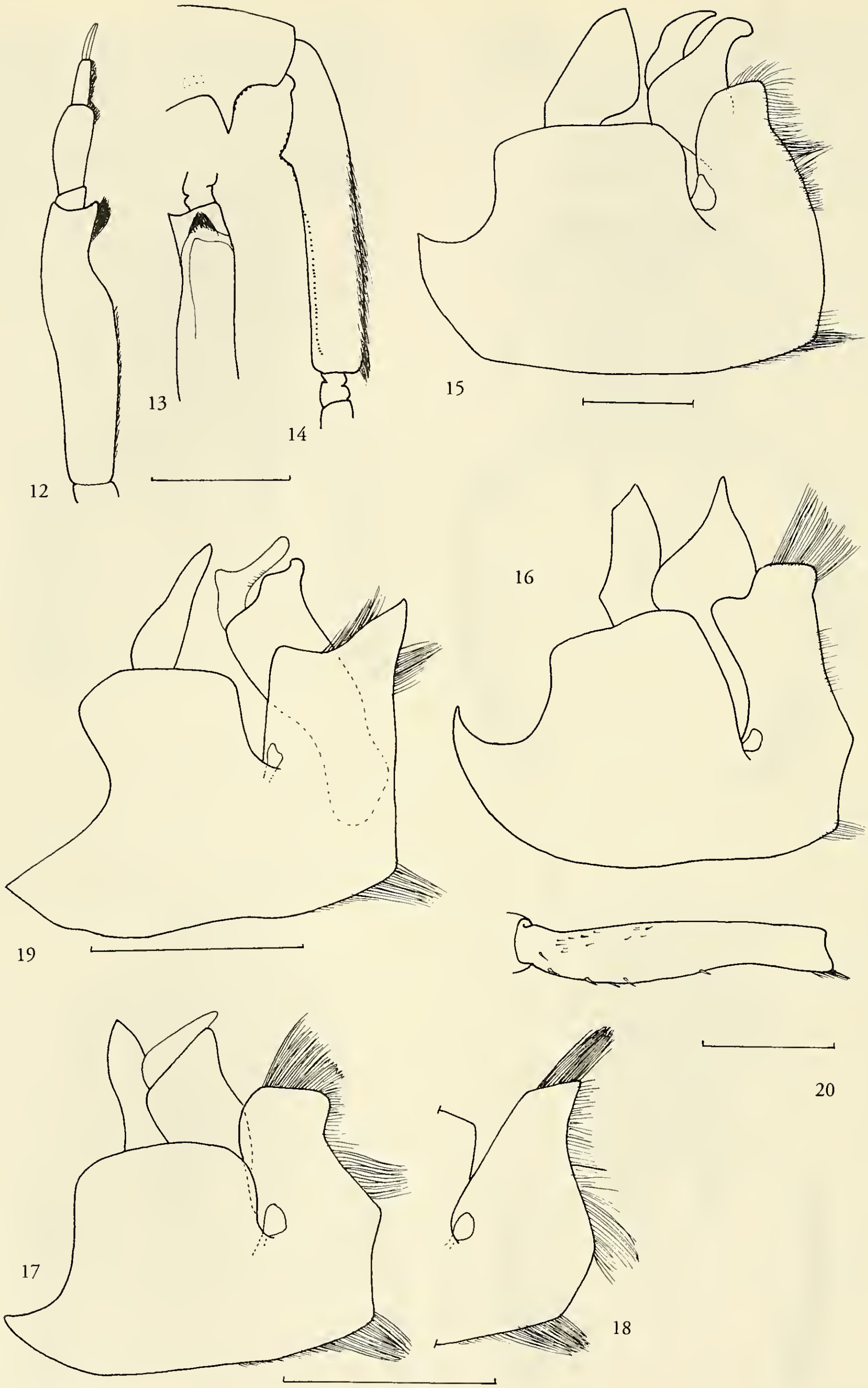
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Male. Fore tibia with a wide and deep subapical incision accentuated by a dense tuft of bristles (figs. 12, 13), middle tibia with a small blunt tooth ventrally near base (fig. 14). Genital capsule as in fig. 15.

Etymology. – *Charakia*, a Greek noun meaning incision, referring to the anterior tibia of male.

Comparative notes (see key). – The male can be immediately recognised by the incised fore tibia. The female would run to *E. bergrothi* Montandon & *E. hebridensis* Lansbury in the key by Lansbury (1968). Both are smaller (up to 10.5 mm) and have the metaxiphus without protracted apex; the expanded dorsal margin of pronotal fovea is also diagnostic. They are, moreover, restricted to the Nouv. Calédonie and New Hebrides region. Females of similar Sulawesi species will, as a rule, be somewhat smaller except for *E. horvathi* which is reported to have the nodal furrow less than its own length removed from the membranal suture (Lansbury 1968).

Enithares ektakta sp. n.

(figs. 11, 17)

Type material. – Holotype male (ZMAN, dark form), INDONESIA: Sulawesi Utara, Pulau Sangihe, Bowokulu, small mountain stream, [between large boulders, narrow stretches with strong current alternating with small, virtually stagnant pools (*Enithares* in the pools)], 19 Nov. 1994, N9477, leg. N. Nieser. Paratypes, same data as holotype, 10♂ 11♀ distributed as follows: 1♀ (allotype, pale form) ZMAN; 1♂ 1♀ BPBM, 2♂ 3♀ JTPC, 1♂ 1♀ MBBJ, 1♂ 1♀ RMNH. Additional paratypes (adults only), all P. Sangihe and Leg. N. Nieser: Desa Laine, Sungai Laine at waterfall, [*Enithares* in shade under tree in pothole at foot of waterfall, one specimen in a rock pool], 12. XI.1994, N9463, (1♂ 1♀ NHMW); Desa Utaurano, Sungai Apanukang, [*Enithares* in small rock pool (0.2x0.2m, 0.1m deep) partly hidden under vegetation], 14. XI. 1994, N9465, 1♂ 3♀, 2 lvIV; Makariahe, small mountain stream [virtually a trickle of water between small pools between boulders, *Enithares* in the pools], 19. XI. 1994, N9478, 1♂ 11♀, 1 lvIV, 4 lvV (1♀ MBBJ, 1♀ MUDH, 2♀ NMSC, 1♂ 1♀ SEMC, 2♀ USCP, 1♀ ZC); Sungai Limu, small mountain stream, [cascades and pools between boulders], 19.XI.1994, N9479, 3♂ 3♀.

Description. – Shape (fig. 11), medium sized with greatest width across the protruding humeral angles of pronotum. Dimensions. Length ♂ 9.5-10.4, ♀ 9.5-10.5; width (= humeral width of pronotum) ♂ 3.80-4.28, ♀ 3.85-4.13; width of head ♂ 3.18-3.30, ♀ 3.03-3.30; anterior width of vertex ♂ 1.03-1.30, ♀ 0.99-1.25; synthlipsis ♂ 0.75-0.80, ♀ 0.70-0.80.

Colour. – Dark form, dorsally black, eyes dark castaneous, interocular space pale, anterior half of pronotum and scutellum variable from pale to nearly entirely black. Venter and legs light brownish with dark spots, pilosity and small pegs on connexiva black. Pale form, dorsally pale, eyes castaneous; humeral angle and costal margin of hemielytra grey.

Structural characteristics. – Anterior margin of head transverse with vertex hardly protruding, width of head slightly over twice its median length (3.2/1.5). Median length of head about one and a half times the anterior width of vertex (1.5/1.1) and subequal to median length of pronotum (1.5/1.5). Humeral width of pronotum nearly three times its length (4.0/1.5), lateral margins strongly diverging posteriorly, humeral angles laterally produced, hind margin gently sinuate. Dorsal margin of pronotal fovea anteriorly parallel or very slightly diverging behind eyes, anterolateral angles of pronotum broadly rounded in both sexes. Costal margin of hemielytra (in closed position) in dorsal view converging gradually over their entire length (fig. 11). Embolium distinctly expanded anteriorly. Nodal furrow short, softly curved cephalad, somewhat more than its own length removed from membranal suture (0.65/0.55). Fore trochanter narrow posteriorly, without ventral nodule; mesotrochanter rounded posteriorly. Pilosity and spinosity of legs as in its nearest relatives (*E. margarethae* & *E. producta*). Sides of metaxiphus convex in basal part resulting in a elongate acute apex. Connexiva of segments 1-3 with small dark spines, not ridged.

Male. – Anterior tarsus, intermediate tibia and tarsus somewhat thicker and more pilose than in female. Genital capsule as in fig. 17.

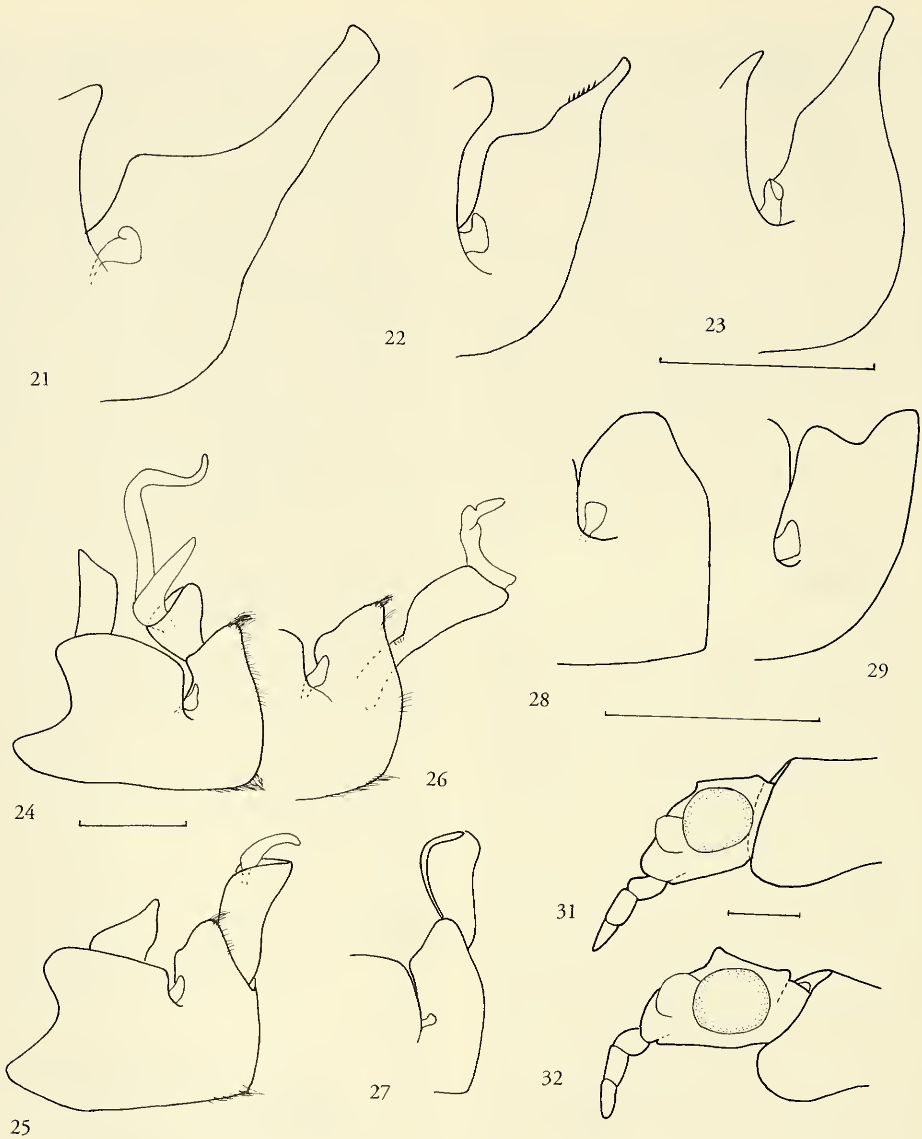
Etymology. – *Ektaktos*, a Greek adjective meaning protruding, referring to the protruding humeral angles of pronotum.

Comparative notes. – Similar to *E. producta* Lansbury and *E. margarethae*, differences are given in the key. See also under *E. margarethae*.

Figs. 12-16. *Enithares* male paratypes. – 12-15, *E. charakia*; 12, fore tibia and tarsus outer view, 13 apex of fore tibia inner view, 14 middle tibia, 15 genital capsule; 16, *E. stansae* genital capsule. Scales 7-9 1mm, 10-11 0.5 mm.

Figs. 17-19. Genital capsules of *Enithares*: 17, *E. ektakta* paratype, 18, *E. producta* (posterior lobe only), 19, *E. margarethae* paratype. Scale 0.5 mm.

Fig. 20. Middle tibia of male *E. margarethae*, scale 1mm.



Figs. 21-29. *Enithares* species. – 21-23, Outline of hind lobe of genital capsule; 21, *E. horvathi* (redrawn from Lansbury 1968); 22, *E. lansburyi*; 23, *E. skutalis* (scale for figs. 22-23, 1 mm). – 24-27, genital capsules. 24, *E. paramegalops*, specimen from Sulawesi Tengah; 25, idem, specimen from Bacan; 26, idem, posterior lobe of holotype; 27, posterior lobe of *E. megalops* (redrawn from Lansbury 1968). Scale 0.5 mm. – 28-29, Outline of hind lobe of genital capsule. 28, *E. phenakismos*; 29, *E. caesaries*. Scale 1 mm.

Figs. 31-32. Head and anterior part of pronotum of *Ranatra* paratypes. – 31, *R. sulawesii sebui*; 32, *R. sulawesii sulawesii*. Scale 1 mm.

Enithares margarethae sp. n.
(figs. 19, 20, 30)

Type material. – Holotype male (ZMAN), INDONESIA, Sulawesi Selatan: SW Sulawesi, Karangan ca. 30 km NE of Enrekang, 1450m, gardens, 10-11 Nov. 1993, rather sluggish stream, width 4-5 m, leg. J.P. & M.J. Duffels. Paratypes, same data as holotype, 1 ♀ allotype ZMAN, 1 ♂ NCTN.

Description. – Shape, medium sized with greatest width across the caudal part of scutellum. Dimensions, length ♂ 11.3-11.9, ♀ 11.2; width ♂ 4.85-5.00, ♀ 4.40; width of head ♂ 3.60-3.68, ♀ 3.50; anterior width of vertex ♂ 1.22-1.32, ♀ 1.32; synthlipsis ♂ 0.81-0.84, ♀ 0.80; humeral width of pronotum ♂ 4.43-4.46, ♀ 4.20.

Colour. Pale form, dorsally sordid pale yellowish, eyes castaneous; head, pronotum and scutellum of male paratype dark.

Structural characteristics. – Anterior margin of head transverse with vertex hardly protruding, width of head twice its median length (3.6/1.8). Median length of head nearly one and a half times the anterior width of vertex (1.8/1.3) and longer than median length of pronotum (1.8/1.5). Humeral width of pronotum nearly three times its length (4.5/1.5) in males, slightly less in female (4.2/1.5); lateral margins strongly diverging posteriorly, humeral angles laterally broadly produced, hind margin gently sinuate. Dorsal margin of pronotal fovea anteriorly parallel behind eyes, anterolateral angles of pronotum broadly rounded in both sexes. Costal margin of hemielytra (in closed position) in dorsal view convex in anterior third (more distinct in males) converging gradually over posterior two thirds (as in *E. producta*, fig. 10). Embolium distinctly expanded anteriorly more obviously in males than in females especially in dorsal view. Nodal furrow short, hardly curved cephalad, about its own length removed from membranal suture (0.6). Fore trochanter narrow posteriorly, without ventral nodule; mesotrochanter rounded posteriorly. Pilosity and spinosity of legs as in its nearest relatives (*E. producta, E. ektakta*). Sides of metaxiphus convex in basal part resulting in a elongate acute apex. Connexiva of segments 1-3 with small dark spines, not ridged.

Male. – Anterior tarsus, intermediate tibia and tarsus somewhat thicker and more pilose than in female. Intermediate tibia in outer view concave on apical half of anterior margin (fig. 20). Genital capsule with posterior lobe broad with a concave dorsal margin (fig. 19).

Etymology. – The species is named after Mrs. Greet Duffels who collected the specimens.

Comparative notes. – Similar to *E. ektakta* and *E. producta*, differences are given in the key, the body shape (base of abdomen parallel in *E. ektakta* versus divergent or convex in the other two) is also characteristic for females. In addition the concave margin of the apical half of the middle femur of male is distinct in *E. margarethae*, slight in *E. producta* whereas in *E. ektakta* this margin is straight. Isolated females of *E. margarethae* and *E. producta* will be difficult to identify. The female of *E. margarethae* is larger than those of *E. ektakta* (length up to 10.5) and *E. producta* (length up to 10).

Enithares stansae sp. n.
(figs. 9, 16, 30)

Type material. – Holotype male (RMNH), INDONESIA: Sulawesi Selatan, c. 10 NW Palopo (km 15 Palopo-Rantepao: Salo Tandung, 300-400 m asl., 2°58'S 120°07'E; width 10m, large boulders, torrents, seepage areas in open secondary forest, 27. April, 1991, leg. S. Kofman, (91JvT15). Paratypes: same data as holotype, 1 ♀ (allotype) (RMNH), 1 ♂ (NC); 15 km W of Palopo, Sungai Tandung, gardens and disturbed rain forest, 300-400m, 2°57'S 120°07'30"E, 30.X.1993, leg. J.P. Duffels & Mr. Gala, 1 ♀ (ZMAN).

Description. – Shape (fig. 9), medium sized, in posterior two thirds wedge-shaped species, greatest width across pronotal humeri. Dimensions (the male with the smaller dimensions is the holotype), length ♂ 9.5-9.8, ♀ 9.9-10.0; humeral width of pronotum ♂ 3.90-4.03, ♀ 3.91-3.92; width of head ♂ 3.10-3.20, ♀ 3.11-3.17; anterior width of vertex ♂ 1.19-1.21, ♀ 1.18-1.22; synthlipsis ♂ 0.67 ♀ 0.66-68.

Colour. – Dorsally generally shining blackish, due to black abdomen visible through wings. Vertex, anterior part of pronotum, oblong stripes postero-laterally on scutellum, legs and frons pale yellowish. Labrum and rostrum partly medium brown, apical segment of rostrum blackish, venter laterally and caudally pale, centrally grey. Hemielytra hyaline with embolium, stripe along embolium and most of basal part of membrane dark smoky brown. Hind wings largely light to medium smoky brown.

Structural characteristics. – Anterior margin of head transverse with vertex hardly protruding, width of head nearly two and a half times its median length (3.1/1.3). Median length of head slightly larger than anterior width of vertex and equal to median length of pronotum. Humeral width of pronotum three times its length, lateral margins diverging posteriorly, hind margin gently sinuate. Dorsal margin of pronotal fovea slightly diverging (nearly parallel) behind eyes. Embolium only slightly expanded anteriorly. Nodal furrow curved cephalad, about its own length

Fig. 30. Localities of *Enithares* species in Sulawesi.

removed from membranal suture (slightly more in holotype: 0.55/0.60, equal in allotype: 0.55/0.55 and paratype ♂: 0.60/0.60). Fore trochanter narrow posteriorly, without ventral nodule; mesotrochanter roundly angulate posteriorly. Pilosity and spinosity of legs roughly as in related species except for mesotrochanter and mesofemur in male which are beset with a fleece of long hairs in ventral half. Sides of metaxiphus converging, slightly convex in basal part, accentuating somewhat the acute apex. Connexiva of segments 1-3 with small black spines, not ridged.

Male. – Middle trochanter and proximal part of femur hairy. Genital capsule with caudal lobe incised dorsally (fig. 16).

Etymology. – The species is named in honour of Mrs. Stans Kofman, who collected the specimens.

Comparative notes. – The male can be separated from most species by the thick hair cover on ventral half of middle femur which it shares with *E. caesaries* Nieser & Chen and *E. alexis* Lansbury. *E. alexis* has middle trochanter distinctly pointed and apex of metaxiphus obtuse. *E. caesaries* is slightly larger, has its greatest width at level of apex of scutellum and has a different genital capsule (see key). The female would run to *E. freyi quadrispinosus* Lansbury, *E. ripleyana* Lansbury or *E. timorensis* Brooks in the key by Lansbury (1968). All are smaller (up to 9.75 long and 3.75 wide) and have width of head nearly to slightly over three times anterior width of vertex (in *E. stansae* 2.6). The females of *E. caesaries* and *E. skutalis*, which may be very similar, are not known.

Enithares bakeri Brooks

Enithares bakeri Brooks, 1948: 40.
Enithares bakeri; Nieser & Chen 1991: 59.

Material. – INDONESIA, Sulawesi Utara, Pulau Sangihe: pond along road near bridge [see N9456a], 27.VI.1994, N9455, 2♂ 4♀; Sungai Laine (near Naha), at third bridge [upstream from mouth, slow current, much *Hydrilla*], 17.XI.1994, N9456a, 1♂ 1♀; Masalihe, pond along road, algal bloom, 16.XI.1994, N9469, 1♂ 1♀. Sulawesi Utara: Dumoga Bone N.P., Toraut, Tümpel at Labor [pools at laboratory], 13.X.1985, 3♂ 1♀, leg. G. Zimmermann. – PHILIPPINES: Mindanao, Lake Sebu area, [upstream of barangay Bakdolong valley], narrow stream [in hilly country, shaded], pools [and quiet bays], 10.XII.1994, N9376, 1♀. Leg. N. Nieser unless otherwise indicated.

Distribution. – Widespread in E. Indonesia, N. Borneo and the Philippines.

Enithares martini Kirkaldy

Enithares martini Kirkaldy, 1898, Bull. Mus. Natn. Hist. Nat. Paris 1898: 151.
Enithares martini. – Lansbury 1968: 432-433 (redescription).

Material examined. – PHILIPPINES, Mindanao, Lake Sebu area: 'Cold River', short narrow side channel fed by seepage [from main river, shaded], 8. XII. 1993, N9376, 2♂ 7♀ (1♂ 3♀ USCP); [upstream of Bakdolong valley], narrow stream [in hills], pool [alongside stream bed, shaded], 10.XII.1993, N9379 1♂; same, pothole downstream of culvert, virtually stagnant, fully exposed to sunshine, 10.XII.1993, 2♀. All leg. N. Nieser.

Recorded previously from Luzon, and Mindanao (including Sulu Is.). The pale stripes at lateral margins of scutellum in dark specimens have in living specimens a vivid somewhat fluorescent orange tinge.

Enithares paramegalops Lansbury
(figs. 24-26, 30)

Enithares paramegalops Lansbury, 1968: 406-408.
Enithares ripleyana. – Nieser & Chen 1991: 59 (not *E. ripleyana* Lansbury: misidentification).

Material examined.- INDONESIA: Sulawesi Tengah, Ampana [Tanjung Api (=Fire Cape), ± 121°35'E, 0°50'S, ca. 200m from seashore, ca. 100m asl.], Waldtümpel {forest pools}, 2.II.1995, leg. Seyfert & Greindl (55) 1♂ (NHMW). Maluku, Bacan, Wayaua, logged forest, 5-16. VII. 1985, leg. J. Huijbregts, 1♂ (RMNH).

Lansbury (1968) described two very similar species, *E. megalops* and *E. paramegalops* which were distinguished by body size and characteristics of the male genital capsule (figs. 26, 27). The paramere of *E. paramegalops* is narrowed towards its apex, while the paramere of *E. megalops* is narrower at base and broad apically. The inner margin of the hind lobe has a projection in *E. paramegalops* which is lacking in *E. megalops*. The present specimens are intermediate in respect to size and to some extent in the shape of the posterior lobe of genital capsule. The holotype of *E. megalops* has a length of 7, that of *E. paramegalops* 7.75 mm, the present specimens have a length of 7.30 (Sul. Tengah) and 7.45 (Bacan). It is possible that *E. paramegalops* will turn out to be a synonym of *E. megalops* but more specimens, especially some longer series collected at the same locality are needed to solve this problem.

E. paramegalops was only known by its type series from Irian Jaya, Wisselmeren, which is now called Danau Paniai, near Enarotadi in the western part of the central mountain range (Pegunungan Maoke).

Enithares producta Lansbury
(figs. 10, 30)

Material. – Sulawesi Utara: Dumoga Bone N.P., Toraut, Tümpel in Wald (puddle in woods) near Base camp, 18.X.1985, 1 ♀ leg. G. Zimmermann.

Remarks. – Lansbury (1974) records two females of *E. producta* from Sumatera, stating that a male is needed to confirm this. As there are at least three closely related species, of the '*producta*-group' in Sulawesi, it is more probable that the Sumatera specimen belongs to an undescribed species. In view of the distribution we suppose the 2 ♀ paratypes *E. producta* from Rantepao (which is some 60 km N of Enrekang, fig. 30) cited by Lansbury (1968) are actually females of *E. margarethae*.

Enithares sp. near *timorensis* Brooks

Enithares vulgaris. – Nieser & Chen 1991: 59 (not *E. vulgaris* Lansbury: misidentification).

Material. – Sulawesi Tenggara, 20 Km E. Kolaka, N8934, 3. III. 1989, small stream in hilly woodland, leg. N. Nieser 1 ♀ (NCTN). Sulawesi Tengah, Sul. 37, Puncak Palopo, [puncak = summit of hill etc., narrow river 24 km N. of Rantepao, 800m asl.], 31. X. 1993, leg. H. Duffels 1 ♀ (ZMAN).

Remarks. – After comparing these specimens with some specimens of *E. vulgaris* Lansbury from Biak it turned out that the Sulawesi specimens do not belong in *E. vulgaris*. Apart from being slightly larger the general shape is different, *E. vulgaris* has the sides of body largely parallel behind humeral angles of pronotum over two thirds of the length of abdomen whereas it is convergent over the whole length of abdomen in the Sulawesi specimens. The apex of scutellum is somewhat narrower and longer in *E. vulgaris*. It has been compared with some specimens of *E. timorensis* from Sumba (leg. Dammerman, cited by Lansbury 1968, in RMNH). Although the Sulawesi specimen is similar to *E. timorensis* there are some differences: *E. timorensis* makes a more robust impression as it has the sides of body parallel over most of its length and tapering strongly posteriorly, whereas the sides of body are gradually converging over their entire length in the Sulawesi specimen. In addition the distance between the anterolateral angle of the pronotal foveal and the posterolateral angle of the eye is greater in *E. timorensis*, the apex of the metaxiphus is somewhat more solid and thus appears somewhat shorter in the Sulawesi specimen and the ventral rim of embolium is wider anteriorly in the Sulawesi specimens (0.22/0.15). Probably this is an undescribed species but males are needed for a definitive identification.

The key to *Enithares* from Sulawesi by Nieser & Chen 1991 deals with eight species, as there are now twelve species known it is rewritten here.

Key to males of *Enithares* of Sulawesi

(The females of some Sulawesi species are not yet known, in most cases females will run to species groups and have to be checked with descriptions and comparative notes.)

1. Embolium in ventral view (ventral ridge of hemielytron) greatly expanded anteriorly, pronotal humeral angles produced into broad knobs (figs. 10, 11). Length about 9 mm 2
– Embolium in ventral view not greatly expanded, pronotal humeral angles not produced 4
2. Lateral margin of hemielytron in dorsal view parallel in basal quarter, caudal three quarters converging (initially only slightly, fig. 11). Genital capsule as in fig. 17 [P. Sangihe] ....*E. ektakta* **sp. n.**
– Lateral margin of hemielytron in dorsal view diverging in basal quarter, caudal three quarters converging (fig. 10) 3
3. Genital capsule as in fig. 18, ventral margin of ... middle tibia virtually straight [Sulawesi Utara, Tengah] .... *E. producta* Lansbury
– Genital capsule as in fig. 19, ventral margin of middle tibia shallowly but distinctly concave (fig. 20) [Sulawesi Selatan] ...... *E. margarethae* **sp. n.**
4. Length up to 9 mm 5
– Length 9.5 mm or more 7
5. Rather slender species, length 7-7.75 mm, humeral width of pronotum about 2.5 mm, inner margin of hind lobe of genital capsule produced (figs. 24-26), paramere narrowed apically [Irian Jaya, Maluku, Sulawesi] .... *E. paramegalops* Lansbury
– More robust species, humeral width of pronotum over 2.5 mm, usually about 3mm or more 6
6. Length 7.5-8.5, width of an eye slightly less than the anterior width of vertex (0.95/1.00), nodal furrow short, more than its own length removed from membranal suture (0.4/0.6). genital capsule large with a distinctly bilobed dorsal margin of anterior lobe [Mindanao, N. Borneo, Sulawesi, Maluku, Flores] .... *E. bakeri* Brooks
– Length 9.1 mm (♀), width of an eye equal to the anterior width of vertex (1.1), nodal furrow less than its own length removed from the membranal suture (0.55/0.45). Genital capsule unknown [Sulawesi Tengah & Tenggara] .... *E.* sp. near *timorensis*
7. Length 12.5 mm, dorsal part of posterior lobe of

genital capsule rod-like (fig. 21) [Sulawesi Selatan] .... *E. horvathi* Kirkaldy
– Length not over 12 mm, if apex of posterior lobe of genital capsule rod-like, length not over 11 mm 8
8. Apex of posterior lobe of genital capsule rod-like 9
– Apex of posterior lobe of genital capsule rounded 10
9. Middle tibia not distinctly broadened, rod-like apex of posterior lobe of genital capsule rather short with small solid pegs on inner side (fig. 22) [Sulawesi Tenggara] ....*E. lansburyi* Nieser & Chen
– Middle tibia distinctly broadened, rod-like apex of posterior lobe of genital capsule more elongate without small pegs on inner side (fig. 23) [P. Buton] .... *E. skutalis* Nieser & Chen
10. Fore tibia with a distinct subapical incision accentuated by an apical tuft of bristles (fig. 12), middle tibia with a small blunt tooth ventrally near base (fig. 14) [Sulawesi Tengah] ....*E. charakia* sp. n.
– Fore tibia without a subapical incision, middle tibia without tooth ventrally near base 11
11. Dorsal margin of posterior lobe of genital capsule bilobed (figs. 16, 29), middle femur hirsute .. 12
– Dorsal margin of posterior lobe of genital capsule rounded (fig. 28), middle femur not particularly hirsute [Sulawesi Tengah] .... *E. phenakismos* Nieser & Chen
12. Lobes on dorsal margin of hind lobe of genital capsule about equally high (fig. 29), middle femur strongly hirsute in distal half [Sulawesi Tengah] .... *E. caesaries* Nieser & Chen
– Inner lobe on dorsal margin of posterior lobe of genital capsule lower than the posterior lobe (fig. 16), middle femur hirsute in proximal half [Sulawesi Selatan] .... *E. stansae* sp. n.

Nepidae

Laccotrephes sp. n.

The specimen of '*Laccotrephes tristis*' cited by Nieser & Chen 1991: 54, belongs, according to J. T. Polhemus (personal communication), to an undescribed species to be published in the near future.

Ranatra sulawesii sebui subsp. n.
(fig. 31)

Type material. – Holotype ♀ (USCP), PHILIPPINES, Sarangani prov. (= S. Cotabato), lake Sebu, village pond behind market, ring-shaped shallow pond with rich vegetation, used e.g. for bathing water buffalo, 7. Dec. 1993, leg. N. Nieser N9347. Paratypes: 1 ♀ same data as holotype, 1 ♀ same locality as holotype, 9. XII. 1993 (NCTN).

Description. – This species is identical to *R. s. sulawesii* Nieser & Chen (1991), except for being probably slightly smaller on average, length 32.5-35.2, humeral width of pronotum 3.10-3.30. The tubercle on head between eyes less distinct, the anteroventral lobe of pronotum less pronounced (figs. 31, 32) and the lateral length of pronotum equal to length of fore femur (1.1 × in *R. s. sulawesii*).

Comparative notes. – This species is associated with the *R. gracilis*-group of Lansbury (1972) in view of its tuberculate vertex and the emarginate metasternum. In the key by Lansbury (1972) both subspecies of *R. sulawesii* run to *R. parmata* Mayr, a widespread species in SE Asia which has the tubercle on vertex much more pronounced and the siphon relatively shorter, about one third body length (equal to slightly longer than body length in both subspecies of *R. sulawesii*).

Remarks. – The differences between *R. s. sebui* and *R. s. sulawesii* are small but as all three Mindanaoan specimens differ in the same way from four Sulawesi females there is strong indication for some genetic isolation between these populations. For elucidation of the definitive status of these taxa males from Sebu and specimens from other populations on Sulawesi and Minadanao are needed.

REFERENCES

Brooks, G. T., 1948. New species of *Enithares* (Hemiptera, Notonectidae). – Journal of the Kansas Entomological Society 21: 37-54, 3 plates.

Kirkaldy, G. W. 1898. Description d'une espèce nouvelle de Notonectidae (Hemiptera) de la collection du Muséum d'histoire naturelle de Paris. – Bulletin du Muséum National de Histoire Naturelle de Paris 1898: 151.

Lansbury, I., 1968. The *Enithares* (Hemiptera - Heteroptera: Notonectidae) of the Oriental region. – Pacific Insects 10: 353-442.

Lansbury, I., 1974. Notes on the genus *Enithares* Spinola (Hem., Notonectidae). – Entomologist's Monthly Magazine 109 (1973): 226-231.

Lansbury, I., 1972. A review of the Oriental species of *Ranatra* Fabricius (Hemiptera - Heteroptera: Nepidae). – Transactions of the Royal Entomological Society of London 124: 287-341.

Nieser, N. & P. P. Chen, 1991. Naucoridae, Nepidae and Notonectidae, mainly from Sulawesi and Pulau Buton (Indonesia). Notes on Malesian aquatic and semiaquatic bugs (Heteroptera), I. – Tijdschrift voor Entomologie 134: 47-67.

Nieser, N. & P. P. Chen 1995. Nine new species of *Pseudovelia* and a new *Xiphovelia* (Heteroptera: Veliidae) from Sulawesi (Indonesia) and Mindanao (Philippines). – Tijdschrift voor Entomologie 138:69-87.

Polhemus, D. A. & J. T. Polhemus, 1988. The Aphelocheirinae of tropical Asia (Heteroptera: Naucoridae). – Raffles Bulletin of Zoology 36: 167-300.

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TRIFURCULA SILVIAE VAN NIEUKERKEN: BIOLOGY AND NEW RECORDS (LEPIDOPTERA: NEPTICULIDAE)

Nieukerken, E. J. van, J. Junnilainen, N. Savenkov & I. Šulcs, 1996. *Trifurcula silviae* Van Nieukerken: biology and new records (Lepidoptera: Nepticulidae). – Tijdschrift voor Entomologie, 139: 175-179, figs. 1-6. [ISSN 0040-7496]. Published 18 December 1996.

Trifurcula silviae van Nieukerken, 1990, previously known only from the French Alps only has been discovered in eastern Latvia, where stem-mines and larvae have been discovered on *Onobrychis arenaria.* New records are also given for the Italian and French Alps and Spain.

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Key words. – Nepticulidae, Latvia, disjunct distribution, stem-mines, biology, new records.

Trifurcula silviae van Nieukerken, 1990 was described after a small number of specimens from Southeastern France. It was found at relatively low and warm localities in the southern Alps up to high alpine localities (1800 m). Although the biology was unknown, its relationships in the *Trifurcula subnitidella* group and its occurrence in meadows without trees or shrubs indicated that it was, most likely, feeding on a leguminosous herb, with *Anthyllis, Lotus* and *Onobrychis* as suggested possibilities (Van Nieukerken 1990). After visiting several of its localities, the senior author had a strong suspicion that the last plant genus was the most likely candidate, since the species *Onobrychis montana* DC. occurred in all localities, often in large numbers.

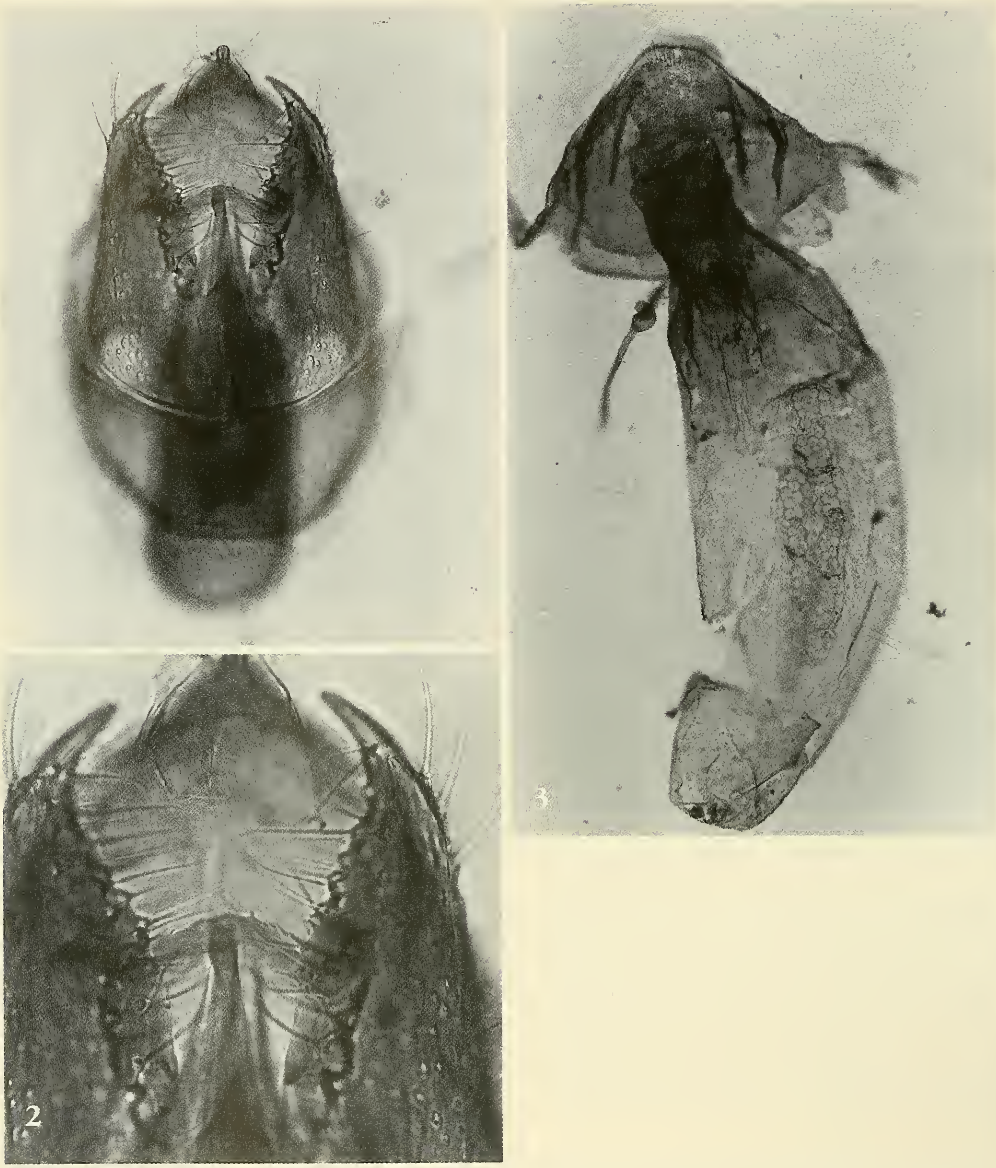
In the area near Šķaune, eastern Latvia, the third author discovered an unknown *Trifurcula* when sweeping plants of *Onobrychis arenaria* (Kit.) DC in 1985. This was identified by R. Puplesis as *Trifurcula subnitidella* (Duponchel) (at that time the only known species in this group) and published under its junior synonym *T. griseella* Wolff by Savenkov (1989, see also Savenkov 1994). Later the three junior authors discovered more specimens of this species and, unhappy with the original identification, turned to the senior author for an identification. In August 1994 they finally discovered empty and tenanted stem-mines of a nepticulid in the forementioned plant.

Although the locality is far apart from the area where the species was known, the senior author immediately considered it most likely to be *T. silviae,* which he could confirm after studying some specimens. The mines and larvae were also considered to belong to this species, which is now confirmed by the first emerging adults.

Also in 1994 the species was discovered in Spain by A. and Z. Laštůvka and some unidentified Nepticulidae from G. Bassi contained the first Italian specimen, confirming a larger distribution than hitherto known. Since the original description was published, two more French specimens were found amongst unidentified material. The species is recorded for the first time from the area dealt with by Van Nieukerken & Johansson (1990) and by Puplesis (1994), we therefore provide a diagnosis and illustrations as an addition to these works.

Trifurcula (Trifurcula) silviae Van Nieukerken

Trifurcula silviae van Nieukerken, 1990: 230. Holotype ♂: France, 1 km NW Ceillac (Htes Alpes), 1800 m, 24.vii.1987, van Nieukerken & Richter (National Museum of Natural History, Leiden, RMNH) [examined]



Figs. 1-3. *Trifurcula silviae*, Latvia, Šķaune area. – 1, Male genitalia, slide EJvN 2833; 2, Idem, detail gnathos; 3, Female genitalia, slide EJvN 2828.

Diagnosis

T. silviae male lacks the typical yellow patch of other species of the *T. subnitidella* group, but can be relatively easily distinguished by a row of dark brown scales along the costal fold of the forewing and a similar row along the hindwing costa. The species is relatively pale and small (wingspan ca 5.8-7.0 mm). It could be confused with a small specimen of *T. immundella* (Zeller), with *T. serotinella* Herrich-Schäffer or perhaps with a worn *T. cryptella* (Stainton), but all lack the brown scales and *cryptella* has a white hair-pencil on the hindwing. Females have a relatively

Fig. 4. Tenanted and vacated stemmines of *Trifurcula silviae* in *Onobrychis arenaria*; Foto Jari Junnilainen.

blunt abdominal tip, but are otherwise very similar to the forementioned species. The male genitalia (fig. 1) resemble those of *T. subnitidella* (Duponchel), but the gnathos (fig. 2) lacks the asymmetrical point and has a serrated margin. Male genitalia are hard to distinguish from *T. iberica* Van Nieukerken, 1990 from Spain, which strongly differs in secondary sexual characters of the male. Female genitalia (fig. 3) differ from *T. subnitidella* by the more truncated abdominal tip and more numerous setae on anal papillae. For more details see Van Nieukerken (1990).

Biology

Host plants. – *Onobrychis arenaria* (Kit.) DC. and probably *O. montana* DC.

Life history. – Egg on the stem of the hostplant. The larva is about 5 mm long, yellowish. Mines can be found on different heights in the stem, from ground level to about 40 cm, occasionally with several mines occurring in the same stem. The mine (fig. 4) is a long gallery in the bark, typically with the larva first mining downwards, changing its direction a few times lengthwise. Total length of mine approximately 8-16 cm. The first 0.5-1.0 cm of the mine is very narrow (less than 0.5 mm wide), reddish brown. The remaining part of the mine is paler yellowish, with its width increasing to 2 mm. Frass not completely in centre, but often on the lateral edge of the mine, brown, quite well visible in the fresh mine.

Voltinism. – Larvae have been found in August, at the same time as old mines, indicating an earlier occurrence. Adults from June to August, possibly as one prolonged generation, but the existence of two generations cannot be excluded. Cocoon unknown. The life history of *T.silviae* resembles that of *T.subnitidella* (Duponchel).

Habitat. – Mountain pastures, dry calcareous or sandy hills, usually with low vegetation, occasionally with shrubs. In Spain on rocky limestone slope with *Onobrychis* sp., *Anthyllis vulneraria*, *A. montana*, *Astragalus monspessulanus*, *Hippocrepis comosa* and others. Altitude from 200 m to 2000m. See fig. 5 for an impression of the Latvian habitat.

Fig. 5. Habitat of *Trifurcula silviae* in Šķaune area, with plants of *Onobrychis* in foreground. Foto Jari Junnilainen.

Fig. 6. Distribution of *Trifurcula silviae* in Europe, plotted on 50×50 km squares.

Distribution (fig. 6)

Spain, French and Italian Alps and Latvia. Most likely to occur in other localities, especially in the Alps and southern Europe, but possibly with disjunct distribution. See discussion.

Material examined (in addition to type series). – FRANCE: 1 ♂, 4 km N Eygians (Htes Alpes), 04.vii.1989-22.vii.1989, B. Å. Bengtsson (coll. Bengtsson); 1 ♂, Bessans: Col de la Madeleine (Savoie), 03.viii.1977, R. Buvat (coll. Buvat). – ITALY: 1 ♂, Mompantero, Mt. Rocciamelone (Piemonte), 1200 m, 18.vi.1993, G. Bassi (coll. Bassi). – LATVIA: 3 ♂, Šķaune (Shkyanes), 07.vi.1985, 29.vi.1986, N. V. Savenkov, sweeping over *Onobrychis arenaria* (coll. Savenkov), idem, 07.vi.1989, at light (coll. Šulcs); 1 ♂, 1 ♀, Šķaune, 14.vi.1994, flying over *Onobrychis arenaria*, K. Nupponen & J. Junnilainen (coll. Nupponen, Junnilainen); 2♂, Šķaune 9.vii.1994 by sweeping *Onobrychis arenaria*, K. Nupponen & J. Junnilainen (Colls. Nupponen, Junnilainen); mines and larvae, Šķaune, 18.viii.1994, adults emerging from 22.iii.1995 onwards, J. Junnilainen & I. Šulcs (RMNH, colls. Šulcs & Junnilainen). – SPAIN: 3 ♂, 1 ♀, prov. Teruel, Alcala de la Selva, 1400 m, 22.vi.1994, at light 1 h after sunset, A. & L. Laštůvka.

Discussion

The Šķaune locality, also known as the nature reserve Grebļakalns, is a sandy ridge, close to the village Šķaune in the extreme eastern part of Latvia, just a few kilometers from the Russian border. The ridge originated after the last glaciation, approximately 12 000 years BP. The lenght of the ridge is 6 km, rising 20-30 m above the surrounding plains. The slopes are covered with pine forest or mixed forest with many shrubs, such as *Euonymus*, *Cotoneaster* and *Corylus*. There are also open places, which are thought to have originated either as gravel pits or wood-burning places. The area has a continental and xerotherm microclimate and is known to be an outpost with relict elements of the Pontic flora and fauna, norably with plants such as *Onobrychis arenaria* (Kit.) DC., *Astragalus danicus* Retz. and *Dracocephalum ruyschiana* L. (see Šulcs 1975). These are thought to be relicts from the Subboreal period and occur in open places on slopes of the ridge.

Several Lepidoptera species in Latvia are known from this area only, such as *Heliophobus kitti* (Schawerda). Several elements of the eastern European fauna occur here, such as *Cryphia ereptricula* (Treitschke), *Lacanobia splendens* (Hübner), *Cabera leptographa* Wehrli, *Stegania cararia* (Hübner) and *Udea costalis* (Eversmann) amongst others (Savenkov 1986, Šulcs 1973, 1975, 1976, 1978).

Most interesting, however, is a number of Lepidoptera associated with *Onobrychis arenaria*, and only known from this locality in Latvia: *Agrodiaetus damon* (Denis & Schiffermüller) (Šulcs 1964), *Zygaena carniolica* Scopoli forma *berolinensis* Staudinger (Savenkov 1986), *Cydia caecana* Schläger (Šulcs 1976), and now *Trifurcula silviae. O. arenaria* is a rare and very local plant in Latvia, included in the Latvian Red List. Most populations of this plant are adventive and occur in secondary habitats such as road verges and railways. Natural populations are scarce, and the present one is the largest. Despite thorough search for it, *A. damon* has been found nowhere else and should be regarded as confined to this locality. We may therefore assume that the occurrence of *T. silviae* is also extremely localized, and that its distribution in Northeastern Europe might also be rather disjunct, comparable to that of *A. damon.* In the Alps, however, we expect a much larger distribution of this species than known at present. Now its mines are known, it will probably be found more frequently.

Acknowledgements

The authors are indebted to Aleš and Zdenek Laštůvka for the information on the Spanish record and to B. Bengtsson, G. Bassi and R. Buvat for the loan of material. We thank P. A. J. Frigge and J. B. M. Thissen (Wageningen, Netherlands) for the permission to use their program 'STIPT-EU' to prepare fig. 6. S. Whitebread kindly corrected the English languague.

References

Nieukerken, E. J. van, 1990. The *Trifurcula subnitidella* group (Lepidoptera : Nepticulidae) : taxonomy, distribution and biology. – Tijdschrift voor Entomologie 133 : 205-238.

Nieukerken, E. J. van & Johansson, R., 1990. Tribus Trifurculini. In Johansson, R. et al. The Nepticulidae and Opostegidae of North West Europe. – Fauna Entomologica Scandinavica 23 : 239-321.

Puplesis, R., 1994. The Nepticulidae of eastern Europe and Asia : Western, Central and Eastern parts. – Backhuys Publishers, Leiden. 291 pp., 840 figs.

Savenkov, N., 1986. New species of Lepidoptera in the fauna of Latvia. – Latvijas Entomologs 29 : 24-30. [In Russian].

Savenkov, N., 1989. New and rare Lepidoptera species in the fauna of Latvia. The report of 1987. – Latvijas Entomologs 32: 86-91. [In Russian].

Savenkov, N., 1994. New and rare Lepidoptera species in the fauna of Latvia, collected mainly in 1990-1994. – Daba un muzejs.- Gandrs. Rīga 5: in press.

Šulcs, A., 1964. Neue und wenig bekannte Arten der Lepidopteren-Fauna Lettlands, 3. – Fauna Latvijskoj SSR sopredel'nych territorij 4 : 165-202. [In Russian].

Šulcs, A., 1973. Neue und wenig bekannte Arten der Lepidopteren-Fauna Lettlands, 5. – Annales Entomologici Fennici 39 : 1-16.

Šulcs, A., 1975. Charakteristische Kennzeichen des Naturschutzobjekts Grebļakalns. – In: Ochrana primetsatel'nych prirodnych ob"ektov v Latvijskoj SSR : 83-99. Rīga, Zinatne.

Šulcs, A., 1976. Neue und wenig bekannte Arten der Lepidopteren-Fauna Lettlands, 6. – Annales Entomologici Fennici 42 : 4-21.

Šulcs, A., 1978. *Heliophobus texturata* ssp. *kitti*, eine für Lettland neue Noktuide (Lepidoptera, Noctuidae). – Notulae Entomologicae 58 : 27-31.

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BOOK REVIEW

Hans-Joachim Hannemann, 1995. Kleinschmetterlinge oder Microlepidoptera IV. Flachleibmotten (Depressariidae). – Die Tierwelt Deutschlands, 69. 192 pp., 13 plates (3 in colour), 84 text-figs., 84 maps. Gustav Fischer, Jena. Paperback. [ISBN 3-334-60959-6]. Price DEM 148.–.

After almost 20 years the fourth volume on Microlepidoptera is published in the series 'Tierwelt Deutschlands', written by the same author as the former three. It deals with the 84 Central European species of the small family Depressariidae, until recently considered to belong to the Oecophoridae and by some recent authors included in an enlarged concept of Elachistidae.

The text provides keys to species, descriptions of externals and genitalia, a short description of caterpillar and biology. The distribution is very briefly summarized and plotted on European maps by horizontal hatching. The maps provide very little detail. The distribution in Central Europe is described in some more detail. The identification is eased by accurate drawings of male and female genitalia and by black and white photographs of wing patterns. The colour plates are of poor quality, the moths are shown in natural size, not in focus, and the plates show shadows of the pins. For colour plates one should use Eivind Palms volume on Oecophoridae in the series 'Danmarks Dyreliv' (volume 4), which are enlarged twice and show the small details much better.

This book, however, is certainly a useful addition, because it brings together all information on this group from Central Europe for the first time. Most of this was previously dispersed in papers by Hannemann. It is also more complete than the Danish volume. Like the latter, also here I am missing a check-list and a hostplant catalogue or index. Specialists tend to forget that other users often want to have an entry on the basis of plant names rather than insect names.

Identification of the speciose genus *Agonopterix* is made easier by a split in four species groups, but identification of the groups is only possible on the basis of the hostplants! Therefore for the identification of non-reared specimens one must run through four keys. For the genus *Depressaria* there are only keys on the basis of the male genitalia.

This book certainly will be welcomed by lepidopterists, despite the relatively high price for a paperback of this size.

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FIVE NEW MINING LEPIDOPTERA (NEPTICULIDAE, BUCCULATRICIDAE) FROM CENTRAL ASIA

Puplesis, R. & Diškus, A., 1996. Five new mining Lepidoptera (Nepticulidae, Bucculatricidae) from Central Asia. – Tijdschrift voor Entomologie 139: 181-190, figs. 1-30. [ISSN 0040-7496]. Published 18 December 1996.

Three new species of Nepticulidae (*Stigmella johanssoni* sp. n., *Fomoria flavimacula* sp. n., *F. lacrimulae* sp.n.) and two new Bucculatricidae (*Bucculatrix multicornuta* sp. n., *B. macrognathos* sp. n.) are described from the mountains of Turkmenistan, Tadzhikistan and southern Kazakhstan.

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Key words. – Leaf-miners, Nepticulidae, Bucculatricidae, new species, Central Asia.

The growing international concern over the biodiversity crisis has revitalized biological systematics. Committed efforts to the inventory the world's major biota have never been more needed than now. In this light the Zoological Department of the Vilnius Pedagogical University started in 1995 to revise the fauna of the mining Lepidoptera of Central Asia. The generally small primitive leaf-mining Lepidoptera have been relatively poorly studied on a global scale, the fauna of such vast areas as Central Asia being almost completely neglected until recently (Puplesis et al. 1996c). This study comprises most taxa of lepidopteran miners. The work on these groups was divided among entomologists of our department as follows: Nepticulidae, Opostegidae, Tischeriidae and Bucculatricidae by R. Puplesis and A. Diškus; Heliozelidae and Elachistidae by V. Sruoga; Lyonetiidae, Gracillariidae and Phyllocnistidae by R. Noreika and karyological studies by J. Puplesienė. Some other families, such as Eriocraniidae, Momphidae and Coleophoridae, currently studied at the Zoological Institute of the Russian Academy of Sciences (St. Petersburg), were not considered in our project.

Surveys on all the microlepidopteran families studied by us are now in a preparation. The present paper includes just the report of five hitherto undescribed species. To have their names available for an updated check-list (Puplesis et al. 1996) we describe these here. The combination of phylogenetically not related taxa (Nepticulidae and Bucculatricidae) in this paper was purely for practical reasons.

The Nepticulidae of Central Asia have been reviewed by Puplesis (1994), the Bucculatricidae by Seksjaeva (1993). In addition, five other species of Nepticulidae (*Acalyptris argyraspis, Etainia leptognathos, E. obtusa, Stigmella cerasi, S.aflatuniae*) were recently described by Puplesis & Diškus (1995, 1996a, 1996b). Some more species will be described in forthcoming papers. Methods, terminology and nomenclature used in the descriptions follow Seksjaeva (1989, 1993) and Puplesis (1994).

The genus *Fomoria* Beirne (Nepticulidae) is treated here as a separate genus, not a subgenus of *Ectoedemia* Busck (i.e. van Nieukerken 1986). However, as has been stated by van Nieukerken (1986), the monophyly of *Fomoria* is still not established. Thus any decisions on rank or validity of this taxon are still to be regarded as provisional.

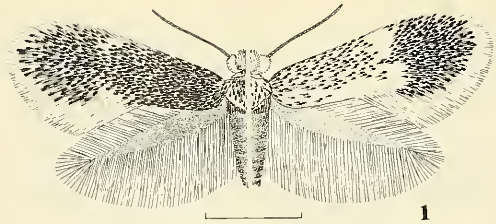
Abbreviations for depositories: RMNH (Nationaal Natuurhistorisch Museum, Leiden, Netherlands), VPU (Vilnius Pedagogical University, Lithuania), ZITAS (Zoological Institute of the Turkmenian Academy of Sciences, Turkmenistan).Diškus

Descriptions

Nepticulidae

Stigmella johanssoni sp. n.
(figs. 1, 6-9, 28)

[*Stigmella salicis* (Stainton); Puplesis 1994: fig. 350. misidentification]



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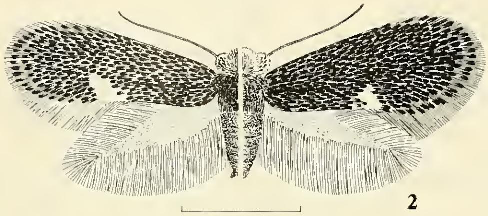

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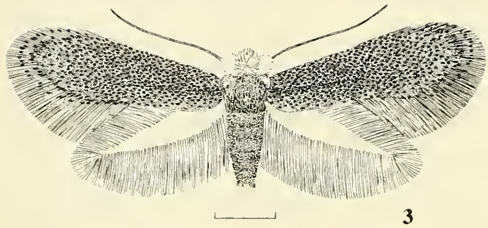

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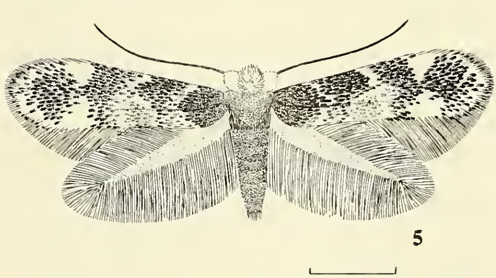
Figs. 1-3. Adult Nepticulidae. – 1, *Stigmella johanssoni*, male, showing variation in 2 paratypes; 2, *Fomoria flavimacula*, right side female paratype (central Tadzhikistan), left side male holotype; 3, *F. lacrimulae*, female paratype. Scales 1 mm.

4



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Figs. 4, 5. Adult *Bucculatrix* spp. – 4, *B. multicornuta*, male paratype; 5, *B. macrognathos*, male paratype (head reconstructed). Scales 1 mm.

Type material. – Holotype ♂: Kazakhstan (western Tyan Shan' mountains), 90 km E Tschimkent, H - 1300 m, Aksu Dzhabagly Reserve, 11.viii.1987, leg. R. Puplesis (VPU). Paratypes: 60♂, 80♀, same data as holotype (VPU, RMNH).

Diagnosis. – Closely resembling *S. salicis*, but all cornuti are collected in one basal cluster. In contrast to *S. salicis*, the vinculum of *johanssoni* is longer, and the forewing colour is often distinctly paler.

Male (fig. 1). – Forewing length 2.3-2.6 mm. Head: frontal tuft from white or pale yellow to orange; eye-caps and collar white or creamy; antenna greyish to creamy-brownish. Colour of thorax and forewing extremely variable (fig. 1); coarsely scaled, irrorated with brown scales. Cream costal and dorsal spots on forewings of varying shape; an additional large basal spot is sometimes present. Cilia cream. Hindwing and its cilia pale brownish to almost cream. Abdomen brown, underside cream. Anal tufts cream.

Female. – Also variable, usually slightly paler than male, but otherwise similar.

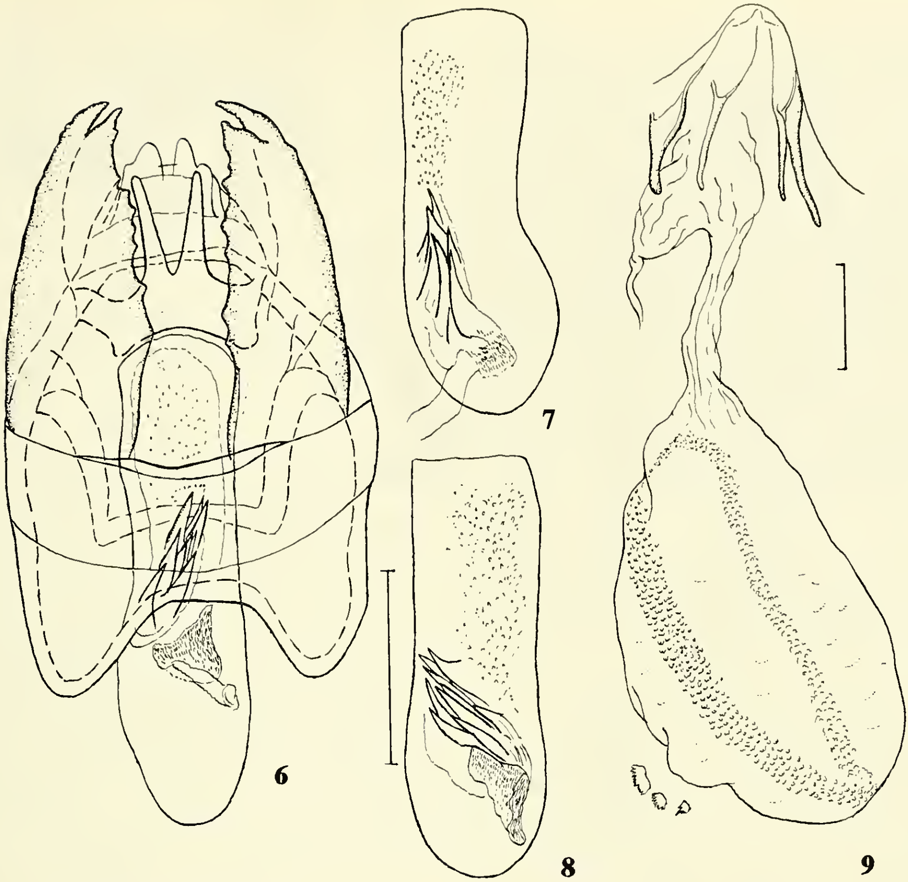
Male genitalia (figs. 6-8). – Valva with two short pointed distal processes. Transtilla without sublateral processes. Uncus with deep, square medial emargination and paramedial notches. Gnathos with long horns, closely set at base. Vinculum comparatively longer than in *S. salicis*, with wide lateral lobes. Aedeagus (figs. 7, 8) shorter than genital capsule, with about 9 cornuti in one basal cluster; cornuti spine-like, rather weakly sclerotized. Further vesica with extensive group of tiny spines.

Female genitalia (fig. 9). – Apophyses long, almost equal in length, or anteriores slightly longer than posteriores. Corpus bursae with sparse pectinations and a distinct band of scallop-shaped minute plates. Ductus spermathecae without spines. Ovipositor slightly protruding, tip almost pointed.

Biology. – Host-plant: *Salix* sp. All specimens have been caught with a light trap, in a small canyon near the Dzhabagly river. The trap was surrounded by a dense vegetation of *Salix*. On these trees we found numerous empty leaf-mines, supposedly of this species. The mine is a broad gallery, occasionally forming a false blotch. The black frass deposited in a broad and irregular central line. Adults have been collected in August, but probably fly in early summer as well, because some very old empty mines were found in August.

Distribution. – Western Tyan Shan' mountains (southern Kazakhstan) (fig.28).

Etymology. – This species is named in honour of Mr. Roland Johansson (Växjö, Sweden), specialist of Nepticulidae, and outstanding painter of these moths.



Figs. 6-9. *Stigmella johanssoni*, genitalia. – 6, Male, holotype; 7, 8, Aedeagus, two different paratypes; 9, Female, paratype. Scales 0.1 mm.

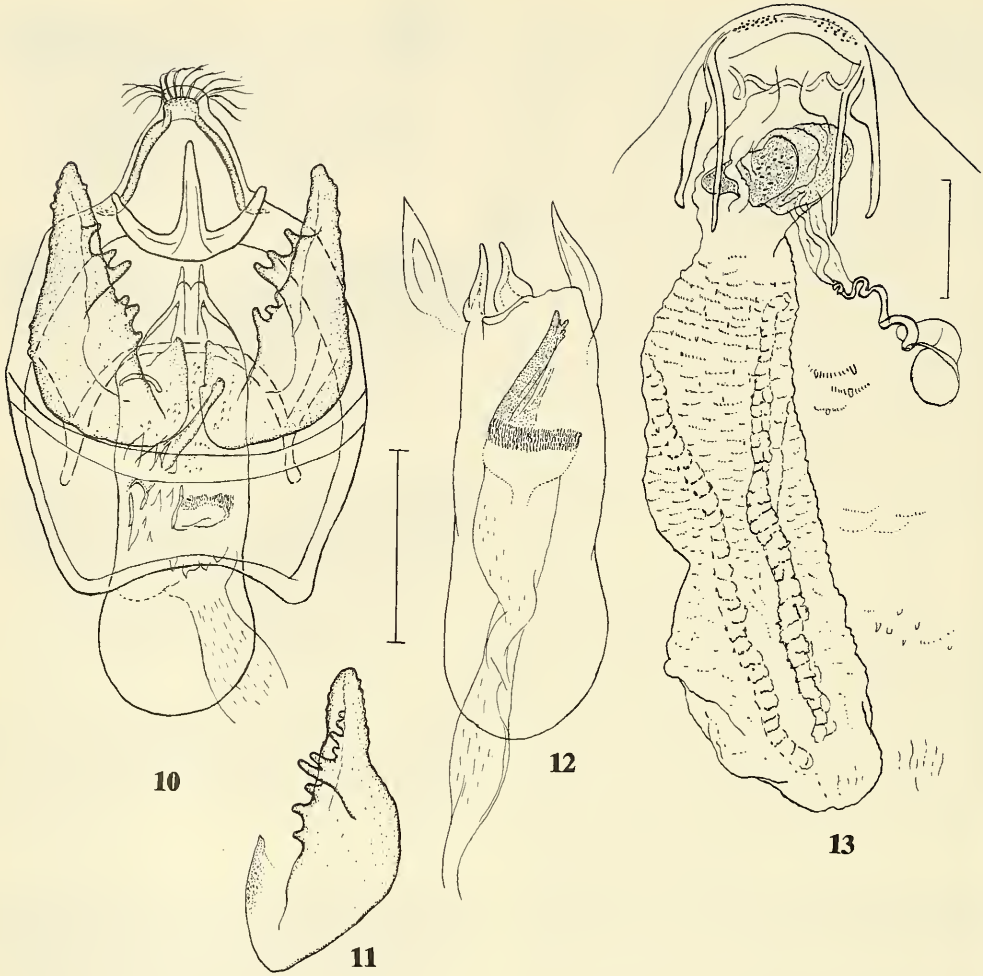
Fomoria flavimacula sp. n.
(figs. 2, 10-15, 28)

Type material. – Holotype ♂: southern Tadzhikistan, Tigrovaya Balka Reserve (= env. of Dzhilikul'), 26.vii.1990, leg. R. Puplesis (VPU). Paratypes: 2♂, 1♀, same locality, 26.vii-17.viii.1990, leg. R. Puplesis; 1 ♀, central Tadzhikistan, 30 km N Dushanbe (Kondara), larvae on *Populus* sp., 17.vii.1991, N 4241, leg. R. Puplesis & A. Diškus (VPU).

Diagnosis. – The male cannot be mistaken because of the combination of a white tornal spot at two-thirds of the forewing and the peculiarly shaped hindwing with yellowish cream androconial scales. The female resembles *F. septembrella* (Stainton) which also has a tornal spot, but differs by the shape of the ductus spermathecae. Male genitalia easily recognizable from all other *Fomoria* species by medial processes of valva and slender posterior process of gnathos.

Male (fig. 2, left side). – Forewing length 1.6-1.8 mm. Head: frontal tuft orange to pale orange; eyecaps densely covered or just irrorated with fuscous black scales on upperside; collar pale brown cream to cream; antenna varying from mixed grey with cream to almost fuscous. Thorax and forewing blackish fuscous, scales with pale bases. Forewing with a white tornal spot at two-thirds. Underside of forewing with silver lustre and with large elongate spot of yellowish cream androconial scales in the basal half. Cilia and hindwing cream. Hindwing very broad at base, clearly cuspidate towards tip; upper surface in basal half with a large spot of yellowish cream or brownish cream androconial scales. Abdomen not examined.

Female (fig. 2, right side). – Frontal tuft cream

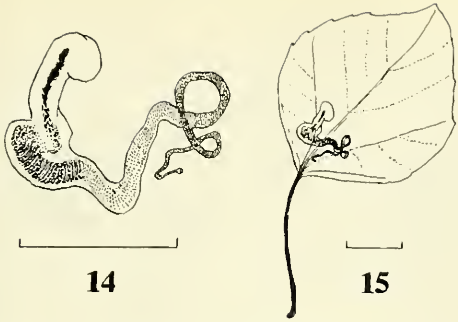


Figs. 10-13. *Fomoria flavimacula*, genitalia. – 10, Male, holotype; 11, Valva, paratype (southern Tadzhikistan); 12, Aedeagus, paratype (southern Tadzhikistan); 13, Female genitalia, paratype (central Tadzhikistan). Scales 0.1 mm.

with some blackish scales distally. Underside of forewing distinctly less silvery lustrous than in male, without androconial spot. Hindwing greyish, not broadened basally and without yellowish spot of androconia. Otherwise as in male.

Male genitalia (figs. 10-12). – Valva triangular, additionally with a triangular, pointed, weakly sclerotized basal process (fig. 11). Inner side of valva with distinct long papillae and processes of varying shape. Transtilla with slender, not very long sublateral processes. Pseuduncus long, rounded distally, but varying in width, with numerous long setae at apex. Uncus in shape of inverted 'v', distally well sclerotized and with numerous setae. Gnathos with very narrow, long and pointed posterior process. Vinculum large, distally hardly excavated. Aedeagus (fig. 12) with a pair of slender triangular dorsal carinae and a pair of long pointed ventral carinae. Vesica with rather small groups of different cornuti: some of them strongly sclerotized and irregular in shape, other less sclerotized, but triangular or spine-like.

Female genitalia (fig. 13). – Anterior apophyses slightly shorter than posterior ones. Vaginal sclerite sclerotized, with an irregular plate-like shape. Ductus spermathecae with about 4.5 convolutions. Corpus bursae elongate, with distinct pectinations and ex-



Figs. 14, 15. Leaf-mine of *Fomoria flavimacula*. – 14, Gallery with frass; 15, Leaf of *Populus* sp. with leaf-mine. Scales 1 cm.

tremely long but slender signa; they have indistinct borders, the pectinations forming squares.

Biology. – Host-plant: *Populus* spp., probably including *Populus pruinosa* Schrenk, which was particularly common in the type-locality. Egg on upperside of leaf. Larvae were found in July. Mine (figs. 14, 15) starts as a slender sinuous or even contorted gallery almost completely filled with green, occasionally brownish frass; further gallery gradually widening, green or blackish frass neatly coiled; in the last part of gallery frass linear and always black. Exit hole on leaf upperside. Cocoon dark grey-brown. Adults fly in June-August.

Distribution. – Tadzhikistan: mountainous region near the Varzob river (Gissar ridge) and southern Vakhsh river valley (tugai formation) close to Afghanistan (type-locality, fig. 28).

Etymology. – Flavus (latin) = golden; macula (latin) = a spot, referring to the distinct androconial spot of yellow-cream scales on the male hindwing.

Fomoria lacrimulae sp. n.
(figs. 3, 16-19, 28-30)

Type material. – Holotype ♂: Turkmenistan, western Kopet Dag, 40 km E Kara Kala (=Garrygala), 800 m, 18.v.1993, leg. R. Puplesis & A. Diškus (VPU). Paratypes: 3 ♂, 129 ♀, same locality, 12.v-12.vi.1993, leg. R. Puplesis & A. Diškus (VPU, ZITAS).

Diagnosis. – Relatively large species with distinctive male and female genitalia. The male can be easily distinguished from all known species by the very specialized valva with long curved apically process, the extremely long dorsal carinae of aedeagus and the distally truncate uncus. The female is easily recognised by the unusually large apophyses in comparison with the small corpus bursae with special-shaped signa, and the very long ductus spermathecae with 6-7 convolution.

Male (fig. 3). – Forewing length 3.6-3.8 mm. Head: frontal tuft pale brownish orange to cream; eye-caps and collar cream; antenna pale brownish to brown cream. Thorax cream to yellowish, occasionally with some brownish scales. Forewing densely irrorate with brown tipped scales with golden cream (occasionally whitish cream) bases. Dorsal margin of forewing usually completely golden cream, without brown tipped scales. Cilia of both wings golden cream. Hindwing brownish to grey. Abdomen grey to pale brownish cream. Forewing venation with very long subcostal, and four radial, two medial veins, one long (curved upwardly) cubital and an anal vein. Anal loop on base of 2A absent or indistinct, however, the anal vein distinctly bent at the base. Closed cell present. Hindwing venation as in most Nepticulidae.

Female. – Very similar to male, but tends to be a bit smaller, forewing length down to 3.2 mm in some paratypes.

Male genitalia (figs. 16-19). – Valva slender, broadened at base and strongly curved at apex (fig.17), and densely covered with setae (except apex). There are also 5-6 long setae on tip of apical process. Transtilla with very long sublateral processes. Pseuduncus broadly triangular. Uncus very wide, truncate, with right angles. Gnathos with broad posterior process and large central plate. Vinculum trapezoid, usually distinctly narrowed distally. Aedeagus (fig.18) with two distinct closely set ventral carinae and with unusually long dorsal carinae. Ventral carinae distally with a ventrally curved, pointed hook; dorsal carinae apically slightly curved outwards. Cornuti almost invisible, although a great number of weakly sclerotized spine-like cornuti is present on vesica (fig.19).

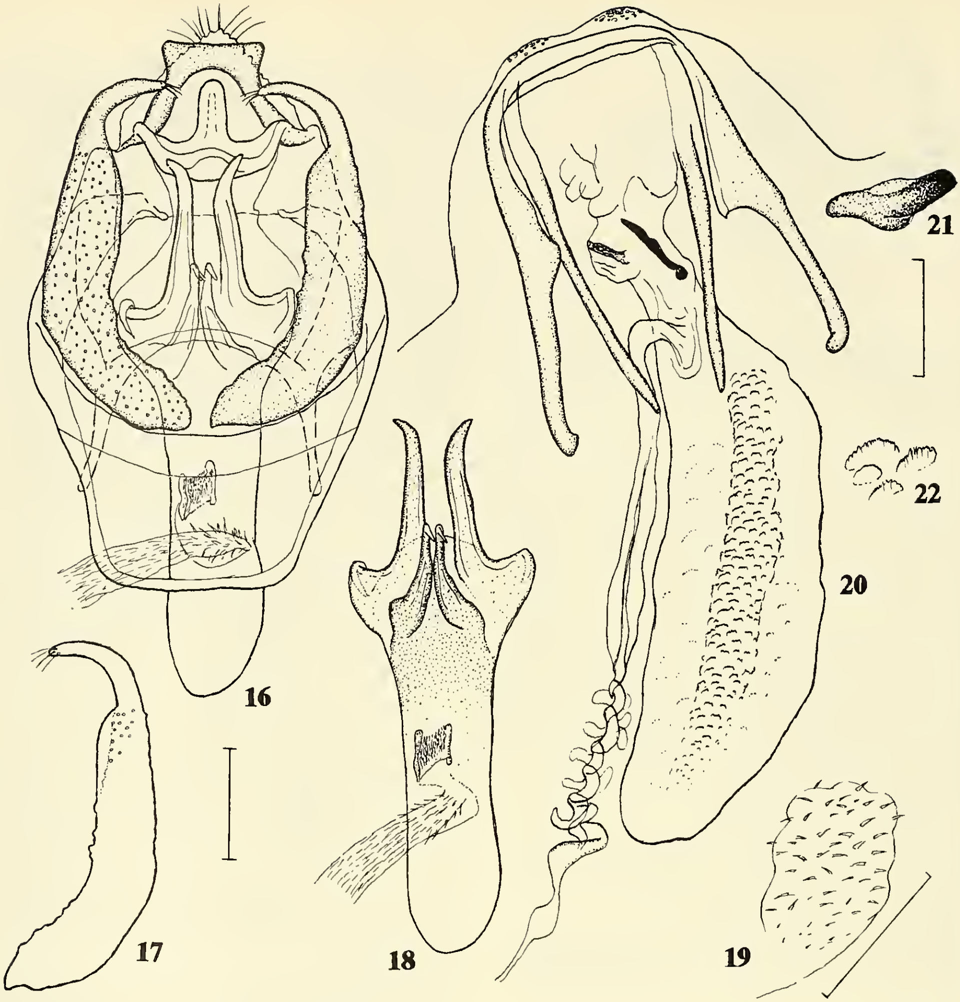
Female genitalia (fig. 20-22). – Both pairs of apophyses very long, almost equal in length. Vaginal sclerite with an irregular shape, sometimes more or less triangular (fig.21), sometimes (in other view) more slender. Corpus bursae comparatively very small, but elongate. Paired signa comprise numerous well sclerotized pectinations (fig.22); borders of signa only weakly marked by elongate pectinations. Ductus spermathecae approximately as long as corpus bursae, with 6.5-7 distinct convolutions. Female abdomen with broad tip; papillae annales rather distinct.

Biology. – Adults fly in May-June (see also remarks).

Distribution. – Known only from the western part of the Kopet Dag ridge in Turkmenistan, where it is a common species (fig. 28).

Etymology. – Lacrimula (latin) = a tear-drop, referring to the relatively small distinctly brown tipped scales which densely and uniformly irrorate forewings like small tears.

Remarks. – The collected number of 129 females is

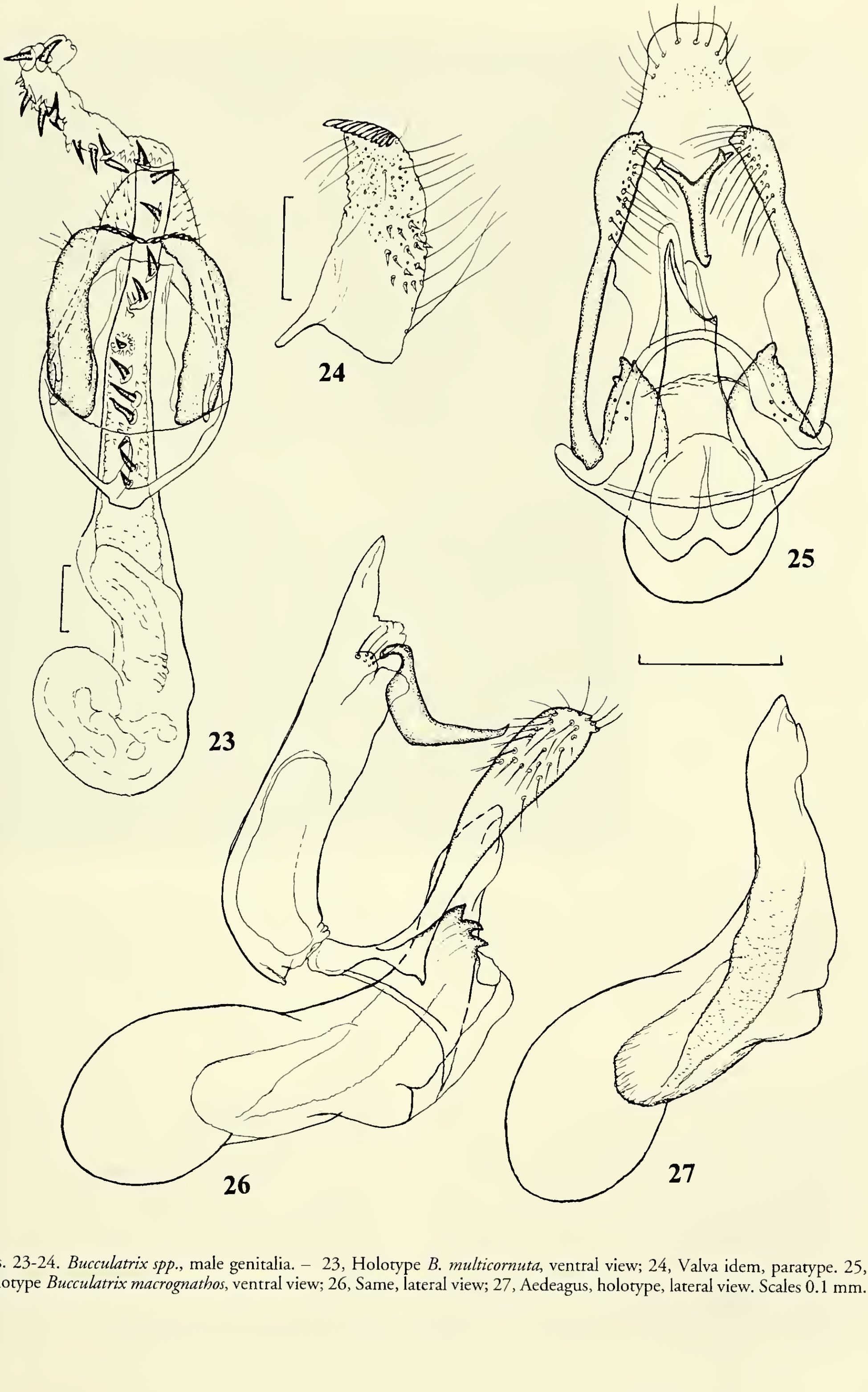


Figs.16-22. *Fomoria lacrimulae*, genitalia. – 16, Male, holotype; 17, Left valva, holotype; 18, Aedeagus, paratype; 19, Spine-like cornuti on everted vesica, paratype; 20, Female, paratype; 21, Vaginal sclerite, lateral view; 22, Pectinations on corpus bursae. Scales 0.1 mm.

disproportionately high compared with the 4 males. Normally males tend to come at light more frequently. The female abundancy might be explained by a trap position very close to the foodplant (Van Nieukerken pers. comm.). The two main sites where the species was collected represent two small, almost parallel canyons (Khoshdemir and Khertou), with a dense herbaceous vegetation and with a predominance of shrubs and trees as *Crataegus, Acer, Celtis, Paliurus, Cerasus, Rubus, Rosa*, as well as *Rhamnus, Prunus, Salix, Fraxinus* and *Zizyphus* (figs. 29,30). Since we did not find any unidentified mines on woody plants, we tend to believe that the hostplant of *F. lacrimulae* might be herbaceous. Unfortunately we did not identify the plant species of the very rich herbaceous vegetation during the time of our collecting in May and early June; upon return later the semi-ephemeral grasses were almost completely dried out. Therefore a search for mines would probably best be carried out in late April or early May.

Bucculatricidae

Bucculatrix multicornuta **sp.n.**
(figs. 4, 23, 24, 28, 29)



Figs. 23-24. *Bucculatrix spp.*, male genitalia. – 23, Holotype *B. multicornuta*, ventral view; 24, Valva idem, paratype. 25, Holotype *Bucculatrix macrognathos*, ventral view; 26, Same, lateral view; 27, Aedeagus, holotype, lateral view. Scales 0.1 mm.

Type material. - Holotype ♂: Turkmenistan, western Kopet Dag, 40 km E Kara Kala (=Garrygala), 800 m, 05.vii.1993, leg. R. Puplesis & A. Diškus (VPU). Paratypes: 7♂, same locality, 18.v.-23.vii.1993, leg. R. Puplesis & A. Diškus (VPU).

Diagnosis. – The male can immediately be recognized by the numerous straight cornuti. It can easily be distinguished from the Iranian *B. endospiralis* Deschka, which also has some cornuti by the relatively short vinculum and the much straighter aedeagus (compare Deschka 1981). From the similar *B. abrepta* Seksjaeva, 1989 from East Asia, it differs by the wide valva, and trapezoid tegumen.

Male (fig. 4). – Forewing length 2.8-3.2 mm. Head: frontal tuft mostly whitish, with some dark brown or greyish brown scales; eye-caps whitish; antennae cream, annulate with brown. Thorax brownish cream irrorated with dark brown scales. Forewing variable, irrorated with blackish brown scales, in basal 1/3 somewhat paler, and with 6 whitish cream streaks: three along costal margin and three along anal margin (fig. 4). Cilia cream. Hindwing and cilia brownish cream.

Female. Unknown.

Male genitalia (figs. 23-24). – Valva slightly curved, with 18-20 flat setae at apex, forming a pecten (fig. 24). Sublateral process of valva short. Tegumen large, trapezoid with numerous setae; tegminal lobes absent. Vinculum triangular. Aedeagus very long, basally widening and less sclerotized. There are about 22-27 well sclerotized spine-like cornuti on the vesica.

Biology. – Adults fly from May till late July. Otherwise unknown.

Distribution. – Only known from the western part of the Kopet Dag ridge (Turkmenistan) (figs. 28, 29).

Etymology. – Multus (latin) = numerous; cornuta (latin) = horned, referring to a very rare feature among the Bucculatricidae, i.e. the presence of numerous cornuti on the vesica.

Bucculatrix macrognathos sp.n.
(figs. 5, 25-28)

Type material. – Holotype ♂: eastern Turkmenistan, env. Svintsovyy Rudnik (Kugitangtau ridge), 11.viii.1989, leg. V. Sruoga (VPU). Paratype: 1 ♂, same locality, 26.viii.1990, leg. R. Puplesis (VPU).

Diagnosis. – A very remarkable species, immediately recognized by the presence of the large gnathos in the male genitalia and by the pale ochreous tornal spot on the forewing. It is easily distinguished from *B. formosa* Puplesis & Seksjaeva (which also has a gnathos) by the absence of tegminal lobes and the sclerite on the vesica, the short vinculum, as well as by the distinct forewing pattern (compare Puplesis et al. 1992).

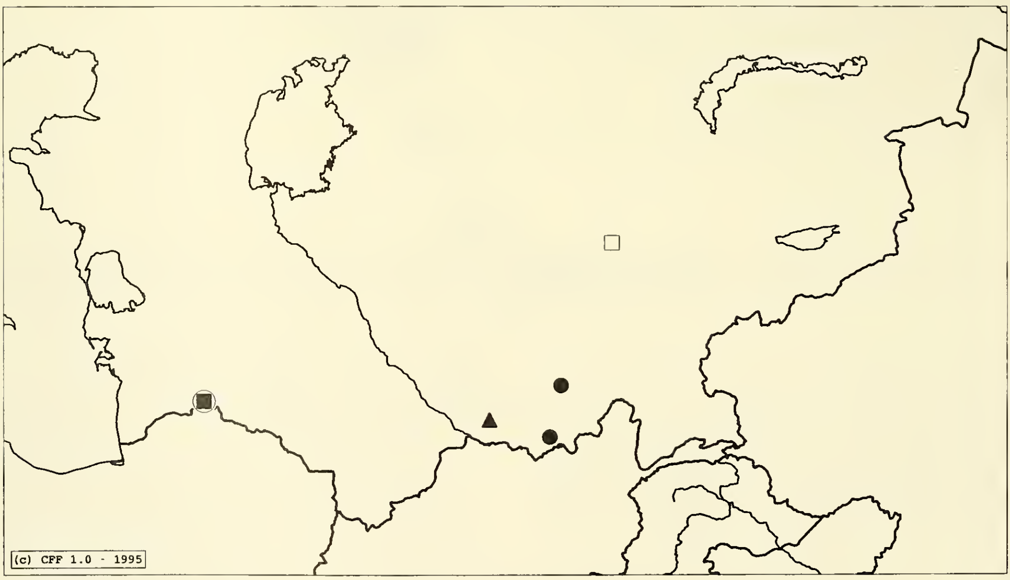


Fig. 28. Distribution of *Stigmella johanssoni* (□), *Fomoria flavimacula* (●), *F. lacrimulae* (○), *Bucculatrix multicornuta* (■), *B. macrognathos* (▲).

29

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Figs. 29, 30. Habitats of *Fomoria lacrimulae* and *Bucculatrix multicornuta* in the Khoshdemir canyon (western part of the Kopet Dag mountains, Turkmenistan).

Male (fig. 5). – Forewing length 2.6-2.8 mm. Head unknown, broken in both specimens. Thorax ochreous cream. Forewing with three cream streaks along costal margin, one very wide anal streak and an irregularly elongate tornal spot (fig. 5); in the centre of this tornal spot there is a distinct patch of pale ochreous scales. Hindwing and cilia of both wings ochreous cream.

Female. – Unknown.

Male genitalia (figs. 25-27). – Valva very slender. Basal process of valva not developed, almost indistinct. Tegumen large, without tegminal lobes. Gnathos with large posterior process and small lateral arms. Vinculum short, slightly bilobed anteriorly and with two large triangular lobes posteriorly; each posterior lobe bears 3 well sclerotized tooth-like processes. Aedeagus (fig. 27) much bulged basally, cornuti absent.

Biology. – Adults have been caught in August.

Distribution. – Only known from the Kugitangtau ridge in eastern Turkmenistan (fig.28).

Etymology. – Macros (greek) = large; gnathos (greek) = a cheek or here: gnathos, referring to the presence of an almost unique feature among the Bucculatricidae, i.e. the well developed gnathos.

Acknowledgements

Special thanks are expressed to our colleague Dr Erik J. van Nieukerken (the Netherlands), who kindly reviewed the manuscript and offered many helpful comments and suggestions. We also want to express our cordial thanks to Mr Roland Johansson (Sweden) for his remarks on the '*Stigmella salicis*' material from the Tyan Shan, resulting in the present description of *S. johanssoni*. Mrs.Birutė Noreikienė (Lithuania) has our sincere thanks and appreciation for her fine drawings of the habitus of the new species. The research described in this publication was made possible in part by Grant N LAO000 & LHX100 from the International Science Foundation.

References

Deschka, G., 1981. Blattminierende Lepidopteren aus dem Nahen und Mittleren Osten. IV. Teil. – Zeitschrift der Arbeitsgemeinschaft fur Österreichische Entomologen 33: 33-41.

Nieukerken, E. J. van, 1986. Systematics and phylogeny of Holarctic genera of Nepticulidae (Lepidoptera, Heteroneura: Monotrysia). – Zoologische Verhandelingen, Leiden 236: 1-96.

Puplesis, R., 1994. The Nepticulidae of Eastern Europe and Asia. – Backhuys Publishers, Leiden, 291 pp., 840 figs.

Puplesis, R. & A. Diškus, 1995. *Acalyptris argyraspis* sp. n., a remarkable species from Tadzhikistan (Lepidoptera: Nepticulidae). – Phegea 23: 51-54.

Puplesis, R. & A. Diškus, 1996a. First record of the genus *Etainia* from Central Asia with descriptions of two new species and some provisional notes on the world fauna (Lepidoptera: Nepticulidae). – Phegea 24: 41-48.

Puplesis, R. & A. Diškus, 1996b. A review of the *Stigmella sorbi* species-group with descriptions of two new species from Turkmenistan and Tadzhikistan (Lepidoptera: Nepticulidae). – Phegea 24 (in press).

Puplesis, R., A. Diškus, R. Noreika & N. Saparmamedova, 1996c. Revised check-list of mining Lepidoptera (Nepticuloidea, Tischerioidea & Gracillarioidea) from Central Asia – Tijdschrift voor Entomologie 139: 191-200.

Puplesis, R., S. Seksjaeva, J. Puplesienë, 1992. *Bucculatrix formosa* sp. n., a remarkable species from the Kugitangtau Mountains (Central Asia) (Lepidoptera: Bucculatricidae). – Nota Lepidopterologica 15: 41-46.

Seksjaeva, S. V., 1989. Pervye svedeniya o miniruyushchikh moliakh sem. Bucculatricidae (Lepidoptera) iz Yuzhnogo Primor'ya s opisaniem 10 novykh vydov. – Entomologicheskoe obozreniye 68: 620-627 [In Russian].

Seksjaeva, S. V., 1993. Obzor krivousykh krokhotok-molei (Lepidoptera, Bucculatricidae) fauny Rossii. – Trudy Zoologicheskogo instituta Rossijskoj Akademii Nauk 225: 99-119 [In Russian].

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REVISED CHECK-LIST OF MINING LEPIDOPTERA (NEPTICULOIDEA, TISCHERIOIDEA AND GRACILLARIOIDEA) FROM CENTRAL ASIA

Puplesis, R., Diškus, A., Noreika R. & Saparmamedova, N., 1996. Revised check-list of mining Lepidoptera (Nepticuloidea, Tischerioidea and Gracillarioidea) from Central Asia. – Tijdschrift voor Entomologie 139: 191-200. [ISSN 0040-7496]. Published 18 December 1996.
The mining Lepidoptera of Central Asia are listed on the basis of revised data: in total 194 species, belonging to the Opostegidae (4), Nepticulidae (87), Tischeriidae (6), Gracillariidae (76) and Bucculatricidae (21). Nineteen species, including seven unnamed, are recorded for the first time from Central Asia, in addition 14 new records are given for the regional faunas. The following new synonymies are established: *Opostega angulata* Gerasimov, 1930 is a junior synonym of *O. spatulella* Herrich-Schäffer, 1855 and *S. pimschoorli* Puplesis, 1994 is a junior synonym of *S. kazakhstanica* Puplesis, 1991. *Micrurapteryx minima* Noreika, 1992 is transferred to *Liocrobyla* Meyrick. A check-list of host plants is also given.
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Keywords. – Leaf-miners, Opostegidae, Nepticulidae, Tischeriidae, Gracillariidae, Bucculatricidae, Central Asia, check-list, host-plants.

The study of leaf-mining Lepidoptera of Central Asia was initiated by Filipjev (1926) and particularly by Gerasimov (1930, 1931, 1932, 1933). The last author noted more than 20 species from Central Asia, including 8 new taxa. Later Danilevsky (1955) added a few new species. Many more species, including 17 new for science were added as a result of Kuznetzov's investigations (1956, 1960, 1975, 1978, 1979). Furthermore, some taxonomic, faunistic and ecological data on Nepticuloidea and Gracillarioidea were published by Sherniyazova (1975, 1982, 1984, 1988a, 1988b), Seksjaeva (1981, 1993), Kozlov (1985), Falkovitsh (1986) and van Nieukerken (1990a, 1990b).

In the course of our own investigations in Turkmenistan, Tadzhikistan, Uzbekistan and southern Kazakhstan, from 1982 to 1995, about 106 species were recorded for the first time in Central Asia, including 80 previously undescribed ones (Puplesis 1984, 1988a, 1988b, 1989, 1990, 1994, Puplesis & Diškus 1995, 1996a, Noreika 1991a, 1991b, Noreika & Puplesis 1992a, 1992b, 1992c).

The fauna of the southern areas of Central Asia is still poorly known. Just two Nepticulidae species were recorded from Iran (Klimesch 1979, van Nieukerken 1985) and one Nepticulidae plus one Opostegidae species from Afghanistan (Davis 1989, van Nieukerken & Puplesis 1991). In the Gracillariidae five species were described from Iran (Deschka 1979, Triberti 1985, 1986, 1989), five from Afghanistan (Deschka 1974, Triberti 1985, 1986, 1989), and two from northern Pakistan (Triberti 1989, Bradley 1980). Just three Bucculatricidae species were recorded from Iran (Deschka 1981).

In the present list all records of species and host plants are summarised: there are 33 new records for regional faunas; 19 species are new for Central Asia, including 7 as yet unnamed species. Two new synonymies are established at the species level and one new combination is made. In total the present list deals with 5 families, 26 genera and 194 species.

The check-list is a part of the scientific project on the main groups of central-asiatic mining Lepidoptera (see Puplesis & Diškus 1996c). However, data on other families dealt with in this project (such as Heliozelidae, Phyllocnistidae, Lyonetiidae and Elachistidae) are still not revised and are not included here.

The region under study comprises the southeastern parts of Armeniya and Azerbaydzhan, southern Kazakhstan, Uzbekistan, Turkmenistan, Tadzhikistan, Kirgiziya, Iran (except southern parts), the northern parts of Afghanistan and Pakistan. The altitudes in this region vary from 132 m below sea-level to about 5600 m. There is a predominantly dry climate, or with rain mainly in winter and spring time. The habitats vary from sandy or salty deserts to forests in mountains or tugai (Puplesis 1994) in river valleys. A characteristic floristic feature of this generally arid region is the predominance of secondary deciduous bush formations, particularly juniper stands and shibliak.

Check-list

Species which at present are considered endemics of Central Asia (see introduction) are marked with an asterisk* behind their number. Species for which there is a note at the end of the list are marked with two asterisks at the end of the text**.

Opostegidae Meyrick, 1893

Genus *Opostega* Zeller, 1839

1. O. spatulella Herrich-Schäffer, 1855
=*O.angulata* Gerasimov, 1930, **syn. n.**
Turkmenistan, Uzbekistan (Gerasimov 1930, Kuznetzov 1960, Kozlov 1985).
2*. *O. rezniki* Kozlov, 1985
Kazakhstan (Kozlov 1985).
3*. *O. afghani* Davis, 1989
Afghanistan (Davis 1989).

Genus *Pseudopostega* Kozlov, 1985

4. *P. auritella* (Hübner, 1813)
Uzbekistan (Gerasimov 1930).

Nepticulidae Stainton, 1854

Genus *Stigmella* Schrank, 1802

S. lapponica-group
5*. *S. maloidica* Puplesis, 1991
Tadzhikistan (Puplesis & Arutyunova 1991, Puplesis 1994).
S. paliurella-group
6. *S. paliurella* (Klimesch, 1940)
Turkmenistan (Gerasimov 1937, 1952, Puplesis 1994).
7*. *S. ficulnea* Puplesis & Krasilnikova, 1994
Turkmenistan (Puplesis 1994).
8*. *S. turbatrix* Puplesis, 1994
Turkmenistan (new record: Kopet Dag, 1993, larvae on *Celtis caucasica*, Puplesis & Diškus leg.); Tadzhikistan (Puplesis 1994).
9*. *S. abaiella* Klimesch, 1979
Iran (Klimesch 1979).
S. ulmivora-group
10. *S. ulmiphaga* (Preissecker, 1942)
Turkmenistan (Puplesis 1994).
11*. *S. kazakhstanica* Puplesis, 1991
= *S. pimschoorli* Puplesis, 1994, **syn.n.**
Kazakhstan, Turkmenistan (Puplesis et al. 1991, Puplesis 1994).
S. betulicola-group
12. *S. nivenburgensis* (Preissecker, 1942)
Turkmenistan (Puplesis 1994).
13. *S. luteella* (Stainton, 1857)
Kazakhstan (Puplesis et al. 1992, 1994).
14*. *S.* sp.n.
Tadzhikistan (Puplesis & Diškus, in prep.).
15*. *S.* sp.n.
Tadzhikistan (Puplesis & Diškus, in prep.).
S. ultima-group
16*. *S. acerna* Puplesis, 1988
Turkmenistan (Puplesis 1988b, 1994).
17*. *S. bicolor* Puplesis, 1988
Kazakhstan, Uzbekistan (new record: E to Tashkent, 1992, Zolotukhin leg.), Tadzhikistan, Kirgiziya (possibly) (Puplesis 1988b, 1994, Puplesis et al. 1992).
18*. *S. semiaurea* Puplesis, 1988
Turkmenistan, Tadzhikistan (Puplesis 1988b, 1994).
S. malella-group
19*. *S. armeniana* Puplesis, 1994
Armeniya (Puplesis 1994).
20*. *S. klimeschi* Puplesis, 1988
Kazakhstan, Tadzhikistan (Puplesis 1988b, 1994, Puplesis et al. 1992).
21*. *S. kopetdagica* Puplesis, 1994
Turkmenistan (Puplesis 1994).
S.anomalella-group
22. *S. anomalella* (Goeze, 1783)
Kazakhstan (Puplesis et al. 1992, Puplesis 1994).
23. *S. spinosissimae* (Waters, 1928)
Kazakhstan (new record: Alma Ata, 1938, larvae on *Rosa* sp., Gerasimov leg.).
S. sanguisorbae-group
24. *S. rolandi* van Nieukerken, 1990
Kazakhstan (Puplesis et al. 1992, Puplesis, 1994).
25. *S. muricatella* (Klimesch, 1978)
Tadzhikistan (Puplesis 1994).
26*. *S. trisyllaba* Puplesis, 1992
Kazakhstan, Tadzhikistan, Kirgiziya (Puplesis et al. 1992, Puplesis 1994).
27*. *S.* sp. n.
Turkmenistan (Puplesis & Diškus in prep.).
S. oxyacanthella-group
28. *S. regiella* (Herrich-Schäffer, 1855)
Turkmenistan (new record: the western Kopet Dag, 1993, Puplesis & Diškus leg.).
29. *S. crataegella* (Klimesch, 1936)
= *S. indigena* Puplesis, **syn.n.**
Turkmenistan (Puplesis 1994, additional material from western Kopet Dag, 1993, larvae on *Crataegus* spp., Puplesis & Diškus leg.).
30*. *S. caspica* Puplesis, 1994
Azerbaydzhan (Puplesis 1994).
31*. *S. crataegi* Gerasimov, 1937
Kirgiziya (Gerasimov 1937).
32. *S. aurora* Puplesis, 1984
Tadzhikistan (new record: Nurek, 1991, Puplesis & Diškus leg.).
33*. *S. lanceolata* Puplesis, 1994
Turkmenistan (Puplesis 1994).
34*. *S. hissariella* Puplesis, 1994
Tadzhikistan (Puplesis 1994).
S. paradoxa-group
35. *S. juryi* Puplesis, 1991
Turkmenistan (Puplesis 1991, 1994).
36*. *S. montana* Puplesis, 1991
Kazakhstan, Tadzhikistan (Puplesis 1991, Puplesis et al. 1992).
37. *S. inopinata* Laštůvka & Laštůvka, 1991
Armeniya (Puplesis 1994).
38*. *S. malifoliella* Puplesis, 1991
Tadzhikistan (Puplesis & Arutyunova 1991, Puplesis 1994).

S. hybnerella-group
39. *S. hybnerella* (Hübner, 1796)
Azerbaydzhan, Turkmenistan (Puplesis 1994).
S. salicis-group
40* *S. johanssoni* Puplesis & Diškus, 1996c
= *S. salicis* sensu Puplesis, 1984 partim [misidentification]
Kazakhstan (Puplesis 1994: fig.350 (right side), Puplesis & Diškus 1996c).
41*. *S. aiderensis* Puplesis, 1988
Turkmenistan (Puplesis 1988b, 1994).
42*. *S. kondarai* Puplesis, 1988
Tadzhikistan (Puplesis 1988b, 1994).
43*. *S. juratae* Puplesis, 1988
Tadzhikistan (Puplesis 1988b, 1994).
44*. *S. flavescens* Puplesis, 1994
Turkmenistan (Puplesis 1994).
S. lurida-group
45. *S. lurida* Puplesis, 1994
Tadzhikistan (Puplesis 1994).
S. sorbi-group
46*. *S. subsorbi* Puplesis, 1994
Tadzhikistan (Puplesis 1994, Puplesis & Diškus 1996b).
47*. *S. cerasi* Puplesis & Diškus, 1996b
Turkmenistan (Puplesis & Diškus 1996b).
48*. *S. aflatuniae* Puplesis & Diškus, 1996b
Tadzhikistan (Puplesis & Diškus 1996b).
S. motiekaitisi-group
49*. *S. motiekaitisi* Puplesis, 1994
Tadzhikistan (Puplesis 1994).
S. marginicolella-group
50*. *S. talassica* Puplesis, 1992
Kazakhstan (Puplesis et al. 1992, Puplesis 1994).
S. aurella-group
51. *S. aurella* (Fabricius, 1775)
Turkmenistan (new record: western Kopet Dag, 1993, larvae on *Rubus* spp., Puplesis & Diškus leg.).
S. pomella-group
52*. *S. fuscacalyptriella* Puplesis, 1994
Azerbaydzhan (Puplesis 1994).
S. hemargyrella-group
53*. *S. kuznetzovi* Puplesis, 1994
Turkmenistan (Puplesis 1994).
S. longispina-group
54*. *S. longispina* Puplesis, 1994
Tadzhikistan (Puplesis 1994).
Unnamed group:
55. *S.* sp.n.
Turkmenistan (Puplesis, Diškus & Nieukerken, in press)

Genus *Ectoedemia* Busck, 1907

Subgenus *Zimmermannia* Hering, 1940
56. *E. amani* Svensson, 1966
Azerbaydzhan (Puplesis 1994).
Subgenus *Ectoedemia* Busck, 1907
E. populella-group
57*. *E. albida* Puplesis, 1994
= *E. turbidella* Zeller,1848 sensu van Nieukerken 1985 partim [misidentification].
Turkmenistan (Puplesis 1994), Iran (van Nieukerken 1985).
E. angulifasciella-group
58. *E. atricollis* (Stainton, 1857)
Tadzhikistan (Puplesis & Arutyunova 1991, Puplesis 1994).
59. *E. arcuatella* (Herrich-Schäffer, 1855)
Kazakhstan (new record: Alma Ata, 1938, Gerasimov leg.).
60. *E. spinosella* (Joannis, 1908)
Turkmenistan (new record: western Kopet Dag, 1993, Puplesis & Diškus leg.).
61*. *E. petrosa* Puplesis, 1988
Tadzhikistan (Puplesis 1988b, 1994).
62*. *E.* sp.n.
Turkmenistan (Puplesis & Diškus, in prep.).
63*. *E. ingloria* Puplesis, 1988
Tadzhikistan (Puplesis 1988b, 1994).
64*. *E. tadshikiella* Puplesis, 1988
Tadzhikistan (Puplesis 1988a, 1994).
65*. *E. insignata* Puplesis, 1988
Tadzhikistan (Puplesis 1988b, 1994).
66*. *E. rosiphila* Puplesis, 1992
Kazakhstan (Puplesis et al. 1992, Puplesis 1994), Tadzhikistan (new record, mines only).

Genus *Fomoria* Beirne, 1945

F. weaveri-group
67. *F. septembrella* (Stainton, 1849)
Azerbaydzhan, Turkmenistan (Puplesis 1994).
F.asiatica-group
68*. *F. asiatica* Puplesis, 1988
Turkmenistan, Tadzhikistan (Puplesis 1988a, 1994).
69*. *F. flavimacula* Puplesis & Diškus,1996c.
Tadzhikistan (Puplesis & Diškus 1996c).
70*. *F. lacrimulae* Puplesis & Diškus,1996c
Turkmenistan (Puplesis & Diškus 1996c).

Genus *Acalyptris* Meyrick, 1921

A. repeteki-group
71*. *A. repeteki* (Puplesis, 1984)
Turkmenistan (Puplesis 1984, 1990, 1994).
72*. *A. vittatus* (Puplesis, 1984)
Turkmenistan (Puplesis 1984, 1994).
73*. *A. arenosus* (Falkovitsh, 1986)
Turkmenistan, Uzbekistan (Falkovitsh 1986, Puplesis 1990, 1994).
74. *A. pallens* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1989, 1990, 1994).
75*. *A. falkovitshi* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1989, 1990, 1994).
76. *A. lvovskyi* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1989, 1990, 1994).
77*. *A. turcomanicus* (Puplesis, 1984)
Turkmenistan (Puplesis 1984, 1990, 1994).
78. *A. galinae* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1990, 1994).
A. shafirkanus-group
79*. *A. shafirkanus* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1990, 1994).
80*. *A. desertellus* (Puplesis, 1984)
Turkmenistan, Uzbekistan (Puplesis 1984, 1989, 1990, 1994).
81*. *A. piculus* Puplesis, 1990
Tadzhikistan (Puplesis 1990, 1994).
82*. *A. kizilkumi* (Falkovitsh, 1986)
Turkmenistan, Uzbekistan (Falkovitsh 1986, Puplesis 1989, 1990, 1994), Iran, Afghanistan (van Nieukerken pers.comm.).

83*. *A. brevis* Puplesis, 1990
Turkmenistan (Puplesis 1990).
84*. *A. egidijui* Puplesis, 1990
Turkmenistan, Tadzhikistan (Puplesis 1990, 1994).
85*. *A. vannieukerkeni* Puplesis, 1994
Turkmenistan (Puplesis 1994).
A. argyraspis-group
86*. *A. argyraspis* Puplesis & Diškus, 1995
Tadzhikistan (Puplesis & Diškus 1995).

Genus *Glaucolepis* Braun, 1917

raikhonae-group
87*. *G. raikhonae* Puplesis, 1985
Kazakhstan, Uzbekistan, Tadzhikistan, Kirgiziya, Afghanistan (Puplesis 1985, 1994, van Nieukerken & Puplesis 1991).
88. *G. melanoptera* (van Nieukerken & Puplesis, 1991)
Armeniya, Turkmenistan (van Nieukerken & Puplesis 1991, Puplesis 1994).

Genus *Trifurcula* Zeller, 1848

T. subnitidella-group
89. *T. puplesisi* van Nieukerken, 1990a
Turkmenistan, Tadzhikistan (van Nieukerken 1990a, Puplesis 1994).

Genus *Etainia* Beirne, 1945

90*. *E leptognathos* Puplesis & Diškus, 1996a
Turkmenistan (Puplesis & Diškus 1996a).
91*. *E. obtusa* Puplesis & Diškus, 1996a
Turkmenistan (Puplesis & Diškus 1996a).

Tischeriidae Spuler, 1910

Genus *Tischeria* Zeller, 1839

T.angusticolella-group
92. *T. gaunacella* Duponchel, 1843
Turkmenistan (Kuznetzov 1960).
93. *T. marginea* Haworth, 1828
Turkmenistan (new record: central and western Kopet Dag, 1991-1993, Puplesis & Diškus leg.).
94. *T. angusticolella* Duponchel, 1843
Turkmenistan (new record: western Kopet Dag, 1993, Puplesis & Diškus).
T. longispicula-group
95*. *T. rosella* Gerasimov, 1937
Turkmenistan (new record: western Kopet Dag, 1993, larvae on *Rosa* sp., Puplesis & Diškus leg.); Uzbekistan (Gerasimov 1937); Tadzhikistan (new record: Gissar ridge, 1990-1991, Noreika, Sruoga, Puplesis & Diškus leg).
96*. *T. longispicula* Puplesis, 1988
Turkmenistan, Uzbekistan (Puplesis 1988)**.
97*. *T.* sp.n.
Tadzhikistan (Puplesis & Diškus, in prep.).

Gracillariidae Stainton, 1854

Genus *Parornix* Spuler, 1910

98*. *P. subfinitimella* Kuznetzov, 1956
Turkmenistan (Kuznetzov 1956, 1981).
99*. *P. hastata* Triberti, 1989
Afghanistan (Triberti 1989).
100*. *P. compressa* Triberti, 1989
Afghanistan, Pakistan (Triberti 1989).
101*. *P. kugitangi* Noreika, 1991a
Turkmenistan (Noreika 1991a).
102*. *P. asiatica* Noreika, 1991a
Turkmenistan, Tadzhikistan (Noreika 1991a, Noreika & Puplesis 1992c).
103*. *P.* sp. n.
Turkmenistan (Kuznetzov, in prep.)**.
104. *P. petiolella* (Frey, 1863)
Kazakhstan (Kuznetzov 1981).
105*. *P. cotoneasterella* Kuznetzov, 1978
Tadzhikistan (Kuznetzov 1978, 1981, Sherniyazova 1982, 1984, Noreika & Puplesis 1992c).
106*. *P. turcmeniella* Kuznetzov, 1956
Turkmenistan (Kuznetzov 1956, 1981).
107. *P. szoecsi* Gozmany, 1952
=*P. amygdalella* Kuznetzov, 1978
Kazakhstan (Kuznetzov 1978, 1981 [as *amygdalella*]).
108*. *P. persicella* Danilevsky, 1955
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan (Danilevsky 1955, Kuznetzov 1960, 1981, Sherniyazova 1982, Noreika 1991a, Noreika & Puplesis 1992c).

Genus *Micrurapteryx* Spuler, 1910

109. *M. kollariella* (Zeller, 1839)
Kazakhstan (Kuznetzov 1981, Kuznetzov & Tristan 1985).
110*. *M. sophorella* Kuznetzov, 1979
Kazakhstan, Uzbekistan (Kuznetzov 1979, 1981, Kuznetzov & Tristan, 1985).
111*. *M. fumosella* Kuznetzov & Tristan, 1985
Kirgiziya (Kuznetzov & Tristan 1985).
112*. *M. tortuosella* Kuznetzov & Tristan, 1985
Tadzhikistan, Kirgiziya (Kuznetzov & Tristan 1985, Puplesis & Noreika 1990, Noreika & Puplesis 1992c).
113*. *M. sophorivora* Kuznetzov & Tristan, 1985
Kazakhstan (Kuznetzov & Tristan 1985), Tadzhikistan (new record: Gissar ridge, 1991, larvae on *Sophora,* Sruoga leg.).
114*. *M. bidentata* Noreika, 1992
Kirgiziya (Noreika & Puplesis 1992b).
115. *M. gradatella* (Herrich-Schäffer, 1855)
Tadzhikistan (new record: Gissar ridge, 1991, Noreika leg.).

Genus *Liocrobyla* Meyrick, 1916

116*. *L. minima* (Noreika, 1992) **comb. n.**
Turkmenistan (new record: western part of the Kopet Dag ridge, 1993, Sruoga leg.), Tadzhikistan (Noreika & Puplesis 1992b).

Genus *Polymitia* Triberti, 1986

117*. *P. eximipalpella* (Gerasimov, 1930)
Turkmenistan, Uzbekistan, Tadzhikistan, Iran, Afghanistan (Gerasimov 1930, Kuznetzov 1960, Triberti 1986, Noreika 1991a, Noreika & Puplesis, 1992c).
118*. *P. laristana* Triberti, 1986
Iran (Triberti 1986).

Genus *Gracillaria* Haworth, 1828

119. *G. loriolella* Frey, 1881
Turkmenistan, Tadzhikistan (Kuznetzov 1960, 1981, Sherniyazova 1982, 1984, Noreika 1991a, Noreika & Puplesis 1992c [Misidentification as *Caloptilia cuculipennella* (Hübner)])**.

Genus *Caloptilia* Hübner, 1825

120. *C. stigmatella* (Fabricius, 1781)
Armeniya, Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Sherniyazova 1975, 1982, Kuznetzov, 1981, Noreika & Puplesis 1992a; 1992c).
121. *C. flava* (Staudinger, 1870)
= *Gracillaria impictipennella* Gerasimov, 1930
Turkmenistan, Uzbekistan (Gerasimov 1930, Kuznetzov 1960, Noreika 1991b, Noreika & Puplesis 1992b).
122. *C. semifascia* (Haworth, 1828)
Turkmenistan (Kuznetzov 1981), Tadzhikistan (new record: Gissar ridge, 1991, Sruoga leg.).
123*. *C. acerivorella* (Kuznetzov, 1956)
Turkmenistan, Tadzhikistan (Kuznetzov 1956, 1960, 1981, Sherniyazova 1982, 1988b, Noreika 1991a, Noreika & Puplesis 1992c).
124*. *C. acericolella* Kuznetzov, 1981
Kazakhstan (Kuznetzov 1981).
125. *C. fribergensis* (Fritzsche, 1871)
Kazakhstan, Turkmenistan (Kuznetzov 1960, 1981, Noreika 1991a).
126. *C. populetorum* (Zeller, 1839)
Kazakhstan (Kuznetzov 1981).
127. *C. roscipennella* (Hübner, 1796)
Uzbekistan, Tadzhikistan (Gerasimov 1930, Kuznetzov 1981, Sherniyazova 1982, Noreika & Puplesis 1992c).
128. *C. fidella* Reutti, 1853
Turkmenistan (new record: western Kopet Dag, 1993, Sruoga leg.).

Genus *Calybites* Hübner, 1822

129. *C. phasianipennella* (Hübner, 1813)
Kazakhstan, Turkmenistan, Uzbekistan (Gerasimov 1930, Kuznetzov 1981, Noreika & Puplesis 1992a), Tadzhikistan (new record: central Tadzhikistan, env. Tursunzade, 1990, larvae on *Polygonum*, Noreika leg.).

Genus *Eucalybites* Kumata, 1982

130. *E. auroguttella* (Stephens, 1835)
Turkmenistan (Kuznetzov 1960).

Genus *Aspilapteryx* Spuler, 1910

131. *A. tringipennella* (Zeller, 1839)
Turkmenistan, Uzbekistan, Tadzhikistan, Afghanistan (Kuznetzov 1960, 1981, Triberti 1985, Noreika 1991a, Noreika & Puplesis 1992c).
132*. *A. magna* Triberti, 1985
Iran (Triberti 1985).

Genus *Cupedia* Klimesch et Kumata, 1973

133. *C. cupediella* (Herrich-Schäffer, 1855)
Turkmenistan, Tadzhikistan (Kuznetzov 1981, Sherniyazova 1988a, Noreika & Puplesis 1992a).

Genus *Acrocercops* Wallengren, 1881

134*. *A. iraniana* Triberti, 1989
Iran (Triberti 1989).

Genus *Dialectica* Walsingham, 1987

135. *D. scalariella* (Zeller, 1850)
Turkmenistan (Noreika 1991b, Noreika & Puplesis 1992a).
136. *D. imperialella* (Zeller, 1847)
Turkmenistan (new record: western Kopet Dag, 1993, Sruoga leg.).

Genus *Leucospilapteryx* Spuler, 1910

137. *L. omissella* (Stainton, 1848)
Kazakhstan (Kuznetzov 1981).

Genus *Cameraria* Chapman, 1902

138*. *C. obliquifascia* (Filipjev, 1926)
Turkmenistan, Uzbekistan, Tadzhikistan (Filipjev 1926, Gerasimov 1932, Sherniyazova 1975, 1984, Kuznetzov 1981, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992a, 1992c, Puplesienė & Noreika 1993).
139*. *C. saliciphaga* (Kuznetzov, 1975)
Turkmenistan, Uzbekistan, Tadzhikistan (Kuznetzov 1975, Sherniyazova 1975, 1984, Kuznetzov, 1981, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992a, 1992c, Puplesienė& Noreika 1993).

Genus *Phyllonorycter* Hübner, 1822

140. *Ph. schreberella* (Fabricius, 1781)
Kazakhstan, Turkmenistan (Kuznetzov 1960, 1981, Puplesis et al. 1991, Noreika 1991a).
141. *Ph. millierella* (Staudinger, 1871)
Kazakhstan, Turkmenistan, Tadzhikistan (Kuznetzov 1960, 1981, Sherniyazova 1984, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis, 1992c).
142*. *Ph. caspica* Noreika, 1992
Azerbaydzhan (Noreika & Puplesis 1992b).
143. *Ph. emberizaepennella* (Bouche, 1834)
Kazakhstan, Turkmenistan (Kuznetzov 1960, 1981, Noreika 1991a).
144*. *Ph. raikhonae* Noreika, 1992
Tadzhikistan (Noreika & Puplesis 1992c).
145*. *Ph. montanella* Bradley, 1980
Pakistan (Bradley 1980).
146*. *Ph. loniceriphaga* Noreika, 1992
Tadzhikistan (Noreika & Puplesis 1992b).
147*. *Ph. juglandicola* (Kuznetzov, 1975)
Tadzhikistan (Kuznetzov 1975, 1981, Sherniyazova 1984, Noreika & Puplesis 1992c).
148*. *Ph. infirma* Deschka, 1974
Afghanistan (Deschka 1974).
149. *Ph. medicaginella* (Gerasimov, 1930)
Kazakhstan , Turkmenistan, Uzbekistan, Tadzhikistan (Gerasimov 1930 [Misidentified as *Ph. insignitella* (Zeller)], 1932, Kuznetzov 1981, Noreika 1991a, Puplesis & Noreika 1990, Noreika & Puplesis 1992c)**.
150*. *Ph. fabaceaella* (Kuznetzov, 1978)
Tadzhikistan (Kuznetzov 1978, 1981, Noreika & Puplesis 1992c).
151. *Ph. pyrifoliella* (Gerasimov, 1933)
Kazakhstan (Gerasimov 1933, Kuznetzov 1981).
152. *Ph. comparella* (Duponchel, 1843)
Kazakhstan (Kuznetzov 1981).
153. *Ph. sagitella* (Bjerkander, 1790)

Kazakhstan (Kuznetzov 1981), Turkmenistan (new record: western Kopet Dag ridge, 1993, Sruoga leg.).
154*. *Ph. populi* (Filipjev, 1926)
= *Lithocolletis populiella* Filipjev, 1926 (preoccupied by *L. populiella* Chambers, 1878) Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan (Filipjev 1926 [as *populiella*], Kuznetzov 1981, Sherniyazova 1984, Noreika & Puplesis 1992a).
155*. *Ph. iranica* Deschka, 1979
Iran (Deschka 1979).
156. *Ph. populifoliella* (Treitschke, 1833)
Kazakhstan, Uzbekistan (Gerasimov 1932, Kuznetzov 1981, Noreika 1991a, Noreika & Puplesis 1992a).
157. *Ph. pastorella* (Zeller, 1846)
= *Lithocolletis fainae* Gerasimov
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Gerasimov 1931 [as *Lithocolletis fainae*], 1932, Kuznetzov 1960, 1981, Sherniyazova 1984, Noreika 1991a, Noreika & Puplesis, 1992a, 1992c, Puplesis et al. 1992).
158*. *Ph. populicola* (Kuznetzov, 1975)
Tadzhikistan (Kuznetzov 1975, 1981, Sherniyazova 1975, 1984, Puplesis & Noreika 1990, Noreika & Puplesis 1992a, 1992c).
159. *Ph. apparella* (Herrich-Schäffer, 1855)
Kazakhstan (Kuznetzov 1981).
160*. *Ph. aceriphaga* (Kuznetzov, 1975)
Turkmenistan, Tadzhikistan (Kuznetzov 1975, 1981, Sherniyazova 1984, 1988b, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992c).
161. *Ph. connexella* (Zeller, 1846)
= *Ph. asiatica* Gerasimov, **syn.n.**
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan (Gerasimov 1931, 1932, Sherniyazova 1975, 1984, Kuznetzov 1981, Noreika 1991a, 1991b, Noreika & Puplesis 1992a, 1992c [as *Ph. asiatica*], Puplesienë & Noreika 1993).
162*. *Ph. dentifera* Noreika, 1992
Turkmenistan, Tadzhikistan (Noreika & Puplesis 1992a).
163*. *Ph. pruinosella* (Gerasimov, 1931)
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan (Gerasimov 1931, 1932, Kuznetzov 1960, 1981, Noreika 1991a, Noreika & Puplesis 1992a, 1992c).
164. *Ph. platani* (Staudinger, 1870)
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Gerasimov 1932, Kuznetzov 1960, 1981, Sherniyazova 1984, Noreika 1991a, Noreika & Puplesis 1992c).
165. *Ph. acerifoliella* (Zeller, 1839)
=*Ph. sylvella* (Haworth)
Kazakhstan (Kuznetzov 1981 [as *Ph. sylvella*]), Turkmenistan (new record: western Kopet Dag, 1993, Puplesis & Diškus leg.).
166*. *Ph. aceripestis* (Kuznetzov, 1978)
Turkmenistan, Tadzhikistan (Kuznetzov 1978, Sherniyazova 1984, 1988b, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992c).
167*. *Ph. turcomanicella* (Kuznetzov, 1956)
Turkmenistan (Kuznetzov 1956, 1960, 1981).
168. *Ph. corylifoliella* (Hübner, 1796)
Kazakhstan, Turkmenistan Uzbekistan, Tadzhikistan (Kuznetzov 1960, 1981, Sherniyazova 1984, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992c).
169. *Ph. turanica* (Gerasimov, 1931)
Azerbaydzhan, Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Gerasimov 1931, 1932, Kuznetzov 1960, 1981, Sherniyazova 1984, Noreika 1991a, Noreika & Puplesis 1992c).
170*. *Ph. hissarella* Noreika, 1992
Tadzhikistan (Noreika & Puplesis 1992c).
171. *Ph. cerasicolella* (Herrich-Schäffer, 1855)
Kazakhstan, Turkmenistan (Kuznetzov 1960, 1981, Noreika 1991a, Puplesienė & Noreika 1993).
172*. *Ph. malella* (Gerasimov, 1931)
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Gerasimov 1931, 1932, Kuznetzov 1981, Sherniyazova 1984, Puplesis & Noreika 1990, Noreika 1991a, Noreika & Puplesis 1992c, Puplesis et al. 1992).
173. *Ph. cydoniella* (Dennis & Schiffermüller, 1775)
Turkmenistan (new record: western Kopet Dag, 1993, Sruoga leg.).

Bucculatricidae Wallengren, 1881

Genus *Bucculatrix* Zeller, 1839

174. *B. artemisiae* Herrich-Schäffer, 1853
= *B. artemisiella* Herrich-Schäffer, 1955
Turkmenistan (Seksjaeva 1993).
175. *B. ratisbonensis* Stainton, 1861
Turkmenistan (Seksjaeva 1993).
176*. *B. anthemidella* Deschka, 1972
Kirgiziya (Seksjaeva 1993).
177. *B. armeniaca* Deschka, 1992
Armeniya (Deschka 1992, Seksjaeva 1993).
178. *B. centaureae* Deschka, 1973
Kazakhstan, Turkmenistan (Puplesis et al. 1992, Seksjaeva 1993).
179*. *B. iranica* Deschka, 1981
Iran (Deschka 1981).
180*. *B. tianshanica* Seksjaeva, 1992
Kazakhstan, Turkmenistan (Puplesis et al. 1992, Seksjaeva 1993).
181. *B. maritima* Stainton, 1851
Kazakhstan (Puplesis et al. 1992, Seksjaeva 1993), Tadzhikistan (new record: Gissar ridge, 1991, Sruoga, Puplesis & Diškus leg.).
182. *B. cristatella* Zeller, 1839
= *B. jugicola* Wocke, 1876
Turkmenistan (new record: western Kopet Dag, 1993, Puplesis & Diškus leg.).
183. *B. cidarella* Zeller, 1839
Kazakhstan (Seksjaeva 1981, 1993).
184 *B. paliuricola* Kuznetzov, 1956
Turkmenistan (Kuznetzov 1956, 1960, Seksjaeva 1981, 1993).
185. *B. ulmifoliae* Hering, 1931
Kazakhstan, Uzbekistan, Kirgiziya (Seksjaeva 1981, 1993).
186. *B. ulmicola* Kuznetzov, 1962
Armeniya, Kazakhstan, Turkmenistan, Uzbekistan (Kuznetzov 1962, Seksjaeva 1981, 1993), Tadzhikistan (new record: Gissar ridge, 1990-1991, larvae on *Ulmus* sp., Bajarūnas leg.).
187*. *B. caspica* Puplesis & Sruoga, 1991
Kazakhstan, Uzbekistan (Puplesis et al. 1991, Seksjaeva 1993), Tadzhikistan (new record: Gissar ridge, 1990-1991, larvae on *Ulmus* sp., Bajarūnas leg.)**.

188. *B. frangutella* (Goeze, 1783)
Turkmenistan, Uzbekistan (Seksjaeva 1981, 1993).
189. *B. crataegi* Zeller, 1839
Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgiziya (Seksjaeva 1981, 1993).
190*. *B. endospiralis* Deschka, 1981
Iran (Deschka 1981).
191*. *B. multicornuta* Puplesis & Diškus, 1996
Turkmenistan (Puplesis & Diškus 1996c).
192*. *B. pectinella* Deschka, 1981
Iran, Turkmenistan (Deschka 1981, Seksjaeva 1993).
193*. *B. formosa* Puplesis & Seksjaeva, 1992
Turkmenistan (Puplesis et al. 1992), Tadzhikistan (new record: Nurek, 1990-1991, Bajarūnas leg.).
194*. *B. macrognathos* Puplesis & Diškus, 1996
Turkmenistan (Puplesis & Diškus 1996c).

Notes

(96). *Tischeria longispicula* Puplesis – No data from Tadzhikistan. Renewed study of all available Tadzhikistanian specimens (Puplesis 1988) has shown that they are identical with the new species cited under no. 97.

(103). *Parornix* sp. – There are no confirmed data of *Parornix torquilella* from Central Asia. Asiatic specimens previously identified as such (i.e. Kuznetzov 1960) belong to this as yet unnamed species (Noreika in prep.).

(119). *Gracillaria loriolella.* – There are no confirmed data of *Caloptilia cuculipennella* (Hübner) from Central Asia. Asiatic specimens previously identified as such (i.e. Kuznetzov 1960, Noreika 1991a, Noreika & Puplesis 1992c) belong to *loriolella.*

(149). *Phyllonorycter medicaginella* – There are no confirmed data of *Ph.insignitella* (Zeller) from Central Asia. Gerasimov's previous record (1930) for Uzbekistan is *medicaginella.*

(187). *Bucculatrix caspica* Puplesis & Sruoga – No data available from Turkmenistan. The distribution data in Seksjaeva (1993) were incorrectly cited.

Host plant relationships of leaf-mining lepidoptera in central asia

Mining Lepidoptera, in particular the Gracillariidae and part of the Nepticulidae are for a major part known through rearing of imagines from larvae, so that there is a large amount of knowledge available on hostplant relationships and bionomics. However, in some taxa such as the Opostegidae, or in such nepticulid genera as *Acalyptris*, *Etainia* and *Ectoedemia*, hostplants are known for less than 20-40% of the species.

The data on bionomics of Centralasiatic leaf-miners are compiled from the works of Kuznetzov (1981), Seksjaeva (1981, 1993), Noreika & Puplesis (1992a, 1992c) and Puplesis (1994). Because many more new data have become available recently, an updated survey is presented below. The plant taxonomy follows Takhtajan (1987), which is the most exhaustive, frequently used and well-known classification for plants in Central Asia.

In summary, leaf-miners of the families under study are known in Central Asia from 60 plant genera and 22 plant families.

Check-list of host plants

The numbers refer to the species in the check-list above. Hostdata which apply to data outside Central Asia are marked with an asterisk*. Hostdata not obtained by rearing, but by indirect evidence (i.e. collecting adults near host) are marked with a questionmark (?).

Chenopodiaceae
Chenopodium: 129. *Calybites phasianipennella*

Polygonaceae
Polygonum: 129. *Calybites phasianipennella*
Rumex: 129. *Calybites phasianipennella*

Platanaceae
Platanus: 164. *Phyllonorycter platani*

Betulaceae
Betula: 13. *Stigmella luteella**, 14. sp.n. (*Stigmella betulicola*-group), 15. sp.n. (*Stigmella betulicola*-group)
Alnus: 183. *Bucculatrix cidarella**

Juglandaceae
Juglans: 127. *Caloptilia roscipennella*, 147. *Phyllonorycter juglandicola*

Clusiaceae (=Guttiferae)
Hypericum: 67. *Fomoria septembrella**, 130. *Eucalybites auroguttella*

Primulaceae
Lysimachia: 129. *Calybites phasianipennella*

Salicaceae
Populus:57. *Ectoedemia albida* (?), 69. *Fomoria flavimacula*, 120. *Caloptilia stigmatella*, 138. *Cameraria obliquifascia*, 152. *Phyllonorycter comparella*, 153. *Ph. sagitella**, 154. *Ph. populi*, 156. *Ph. populifoliella*, 157. *Ph. pastorella*, 158. *Ph. populicola*, 159. *Ph. apparella*, 162. *Ph. dentifera*, 164. *Ph. platani*
Salix: 1. *Opostega spatulella**, 12. *Stigmella nivenburgensis*, 40. *S. johanssoni*, 41. *S. aiderensis*, 42. *S. kondarai* (?), 43. *S. juratae* (?), 44. *S. flavescens*, 45. *S.lurida* (?), 120. *Caloptilia stigmatella*, 138 .*Cameraria obliquifascia*, 139. *C. saliciphaga*, 157. *Phyllonorycter pastorella*, 161. *Ph. connexella*, 163. *Ph. pruinosella*

Ulmaceae
Ulmus: 10. *Stigmella ulmiphaga*, 11. *S. kazakhstanica* , 56. *Ectoedemia amani**, 140. *Phyllonorycter schreberella*, 185. *Bucculatrix ulmifoliae*, 186. *B. ulmicola*, 187. *B. caspica*
Celtis: 8. *Stigmella turbatrix*, 128. *Caloptilia fidella*, 141. *Phyllonorycter millierella*

Moraceae
Ficus: 7. *Stigmella ficulnea*

Cannabaceae
Humulus: 128. *Caloptilia fidella**

Rosaceae
Spiraea: 37. *Stigmella inopinata**
Rubus: 51. *Stigmella aurella*, 93. *Tischeria marginea*
Rosa: 22. *Stigmella anomalella*, 23. *S. spinosissimae*, 24. *S. rolandi**, 25. *S. muricatella**, 26. *S. trisyllaba*, 27. *S.* sp.n. (*S. sanguisorbae*-group), 66. *Ectoedemia rosiphila*, 94. *T. angusticolella* 95. *Tischeria rosella*, 96. *T. longispicula*,
Potentilla: 59. *Ectoedemia arcuatella**
Fragaria: 59. *Ectoedemia arcuatella**
Sanguisorba: 24. *Stigmella rolandi**, *S. muricatella**
Sorbus: 104. *Parornix petiolella**, 169. *Phyllonorycter turanica**
Pyrus: 9. *Stigmella abaiella*, 168. *Phyllonorycter corylifoliella*, 172. *Ph. malella*
Malus: 5. *Stigmella maloidica*, 38. *S.malifoliella*, 58. *Ectoedemia atricollis*, 104. *Parornix petiolella*, 151. *Phyllonorycter pyrifoliella*, 155. *Ph. iranica*, 168. *Ph.corylifoliella*, 169. *Ph. turanica*, 172. *Ph. malella*, 189. *Bucculatrix crataegi*
Amelanchier: 39. *Stigmella hybnerella**
Cydonia: 169. *Phyllonorycter turanica*, 172. *Ph. malella*, 173. *Ph. cydoniella*
Cotoneaster: 5. *Stigmella maloidica*, 39. *S. hybnerella**, 46. *S. subsorbi*, 105. *Parornix cotoneasterella*, 170. *Ph. hissarella*, 172. *Ph. malella*, 189. *Bucculatrix crataegi*
Crataegus: 28. *Stigmella regiella*, 29. *S. crataegella*, 31. *S. crataegi*, 32. *S. aurora**, 34. *S. hissariella*, 35. *S. juryi*, 39. *S. hybnerella*, 98. *Parornix subfinitimella*, 168. *Phyllonorycter corylifoliella*, 169. *Ph. turanica*, 172. *Ph. malella*, 189. *Bucculatrix crataegi*
Cerasus: 47. *Stigmella cerasi*, 60.*Ectoedemia spinosella*, 92. *Tischeria gaunacella*, 171. *Phyllonorycter cerasicolella*
Prunus: 60. *Ectoedemia spinosella*, 92 *Tischeria gaunacella*, 104. *Parornix petiolella* , 107. *P. szoecsi*, 169. *Phyllonorycter turanica*, 171. *Ph. cerasicolella*
Amygdalus: 106 .*Parornix turcmeniella* (?), 107. *P. szoecsi*, 108. *P. persicella*, 169. *Phyllonorycter turanica*, 171. *Ph. cerasicolella*
Aflatunia: 48. *S. aflatuniae*

Lythraceae
Lythrum: 129. *Calybites phasianipennella**

Fabaceae (=Leguminosae)
Sophora: 113. *Micrurapteryx sophorivora*
Astragalus: 111. *Micrurapteryx fumosella*
Glycyrrhiza: 121. *Caloptilia flava**
Vicia: 111. *Micrurapteryx fumosella*
Lathyrus: 112. *Micrurapteryx tortuosella*, 150. *Phyllonorycter fabaceaella* (?)
Melilotus: 111. *Micrurapteryx fumosella*, 112. *M. tortuosella*, 149, *Phyllonorycter medicaginella**
Medicago: 112. *Micrurapteryx tortuosella*, 149, *Phyllonorycter medicaginella*, 150. *P. fabaceaella*
Trifolium: 111. *Micrurapteryx fumosella*
Cytisus: 109. *Micrurapteryx kollariella**

Aceraceae
Acer: 16. *Stigmella acerna*, 17. *S. bicolor*, 18. *S. semiaurea*, 53. *S. kuznetzovi*, 90. *Etainia leptognathos* (?), 91. *E. obtusa* (?), 122. *Caloptilia semifascia*, 123. *C. acerivorella*, 124. *C. acericolella*, 125. *C. fribergensis**, 160. *Phyllonorycter aceriphaga*, 165. *Ph. acerifoliella**, 166. *Ph. aceripestis*, 167. *Ph. turcomanicella*

Anacardiaceae
Pistacia: 133. *Cupedia cupediella*

Rhamnaceae
Rhamnus: 20. *Stigmella klimeschi*, 21. *S. kopetdagica*, 188. *Bucculatrix frangutella**
Paliurus: 6. *Stigmella paliurella* , 184. *Bucculatrix paliuricola*
Zizyphus: 6. *Stigmella paliurella*

Caprifoliaceae
Lonicera: 143. *Phyllonorycter emberizaepennella*, 144. *Ph. raikhonae*, 145. *Ph. montanella*, 146. *Ph. loniceriphaga*

Oleaceae
Fraxinus: 119. *Gracillaria loriolella*

Boraginaceae
Echium: 135. *Dialectica scalariella**
Pulmonaria: 136. *Dialectica imperialella**
Symphytum: 136. *Dialectica imperialella**
Anchusa: 135. *Dialectica scalariella**

Plantaginaceae
Plantago: 131. *Aspilapteryx tringipennella**

Lamiaceae (=Labiatae)
Lycopus: 4. *Pseudopostega auritella**

Asteraceae
Centaurea: 178. *Bucculatrix centaureae**
Anthemis: 176. *Bucculatrix anthemidella**
Achillea: 182. *Bucculatrix cristatella**
Artemisia: 137. *Leucospilapteryx omissella*, 174. *Bucculatrix artemisiae**, 175. *B. ratisbonensis**
Aster: 181. *Bucculatrix maritima**

The strong predominance of Rosaceae in the host record of the fauna of Central Asia (more than 35 %) is not surprising, since this applies also to the whole Palaearctic fauna (van Nieukerken 1986, Puplesis 1994, Noreika & Puplesis 1992a). The tendency within Nepticulidae and Gracillariidae to feed on woody plants and the usual strict hostplant choice (i.e. predominance of monophagous or oligophagous species) was stressed before (Puplesis 1994). And, moreover, this tendency is also present in other families of leaf-miners involved in this survey (Tischeriidae and partly Bucculatricidae). However, because biological considerations on leaf-miners of Central Asia are still hampered by a lack of sufficient knowledge, the present list of hostplants has a preliminary character.

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REFERENCES

Bradley, J. D., 1980. A new species of *Phyllonorycter* (Lepidoptera: Gracillariidae) on *Lonicera quinquelocularis* in northern Pakistan. – Bulletin of Entomological Research 70: 61-63.

Danilevsky, A. S., 1955. Novye vidy nizshikh chesuekrylykh (Lepidoptera, Microheterocera), vredyashchie drevesnym I kustarnikovym porodam v Srednei Azii (in Russian). – Entomologicheskoe Obozrenie 34: 108-123.

Davis, D. R., 1989 Generic revision of the Opostegidae, with a synoptic catalog of the world's species (Lepidoptera: Nepticuloidea). – Smithsonian Contributions to Zoology 478: 1-97 pp.

Deschka, G., 1974. Blattminierende Lepidopteren aus dem Nahen und Mittleren Osten. I. – Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 26: 41-46.

Deschka, G., 1979. Blattminierende Lepidopteren aus dem Nahen und Mittleren Osten.III. Teil. – Zeitschrift Arbeitsgemeinschaft Österreichischer Entomologen 31: 13-16.

Deschka, G., 1981. Blattminierende Lepidopteren aus dem Nahen und Mittleren Osten. IV. Teil. –Zeitschrift Arbeitsgemeinschaft Österreichischer Entomologen 33: 33-41.

Deschka, G., 1992. Blattminierende Lepidopteren aus dem Nahen und Mittleren Osten. VI. Teil. *Bucculatrix armeniaca* sp. n. aus Russisch-Armenien (Lepidoptera, Lyonetiidae). – Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 44: 17-20.

Falkovitsh, M. I., 1986. Chesuekrylye (Lepidoptera) ostankovykh gor Kuldzhunktau i podgornoi ravniny (jugozapadnii Kizylkum). – Trudy Vsesoyuznogo Entomologicheskogo Obshestva 67: 131-186.

Filipjev, N., 1926. Lepidopterologische Notizen. IV. – Russkoe Entomologicheskoe Obozrenie 20: 284-29.

Gerasimov, A. M., 1930. Zur Lepidopteren-Fauna-Asiens. I. Microheterocera aus dem District Kaschka-Darja (SO-Buchara). – Annuaire du Musée Zoologique de l'Academie des Sciences de l'URSS 31 (1): 21-48.

Gerasimov, A. M., 1931. Zur Lepidopteren fauna von Mittelasien III. Neue *Lithocolletis*. – Entomologischen Zeitschrift, Frankfurt am Main 45 (9): 125-132.

Gerasimov, A. M., 1932. Moli-minery. I. Sredne-Aziatskie *Lithocolletis*. – Izvestiya Leningradskogo Instituta borby s vreditelyami v Selskom i Lesnom Khozyaistve 3: 197-248. [in Russian]

Gerasimov, A. M., 1933. Minierende Motten. III. Neue auf Rosaceen lebende *Lithocolletis*-Arten (Lepidoptera, Gracillariidae). – Deutsche Entomologische Zeitschrift 47: 119-122.

Gerasimov, A. M., 1937. Zur systematik der Raupen von *Stigmella* Schrank (*Nepticula* Z.) und *Tischeria* Z. – Entomolgische Rundschau 8: 89-90.

Gerasimov, A. M., 1952. Gusenitsy. Nasekomye chesuekrylye . – Fauna SSSR 1 (2), Moscow, Leningrad, 338 pp.

Klimesch, J., 1979. Beiträge zur Kenntnis der Nepticuliden. Beschreibung zweier neuer Arten [*Stigmella abaiella* n. sp. und *Trifurcula* (*Fedalmia*) *sanctibenedicti* n. sp.] (Lepidoptera, Monotrysia). – Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 31: 21-27.

Kozlov, M. V., 1985. Novye i maloizvestnye opostegidy (Lepidoptera, Opostegidae) iz Aziatskoi chasti SSSR. – Trudy Zoologicheskogo Instituta Akademii Nauk SSSR 135: 49-58. [in Russian]

Kuznetzov, V. I., 1956. Novye listovertki (Tortricidae) i moli-pestryanki (Lithocolletoidea) iz zapadnogo Kopet-Daga. – Entomologicheskoe Obozrenie 35: 447-461.

Kuznetzov, V. I., 1960. Materialy po faune i biologii chesuekrylykh (Lepidoptera) Zapadnogo Kopet-Daga. – Fauna i Ekologya Nasekomykh Turkmenii 27: 11-27.

Kuznetzov, V. I., 1962. Il'movaya krivousaya mol' – *Bucculatrix ulmicola* Kuznetz. sp. n. (Lepidoptera, Bucculatrigidae) - vreditel' il'mov v Zakavkaz'e i Srednei Azii. – Doklady Akademii Nauk Armiyanskoi SSR 35 (2): 81-83. [in Russian]

Kuznetzov, V. I., 1975. Novye vidy nizshikh chesuekrylykh (Lepidoptera, Carposinidae, Lithocolletidae) iz Tadzhikistana. – Entomologicheskoe Obozrenie 54: 415-420. [in Russian]

Kuznetzov, V. I., 1978. Novye vidy nizshikh cheshuekrylykh (Lepidoptera: Gracillariidae, Alucitidae, Pyralidae) iz Srednei Azii. – Trudy Zoologicheskogo Instituta Akademii Nauk SSSR 71: 110-119. [in Russian]

Kuznetzov, V. I., 1979. Novye miniruyushie moli-pestryanki (Lepidoptera, Gracillariidae) Aziatskoi chasti SSSR. – Trudy Zoologicheskogo Instituta Akademii Nauk SSSR 88: 77-84. [in Russian]

Kuznetzov, V. I., 1981. Semeistvo Gracillariidae (Lithocolletidae) - moli-pestryanki. – Opredelitel' Nasekomykh Evropeiskoi Chasti SSSR 4 (2): 149-311.

Kuznetzov, V. I. & N. I. Tristan, 1985. Obzor miniruyushikh molei roda *Micrurapteryx* Spuler (Lepidoptera, Gracillariidae) Palearkticheskoi fauny. – Entomologicheskoe Obozrenie 64: 177-199. [in Russian]

Nieukerken, J. van, 1985. A taxonomic revision of the western palaearctic species of the subgenera *Zimmermannia* Hering and *Ectoedemia* Busck s.str. (Lepidoptera, Nepticulidae), with notes on their phylogeny. – Tijdschrift voor Entomologie 128:1-164.

Nieukerken, E, J. van, 1986. Systematics and phylogeny of Holarctic genera of Nepticulidae (Lepidoptera, Heteroneura: Monotrysia). – Zoölogische Verhandelingen, Leiden 236: 1-96.

Nieukerken, E. J. van, 1990a. The *Trifurcula subnitidella* group (Lepidoptera: Nepticulidae): taxonomy, distribution and biology. – Tijdschrift voor Entomologie 133: 205-238.

Nieukerken, E. J. van, 1990b. Opostegidae. – *In* Johansson, R. *et al.* The Nepticulidae and Opostegidae (Lepidoptera) of North West Europe. – Fauna Entomologica Scandinavica 23:357-372.

Nieukerken, E. J. van & R. Puplesis, 1991. Taxonomy and distribution of the *Trifurcula* (*Glaucolepis*) *raikhonae* group (Lepidoptera: Nepticulidae). – Tijdschrift voor Entomologie 134: 201-210.

Noreika, R. V., 1991a. Obzor fauny molei-pestryanok (Lepidoptera, Gracillariidae) Turkmenii (in Russian). – Entomologicheskoe Obozrenie 70: 429-443.

Noreika, R. V., 1991b. Vidurinės Azijos Gracillariidae (Lepidoptera) fauna ir trofiniai ryšiai. – Respublikinės biologinės krypties aukštųjų mokyklų studentų mokslinės konferencijos pranešimų tezės, Kaunas, Miškininkystės Akademija: 10-12. [in Lithuanian]

Noreika, R. & R. Puplesis, 1992a. Salicaceae feeding

Gracillariidae (Lepidoptera) of Central Asia. – Tijdschrift voor Entomologie 135: 27-41.

Noreika, R. V. & R. K. Puplesis, 1992b. Opisanie novykh vidov chesuekrylykh sem. Gracillariidae (Lepidoptera) iz Azerbayidzhana i Srednei Azii s sinonimizaciei *Gracillaria impictipennella* Grsm. – Entomologicheskoe Obozrenie 71: 414-421. [in Russian]

Noreika, R. & R. Puplesis, 1992c. Review of the Gracillariidae (Lepidoptera) of the Gissarskiy Ridge (Central Asia, Tajikistan) with the descriptions of two new species of *Phyllonorycter*. – Nota Lepidopterologica 15: 123-147.

Puplesienė, J. & R. Noreika, 1993. A brief karyological rewiew of the Gracillariidae (Lepidoptera). – Phegea 21: 55-63.

Puplesis, R., 1984. Obzor vidov roda *Microcalyptris* (Lepidoptera, Nepticulidae) s opisaniem novykh vidov iz pustyn' Mongolii I SSSR. – Nasekomye Mongolii 9: 484-507.

Puplesis, R., 1985. Novye vidy molei-malyutok (Lepidoptera, Nepticulidae) s yuga Dal'nego Vostoka i Tadzhikistana (in Russian). – Trudy Zoologicheskogo Instituta Akademii Nauk SSSR 134: 59-72.

Puplesis, R., 1988a. Tri novykh vida neptikulid (Lepidoptera, Nepticulidae) iz aziatskoi chasti SSSR. – Nauchnye Trudy Vysshikh Uchebnych Zavedenii Litovskoi SSR, Biologiya 26: 24-29. [in Russian]

Puplesis, R., 1988b. New species of plant mining Lepidoptera (Nepticulidae, Tischeriidae) from Central Asia. – Stapfia 16: 273-290.

Puplesis, R., 1989. Opisanie samok 5 vidov roda *Acalyptris* Meyrick (Lepidoptera, Nepticulidae). – Nasekomye Mongolii 10: 506-511. [in Russian]

Puplesis, R., 1990. The genus *Acalyptris* Meyrick (Lepidoptera, Nepticulidae) in the USSR: distribution and taxonomy. – Nota Lepidopterologica 13: 62-88.

Puplesis, R., 1991. The *Stigmella paradoxa* species-group (Lepidoptera, Nepticulidae) in the USSR. – Entomologica Scandinavica 22: 13-127.

Puplesis, R., 1994. The Nepticulidae of East Europe and Asia. – Backhuys Publishers, Leiden, 291 pp., 840 figs.

Puplesis, R. & N. V. Arutyunova, 1991. Dva novykh vida molei-malyutok (Lepidoptera, Nepticulidae), miniruyushchikh list'ya yabloni, iz Tadzhikistana. – Entomologicheskoye Obozreniye 70: 571-573.

Puplesis, R. & A. Diškus, 1995. *Acalyptris argyrapsis* sp. n., a remarkable species from Tadzhikistan (Lepidoptera: Nepticulidae). – Phegea 23: 51-54.

Puplesis, R. & A. Diškus, 1996a. First record of the genus *Etainia* from Central Asia with descriptions of two new species and some provisional notes on the world fauna (Lepidoptera: Nepticulidae). – Phegea 24: 41-48.

Puplesis, R. & A. Diškus, 1996b. A review of the *Sigmella sorbi* species-group with descriptions of two new species from Turkmenistan and Tadzhikistan (Lepidoptera: Nepticulidae).-Phegea 24 (3) (in press).

Puplesis, R. & A. Diškus, 1996c. Five new mining Lepidoptera (Nepticulidae, Bucculatricidae) from Central Asia. – Tijdschrift voor Entomologie 139: 181-190.

Puplesis, R.& R. Noreika, 1990. K faune molei-pestryanok (Gracillariidae) Yuzhnogo sklona Gissarskogo khrebta. – Uspekhi Entomologii v SSSR: nasekomye pereponchatokrylye i cheshuekrylye: 201-202.[in Russian]

Puplesis, R., S. Seksjaeva, R. Noreika & J. Puplesienė, 1992. Some leaf-mining Lepidoptera from the Aksu Dzabagly Reserve (western Tian Shan') with the descriptions of four new species (Lepidoptera: Nepticulidae, Bucculatricidae). – Nota Lepidopterologica 15: 47-64.

Puplesis, R., S. Seksjaeva & J. Puplesienė, 1992. *Bucculatrix formosa* sp. n., a remarkable species from the Kugitangtau Mountains (Central Asia) (Lepidoptera: Bucculatricidae). – Nota Lepidopterologica 15: 41-46.

Puplesis, R., S. Seksjaeva & V. Sruoga, 1991. Leaf-mining Lepidoptera (Nepticulidae, Bucculatricidae, Gracillariidae) from *Ulmus* in northern Caspiya (Kaspia). – Tijdschrift voor Entomologie 134: 69-73.

Seksjaeva S. V., 1981. Bucculatricidae - krivousye krokhotki-moli. – Opredelitel' Nasekomykh Evropeiskoi Chasti SSSR 4(2): 136-148. [in Russian]

Seksjaeva, S. V., 1993. Obzor krivousykh krokhotok-molei (Lepidoptera, Bucculatricidae) fauny Rossii. – Trudy Zoologicheskogo Instituta Rossiiskoi Akademii Nauk 225: 99-119. [in Russian]

Sherniyazova, R. M., 1975. K faune i ekologii nizshikh chesuekrylykh ivovykh yuzhnogo sklona Gissarskogo khrebta. – Entomologiya Tadzhikistana 1: 187-190. [in Russian]

Sherniyazova, R. M., 1982. K poznaniyu nizshikh chesuekrylykh (Lepidoptera, Gracillariidae) svyazannykh s drevesno-kustarnikovymi rasteniyami yuzhnogo sklona Gissarskogo khrebta i Gissarskoi doliny. – Izvestiya Akademii Nauk Tadzhikskoi SSR 3: 38-43. [in Russian]

Sherniyazova, R. M., 1984. Moli-pestryanki (Lepidoptera, Gracillariidae) obitayushchie na drevesno-kustarnikovykh rasteniyakh na yuzhnom sklone Gissarskogo khrebta i Gissarskoi doliny. – Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Biologicheskikh Nauk 3 (112): 33-37. [in Russian]

Sherniyazova, R. M., 1988a. Nizshie chesuekrylye, sviyazanye s fistashkoi na yuzhnom sklone Gissarskogo khrebta. – Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Biologicheskikh Nauk 2: 25-28. [in Russian]

Sherniyazova, R. M. , 1988b. Ekologo-faunisticheskii obzor nizchikh chesuekrylykh, svyazannykh s klenom Regelya i klenom turkestanskim na yuzhnom sklone Gissarskogo khrebta. – Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Biologicheskikh Nauk 3 (112): 77-79. [in Russian]

Takhtajan, A. L., 1987. Sistema magnoliofitov. – Nauka Publishers, Leningrad, 439 pp. [in Russian]

Triberti, P., 1985. A revision of the genus *Aspilapteryx* Spuler (Lepidoptera, Gracillariidae). – Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 37: 1-16.

Triberti, P., 1986. Note su *Leucospilapteryx dorsiliniella* Amsel e *Acrocercops eximipalpella* Gerasimov, con descrizione di due nuovi generi ed una specie (Lepidoptera, Gracillariidae). – Bolletina del Museo Civico di Storia Naturale di Verona 13: 249-264.

Triberti, P., 1989. Three new Palaearctic species of the subfamily Gracillariidae (Lepidoptera, Gracillariidae). – Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 41: 65-70.

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NEW SPECIES OF *SIGMELLA* HEBARD (BLATTARIA: BLATTELLIDAE, BLATTELLINAE)

Roth, L.M. 1996. New species of *Sigmella* Hebard (Blattaria: Blattellidae, Blattellinae). – Tijdschrift voor Entomologie 139: 201-213, figs. 1-43. [ISSN 0040-7496]. Published 18 December 1996.

Seven new species of the cockroach genus *Sigmella* Hebard are described; six are from Sabah and one is from Kalimantan. A key is given to distinguish males of the eight species known from Borneo.

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Key words.- *Sigmella*, cockroaches, Blattellidae, new species, taxonomy, Borneo.

Five of the seven new species on which this paper is based were sent to me by Dr. J. van Tol of the National Museum of Natural History (formerly Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands, (RMNH). One or two others came from Dr. Roy Danielsson of the Zoological Institut, Lund, Sweden (ZILS), and Mr. Willem Hogenes, Zoological Museum Amsterdam (ZMAN). A few specimens have been retained in the Museum of Comparative Zoology, Harvard University, Cambridge, MA, U.S.A. (MCZC).

Systematic part

Sigmella Hebard

Sigmella Hebard, 1940: 236; Roth, 1991: 1 (revision).

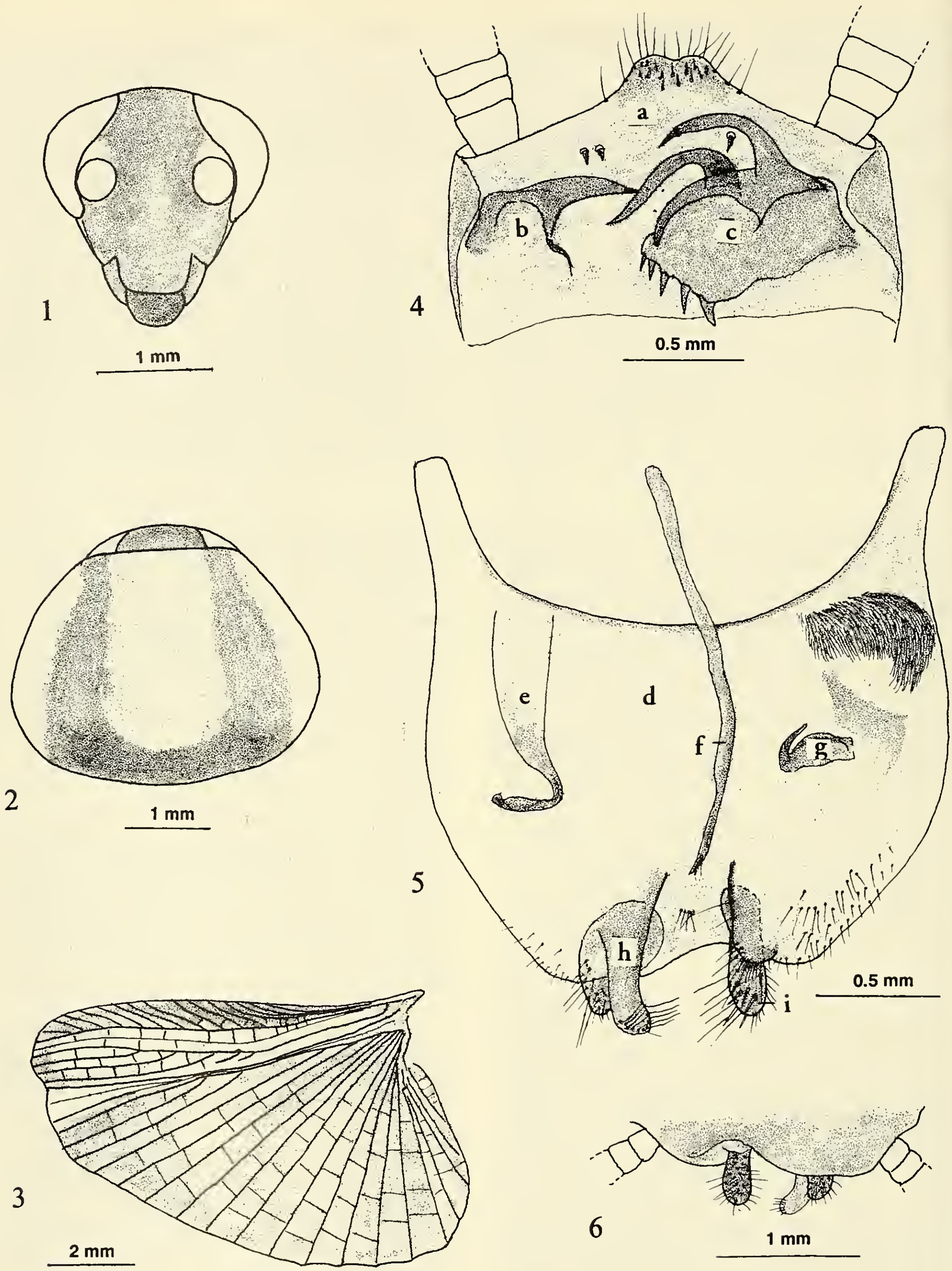
Diagnosis (Borneo species). – Tegmina and wings fully developed, the former with longitudinal discoidal sectors. Hind wing with narrow costal field, costal veins usually simple, radial vein simple, media and cubitus veins strongly curved (often referred to as sigmoid shaped), the latter with two or three complete and one to three (rarely none, fig. 7) incomplete branches, apical triangle small (figs. 3, 12, 19, 28). Front femur Type B_3, with three to five large proximal spines; pulvilli on four proximal tarsomeres, tarsal claws symmetrical, simple. Male: First abdominal tergum always specialized; seventh segment rarely specialized. Supraanal plate symmetrical, intercercal processes absent, right and left paraprocts dissimilar (fig. 4). Subgenital plate asymmetrical, with a pair of styles; a variably developed process arises on the dorsal surface of the plate, usually associated with the left style (fig. 5; the process often is not visible in the pinned specimen and slides have to be prepared to reveal them). Genital hook on the left side (fig. 5).

Remarks. – The genus *Sigmella* is very close to *Scalida* Hebard, and the two have been considered synonyms (Bruijning 1948: 67, Princis 1969: 800). However, I (Roth 1991: 1) have treated them as distinct taxa. There are 17 known species of *Sigmella* arranged in two species groups. The seven new species described below belong in the *adversa* group (Roth 1991: 7).

Key to males of *Sigmella* species from Borneo

Roth (1991: 7) presented a key to 13 known males of *Sigmella* from Burma, China, Java, Kalimantan, Philippines, Sumatra, and Taiwan. The following is a key to the known species from Borneo (I have included *Sigmella charon* (Hanitsch) from Pajau River, East Borneo, although it is not discussed in this paper.)

1. First and seventh abdominal terga specialized . 2
– Only the first abdominal tergum specialized ... 3
2. Pronotal disk yellowish, with a U-shaped, reddish brown macula, lateral and anterior borders opaque yellowish (fig. 33). Subgenital plate and styles as in figs. 37, 38 .... *balikpapanensis*
– Pronotum light reddish brown, lateral areas light yellowish (fig. 20). Subgenital plate as in figs. 22, 23. Styles slender, the right one longer (fig. 22) . ... *sipitanga*
3. Hind margin of supraanal plate with a pair of small lobes (fig. 8). Pronotum dark brown with a pair of hyaline areas on the posterior half (fig. 10) .... *kinasaba*
– Hind margin of supraanal plate and pronotum not as above 4
4. Hind margin of supraanal plate with a pair of ...



Figs. 1-6. *Sigmella achterbergi* sp. n., males from Sabah: 1, 2, holotype, head and pronotum; 3-6, paratypes: 3, hind wing; 4, supraanal plate and paraprocts (ventral); 5, subgenital plate and genitalia (dorsal); 6, tip of hind margin of the subgenital plate showing the styles and process near the base of the left style (ventral). Abbreviations: a, supraanal plate; b, left paraproct; c, right paraproct; d, subgenital plate; e, left phallomere (hook); f, median phallomere; g, right phallomere; h, process at base of left style; i, right style.

widely separated papillae, each capped by a small spine (figs. 13, 17) .... *huismanae*
– Hind margin of supraanal plate not as above ... 5
5. Styles elongated and contiguous (figs. 41,43). Supraanal plate hindmargin undulate, ventrally incrassate on each side of the midline, the thickened areas setose (fig. 42) .... *mendolonga*
– Styles more widely separated. Supraanal plate not as above 6
6. Right style huge, much larger than left one (fig. 26); the process at base of left style greatly reduced (fig. 29) .... *barrafordae*
– Styles and process at base of left style not as above 7
7. Supraanal plate with sides of hind margin oblique, the narrow apex weakly indented (fig. 4). Median genital phallomere not forked apically (fig. 5). Pronotum with a dark U-shaped macula (fig. 2) .... *achterbergi*
– Supraanal plate convexly rounded, apex rounded, entire. Median genital phallomere apically bifurcate. Pronotum reddish brown, posterior region blackish (figs. 9B, E, F, in Roth 1991) .... *charon*

Sigmella achterbergi sp. n.
(figs. 1-6)

Type specimens. – Holotype, ♂, E. Sabah, Lahad Datu, 60 km W. of: Danum Valley Field Centre, at junction Sg Segama and Sg Palum Tambun, 4.58N 117.48E, 150 m, at light, 18.30-21.00 h., Palum Tambun, edge of untouched evergreen lowl. rainforest, 17, 18. iii.1987, van Tol & Huisman; in RMNH. – Paratypes: Sabah. RMNH: same data as holotype, 1♂, Malaysia-SE. Sabah, nr. Danum Valley Field C., c. 150 m: Mal. trap 6, 1♂ (terminalia slide 160), 15-19.iii.1987, C. v. Achterberg; same locality as previous specimens, WO. Mal. trap 5, 2♂, 1♀ (abdomen missing), 19.iv.-5.v.1987, 2♂ (1 with terminalia slide 161), 20.vi-12.vii.1987, 1♂, 26.v.-20.vi.1987, 1♂ (terminalia slide 178), 26.x.-22.xi.1987, Mal. trap 11, 1♀, 20-26.iii.1987, Achterberg & D. Kennedy. Four specimens retained in the MCZC.

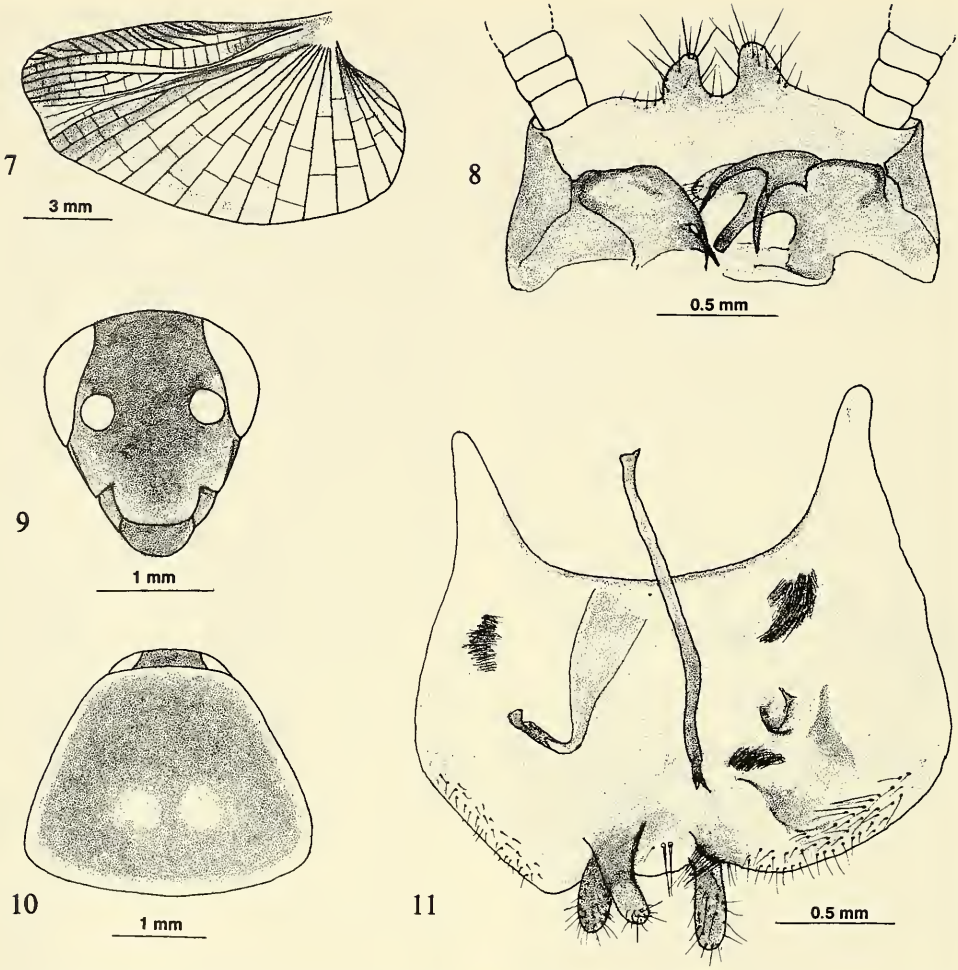
Description. – Male: Head exposed, sometimes only slightly beyond margin of pronotum, interocular space about the same as distance between ocellar spots and antennal sockets (fig. 1). Pronotum suboval, widest behind the middle (fig. 2). Tegmina and wings fully developed extending beyond end of abdomen, the former with simple radial vein, and longitudinal discoidal sectors. Hind wing with proximal costal veins thickened (not clubbed), radial vein weakly curved, simple, media and cubitus veins distinctly sigmoid, the former simple, the latter with two or three complete and two incomplete branches, apical triangle small (fig. 3). Front femur Type B_3 with four large proximal spines; pulvilli on four proximal tarsomeres of all legs, tarsal claws symmetrical, simple, arolia present. First abdominal tergum specialized with a deep median depression. Seventh abdominal tergum apparently unspecialized. Supraanal plate symmetrical, with sides of hind margin oblique, narrowly and shallowly concave apically, corners rounded; paraprocts strongly asymmetrical, the left one with a single large process that terminates with a spine (there may be an additional smaller, preapical spine), the right one with three curved processes (one has a terminal spine), these arising from a plate whose inner margin is spined; between the cerci, arising from the ventral surface of the plate, are one or two small spines below each of the paraprocts (when viewed ventrally) (fig. 4). Subgenital plate with a pair of stout setose styles, the right one longer; arising well within the margin of the plate near the base of the left style is a large process about the length of the left style, its distal margin bordered with setae (figs. 5, 6). Genitalia as in fig. 5: hook on the left side with a preapical incision; median phallomere a slender rod, its acute apex with one or two slender setae; right phallomere a greatly reduced cleft, and in addition on the right side is a setose structure.

Female: Supraanal plate trigonal, apex rounded. Front femur Type B_3 with three large proximal spines. Cubitus vein of hind wing with two or three complete and two incomplete branches, apical triangle practically absent. Subgenital plate hind margin, not crimped.

Colour. – Head yellowish, without distinct markings, labrum brown (fig. 1); maxillary palpomeres four and five light brown, segments two and three paler. Pronotal disk yellowish, laterally margined with a reddish brown u-shaped band, posteriorly hyaline but the band appears darker because the underlying dark bases of the tegmina are visible through the clear area (fig. 2). Tegmina dark brown, anterior border pale, a continuation of the pale lateral zone of the pronotum. Hind wing infuscated (fig. 3). Abdominal terga dark brown, lateral borders lighter. Abdominal sterna tan. Cerci brown on both surfaces. Legs uniformly pale.

Measurements (mm) (♀ in parentheses). Length, 9.0-12.0 (9.5); 2.6-2.8 × 3.2-3.7 (2.7-2.8 × 3.4-3.6); tegmen length, 10.5-11.5 (10.4-10.6); interocular space, 0.6-0.7 (0.8).

Etymology. – The species is named after the collector of most of the specimens, Dr. C. van Achterberg, hymenopterist in the Leiden Museum.



Figs. 7-11. *Sigmella kinasaba* sp. n., male holotype: 7, hind wing; 8, supraanal plate and paraprocts (ventral); 9, head; 10, pronotum; 11, subgenital plate and genitalia (dorsal).

Sigmella kinasaba sp. n.
(figs. 7-11)

Type specimens. – Holotype, ♂, N. Sabah, Kinabalu Park H. Q., c. 1600 m, Mal. trap 1, 8-11.iii.1987, C. v. Achterberg; in RMNH: Paratype: Sabah. RMNH: same locality, date, and collector as holotype, 1675 m, Mal. trap 3, 1♂ (terminalia slide 179).

Description. – Male: Head slightly exposed, interocular space greater than the distance between antennal sockets; eyes reach slightly below the level of antennal sockets (fig. 9). Pronotum subparabolic, sides strongly deflexed (fig. 10). Tegmina and wings extending well beyond end of abdomen, the former with longitudinal discoidal sectors. Hind wing with proximal costal veins thickened, radial vein simple, media and cubitus veins sigmoid, the former simple, the latter with three complete and no incomplete branches, apical triangle small (fig. 7). Front femur Type B_3 with five large proximal spines, pulvilli on four proximal tarsomeres of all legs, tarsal claws simple, symmetrical, arolia small. First abdominal tergum specialized with numerous long setae on each side of a fossa. Seventh abdominal tergum unspecialized. Supraanal plate transverse, practically symmetrical, hind margin with a pair of deflexed, setose, medial lobes; paraprocts dissimilar, the left one simpler the right one with three processes two of which are apically acute (one terminates with a spine), and the third, apically blunt (fig. 8). Subgenital plate with a pair of large, cylindrical, apically rounded setose styles, the right one slightly longer, the left style with a process, similar in length, originating near its base (fig. 11). Genitalia as in fig. 11: hook on the left side, with a preapical incision; median phallomere a simple rod with two spines at the apex; right phallomere a greatly reduced cleft, and with a couple of setose membranes.

Female: Unknown.

Colour. – Head with occiput and face reddish brown, cheeks, clypeus, and mandibles yellowish, labrum darker (fig. 9). Pronotum dark brown with a pair of hyaline spots on the posterior half through which the pale underlying tissue is visible, the dark zone is surrounded by yellowish (fig. 10). Tegmina hyaline reddish brown with a narrow pale line along the anterior margin (a continuation of the lateral colour of the pronotum). Abdominal terga dark brown, the depressed glandular zone on the first segment, whitish. Abdominal sterna and legs pale, without markings. Cerci pale dorsally, slightly darker ventrally. Legs pale.

Measurements (mm). Length, 9.3-10.0; pronotum length × width, 2.4-2.6 x 3.1; tegmen length, 10.9-11.1; interocular space, 0.8-0.9.

Etymology. – The specific name is a combination of Kinabalu and Sabah.

Remarks. – The bilobed hind margin of the supraanal plate of male *S. kinasaba* is distinctive. Its styles and process near the base of the left style are similar to those of *S. achterbergi.*

Sigmella huismanae sp. n.
(figs. 12-17)

Type specimens. – Holotype, ♂ (terminalia slide 180), N. Borneo, Sabah, 24 km on rd. Keningau-Kimanis (N. side), 116.03E 5.27N, 1350 m, a.l., 19.xi.1987, J. Huisman & R. de Jong; in RMNH. – Paratypes: Sabah. RMNH: same data as holotype, 2♀.

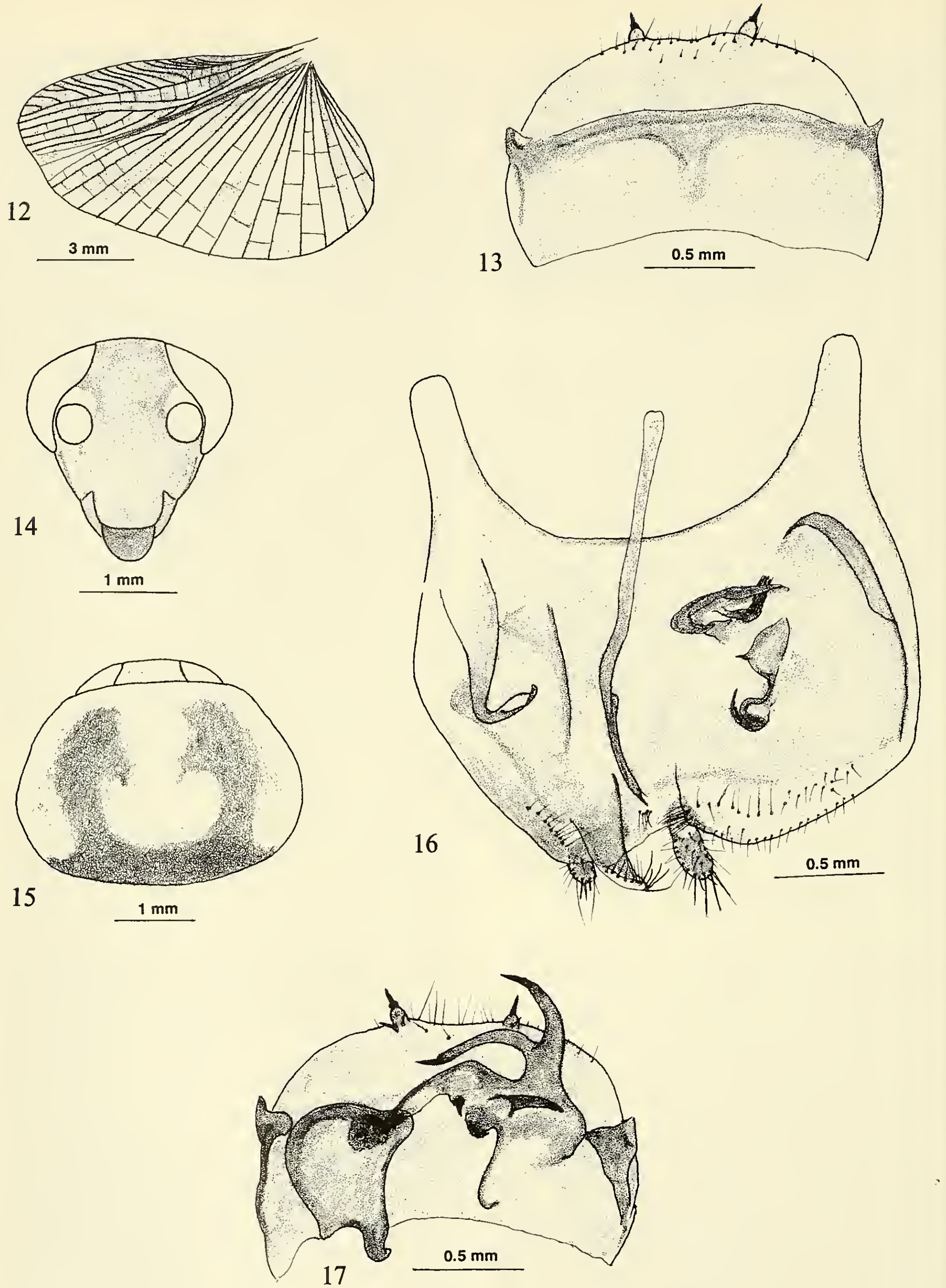
Description. – Male: Interocular space the same as distance between ocellar spots and antennal sockets (fig. 14). Pronotum subelliptical, widest behind the middle (fig. 15). Tegmina and wings extending well beyond end of abdomen, discoidal sectors of former longitudinal. Hind wing with most costal veins thickened, radial vein weakly curved, simple, media and cubitus veins sigmoid, former simple, the cubitus with three complete and three small incomplete branches, apical triangle small (as in ♀, fig. 12). Front femur Type B_3 with five stout proximal spines; pulvilli on four proximal tarsomeres of all legs, tarsal claws simple, symmetrical, arolia small. Abdominal terga one to eight, hairy. First abdominal tergum with an arch in a medial hairless pale zone, and anteriorly on each side of this region is a dense group of setae. Seventh abdominal tergum unspecialized. Supraanal plate with a distinct transverse groove across the middle, sides of the hind margin rounded, leading into the distal margin delineated at each corner by a small, spine capped papilla (figs. 13, 17); paraprocts strongly dissimilar, the left one with a large, stout, straight spinelike process that lies dorsad (not shown in the illustration but is indicated by a dark sclerotized blotch); the right paraproct with four processes, of which two are large, curved, and terminate in a spine, the third one is much shorter, straight, also with a spine at the tip, and the apically rounded tip of the fourth lies under the left paraproct (fig. 17). Subgenital plate asymmetrical with most of the stylar region located to the left of center; styles asymmetrical, cylindrical, densely setose, the right one much larger; a broad, apically rounded structure originates near the base of the left style (fig. 16). Genitalia as in fig. 16: hook on the left side with a preapical incision, apex of the rodlike median phallomere with a spine; right phallomere consisting of a small cleft sclerite that is narrowly attached to an uneven plate, this separated from a few small sclerites under which (viewed ventrally) is a small group of setae.

Colour. – Head in part hyaline, yellowish, labrum light brown (fig. 14); maxillary palpomeres four and five, light brown, the third segment lighter. Pronotal disk yellowish, with a pair of reddish brown lateral bands, the hind border hyaline but darker than the lateral bands because the underlying dark bases of the tegmina are visible (fig. 15). Tegmina light brown, hyaline, humeral vein yellowish. Hind wing infuscated. Abdominal terga brown, supraanal plate and lateral parts of segment nine yellow, the median transverse groove on the former, dark (fig. 13). Abdominal sterna yellowish, without markings. Cerci brownish on both surfaces. Legs pale.

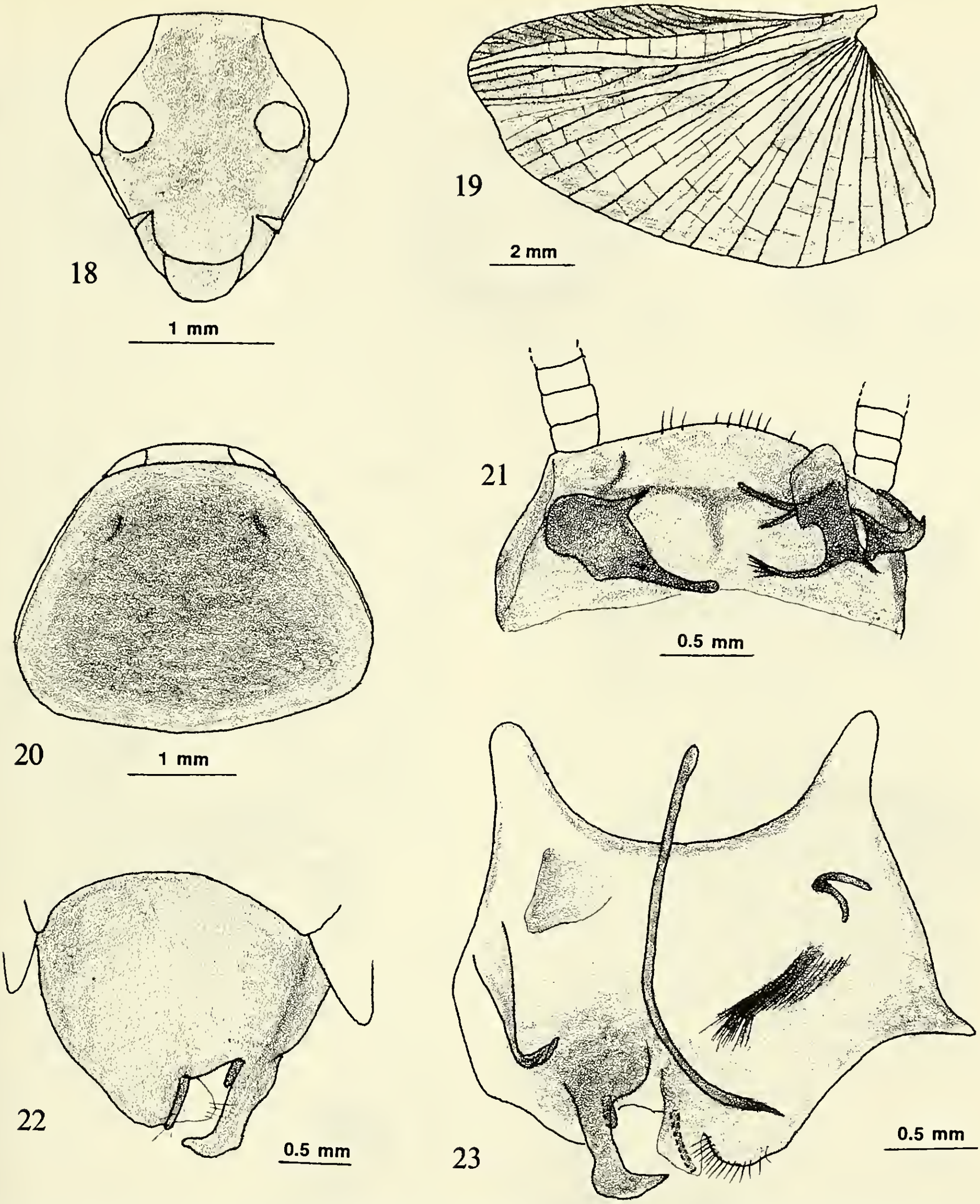
Female: Front femur Type B_3 with four or five heavy proximal spines. Cubitus vein of hind wing with three complete and two incomplete branches (fig. 12). Supraanal plate shallowly trigonal, brown with a pale anteromedial zone, or mostly pale with a narrow, dark, transverse stripe near the hind margin.

Measurements (mm) (♀ in parentheses). – Length, 11.0 (9.1-11.3); pronotum length x width, 2.6 × 3.6 (2.6 × 3.6); tegmen length, 12 (10.3-11.7); interocular space, 0.7 (0.8).

Etymology. – The species is named after Mrs. Jolanda Huisman who spent more than a year collecting in Sabah.



Figs. 12-17. *Sigmella huismanae* sp. n., from Keningau-Kimanis, Sabah: 12, female paratype, hind wing; 13-17, male holotype: 13, supraanal plate (dorsal); 14, head; 15, pronotum; 16, subgenital plate and genitalia (dorsal); 17, supraanal plate and paraprocts (ventral).

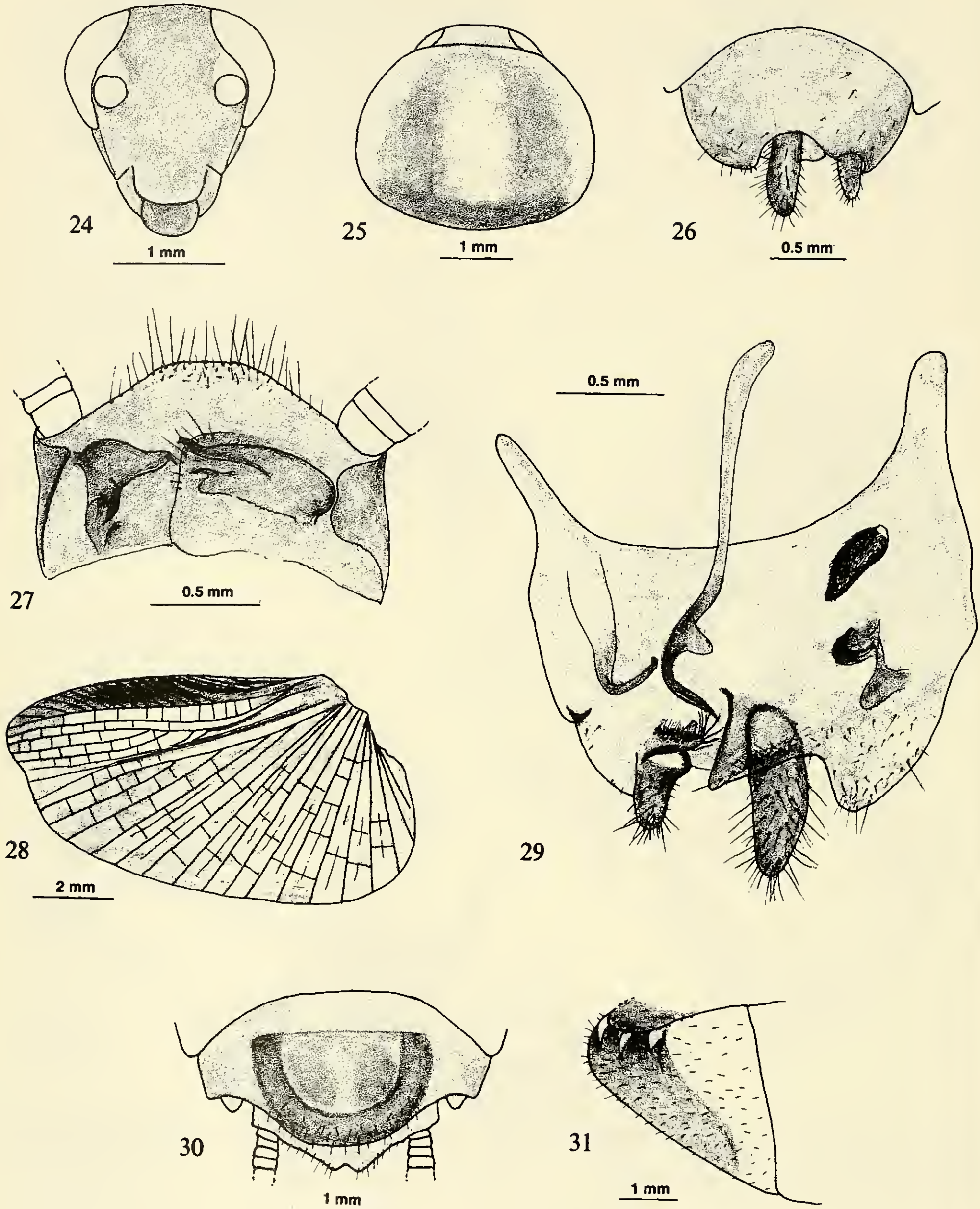


Figs. 18-23. *Sigmella sipitanga* sp. n., male holotype: 18, head; 19, hind wing; 20, pronotum; 21, supraanal plate and paraprocts (ventral); 22, subgenital plate (ventral); 23, subgenital plate and genitalia (dorsal; the styles arise on the ventral surface of the plate and are shown by broken lines).

Sigmella sipitanga **sp. n.**
(figs. 18-23)

Type specimens. – Holotype, ♂ (terminalia slide 435), Malaysia, Sabah, Sipitang, Mendolong, T5/R, 3.v.1988, S. Adebratt; in ZILS. – Paratype. Sabah. ZILS: same locality and collector as holotype, T1B/W4, 1♀, 14.iii.1989.

Description. – Male: Head slightly exposed, interocular space about the same as the distance between antennal sockets (fig. 18); fifth maxillary palpal segment distinctly swollen. Pronotum subparabolic,



Figs. 24-31. *Sigmella barrafordae* sp. n., from Sabah: 24-29, males, 26, from holotype, others from paratype: 24, head; 25, pronotum; 26, subgenital plate (ventral); 27, supraanal plate and paraprocts (ventral); 28, hind wing; 29, subgenital plate and genitalia (dorsal). 30-31, female paratype from same locality as holotype: 30, subgenital and supraanal plates (ventral); 31, subgenital plate (lateral).

hind margin weakly produced (fig. 20). Tegmina and wings fully developed extending beyond the end of the abdomen, the former with longitudinal discoidal sectors. Hind wing with narrow costal area, all veins simple except for a branched preterminal one, radial vein straight, simple, media and cubitus veins deeply curved, the latter with three complete and one small incomplete branches, apical triangle small (fig. 19). Front femur Type B_3 with four large proximal spines; pulvilli on four proximal tarsomeres, tarsal claws symmetrical, simple, arolia well developed. First abdominal tergum with a large, rectangular, gland anteromedially. Seventh abdominal tergum medially with a pair of distinct fossae separated by a longitudinal ridge. Supraanal plate (segment ten) with a straight, transverse impression medially not extending the full width of the segment (segment ten appears to be two segments, but terga seven to nine are distinct, and the slide preparation shows that the groove does not divide the supraanal plate into two segments); hind margin convexly rounded, entire; right and left paraprocts dissimilar (fig. 21). Subgenital plate asymmetrical, hind margin with left side excavated and bearing a foot-shaped process, its toe directed to the right; a pair of small styles arise on the ventral surface on either side of the excavation, the right one longer and more slender (figs. 22, 23). Genitalia as in fig. 23: hook on the left side with a preapical incision; median phallomere a slender, curved, apically acute rod; right phallomere reduced to the cleft remnant of a sclerite; a large group of setae is also present on the right side.

Colour. – Head with yellowish occiput, vertex and face light reddish brown, the clypeus, labrum and genae lighter (fig. 18); terminal segment of maxillary palpi darker than segments three and four; first two segments of the antennae yellowish, remainder dark. Pronotum opaque, light reddish brown, lateral areas light, yellowish (fig. 20). Tegmina reddish brown, subcostal area yellowish. Hind wing infuscated, costal vein area darker. Abdominal terga a mixture of light and dark brown areas, lateral margins pale; tergal gland on first segment, white; supraanal plate with a transverse dark line along the medial transverse groove (similar to the line in huismanae, fig. 13). Legs yellowish. Cerci yellowish dorsally, brownish ventrally.

Female: Cubitus vein of hind wing with two complete and three small incomplete branches, apical triangle small. Front femur Type B_3, with three large proximal spines. Supraanal plate transverse, hind margin convex, entire. Colour lighter than the male: Head yellowish, unicolorous; maxillary palpi and antennae pale. Pronotum yellowish opaque with a short, transverse, dark line medially near the hind margin. Tegmina brownish yellow-hyaline. Hind wing lightly infuscated, costal vein area darker. Abdominal terga light brown, lateral edges yellowish. Abdominal sterna and legs yellow. Cerci dorsally yellow, ventrally darker.

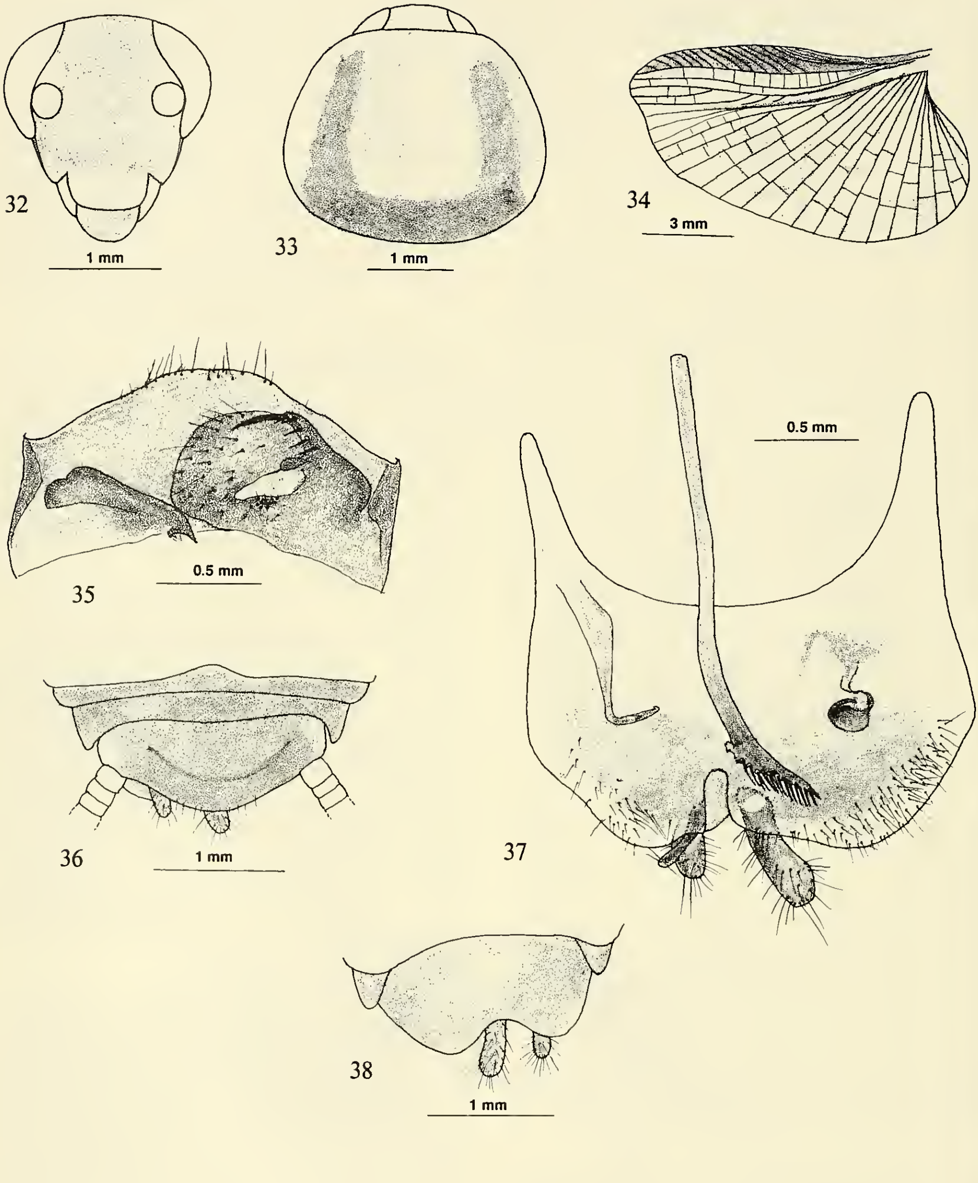
Measurements (mm) (♀ in parentheses). – Length, 10.0 (11.0); pronotum length x width, 2.6 × 3.3 (2.4 × 3.2); tegmen length, 10.9 (10.5); interocular width, 0.7 (0.7).

Remarks. – The male subgenital plate, styles, and genitalia of *sipitanga* are similar to those of *Sigmella emarginata* (Bruijning) from Sumatra (see fig. 11G, in Roth, 1991), and suggest a close relationship between these two species. However, the supraanal plates and paraprocts clearly differ between these two taxa.

Sigmella barrafordae sp. n.
(figs. 24-31)

Type specimens. – Holotype, ♂, Malaysia, SE. Sabah nr. Danum Valley Field C., WO, c. 150 m, Mal. trap 11, 14-20.iii.1987, C. v. Achterberg; in RMNH. – Paratypes: Sabah. RMNH: same data as holotype, 1 ♀; S. Sabah, Beaufort, 105 km S. of Long Pa Sia area, confluence Sg Pa Sia, Mega., 1210 m, along S. Mega., 4.26N 115.40E; at light, undisturbed tropical rainforest, 1 ♂ (terminalia slide 181), 4.iv.1987, J. van Tol & J. Huisman; SW. Sabah, nr. Long Pa Sia (East), c. 1000 m, Mal. trap 5, 1 ♀ (abdomen missing), 1-13.iv.1987, C.v. Achterberg. The following were collected by C.v. Achterberg & D. Kennedy: SE. Sabah nr. Danum Valley Field C., c. 150 m, WO, Mal. Trap 5, 1 ♀ (abdomen missing), 26.v.-20.vi.1987; same locality data, 1 ♀ (abdomen missing), 26.x.-22.xi.1987. One specimen retained in the MCZC. ZMAN: Sabah, Danum Valley, Sungai Segama, 70 km W. Lahad Datu, W. side suspension bridge, 150 m, Sample Sab. 49, understory, secondary growth/canopy, riverine rainforest, at light, 1 ♂, 30.xi.1989, M.J. & J.P. Duffels.

Description. – Male: Head slightly exposed; interocular space about the same as the distance between ocellar spots (fig. 24). Pronotum suboval (when sides are not deflexed) (fig. 25). Tegmina and wings fully developed extending beyond end of abdomen, the former with simple radial vein and longitudinal discoidal sectors. Hind wing with unbranched costal veins, most of them thickened, radial vein almost straight, simple, media and cubitus veins sigmoid, the former simple, the latter with two complete and one or two incomplete branches, apical triangle small (fig. 28). Front femur Type B_3, with four or five large proximal spines; pulvilli on four proximal tarsomeres of all legs, tarsal claws symmetrical, simple, arolia well developed. First abdominal tergum specialized, medi-



Figs. 32-38. *Sigmella balikpapanensis* sp. n., male holotype: 32, head; 33, pronotum; 34, hind wing; 35, supraanal plate and paraprocts (ventral); 36, supraanal plate (dorsal); 37, subgenital plate and genitalia (dorsal); 38, subgenital plate and styles (ventral).

ally with a depression and small arch, and numerous setae anterior and to the sides of the fossa. Seventh abdominal tergum unspecialized. Supraanal plate with hind margin convexly rounded (in the holotype, the distal part of the plate is curled under so that the actual shape cannot be seen); paraprocts dissimilar, the right one with two terminally acute processes, the left paraproct with a small terminal spine (fig. 27). Subgenital plate asymmetrical with a pair of setose styles, the right one much larger; at the base of the dorsal surface of the left style is a small setose process (hidden in the pinned specimen, fig. 26) and on the right side the subgenital plate forms a shelflike extension above the right style (fig. 29). Genitalia as in fig. 29: hook on left side; distal end of median phallomere curved, apex acute, and with a small preapical extension; on the right side is a dark setose structure and a small cleft sclerite.

Colour. – Head yellow without markings, labrum slightly darker, ocellar spots white (fig. 24). Pronotal disk yellowish with broad poorly defined light brown lateral bands, hind border region hyaline but very dark due to the visible bases of the underlying tegmina, lateral border regions yellowish (fig. 25). Tegmina hyaline, reddish brown, part of the basal costal vein margin yellowish. Hind wing darkly infuscated in the costal vein region, lighter on the rest of the wing with large clear zones in the anterior field (fig. 28). Abdominal terga dark brown, depressed glandular area on the first segment, white. Abdominal sterna yellowish. Cerci yellowish dorsally, ventrally brown except for three pale terminal segments. Legs pale.

Female: Hind margin of supraanal plate with a shallow medial excavation (fig. 30). Subgenital plate with distal region curved upwards, its margin crimped forming a basketlike structure (fig. 31). The pronotal disk is yellowish without dark lateral borders, but the hyaline hind border is very dark, as in the male. The base colour of the subgenital plate is yellow, but a large area is hyaline and dark (greyish) because of an underlying U-shaped structure (fig. 30).

Measurements (mm) (♀ in parentheses). – Length, 9.1-10.0 (9.0-10.0); pronotum length × width, 2.5 × 3.0-3.2 (2.4-2.7 × 3.1 [deflexed]-3.6); tegmen length, 10.3-10.6 (10.0-10.5); interocular space, 0.7 (0.8).

Etymology. – The species is dedicated to Dr. Nora M. Barraford, artist, writer, poet, editor, emeritus English Professor, and dear friend.

Remarks. – The female's subgenital plate is unusual and unique for species of *Sigmella.*

Sigmella balikpapanensis sp. n.
(figs. 32-38)

Type specimens. – Holotype, ♂ (terminalia slide 182), E. Borneo, Balikpapan, Wain River, 50 m, Nov.1950, A.M.R. Wegner; in RMNH.

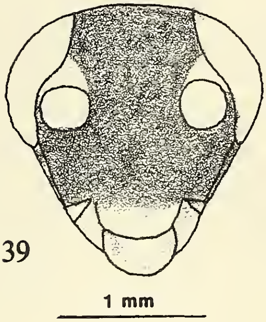
Description. – Male: Interocular space the same as distance between the antennal sockets and ocellar spots (fig. 32). Pronotum suboval (fig. 33). Tegmina and wings fully developed extending beyond end of abdomen the former with simple radial vein, and longitudinal discoidal sectors. Hind wing with simple costal veins, radial vein almost straight, simple, media and cubitus veins sigmoid, the former simple, the latter with two complete and two incomplete branches, apical triangle small (fig. 34). Front femur Type B_3 with three or four stout spines; pulvilli on four proximal tarsomeres of all legs, tarsal claws simple, symmetrical, arolia small. First abdominal tergum specialized, with a small posteromedial arch. Seventh abdominal tergum with a pair of large, shallow depressions separated by a low longitudinal ridge, small setae not concentrated in the fossae but uniformly distributed over the whole segment. Supraanal plate with a transverse, curved groove that doesn't reach the sides of the plate, hind margin unevenly, convexly rounded, (fig. 36); paraprocts strongly dissimilar, the right one larger with a setose plate and spined sclerite (fig. 35). Subgenital plate asymmetrical, with a pair of setose styles, the right one larger; originating on the dorsal surface at the base of the left style is a small, apically rounded rod (fig. 37) (in ventral view hidden in the pinned specimen, fig. 38). Genitalia as in fig. 37: hook on the left side, curved distal portion slender, with a preapical incision; median phallomere rodlike its distal margin with a row of large, closely spaced spines; right phallomere a reduced cleft sclerite.

Female: Unknown.

Colour. – Head, hyaline, mostly yellowish, clypeus and mandibles whitish (fig. 32). Pronotal disk yellowish, with a reddish brown U-shaped macula, lateral and anterior borders opaque yellowish (fig. 33). Tegmina hyaline, reddish brown. Hind wing infuscated, darkest in the costal vein area, pale clear areas in the anterior field, posterior field uniformly dark (fig. 34). Abdominal terga dark reddish brown, glandular area on the first segment whitish, the longitudinal ridge separating the fossae on the seventh abdominal tergum pale. Abdominal sterna yellowish brown. Cerci dark brown on both surfaces.

Measurements (mm). Length, 9.0; pronotum length × width, 2.5 × 3.2; tegmen length, 10.4; interocular space, 0.7.

Remarks. – The supraanal plate of *balikpapanensis* (fig. 36) is similar to that of *S. charon* (Hanitsch) (Roth, 1991: fig. 9G). Their paraprocts and median genital phallomere are strikingly different (cp. figs. 35, 37, with figs. 9E, F in Roth 1991).



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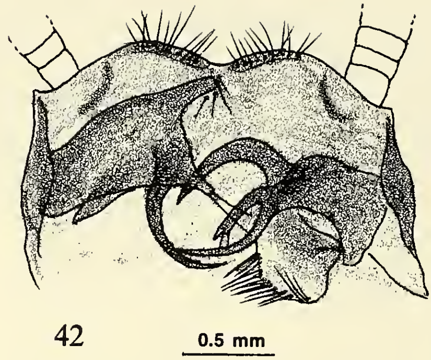

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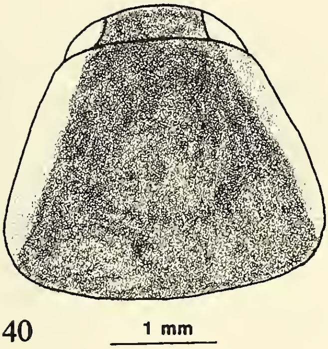

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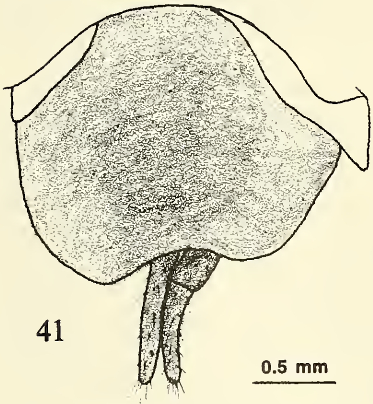

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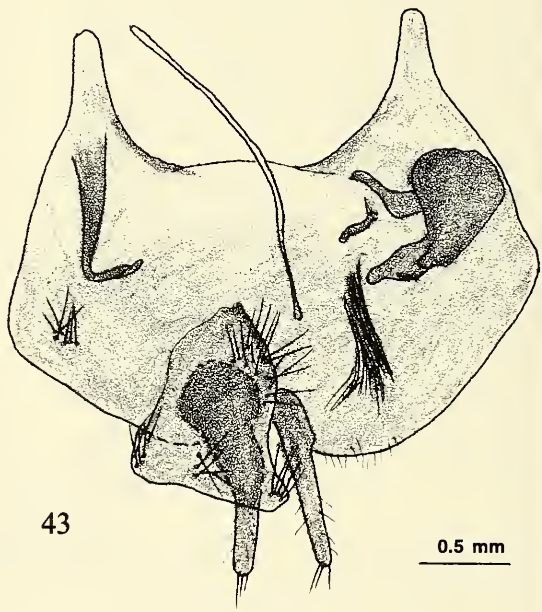

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Figs. 39-43. *Sigmella mendolonga* sp. n., male holotype: 39, head; 40, pronotum; 41, subgenital plate (ventral; the large setose process that arises on the dorsal surface of the plate anterior to the styles is not visible in the pinned specimen); 42, supraanal plate and paraprocts (ventral); 43, subgenital plate and genitalia (dorsal; the broken line indicates that part of the left style that is hidden by the large setose plate).

Sigmella mendolonga sp. n.
(figs. 39-43)

Type specimens. – Holotype, ♂ (terminalia slide 436), Malaysia, Sabah, Sipitang, Mendolong, T1B/W4, 17.iii.1989, S. Adebratt; in ZILS. – Paratype. Sabah. ZILS: same locality and collector as holotype, T5/R, 1 ♀, 29.iv.1988.

Description. – Male: Head with interocular space slightly greater than the distance between antennal sockets (fig. 39). Pronotum subparabolic, hind margin weakly curved (fig. 40). Tegmina and wings fully developed extgending well beyond end of abdomen, the former with longitudinal discoidal sectors. Hind wing with simple costal veins, costal field narrow, radial vein simple, weakly curved, media and cubitus veins deeply curved, the latter with two complete and one small incomplete branches, apical triangle small. Front femur Type B_3 with four large proximal spines; pulvilli on four proximal tarsomeres, tarsal claws symmetrical, simple, arolia present. Anteromedial region of first abdominal tergum with a deep, square depression containing a raised mound. Seventh abdominal tergum apparently unspecialized. Supraanal plate hind margin undulate, ventrally incrassate on each side of the midline, the thickened areas bearing a row of setae (in the pinned specimen the hind margin is curled ventrad and its true shape is not seen until a slide is made); right and left paraprocts dissimilar, complex, bearing large, curved spinelike processes (fig. 42). Subgenital plate weakly asymmetrical, hind margin bearing a long pair of contiguous, cylindrical styles (figs. 41, 43); in dorsal view there is a large, irregular, setose plate arising anterior to the left style [this is not seen in the pinned specimen but is strikingly shown in the slide preparation (fig. 43)]. Genitalia as in fig. 43: hook on the left side, with a preapical incision; median phallomere a filamentous, apically rounded rod; right phallomere consisting of three sclerites, a cleft apparently absent; a group of setae is present on the right side.

Female: Cubitus vein of hind wing with one forked complete and one incomplete branches, apical triangle small. Supraanal plate hind margin convexly rounded, entire.

Colour. – Head (including occiput and vertex) dark reddish brown, except for the yellow clypeus, labrum, and mandibles (fig. 39). Pronotum dark reddish brown, the lateral regions opaque yellow (fig. 40). Tegmina dark reddish brown, subcostal field yellow. Hind wing darkly infuscated, costal vein area darker. Abdominal terga brown. Abdominal sterna and legs brownish yellow. Cerci dorsally light brown, ventrally darker.

Measurements (mm) (♀ in parentheses). – Length, 9.0 (9.0); pronotum length x width, 2.6 × 3.3 (2.6 × 3.1); tegmen length, 9.9 (10.0); interocular width, 0.8 (0.9).

Remarks. – The long, contiguous styles distinguish this species from all other known species of *Sigmella*. The colour pattern of the pronotum of *mendolonga* is similar to that of *Sigmella fragilis* Hebard from Sumatra (see fig. 7A in Roth 1991).

Acknowledgements

I thank the Australian Biological Resources Survey (ABRS) for partial support, and the museums, curators, and collection managers indicated in the introduction, who loaned me specimens.

References

Bruijning, C.F.A., 1948. Studies on Malayan Blattidae. – Zoologische Mededelingen Leiden 29: 1-174.

Hebard, M., 1940. New generic name to replace *Sigmoidella* Hebard, not of Cushman and Ozana (Orthoptera: Blattidae). – Entomological News 51: 236.

Princis, K., 1969. Blattariae: Subordo Epilamproidea, Fam.: Blattellidae. – In Beier (ed.): Orthopterorum Catalogus 13: 711-1038. 's-Gravenhage.

Roth, L.M., 1991. The cockroach genera *Sigmella* Hebard and *Scalida* Hebard (Dictyoptera: Blattaria: Blattellidae). – Entomologica Scandinavica 22: 1-29.

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BOOK REVIEW

Eivind Palm, 1996. Nordeuropas Snudebiller. 1. De kortsnudede arter (Coleoptera: Curculionidae) - med saerligt henblik på den danske fauna. – Danmarks Dyreliv 7, 356 pp. 8 colour plates, 491 text figs. In Danish with English summary. Hardback. [ISBN 87-88757-38-2]. Price DKK 400.–.

The series Danmarks Dyreliv ('Fauna of Denmark') is a nicely made series, usually with colour plates, dealing up till now with insects only. Sofar most volumes were on Lepidoptera, two dealt with Syrphidae, and this is the first volume on beetles (Coleoptera). As in most previous volumes, the book treats the fauna of a large part of northern Europe. In this case 177 species belonging to the subfamilies Brachycerinae and Otiorhynchinae are dealt with. The remaining (sub)families of weevils will be covered in another two or three volumes.

Despite the fact that the book is written in Danish, which might pose a problem to those not familiar with scandinavian languages, it is a very good addition to the existing keys for curculionid beetles. This is particularly so because of the superb colour-plates made by Geert Brovad. Existing keys (Faune de France, Käfer Mitteleuropas) only have simple line-drawings. Although the many very similar species certainly cannot be identified by the colour-plates alone, it is of a great help compared with previous keys. The natural size of the beetles is shown in black contours facing the plates, which are enlarged about 2 to 4 times.

After a short introduction, all species are treated in detail, with keys for each subfamily and genus. Many text-figures provide details for identification; some species are shown in enlarged habitus drawings (mostly from Victor Hansen's Danmarks Fauna volume) or black and white photographs. The descriptions are lengthy, with much detail on faunistics and biology. There is always a map of northern Europe, with dots for each district where the species was recorded. For Denmark and southeastern Sweden a detailed UTM map (10 km grid) is shown when relevant. The biology is frequently illustrated with a sketch of the damage pattern. In some cases the habitat is shown in a photograph. The English summary for each species covers distribution and biology. References are cited by number. There is a list of 1044 literature references and 165 references to letters or personal communications. The use of the number system has as a consequence that the list of references is not completely alphabetical. After the 'Z' follow still almost 20 references out of alphabetic order.

It is a pity that there is no index or catalogue to hostplants; it is to be hoped that it will be added in the coming volumes. Also a check-list is missing. Another minor point of criticism is that the recent faunistic literature for The Netherlands was missed.

Eivind Palm has made a remarkable contribution to entomology. Within the last ten years he has written three volumes in the series Danmarks Dyreliv, the previous two ones on Microlepidoptera, and now he is only beginning with this new series on weevils.

[Erik J. van Nieukerken]

Louis M. ROTH

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THE COCKROACH GENERA *SUNDABLATTA* HEBARD, *PSEUDOPHYLLODROMIA* BRUNNER, AND *ALLACTA* SAUSSURE & ZEHNTNER (BLATTARIA: BLATTELLIDAE, PSEUDOPHYLLODROMIINAE)

Roth, L. M., 1996. The cockroach genera *Sundablatta* Hebard, *Pseudophyllodromia* Brunner, and *Allacta* Saussure & Zehntner (Blattaria: Blattellidae, Pseudophyllodromiinae). – Tijdschrift voor Entomologie 139: 215-242, figs. 1-77. [ISSN 0040-7496]. Published 18 December 1996.
The known species of *Sundablatta* and *Pseudophyllodromia* are redescribed. Two new species of *Pseudophyllodromia* are described. Keys are presented to distinguish the adults in both genera. *Euhanitschia* Princis and *Compsosilpha* Princis are synonymized with *Allacta*, and their type species are redescribed. *Allacta figurata* (Walker) and *A. diluta* (Saussure) are distinct species.
Dr. L.M. Roth, 81 Brush Hill Road, Sherborn, MA 01770, U.S.A.
Key words. – *Sundablatta*, *Pseudophyllodromia*, *Allacta*, Blattaria, Blattellidae, cockroaches, taxonomy, redescriptions, new species, synonymies.

Princis (1969: 931) listed two species under *Sundablatta*, namely *sexpunctata* and *pulcherrima*, and a third, *Margattea inermis* Bey-Bienko with a query. Bey-Bienko's (1938: 121) description of *inermis* does not agree with the diagnostic characters of the genus. Excluding *inermis* which I have not seen, I added a third species, namely *Allacta raapi* Hanitsch, as a new combination, based on the original description and illustration (Roth 1993: 387). I also describe below, a strikingly coloured nymph which may prove to be a new species when the adults are found.

Princis (1969: 932) listed five species and one subspecies of *Pseudophyllodromia*. These are redescribed, and the previously unknown or undescribed males of *ornata* and *laticeps* are described. Two new species, *simalurensis* and *aronsoni* are described, and *poiensis laeta* Hanitsch is raised to species rank.

Two of Princis's genera (1950: 178, 180), namely *Euhanitschia* and *Compsosilpha* are synonymized with *Allacta* Saussure and Zehntner.

The following museums and their collection managers or curators kindly loaned me specimens:

ANSP – The Academy of Natural Science of Philadelphia, Philadelphia. PA, U.S.A.; Mr. Donald Azuma; HECO – Hope Entomological Collections, University of Oxford, England; Dr. George C. McGavin & Mr. I. Lansbury; MCZC – Museum of Comparative Zoology, Harvard University, Cambridge, MA, U.S.A.; RMNH – National Museum of Natural History (Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands; Mr. J. van Tol; ZILS – Zoological Institute, Lund, Sweden; Dr. Roy Danielsson.

Systematic part

Subfamilial placement and affinities

Sundablatta, *Pseudophyllodromia*, and *Allacta* Saussure and Zehntner are closely related by reason of strong similarities in their wing venation and male genital phallomeres, subgenital plate, and styles (cf. illustrations in this paper with those in Roth 1991, 1993, 1995). Their male genital hook is on the right side placing them in the Pseudophyllodromiinae (= Plectopterinae of McKittrick, 1964). Wing venation is similar.

Princis (1950: 180) included four genera in the Pseudophyllodromiae group, namely *Pseudophyllodromia*, *Sundablatta*, *Euhanitschia* Princis, and *Compsosilpha* Princis. After examining the type species of the last two genera I am redescribing them (below) and synonymizing them with *Allacta*.

Princis listed *Allacta* (genus 114) near the above four genera (genera 115 to 118) in his Catalogus suggesting that he was aware of their close relationship. Princis presented a key to distinguish the four genera (omitting *Allacta*) in his Pseudophyllodromiae group. The following key replaces his key (it is understood that his Pseudophyllodromiae group may include other genera not studied here).

1. Front femur Type C; pulvilli only on the fourth proximal tarsomere of all legs. Eyes not extending below the level of the antennal sockets (e.g., fig. 3) .... *Sundablatta*
– Front femur usually Type B 2
2. Pulvilli on four proximal tarsomeres of the front and midtarsi, and only on the fourth tarsomere of the hind legs. Eyes do not extend below the level of the antennal sockets (e.g., fig. 13) ....*Pseudophyllodromia*
– Pulvilli only on the fourth proximal tarsomere of all legs. Eyes usually extend below the level of the antennal sockets (e.g., fig. 60; see also figs. in Roth 1991, 1993, 1995); if the eyes do not extend below the sockets then the head and pronotum have markings as in figs. 65 and 66 ... *Allacta* (= *Euhanitschia* and *Compsosilpha*)

Genus *Sundablatta* Hebard

Sundablatta Hebard, 1929: 76. – Type species: *Pseudophyllodromia sexpunctata* Hanitsch. – Hebard 1929: 76, by selection.

Diagnosis (after Hebard). – Head very broad projecting beyond pronotum, interocular space very wide. Pronotum symmetrically transverse trapezoidal with rounded angles. Tegmina and wings moderately reduced, discoidal sectors of former oblique, area of costal veins of latter very broad. Front femora very heavy, anteroventral margin armed with a row of piliform spinules, terminating in two long distal spines [Type C_2]; median tarsi with a small pulvillus on the fourth segment only. Male abdominal terga unspecialized. Subgenital plate of the *Balta* [=*Mareta*] type.

To the above can be added the following: The interocular space is about the same or greater than the distance between the antennal sockets; eyes do not extend below the antennal sockets (figs. 3, 11). The shape of the adult pronotum is more oval than trapezoidal (figs. 1, 7). Hind wing with simple radial and media vein, the cubitus vein straight with complete and with or without an incomplete branch, apical triangle subobsolete or absent (figs. 6, 10). Fourth tarsomere of all legs (not just the median tarsus) with a pulvillus, tarsal claws simple, symmetrical, arolia present. Genital hook on the right side; distal end of median phallomere with setal brushes.

The habitus of the three known species are similar and readily identifies the genus: the head is black with a narrow white band between the eyes above the antennae (figs. 3-11; the pronotum is black with a narrow white or white and yellowish band partially or completely surrounding the border, and the tegmina are black with white, white and yellowish, or orangish maculae (figs. 1, 7).

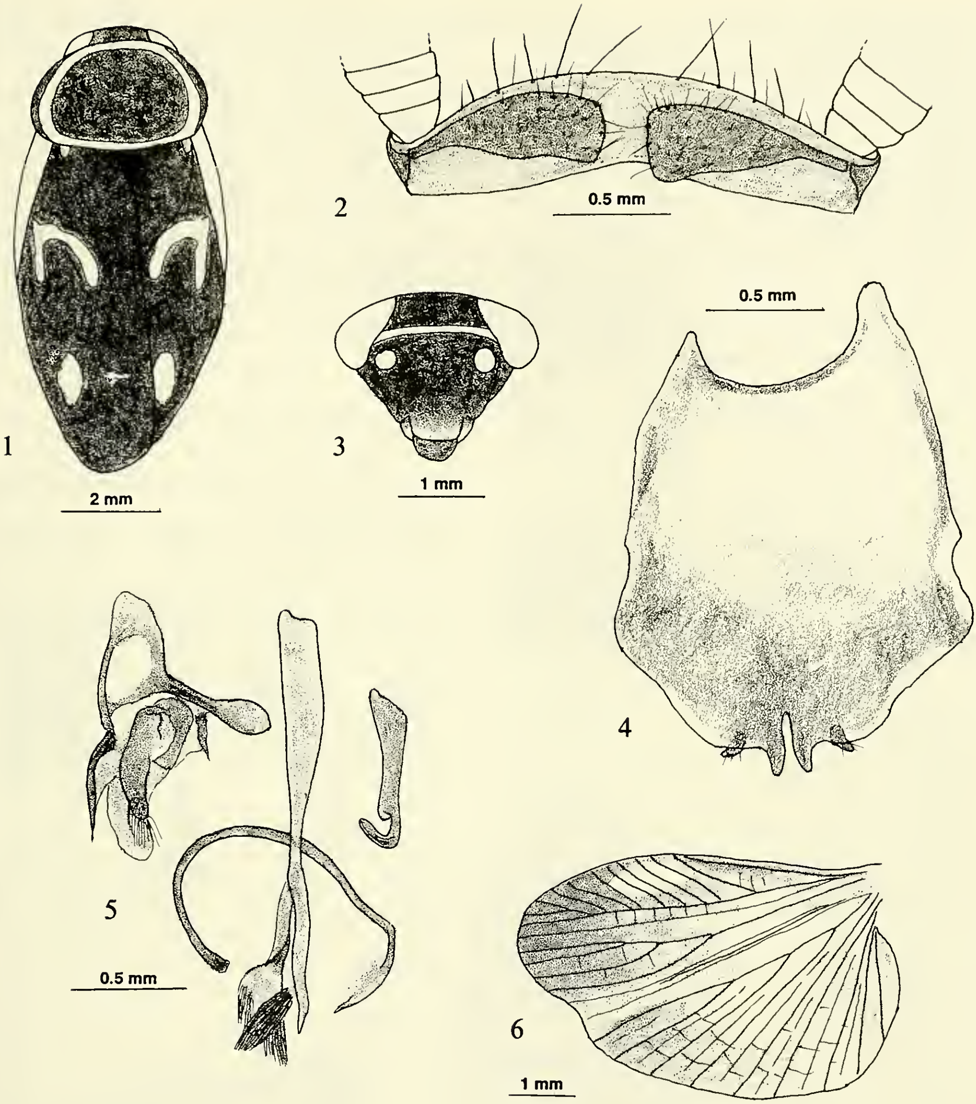
Key to adults of *Sundablatta*

1. Pale band around the pronotal macula horseshoe shaped, following the lateral and anterior margins but not extending along the hind border (Hanitsch, 1932a: fig. 8) .... *raapi*
– Pale band completely or almost completely surrounds the lateral, anterior, and posterior margins of the macula 2
2. Pale band is complete around the edge of the pronotum (e.g., fig. 1). Tegmina with two pale maculae (exclusive of the pale subcostal area) .. 3
– Pale band on pronotum is interrupted in the middle of the hind margin (fig. 7). Tegmen with three elongated, separated maculae, one in the center, another in the apical part of the marginal field, and a third in the middle of the wing cover (fig. 7). Male interstylar margin as in fig. 8 .... *sexpunctata*
3. Tegmina with the anterior pale macula an inverted V-shape (fig. 1). Male interstylar margin as in fig. 4 .... *pulcherrima*
– Tegmina with the anterior pale macula an oblique stripe, not V-shaped (♀) ....sp. (unnamed)

Sundablatta pulcherrima (Shelford)
(figs. 1-6)

Pseudophyllodromia pulcherrima Shelford, 1906: 266, pl. 14, fig. 3 (male and female). – Shelford 1908: 17; Hanitsch 1915: 59, pl.3, fig. 15; 1923a: 464; 1925: 89; 1933a: 314; 1933b: 232.
Sundablatta pulcherrima. – Hebard 1929: 76; Bruijning 1948: 89; Princis 1969: 931.

Material examined. – Lectotype (here designated), ♂, N.W. Borneo, Kuching [SARAWAK], capt. 9.x.1899 by Dyak coll., pres. 1900 by R. Shelford; Type 108 $^{8}/_{11}$, in HECO. SARAWAK. Paralectotypes: HECO: same locality and collector data as for the lectotype, with different capture dates and type numbers as follows: 1♂, 108$^{1}/_{11}$, 14.viii.1899, 1 ♂, 108$^{2}/_{11}$, 13.vii.1899, 1♀, 108$^{3}/_{11}$, 5.viii.1899, 1♀, 108$^{4}/_{11}$, 9.x.1899, 1♀, 108$^{5}/_{11}$, 7.iii.1900, 1♂, 108$^{6}/_{11}$, 26.x.1899, 1♂, 108$^{7}/_{11}$, 27.vii.1900. Additional material: BORNEO. ANSP: Kuching, N.W. Borneo, 1 ♀ (only head and pronotum intact), flowering tree, 17.ix.1900, 1♀, 9.viii.1899, Dyak coll., pres. 1900 by R. Shelford. Additional material. – Sarawak. ZILS: Bako National Park, 1♀, 1-9.i.1979, Gärdenfors, Hall, Hansson, Samuelsson. HECO: 1♀, Mount Poi, 200 ft.; retained in MCZC. Borneo. RMNH: 16 km N. of Bario, Long Rapun, Sg. Dapur, 115.35°E 3.53°N, 1200 m, 1♂ (terminalia slide 166), 1♀, 22.ii.1987, 2♀, 20.ii.1987, J. Huisman. ANSP: 1♂, 1911-178, C.J. Brooks (det. Hebard, 1927, and Uvarov). Two females retained in MCZC. Sabah. ZILS: Malaysia, Sabah, Sipitang, Mendolong, T1B/W4, 1♀, 14.iii.1989, S. Adebratt. RMNH: SE. Sabah,



Figs. 1-6. *Sundablatta pulcherrima* (Shelford). – 1, 3, 6, female paralectotype from Kuching, Sarawak, habitus, head, and hind wing respectively; 2, 4, 5, male from 16 km north of Bario, Long Rapun, Sarawak: 2, supraanal plate and paraprocts (ventral); 4, subgenital plate (dorsal); 5, genitalia (dorsal).

Malaysia, Danum Valley Field C., c. 150 m, Malaise trap 10, 1♀, 20-26.iii.1987, C. v. Achterberg. ANSP: Sandakan, Borneo, 2♀ (det. Hebard, 1927), Baker. BRUNEI. ZILS: Brunei, Borneo, 1♀, Staudinger, coll. Br. v. W.

Redescription. – Male: Head projecting beyond edge of pronotum. Interocular distance the same as the space between the antennal sockets (fig. 3). Pronotum suboval (fig. 1). Tegmina and wings reaching slightly beyond end of abdomen, discoidal sectors of former oblique. Hind wing with subcostal vein reaching to about middle of the costa, costal veins thickened on distal halves, radial vein straight, simple or with a small apical branch; cubitus vein straight with three or four complete and no, or one small incomplete branch, apical triangle absent (fig. 6). [in one specimen, the left hind wing is abnormal with the positions of the media and cubitus veins apparently reversed; the media vein is straight with three complete branches, cubitus vein oblique at distal end with one small branch, apical triangle absent]. Front femur with a row of closely spaced piliform spinules, distally there may be two to four more widely spaced and thicker 'spinules' of similar length (Type C_2); fourth tarsomere of all legs with pulvilli, tarsal claws simple, symmetrical, arolia small. Abdominal terga unspecialized. Supraanal plate strongly transverse, very narrow, hind margin convexly rounded; right and left paraprocts similar, large sclerotized plates (fig. 2). Subgenital plate symmetrical, hind margin with a deep, narrow excision medially, forming a pair of acute lobes, which (in pinned specimen) are contiguous forming a longitudinal keel-like ridge; styles similar, small, each located to the side of the lobes (fig. 4). Genitalia as in fig. 4: hook on the right side with a preapical incision; median phallomere with a large setal brush near its apex, and arising near the middle is a branch whose distal half is enlarged and setose; a narrow, curved, accessory median phallomere, lies under the median sclerotization; left phallomere consisting of several sclerites, one with some setae.

Female: Supraanal plate transverse, hind margin with a shallow indentation mesad, not reaching hind margin of the trigonal subgenital plate whose sides are upturned. Tegmina and wings fully developed, but reaching only slightly beyond end of abdomen.

Colour. – Head black with a narrow, transverse, yellowish white line between the eyes, just above the antennal sockets; lower half of clypeus and distal half of mandibles pale (fig. 3). Pronotum black bordered by a partly hyaline, whitish band which extends around the anterior and posterior margins, but laterally is submarginal (fig. 1). Tegmina with the humeral region whitish, and an inverted V-shaped yellowish white, sometimes partly hyaline macula, one arm whitish the other often yellowish; posterior to the V shaped macula is a whitish mark (with yellowish tinge along the margins) that usually does not extend to the wing margin (fig. 1). Wings infuscated, darker in the proximal half of the costal area just before a whitish, hyaline macula, and in the distal region of the anterior field (fig. 6). Abdominal terga black with small triangular white spots on the lateral margins of three or four medial segments. Abdominal sterna black with reddish spots (hyaline areas through which the underlying tissue is visible), basomedially on the subgenital plate and two of the preterminal segments. Coxae black, their apexes, and trochanters yellowish, femora and tibiae black, metatarsi brown, remaining tarsomeres similar or slightly darker. Cerci dorsally black with three terminal segments white, the acute apex dark; ventrally dark except for a pale preterminal spot. The hind margin of the female's supraanal plate has a small white dot at the median invagination.

Measurements (mm) (♀ in parentheses). Length, 7.0-8.0 (7.0-9.0); pronotum length × width,2.2-2.3 × 3.3-3.5 (2.2-2.4 × 3.3-3.6); tegmen length, 6.8-7.5 (6.5-7.2); interocular width, 0.9-1.0 (0.9-1.0).

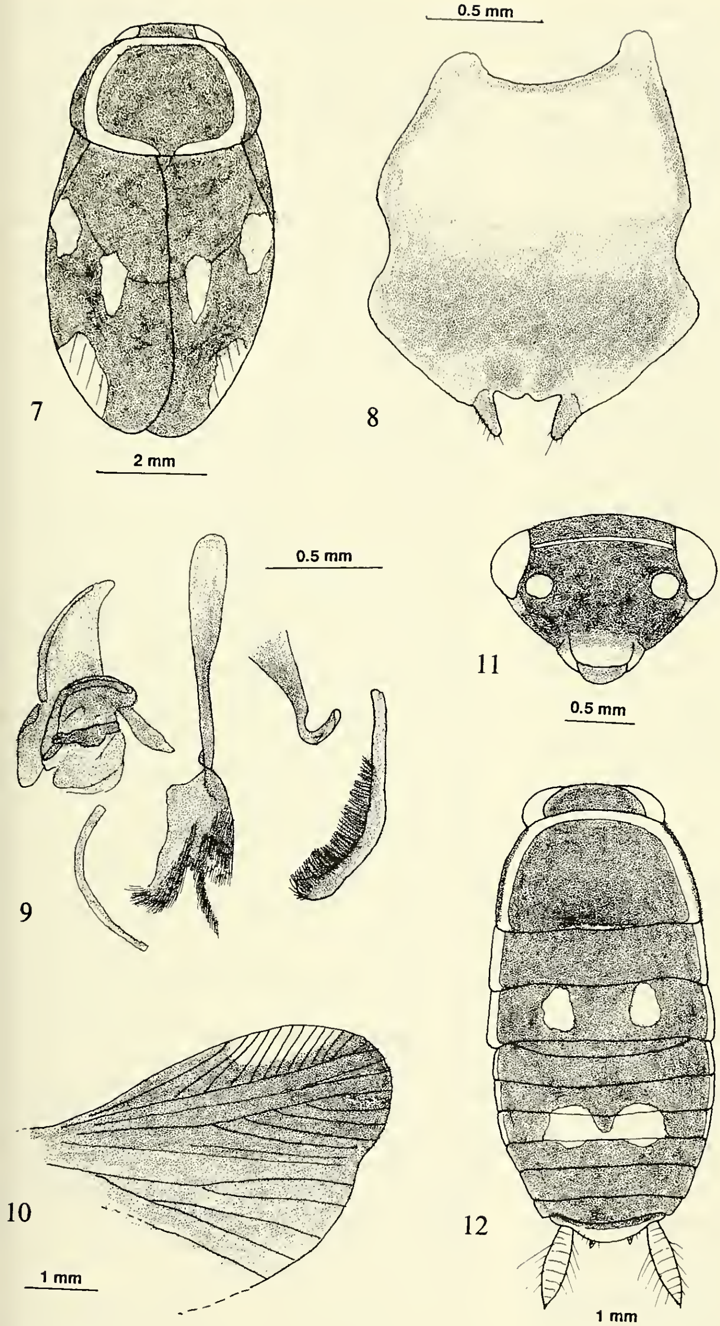
Remarks. – According to Shelford (1906: 267) this species is abundant in decayed wood. He also stated that the almost cylindrical ootheca is carried by the female, with the keel uppermost (not rotated). This plus the fact that the male's genital hook is on the right side places the genus in the Pseudophyllodromiinae.

Sundablatta sexpunctata (Hanitsch)
(figs. 7-10)

Pseudophyllodromia sex-punctata Hanitsch, 1923a: 418, fig. 15 (male and female).
Sundablatta sexpunctata. – Hebard 1929: 76; Bruijning 1948: 89; Princis 1969: 932.

Material examined. – Lectotype (here designated), ♂, MALAYSIA, Selangor, collected 1907 and presented 1908 by H. C. Pratt; Type Orth. 267¹/₂, in HECO. Paralectotype. MALAYSIA. HECO: Type Orth, 267²/₂, same locality as lectotype, ♂ (not ♀, as published) (terminalia slide 241), capt. 22.ii.1908 and pres. 1908 by G. Meade-Waldo. Additional material. – ANSP: Perak Hills, 2300-4000 ft., 1 ♀, 1903-229, H.N. Ridley (det. Hebard, 1927, and Uvarov). MCZC: Selan. Lima Blas Est., 1 ♀, 5.i.1975, J. Fleagle.

Redescription. – Male: Head exposed, interocular space about the same as the distance between antennal sockets. Pronotum suboval, widest behind the middle (fig. 7). Tegmina and wings reaching to end of abdomen, the former with oblique discoidal sectors. Hind wing with subcosta reaching to about middle of the costa, most costal veins thickened, radial vein straight, simple, media vein straight with one long and one short branch at distal end (left wing), or with one branch only (right wing of same specimen); cubitus vein straight with four or five complete (differs on the right and left wings of same specimen) and no incomplete branches, apical triangle absent (fig. 10). Front femur Type C_2; pulvilli only on the fourth tarsomere of all legs, tarsal claws symmetrical, simple, arolia small. Abdominal terga unspecialized. Supraanal plate transverse, convexly rounded, right and left paraprocts similar, simple plates. Subgenital plate symmetrical, styles small, similar, cylindrical, interstylar margin with a small V shaped medial excision (fig. 8). Genitalia as in fig. 9: hook on the right side with a preapical incision; in addition there is a large setal brush on the right side; median phallomere broad proximally, becoming narrow, and with about the distal third modified with setal brushes; left phal-



Figs. 7-12. *Sundablatta* spp. 7-10, *Sundablatta sexpunctata* (Hanitsch) males from Selangor, Malay Peninsula: 7, lectotype, habitus; 8-10, paralectotype: 8, subgenital plate (dorsal); 9, genitalia (dorsal); 10, hind wing. – 11, 12, *Sundablatta* sp. male nymph from Sabah, head and habitus respectively.

lomere consisting of several nonsetose sclerites.

Female (not seen): Hanitsch claimed to have described both the male and female, but the two type specimens are males. Hanitsch (1923a: 419) stated that he collected males and females on Bukit Kutu, Selangor, Gunong Kledang, Perak, and Penang Hill. The female apparently is undescribed, but its habitus is probably similar to the male.

Colour. – Shining black. Head black with a narrow, transverse, whitish line above the antennal sockets between the eyes. Pronotum shiny black bordered with a white, yellowish tinged encircling band which is submarginal laterally, and reaches the anterior and posterior margins, the latter narrowly interrupted medially (fig. 7). Tegmina black each with three maculae: the most anterior one (white and orangish) in the center of the marginal field, the second (white) elongate, in the middle, and the most posterior one (hyaline, through which a white macula in the costal vein region of the hind wing is visible) reaches the wing margin (fig. 7). Hind wing infuscated, with a white macula on the thickened parts of the costal veins (fig. 10). Coxae, femora, and tibiae black, tarsi reddish brown. Cerci dorsally with apical segment black, penultimate segment white, the preceding one with white laterally on one side, remaining cercomeres black, ventral surface black.

Measurements (mm). – Length, 6.8-7.5; pronotum length × width, 2.2 × 3.4-3.5; tegmen length, 5.5-5.9; interocular width, 0.9-1.0.

Sundablatta raapi (Hanitsch)

Allacta raapi Hanitsch, 1932a: 66, fig. 8 (♀); Princis, 1969: 1013 (sp. *incertae sedis*). – Holotype [not examined]: ♀, Batu Island, W. Sumatra, 1896-7, H. Raap; in the Genova Museum, Italy.
?*Pseudoceratinoptera raapi* (Hanitsch). – Bruijning 1948: 88.
Sundablatta raapi (Hanitsch). – Roth 1993: 387.

Description (after Hanitsch). – Female: Head freely exposed. Pronotum subparabolic. Tegmina and wings not quite reaching end of abdomen, discoidal sector of former oblique. Hind wing with simple radial and media veins, cubitus with four branches. Front femur unarmed.

Colour. – Head deep amber, with a transverse white line between the eyes and antennal sockets. Pronotum deep amber with a broad, horseshoe shaped white line that extends from the posterior corners, submarginally along the lateral and marginally around the anterior margins; the white line is absent from along the hind margin of the pronotum. Tegmina amber with two lighter patches, one in the center, the other near the distal end of the anterior border. Wings dull orange, costal area with a large whitish patch. Abdomen light castaneous to dark amber. Cerci brownish with whitish tips. Legs dark amber.

Total length, 9.0 mm.

Remarks. – Hanitsch's habitus drawing, and description of the head and pronotal colour pattern, the reduced tegmina (with its pale markings) and wings, convinces me that this species belongs in *Sundablatta*. Although Hanitsch claimed the front femur is unarmed he may not have seen the piliform spinules (which are difficult to detect along the black femur), or he did not consider the spinules as 'armament'.

Sundablatta sp.
(figs. 11, 12)

Material examined. – SABAH. RMNH: Malaysia, Sabah, LPS-L, Semado trail nr. Borden, 115.40°E 4.20°N, 1520 m, 1 ♂ nymph, 22-24.x. 1986, J. Huisman.

Description. – Nymph (male; habitus, fig. 12): Head exposed, interocular space greater than the distance between antennal sockets (fig. 11). Pronotum parabolic, hind margin almost straight (fig. 12). Tegmina and wings absent (fig. 12). Front femur with a row of piliform spinules, terminating in one large spine (Type C_1); pulvillus on fourth tatsomere of all legs, tarsal claws symmetrical, simple, arolia present. Supraanal plate strongly transverse, very narrow, hind margin convexly rounded, entire.

Colour . – Head black with a fine white line between the eyes, distal part of clypeus pale, labrum dark (fig. 11); antennae yellowish, maxillary palps pale. Thorax and abdominal terga black with the following markings: pronotum with a yellowish (and whitish tinge) horseshoe shaped band, hind margin with a very fine, partly incomplete, whitish line; the yellow band of the pronotum continues along the lateral margins of the meso and metanotum, the latter with a pair of large, slightly irregular, round, medial yellow maculae. Abdominal terga two to four with a narrow yellow marginal stripe; abdominal tergum four with a pair of broad yellow maculae which are connected on the hind margin of the segment, the yellow colour narrowly overlapping the posterior margin of segment three and the anterior margin of segment four; distal half of supraanal plate yellow (fig. 12). Abdominal sterna dark brown. Femora and tibiae dark brown, tarsi pale. Cerci yellow on both surfaces, their acute apexes dark.

Adults. – Unknown.

Measurements (mm). – Length 4.8; pronotum length × width, 1.3 × 2.2.

Remarks. – This species is either the immature of one of the known species of *Sundablatta*, or it may prove to be a new taxon when the adult is found.

Sundablatta sp.

Sundablatta pulcherrima. – Princis 1950: 178 (female) (not Shelford).

Material examined. – SUMATRA. ZILS: Sumatra, Tandjong, Sakti, 1 ♀, Mrs. M.E. Walsh (det. as *pulcherrima* by Princis).

Description. – Head with interocular width the same as the distance between antennal sockets; fifth maxillary palpomere swollen, longer than the fourth segment; antennae filamentous. Tegmina and wings equally developed but somewhat reduced reach to about the supraanal plate. Pronotum flattened, subelliptical, widest near the hind margin. Front femur Type C_2, pulvilli on fourth tarsomere of all legs, tarsal claws symmetrical, simple, arolia present. Hind wings with simple radial vein, median vein apparently absent, cubitus vein with one or two complete and no incomplete branches, apical triangle absent. Supraanal plate transverse, hind margin convexly rounded with a distinct medial excavation.

Colour. – Head and pronotal markings as in *pulcherrima* (figs. 1, 3). Mesonotum black, metanotum brown. Tegmina black proximally becoming brown distally and with some clear areas apically and with two narrow yellowish stripes, one near the subcostal area and the other shorter one to its left and partly posterior to it. Hind wings darkly infuscated, and with a white macula in the costal area (as in fig. 6). Abdominal terga on distal half of the abdomen brown, only two of these segments with yellowish spots on their lateral margins, segments on posterior half of abdomen blackish. Abdominal sterna blackish brown. Coxae dark brown, trochanter yellowish, femora dark brown, tibiae lighter brown, tarsal segments lighter.

Measurements (mm). – Length, 8.5; pronotum length × width, 2.4 × 3.7; tegmen length, 5.4; interocular width, 1.0.

Remarks. – Princis identified this specimen as *S. pulcherrima*. However, the tegminal markings markedly differ (the anterior tegminal macula is not an inverted V-shape), whereas more than 20 specimens of *pulcherrima* that I have examined have markings similar to that shown in fig. 1. Abdominal terga and sterna, and legs also differ in colour. The tegminal and pronotal markings of this specimen differ from those of *sexpunctata* (fig. 7) and *raapi* (see description).

Pseudophyllodromia Brunner

Pseudophyllodromia Brunner, 1865: 111. – Hebard 1929: 76.

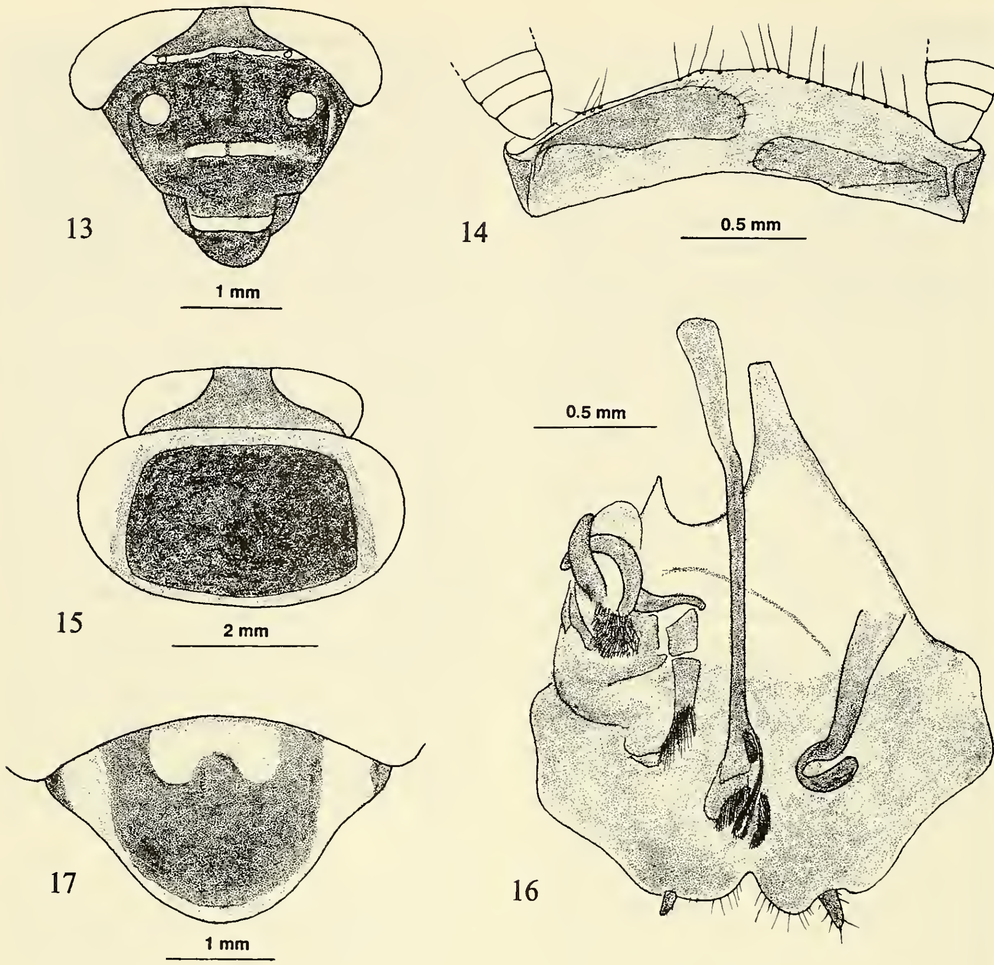
Type species: *Pseudophyllodromia ornata* Brunner, by monotypy.

Diagnosis (after Hebard). – Head broad, projecting beyond the pronotum. Interocular space narrow. Pronotum transverse trapezoidal with rounded angles. Tegmina and wings fully developed, discoidal sectors of former longitudinal. Costal vein area of hind wing broad. Anteroventral margin of front femur with proximal heavy spines, succeeded by a row of piliform spines, terminating in three elongate distal spines (Type B_3); median tarsi with small pulvilli on four proximal tarsomeres. Male abdominal terga unspecialized. Subgenital plate of the *Mareta* [=*Balta*] type.

To the above can be added the following: Interocular space distinctly less than the distance between the antennal sockets, and the eyes do not extend below them (fig. 13). The pronotum usually is more subelliptical than trapezoidal (fig. 15). Discoidal sectors of the tegmina may be longitudinal, oblique, or intermediate between the two (i.e., sublongitudinal); the veins may be longitudinal on one tegmen and oblique on the other, in the same specimen. The cubitus vein of the hind wing with three to five complete rami (figs. 38, 51), and rarely with an incomplete branch (fig. 48), apical triangle absent. The front and mid tarsi with pulvilli on four proximal tarsomeres, hind tarsus with a pulvillus on the fourth tarsomere only; tarsal claws symmetrical, simple, arolia present. The subgenital plate usually is not *Balta*-like. Male genital hook on the right side; median genital phallomere with setal modifications at the distal end.

Key to adults of *Pseudophyllodromia*

1. Face without pale markings (exclusive of a pale band on the clypeus) (figs. 22, 25)...... 2
– Face with pale markings 5
2(1) Last maxillary palpomere white. Pronotal disk macula subtrapezoidal, the oblique margins highlighted with a narrow yellowish band (fig. 23) (♂ & ♀); male genitalia as in fig. 21 .... *laticeps*
– Last maxillary palpomere dark brown. Pronotal disk macula not as above 3
3(2) Anterior margin of pronotal disk macula suddenly narrowed and reaching the anterior margin of the pronotum, broad lateral zones yellowish white (fig. 26) .... *mentawiensis*
– Pronotal disk macula not as above 4
4(3) Pronotal disk macula reaching the hind margin of the pronotum, lateral and anterior zones subhyaline yellowish (fig. 30). Male genitalia as in fig. 32 .... *simalurensis*
– Pronotal disk macula trapezoidal, completely surrounded by opaque yellowish (fig. 42) .... *aronsoni*
5(1) Face blackish brown with a very narrow ....



Figs. 13-17. *Pseudophyllodromia ornata* Brunner from Zamboanga, Mindanao, Philippine Islands. 13-16 males: 13, head; 14, supraanal plate and paraprocts (ventral); 15, pronotum; 16, subgenital plate and genitalia (dorsal); 17, female, subgeniral plate (ventral).

transverse, yellow stripe between the eyes above the antennal sockets, and a broader band on the frons (fig. 13). Pronotal disk macula black, completely surrounded by a yellow band (fig. 15) (♂ & ♀). Male interstylar margin with a symmetrical V-shaped excision (fig. 16). Female subgenital plate with a large, inverted U shaped yellow macula anteromedially (fig. 17) .... *ornata*

– Facial markings, female subgenital plate colour pattern, and male interstylar margin (if known), not as above 6

6(5) Face with variable patterns of yellow, and light and dark brown maculae (e.g. fig. 35). Pronotal disk macula black, its anterior border margined with white, sometimes with pale margined posteriorly, and incompletely laterally (fig. 37) (♂ & ♀). Male interstylar margin with a deep, asymmetrical, curved excavation (fig. 39) ....*laticaput*

– Region above the antennal sockets with a curved, whitish band above the antennal sockets. Male interstylar margin not as above 7

7(6) Curved whitish band on head poorly delineated, blending into the yellowish orange face (fig. 46). Pronotal disk macula not clearly delineated, blending into yellowish anterior and posterior margins (fig. 47) (♂ & ♀). Male interstylar margin with a broad, asymmetrical, V-shaped excision (fig. 49). Female subgenital plate without distinct dark maculae (fig. 52) .... *laeta*

– Curved whitish band on head more sharply delineated (fig. 53). Pronotal disk macula black, sharply delineated, completely surrounded by yellow (fig. 54). Female subgenital plate with dark maculae (fig. 55) .*poiensis*

Pseudophyllodromia ornata Brunner (figs. 13-17)

Pseudophyllodromia ornata Brunner, 1865: 112, pl. 3, fig. 9. Holotype [not examined]: ♀, Philippines (coll. Dohrn.); according to Ulrike Aspöck (personal communication) it is in Dohrn Mus. f. Naturk., Stettin (=Sczcecin), Poland. – Walker, 1869: 144; Kirby, 1904: 97; Shelford, 1908: 16.

Material examined. – PHILIPPINES. HECO: Zamboanga, Mindanao, 1♂ (terminalia slide 242), 1♀, Baker. ANSP: Port Banga, 3♂, 5.i.1915, 1♂, 8.1.1915, 1♀, 14.i.1915, 2♀, 13.i.1911, W. Boettcher (all labelled *ornata* by Princis, 1960); Todaya Plateau, Mt. Apo, Mindanao, 4000 ft., 1♀, 8.x.1930, C.F. Clegg; Davao, Mindanao, 1♀ (labelled topotype by Hebard), Baker; Mumungan, Lanao, Mindanao, 1♀, 21.ii.1915, W. Boettcher; Surigao, Mindanao, 1♂ (labelled topotype by Hebard). Two specimens retained in the MCZC.

Description. – Male (previously undescribed): Head exposed, interocular space distinctly less than the distance between antennal sockets, eyes do not extend below small antennal sockets (fig. 13). Pronotum subelliptical (fig. 15). Tegmina and wings fully developed extending well beyond end of abdomen (glued together and could not be spread). Front femur Type B_3 with two large proximal spines; pulvilli on four proximal tarsomeres of front and mid legs, only on fourth tarsomere of hind leg, tarsal claws symmetrical, simple, arolia present. Supraanal plate strongly transverse, hind margin narrowly truncate at apex; paraprocts simple plates (fig. 14). Subgenital plate symmetrical with a pair of widely separated small styles, the right one larger, interstylar margin with a symmetrical V-shaped emargination (fig. 16). Genitalia as in fig. 16: hook on the right side; apex of median phallomere modified with small setal brushes; left phallomere composed of several sclerites and some setal brushes.

Colour. – Head with occiput dark reddish, remainder blackish brown with three transverse yellow stripes as follows: a narrow one between the ocellar spots, a broader one across the middle of the frons, and a third on the distal half of the clypeus (fig. 13); basal parts of maxillary palpomeres three and four dark, remainder pale, last segment black. Pronotal disk with a subrectangular black macula which is completely surrounded by a yellow band, remaining lateral portions subhyaline (fig. 15). Tegmina dark reddish brown, narrowing beyond the anal veins to the rounded apex; the yellow from the pronotum continues as a narrow margin along the dark reddish brown region, with the humeral area and distal region of the costal veins hyaline. Abdominal terga dark brown. Abdominal sterna mostly brown, mottled with light areas. Front femur with dark basal and apical maculae, mid and hind coxae mostly dark brown, rest of legs a mixture of light and dark brown. Cerci dorsally with six basal segments dark brown succeeded by four partly yellowish and brown cercomeres, the remaining two segments brown, ventrally dark brown with a pale apical spot.

Female: Supraanal plate strongly transverse with a medial V- shaped emargination, the margins on either side of the V, thickened, yellow. Subgenital plate laterally yellow, with a broad medial, dark brown macula containing an inverted U-shaped yellow mark on the anterior half (fig. 17). Front femur blackish brown on anterior surface, mid femur dark brown on upper half, remainder pale.

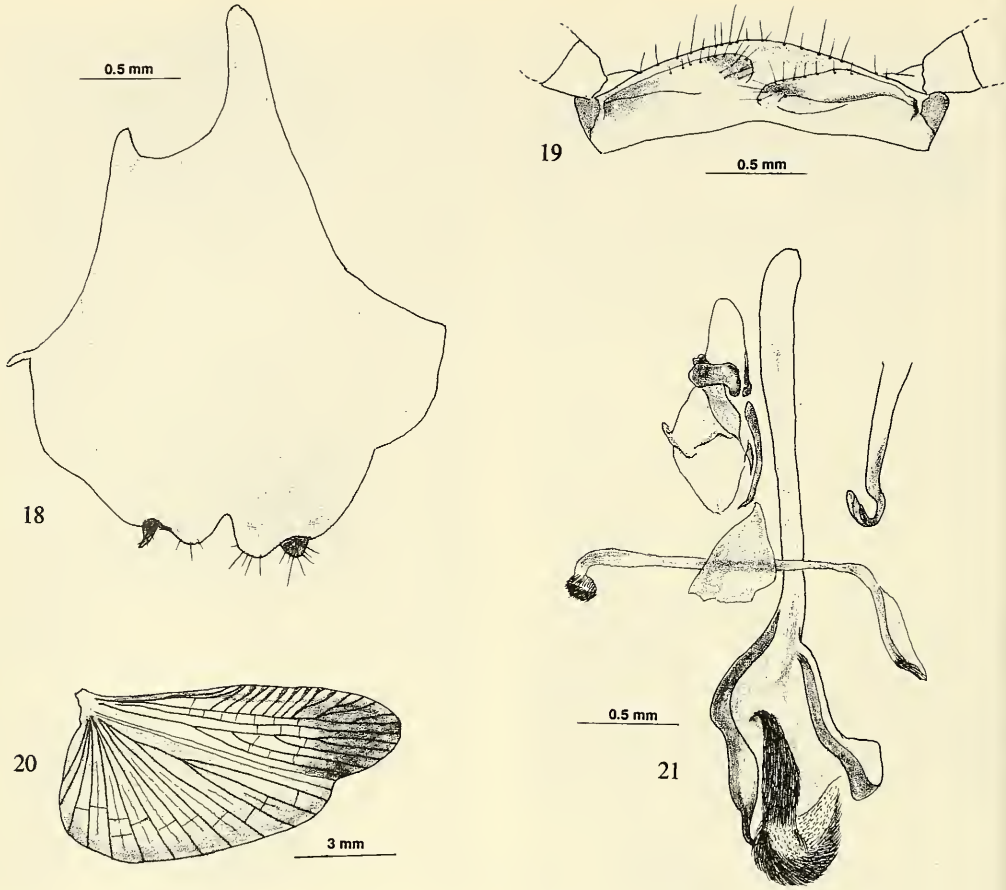
Measurements (mm) (♀ in parentheses). Length, 9.0-10.0 (8.5-10.6); pronotum length × width, 2.3-2.6 × 4.0-4.3 (2.2-2.6 × 4.1-4.5); tegmen length, 10.0-10.2 (8.1-10.1); interocular space, 0.6 (0.7).

Remarks. – Princis (1950: 180, fig. 27) described what he believed to be *ornata* (from Borneo), but the specimen was *laticaput* (fig. 39) (cp. with *ornata*, fig. 16).

Pseudophyllodromia laticeps (Walker) (figs. 18-24)

Blatta laticeps Walker, 1869: 142 (♀).
Phyllodromia laticeps (Walker). – Kirby 1904: 91; Hanitsch 1919: 67.
Pseudophyllodromia laticeps (Walker). – Shelford (1906) 1907: 495; 1908: 17, pl. 1, fig. 8 (exclusive of synonymy); Hanitsch 1915: 60, syn. excl. *laticaput* (the male is *laticaput*); 1919: 72; 1923a: 417, 464; 1925: 77, 89; 1928: 29, 42 (in part; misidentification of *mentawiensis*); 1931: 42, 45; 1932b: 51, 64; 1933a: 312, 313, fig. 6: Hebard 1929: 77; Bruijning 1948: 89; Princis 1969: 932.

Material examined. – Holotype, ♀, Singapore, Wallace, E. coll. (1830-73), W.W. Saunders, purchased and pres. '73, by Mrs. F. W. Hope; Type Orth. 110, in HECO. Additional material. – SINGAPORE: ZILS: Singapore, forest near Macritchie reservoir; slow moving on foliage at lift, *Pseudophyllodromia* sp., 1♀, 2.ii.1968, D.H. Murphy. MALAYSIA. ANSP: Kuala Teku, Pahang, 500-700 ft., 1♂, 4.xii. 1921, F.N. Chasen. MCZC: The following were collected by D. Furth: Kuala Lompat, 1♂, 26.viii.1992; Universiti Kebangsaan Malaysia, campus, 2♂, 1♀, 30.viii.1992.



Figs. 18-21. *Pseudophyllodromia laticeps* (Walker) male from Kuching, Sarawak: 18, subgenital plate (dorsal); 19, supraanal plate and paraprocts (ventral); 20, hind wing; 21, genitalia (dorsal).

Sarawak. ANSP: Kuching, N.W. Borneo, 1♂ (terminalia slide 429), 29.i.1900, 1♂, 6.ix.1900, 1♂, 19.ix.1899, Dyak coll., pres. 1900 by R. Shelford, 1♂, Cornell U., lot 466; no exact locality, 1♀ (labelled *P. laticeps* by Hebard, 1928, and Uvarov). Most of these specimens were reported by Hebard (1929: 77). One male retained in MCZC.

Description. – Male (previously undescribed): Head partly or completely exposed, eyes do not extend below the antennal sockets; interocular space less than the distance between antennal sockets (as in ♀, fig. 22). Pronotum transverse, subelliptical, widest about the middle. Tegmina and wings fully developed extending beyond the end of the abdomen, the former with sublongitudinal discoidal sectors. Hind wing with most costal veins distinctly clubbed, radial vein straight, simple, media and cubitus veins straight, the former simple, cubitus with four complete and no incomplete branches, apical triangle absent (fig. 20). Front femur Type B_3 with two large proximal spines; pulvilli on four proximal tarsomeres of front and mid legs, hind tarsus with a pulvillus on the fourth tarsomere only, tarsal claws simple, symmetrical, arolia small. Abdominal terga unspecialized. Supraanal plate transverse, hind margin convexly rounded, right and left paraprocts similar, simple plates (fig. 19). Subgenital plate weakly asymmetrical, hind margin with a median excavation and a pair of small dissimilar styles of equal length, the right one round, bulbous, the left one curved, tapering to an acute apex (fig. 18). Genitalia as in fig. 21: hook small, on right side, with a preapical incision; distal half of median phallomere strongly modified with setose and sclerotized structures; left phallomere consisting of several sclerites; a narrow sclerite modified at both ends lies transversely across the median phallomere.

Colour. – Head yellowish brown or reddish brown, labrum blackish brown or black; third maxillary palpomere dark basad and along dorsal margin, the remainder and segments four and five white; labial palpi blackish. Pronotal disk with a broad macula that usually extends to both the anterior and posterior margins, laterally highlighted by a narrow whitish stripe, lateral border region hyaline (see female, fig. 23). Tegmina hyaline, light to dark brown, anterior border region whitish. Hind wing with clubbed region of costal veins yellow, remainder unevenly infuscated, darkest (sometimes black) at the posterior region of the anterior field. Abdominal terga dark brown, lateral edges yellowish. Abdominal sterna yellowish brown, with some dark lateral infuscation, their hind margins with a narrow, medially interrupted white line. Cerci dorsally with basal four segments dark brown, remaining cercomeres in part or completely whitish, ventrally dark. Legs pale.

Female: Head completely exposed beyond pronotum (fig. 23); interocular space distinctly less than the distance between ocellar spots and antennal sockets both of which are very small (fig. 22). Pronotum subelliptical (fig. 23). Tegmina and wings fully developed, reaching beyond end of abdomen, discoidal sectors of former sublongitudinal. Anteroventral margin of front femur with three heavy proximal spines, succeeded by a row of piliform spinules, terminating in three large spines (Type B_3); pulvilli present on four proximal tarsomeres of front and mid tarsi (hind tarsi missing), tarsal claws symmetrical, simple, arolia present. Supraanal plate strongly transverse, narrow, hind margin with a small, median excavation.

Colour. – Head reddish, without markings, labrum dark brown (fig. 22); third maxillary palpomere dark brown dorsad, remainder pale, segments four and five white; labial palpi black. Pronotal disk with a dark reddish brown, subtrapezoidal macula extending from the anterior to the posterior margins, the weakly oblique lateral margins highlighted by a narrow yellowish-white or white stripe, the remaining narrow lateral region hyaline (fig. 23). Colour of tegmina the same as the pronotal disk, with the yellowish white stripe continuing along the anterior border of the wing cover. Abdominal terga dark brown, the lateral margins narrowly pale. Abdominal sterna with a brownish macula laterally, the intermediate zones yellowish brown, the hind margins narrowly white as in the male; subgenital plate yellowish on basal half, the distal half and anterolateral corners dark brown to black (fig. 24). Coxae infuscated on basal halves, femora pale with a dark brown macula apically.

Measurements (mm) (♀ in parentheses). Length, 7.6-10.1 (8.4-9.4); pronotum length × width, 2.2-2.3 × 3.7-3.9 (2.0-2.4 × 3.5-3.9); tegmen length, 9.8-10.5 (8.0-8.8); interocular width, 0.5 (0.5-0.6).

Pseudophyllodromia sp.

Material examined. – SINGAPORE. ZILS: Nee Soon Swamp Forest, 2♀ (1 carrying an ootheca in the vertical position almost completely surrounded by the intersternal fold), 3.iv.1968, D.H. Murphy; Bukit Timah Nat. Res., Singapore, 1♀, pitfall A, Eth. Glycol, 3.iv.1967.

Description. Female: Head with interocular space less than the distance between antennal sockets. Pronotum subelliptical. Tegmina and wings fully developed reaching beyond the end of the abdomen, the former with almost longitudinal discoidal sectors. Hind wing with five proximal costal veins clubbed, radial and media veins simple, straight, cubitus vein with five complete and no incomplete branches, apical triangle subobsolete. Front femur Type B_3 with three large proximal spines; fore and mid legs with pulvilli on tarsomeres two to four (absent on segment one), hind tarsus with a pulvillus on the fourth segment only.

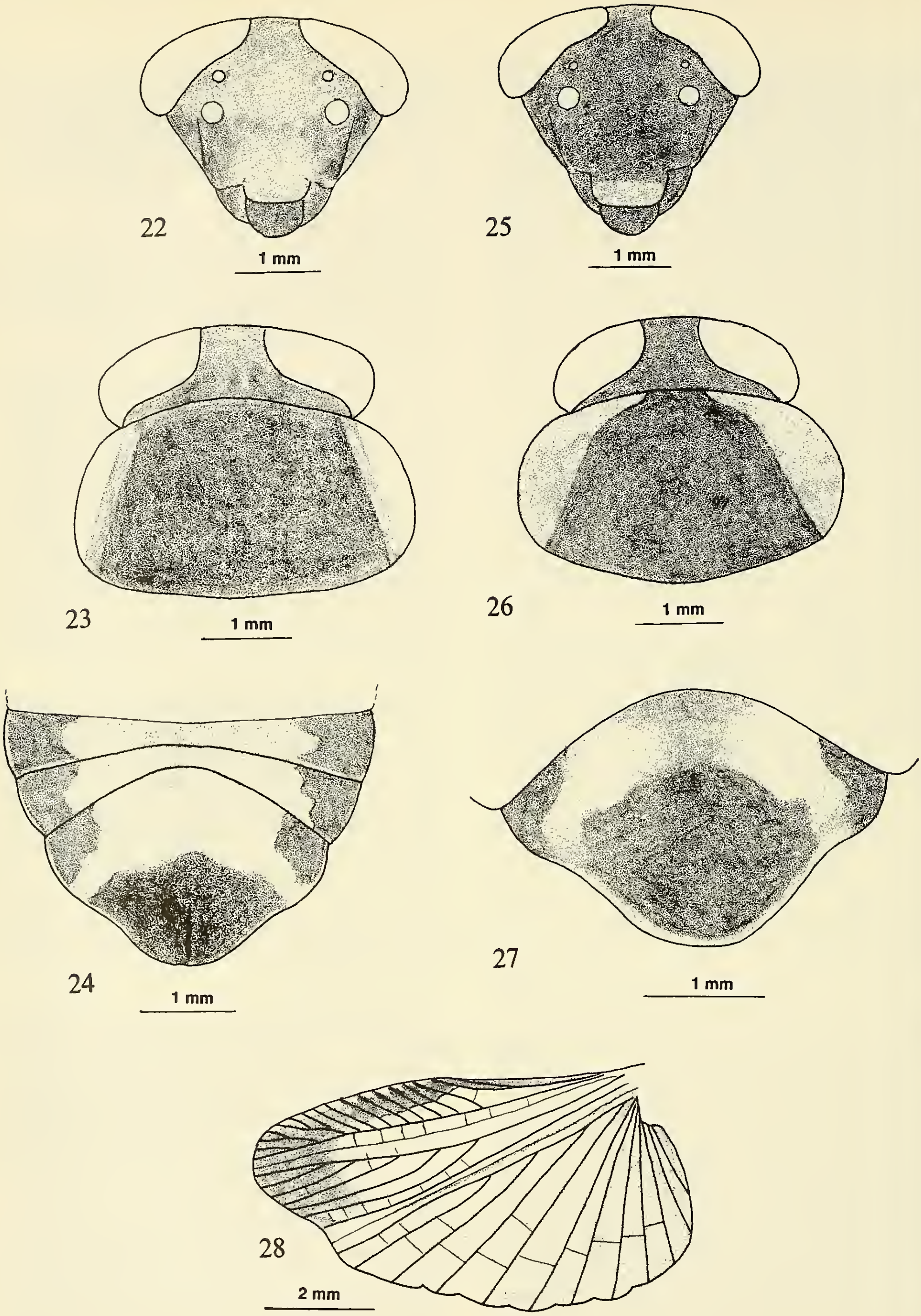
Colour. – Head occiput with four dark narrow longitudinal stripes separated by lighter narrow bands, a narrow zone of the vertex pale, rest of head dark with variable number (and size) of small yellowish markings. Pronotal disk black, completely surrounded by whitish zone. Tegmina reddish hyaline, anterior border region whitish, subcostal vein dark. Hind wing infuscated, the distal region of the anterior field somewhat darker. Legs with coxae and femora (more so on anterior surface) dark brown. Dorsal surface of the cerci with proximal segments dark, remainder pale, ventrally dark.

Measurements (mm). – Length, 8.2-8.3; pronotum length × width, 2.1-2.2 × 3.6-3.8; tegmen length, 7.7-8.0; interocular width, 0.4.

Remarks. – These specimens were sent to me identified as *P. laticeps*. The pale markings on the face, differences in number of pulvilli, and the slight difference in interocular width, suggest that it is a different species or a colour morph of *laticeps*. The discovery of males may help solve this problem.

Pseudophyllodromia mentawiensis Hanitsch (figs. 25-28)

Pseudophyllodromia mentawiensis Hanitsch, 1933a: 313 (♀). – Bruijning 1948: 90.
Pseudophyllodromia laticeps (nec Walker, 1868). – Hanitsch 1928: 29 (in part); Princis 1969: 933.



Figs. 22-28. *Pseudophyllodromia* spp. 22-24, *P. laticeps* (Walker), female holotype: 22, head; 23, pronotum; 24, terminal abdominal sterna. – 25-28, *P. mentawiensis* Hanitsch, females: 25, head; 26, pronotum; 27, subgenital plate, 28, hind wing.

Material examined. – Lectotype (here designated): ♀, MENTAWE[A]I, Siberoet, 13.ix.1924, H.H. Karny; Type Orth. $343^{1}/_{4}$, in HECO. Paralectotypes. HECO: same locality and collector as lectotype, with different type numbers and dates: ♀, $343^{2}/_{4}$ (carrying ootheca in the vertical position), 20.ix.1924, ♀, $343^{3}/_{4}$, 20.ix.1924, ♀, $343^{4}/_{4}$, 15.ix.1924.

Description. – Female: Head exposed, interocular space decidedly less than the distance between minute ocellar spots, and small antennal sockets; eyes do not extend below the antennal sockets (fig. 25). Pronotum subelliptical, widest at about the middle (fig. 26). Tegmina and wings fully developed extending well beyond end of abdomen, the former with longitudinal discoidal sectors. Hind wing with the proximal six costal veins clubbed, radial and media veins simple, straight, cubitus vein weakly concave with five complete and no incomplete branches, apical triangle absent (fig. 28). Front femur Type B_3, with two large proximal spines; pulvilli on four proximal tarsomeres of front and mid legs, only on fourth tarsomere of hind leg, tarsal claws symmetrical, simple, arolia present. Supraanal plate strongly transverse, very narrow, hind margin with a shallow medial indentation. Subgenital plate extending well beyond hind margin of supraanal plate.

Colour. – Head very dark reddish brown, distal half of clypeus yellowish (fig. 25); third maxillary palpomere with pale and brown zones, segment four pale, terminal segment dark brown. Pronotal disk very dark reddish brown extending narrowly from the anterior margin, to broadly at the hind margin, lateral regions yellowish white (fig. 26). Tegmina the same colour as the pronotum with the yellowish white portion continuing but becoming narrower along the anterior margin of the wing cover. Hind wing with apical region of the costal veins whitish, distal region of anterior field darkly infuscated, posterior field lighter (fig. 28). Abdominal terga dark reddish brown, exposed dorsal surface of the subgenital plate yellow. Abdominal sterna dark brown with lateral and hind margins narrowly yellow, or with the medial region yellow with broad lateral zones brown (resembling fig. 24); subgenital plate with about basal third yellow, distal two thirds and anterolateral corners dark brown (fig. 27; the extent of dark brown is variable). Coxae infuscated, femora light to dark brown, tibiae and tarsi light brown.

Male: Unknown.

Measurements (mm). – Length, 9.0-9.5; pronotum length × width, 2.2-2.5 × 4.0-4.2; tegmen length, 9.0; interocular space 0.6.

Pseudophyllodromia simalurensis sp. n.
(figs. 29-34)

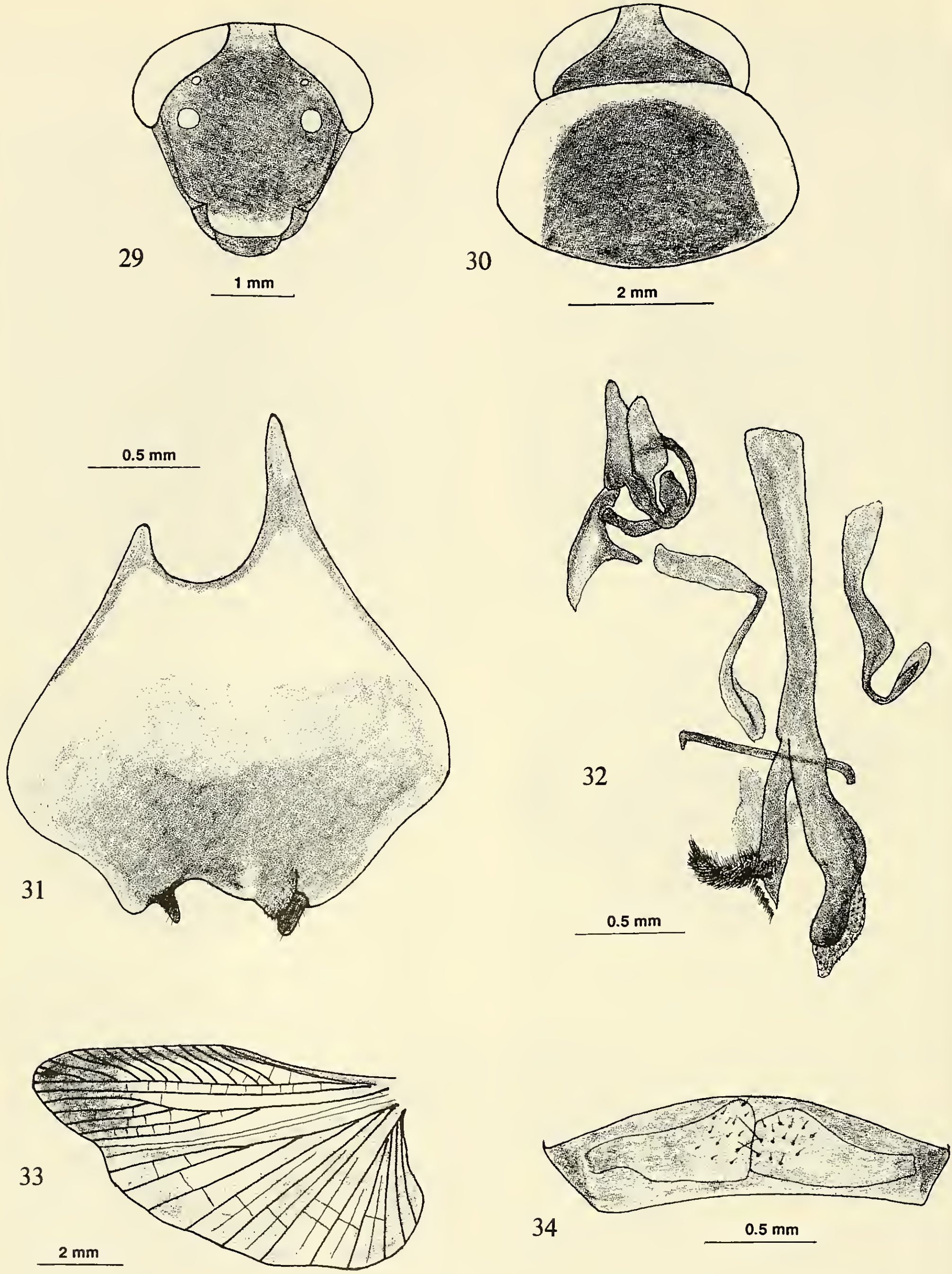
Pseudophyllodromia laticeps (not Walker, 1869). – Hebard, 1929: 77 (misidentification).

Type material. – Holotype, ♂ (terminalia slide 430), Lasikin, Simalur Island, Sumatra, iv.1913, E. Jacobson; in ANSP.

Description. – Male: Head with interocular space considerably less than the space between the antennal sockets; eyes do not extend below the antennal sockets (fig. 29). Pronotum subtrapezoidal, widest behind the middle (fig. 30). Tegmina and wings fully developed extending beyond end of abdomen, the former with oblique discoidal sectors. Hind wings with costal veins not distinctly clubbed (several may be slightly thickened on distal halves); radial and media veins straight, simple, cubitus vein weakly curved with four complete and no incomplete branches, apical triangle absent (fig. 33). Front femur Type B3 with two large proximal spines; pulvilli on four proximal tarsomeres of front and mid legs, only on the fourth tarsomere of the hind legs, tarsal claws simple, symmetrical, arolia small. Abdominal terga unspecialized. Supraanal plate transverse, hind margin convexly rounded, right and left paraprocts simple plates (fig. 34). Subgenital plate asymmetrical, styles cylindrical, dissimilar, the right one slightly larger, interstylar margin asymmetrically excavated (fig. 31; the subgenital plate shown in the figure was flattened in the slide preparation so that the styles are wide apart; in the pinned specimen the interstylar margin looks like a narrow slit with the styles closer together). Genitalia as in fig. 32: genital hook on the right side with a preapical incision and very narrow neck; distal region of median phallomere with two branches, one terminating in a setal brush, the main rod apically rounded and darkly sclerotized and with a membrane covered with minute spicules; a slender transverse bar lies transversely under the median phallomere; left phallomere consisting of several nonsetose sclerites.

Female: Unknown.

Colour. – Vertex light reddish, rest of face dark red, distal half of clypeus pale, labrum dark (fig. 29); maxillary palpomeres three and four yellowish, fifth segment dark brown. Pronotal disk with a large subtrapezoidal, blackish macula which does not reach the front margin of the pronotum whose lateral and narrower anterior zones are semihyaline, yellowish (fig. 30). Tegmina reddish brown hyaline, anterior margins whitish. Hind wing unevenly infuscated, darkest along the distal halves of the costal veins and the apical region of the anterior field, remaining part of the field colourless, posterior field comparatively lightly, evenly darkened (fig. 33). Abdominal terga dark brown, lateral edges yellowish. Abdominal sterna brown laterally, hyaline and yellowish (due to visibility of underlying tissue) medially. Basal halves of coxae dark brown, remaining parts of legs yellowish brown.



Figs. 29-34. *Pseudophyllodromia simalurensis* sp. n., male holotype: 29, head; 30, pronotum; 31, subgenital plate (dorsal); 32, genitalia (dorsal); 33, hind wing; 34, supraanal plate and paraprocts (ventral).

Measurements (mm). – Length, 9.5; pronotum length × width, 2.6 × 4.1; tegmen length, 9.8; interocular space, 0.5.

Etymology. – The specific name refers to the island on which the species was collected.

Remarks. – The modification of the distal region of the median genitalia phallomere of *simalurensis* suggests a close relationship with *laticeps* and *laticaput*.

Pseudophyllodromia laticaput (Brunner) (figs. 35-40)

Phyllodromia laticaput Brunner, 1898: 205, pl. 16, fig. 8 (♂). Syntypes (not examined): ♂, Borneo, Brunei; Baram stream; 'Banguei' Island; in NMWA.– Kirby 1904: 93; Shelford 1906: 267 (incorrectly synonymized under *laticeps*); 1908: 17 (incorrectly synonymized under *laticeps*).

Pseudophyllodromia laticaput (Brunner). – Hanitsch 1933a: 311, fig. 5; 1933b: 232; Bruijning 1948: 90; Princis 1969: 933.

Pseudophyllodromia ornata (not Brunner, 1865):. – Princis 1950: 180, fig. 27 (♂).

Material examined. – SABAH. RMNH: Malaysia SE. Sabah, Danum Valley Field C, E3, c. 175 m, Mal. trap, 1♂ (terminalia slide 159), 15-25.iii.1987, C. v. Achterberg; Keningau area, Nabawan (Site C), podzol forest, 2 human excrement traps, alt. 0450 m, 1♂, 14-17.xi.1987, Krikken & Rombaut. KALIMANTAN. RMNH: Biv. Long Hoet, M.O. Borneo Exp., 1♂, 16-20.viii.1925, H.C. Siebers. The following were collected by A.M.R. Wegner: E. Borneo, Tabang, Bengen River, 125 m, 1♂, 1♀, 25.ix.1956, 1♀, 2.x.1956; E. Borneo, Gunungsari, 95 m, 1♀, 14.viii. 1956. Two specimens retained in the MCZC. ZILS: The following were collected by Mrs. M.E. Walsh: O. Borneo, Samarinda, 1♀, vi.1938; O. Borneo, Pelawan Basir, 1♂, vi.1937.

Redescription. – Male: Head completely exposed (fig. 37), interocular space less than distance between antennal sockets (fig. 35). Pronotum with anterior margin straight, laterally convex, hind margin convex (fig. 37). Tegmina and wings fully developed, extending well beyond end of abdomen, the former with longitudinal discoidal sectors. Hind wing with proximal costal veins thickened distad, radial and media veins simple, cubitus vein weakly curved, with four to five complete and no incomplete branches, apical triangle absent (fig. 38). Front femur Type B_3, with three large proximal spines; front and mid tarsi with pulvilli on four proximal tarsomeres, hind tarsus with a pulvillus on the fourth tarsomere only, tarsal claws symmetrical, simple, arolia small. Abdominal terga unspecialized. Supraanal plate transverse, distal part of hind margin truncate; right and left paraprocts similar, broad, sclerotized plates (fig. 36). Subgenital plate asymmetrical, styles short, right one slightly stouter, interstylar margin with a deep, curved excision to the left of the midline (fig. 39). Genitalia as in fig. 39: small hook on the right side, without a distinct preapical incision; median phallomere broad, distally modified with setal brushes, and with an apically setose branch arising beyond the middle; a curved accessory median phallomere terminates in a setal brush; left phallomere composed of nonsetose sclerites.

Colour. – Head with reddish occiput, face with highly variable patterns of yellow, and light and dark brown markings (fig. 35); maxillary palpomeres three and four white with a small, dark, basal spot, terminal segment black. Pronotal disk black, usually with anterior and posterior margins narrowly whitish (sometimes only anteriorly: fig. 37), broad lateral areas hyaline, rarely opaque whitish, sometimes partially bordered with white. Tegmina dark reddish brown, humeral region and anterior border hyaline, sprinkled with white along the dark brown area. Hind wing with the regions at the apexes of the thickened costal veins white, the distal area of the anterior field darkly infuscated, posterior field distinctly lighter (fig. 38). Abdominal terga dark brown. Abdominal sterna light or mottled dark brown. Cerci with three basal segments blackish brown, fourth cercomere a mixture of brown and white, segments five to nine white, terminal two segments yellowish; ventrally brown except for the two pale terminal segments. Legs pale, dorsal margins of femora dark brown.

Female: Supraanal plate strongly transverse, narrow, hind margin rounded with a small V-shaped excision medially. Subgenital plate with a narrow yellow area anteriorly, a broad dark brown medial macula reaching to the posterior margin, and a smaller mark in the anterolateral corners (fig. 40).

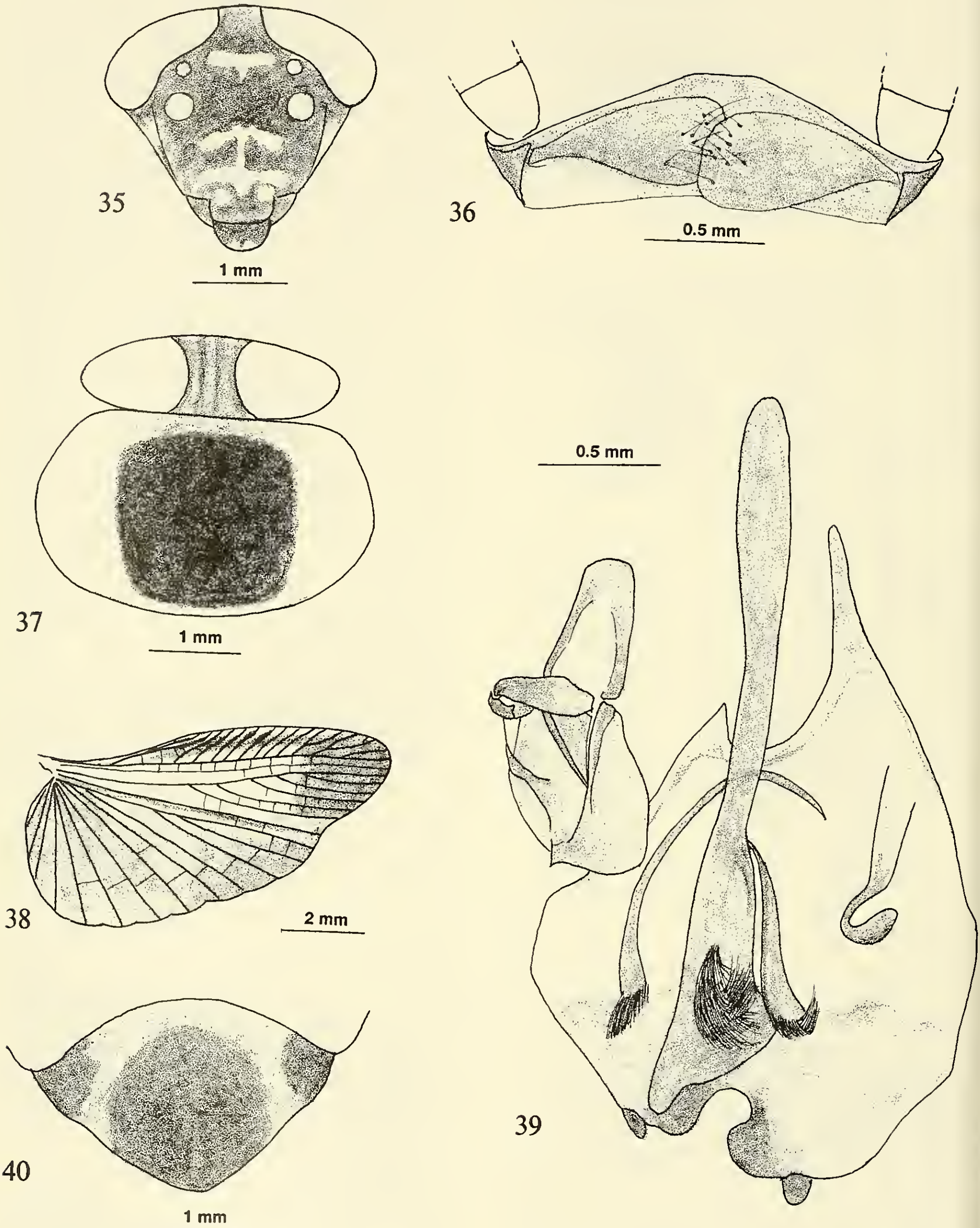
Measurements (mm) (♀ in parentheses). – Length, 9.0-10.0 (8.6-9.6); pronotum length × width, 2.4-2.5 × 3.8-4.2 (2.4-2.5 × 4.0-4.2); tegmen length, 10.0-10.5 (9.2-9.6); interocular space, 0.5 (0.5).

Remarks. – Princis (1950: 179, fig. 27) recorded *Pseudophyllodromia ornata* from Pelawan besar, East Borneo. I have seen his specimen and the male's asymmetrical subgenital plate (see his fig. 27) is similar to that of *laticaput* (fig. 39), and I consider it to be a misidentification. The type of *ornata* is from the Philippines, and its facial markings (fig. 13) are distinctly different from *laticaput* (cf. fig. 35).

Pseudophyllodromia sp.

Material examined. – SARAWAK. HECO: 1♀, Miri, E. Mjöberg (labelled *Pseudophyllodromia laticaput* Brunner; this may be the specimen reported by Hanitsch, 1925: 89, as *Pseudophyllodromia laticeps* Walker).

Remarks. – This specimen does not agree with the characteristics of either *laticaput* or *laticeps*. Its head colour is reddish without distinct markings, and its



Figs. 35-40. *Pseudophyllodromia laticaput* (Brunner). 35-39, male from Sabah: 35, head; 36, supraanal plate and paraproct (ventral); 37, pronotum; 38, hind wing; 39, subgenital plate and genitalia (dorsal); 40, female from Tabang, Bengen River E. Borneo, subgenital plate (ventral).

subgenital plate has a large yellow macula on the basal half, the distal half and anterolateral corners dark brown to black, patterns similar to *laticeps* (figs. 22, 24); however, the fourth palpomere has a brown spot on the distal half, and the basal half of the fifth palpal segment is dark brown, the remaining portions of both segments white, whereas in *laticeps*, both fourth and fifth palpomeres are completely white. The head of *laticaput* is variegated with dark brown and yellow (fig. 35).

Measurements (mm): Length, 9.0; pronotum length × width, 2.5 × 4.0; tegmen length, 9.4; interocular width, 0.5.

Pseudophyllodromia aronsoni sp. n.
(figs. 41-45)

Type material. – Holotype, ♂, Malaysia, SABAH, Sipitang, Mendolong, T4/R, 6.v.1988, S. Adebratt; in ZILS. – Paratype. Sabah. ZILS: 1♂ (terminalia slide 429), same data as for holotype.

Description. – Male: Head exposed, ocellar spots very small, interocular space less than the distance between antennal sockets; the eyes do not extend below the antennal sockets (fig. 41). Pronotum subelliptical, widest behind the middle (fig. 42). Tegmina and wings fully developed extending beyond end of abdomen, the former with longitudinal discoidal sectors. Hind wing with costal veins thickened distad, radial and media veins simple, straight, cubitus vein with four complete and no incomplete branches, apical triangle absent (fig. 45). Front femur Type B_3, with three or four large proximal spines; pulvilli on four proximal tarsomeres of front and mid tarsi, only on the fourth tarsomere of the hind tarsus. Abdominal terga unspecialized. Supraanal plate strongly transverse, hind margin convexly rounded, paraprocts similar plates. Subgenital plate asymmetrical, hind margin with a U-shaped excavation, and with a pair of small styli, the right one stouter than the left (figs. 43, 44). Genitalia as in fig. 44: genital hook on the right side, very small, with a preapical incision; median phallomere with dark sclerotizations and setal brushes apically (in both specimens, the median phallomere protruded beyond the hind margin of the subgenital plate, as in fig. 43); the right phallomere apparently consists of several sclerites that are distributed to the left and right sides of the median phallomere.

Colour. – Head reddish brown without markings, labrum blackish (fig. 41); maxillary palpomeres three and four pale with large black stripes, fifth segment black, apex pale; antennae black, about the proximal ten antennomeres on one side pale. Pronotum with a large blackish brown, trapezoidal macula completely surrounded by opaque yellowish (fig. 42). Tegmina dark reddish brown, anterior border pale. Hind wing anterior field with pale costal margin, the posterior part and apical region dark, remainder lighter, posterior field lightly infuscated (fig. 45). Abdominal terga, and meso- and metanotum very dark brown, edges pale. Abdominal sterna yellowish brown, laterally dark, styles very dark. Coxae dark brown basad, rest of legs brownish yellow. Dorsal surface of the cerci with cercomeres one to five black, segments six to eleven pale, ventrally all segments dark.

Female: Unknown.

Measurements (mm). – Length, 8.5; pronotum length × width, 2.3 × 3.5-3.7; tegmen length, 9.8-10.0; interocular width, 0.4.

Etymology. – The species is dedicated to my friend Melvin P. Aronson, Dr. of Pharmacy and prostheses expert.

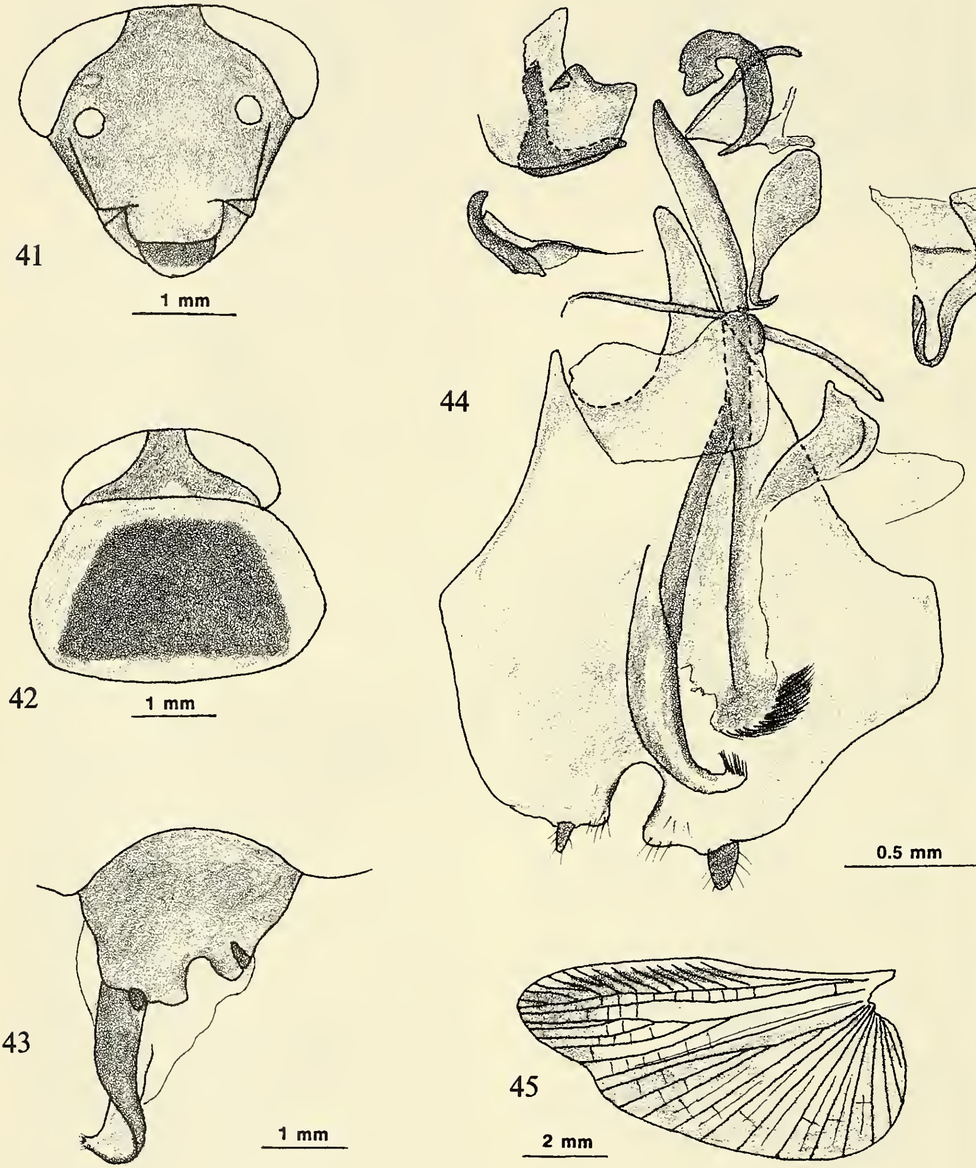
Remarks. – The subgenital plate and styles of *aronsoni* are similar to those of *laticaput*, but the genital phallomeres are strikingly different in the two species (cf. figs. 39 and 44).

Pseudophyllodromia laeta Hanitsch stat. nov.
(figs. 46-52)

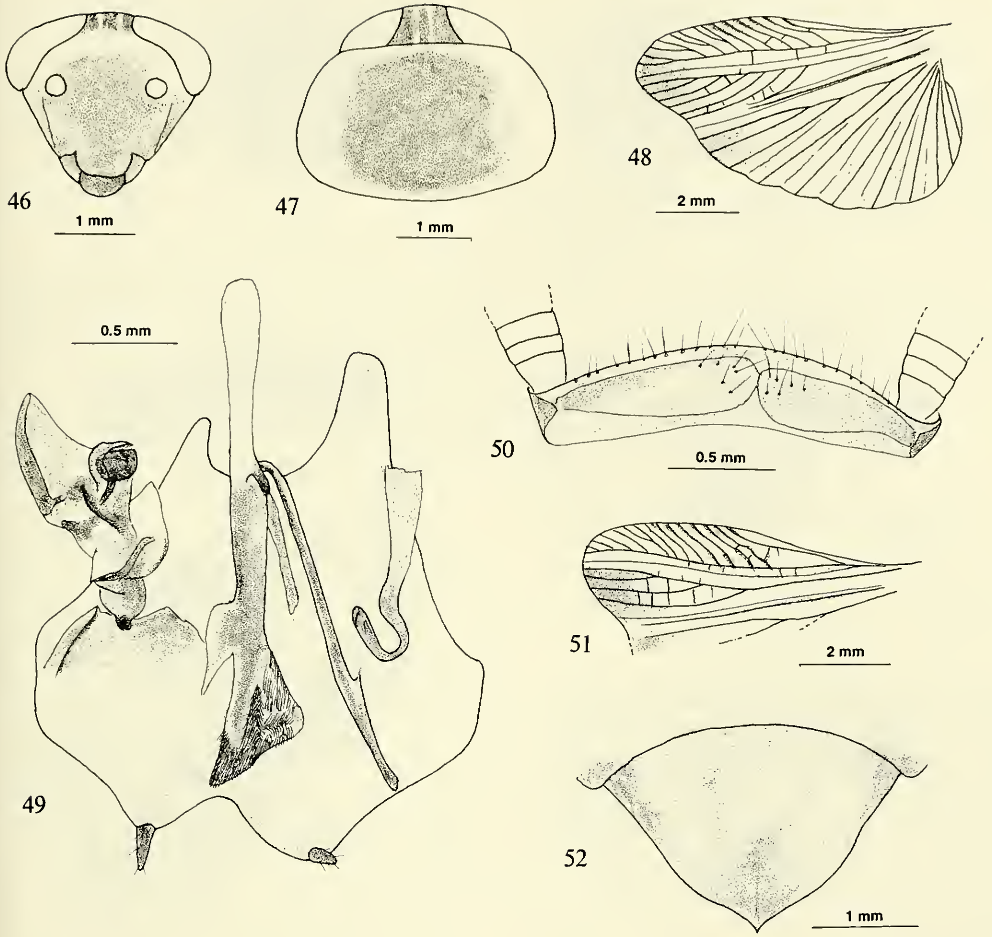
Pseudophyllodromia poiensis laeta Hanitsch, 1933a: 313 (♂ & ♀). – Princis, 1969: 933.

Material examined. – Lectotype (here designated): ♂ (terminalia slide 243), Mt. Poi [Sarawak], 5450 ft., Mjöberg; in HECO. Paralectotype: Sarawak. HECO: same data as lectotype, 1♀ (terminalia slide 246). – Additional material. SARAWAK. HECO: same data as lectotype, 1♂ (terminalia slide 244) (head missing; labelled *Pseudophyllodromia laticaput* Brunner, by Hanitsch).

Redescription. – Male: Head exposed, ocellar spots absent; interocular space less than the distance between small antennal sockets; eyes do not extend below the antennal sockets (fig. 46). Pronotum with anterior margin straight, hind margin weakly curved, lateral margins convexly rounded (fig. 47). Tegmina and wings fully developed, extending beyond end of abdomen, discoidal sectors of the former, oblique. Hind wing with six proximal costal veins clubbed, radial and media veins straight, simple, cubitus vein almost straight, with four or five complete and zero to one incomplete branches, apical triangle absent (fig. 48). Front femur Type B_3, with one to three large proximal spines; pulvilli on four proximal tarsomeres of front and mid legs, only on the fourth segment of the hind leg, tarsal claws symmetrical, simple, arolia present. Abdominal terga unspecialized. Supraanal plate strongly transverse, narrow, hind margin shallowly convexly rounded; paraprocts similar simple plates (fig. 50). Hind margin of subgenital plate with a median, asymmetrical, wide V-shaped excavation,



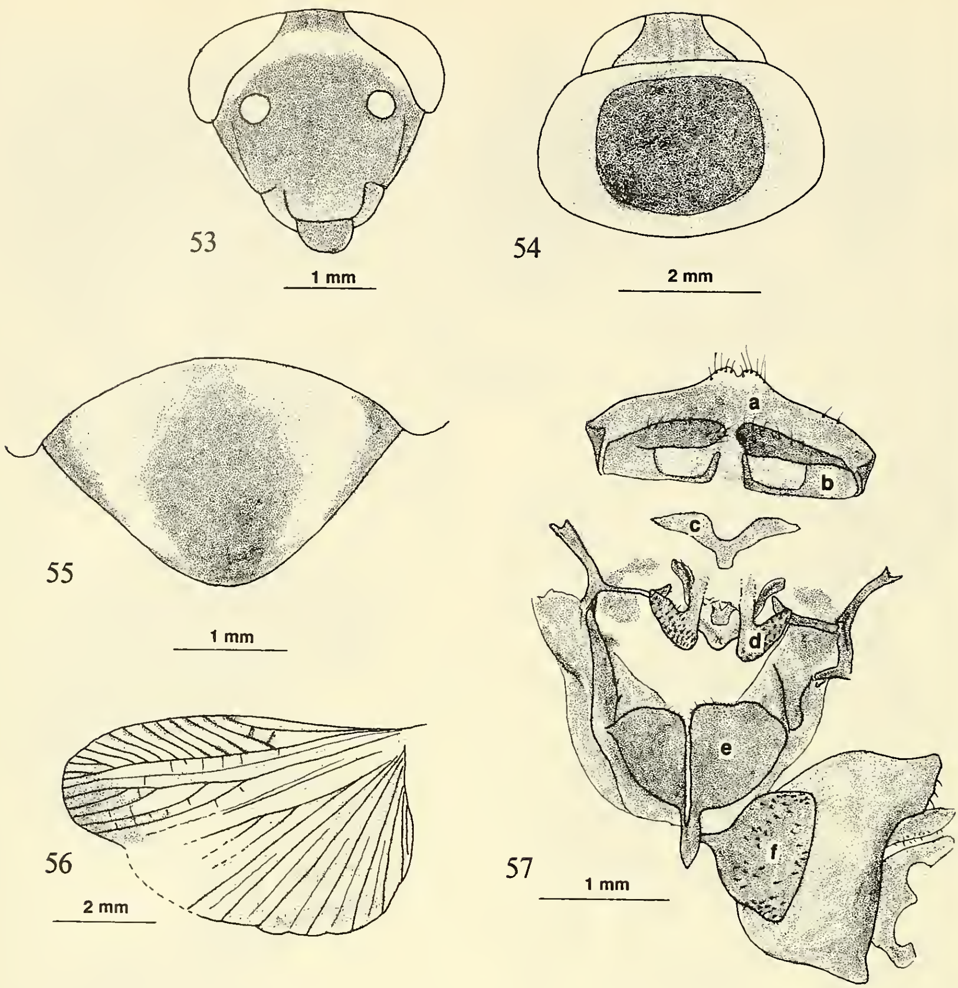
Figs. 41-45. *Pseudophyllodromia aronsoni* sp. n., male paratype: 41, head; 42, pronotum; 43, subgenital plate and protruding median genital phallomere (ventral); 44, subgenital plate and genitalia (dorsal); 45, hind wing.



Figs. 46-52. *Pseudophyllodromia laeta* Hanitsch. 46-48, male lectotype, 49, 50, male paralectotype: 46, head; 47, pronotum; 48, hind wing; 49, subgenital plate and genitalia (dorsal); 50, supraanal plate and paraprocts (ventral); 51, 52, female paralectotype, anterior field of hind wing, and subgenital plate (ventral), respectively.

and a pair of small asymmetrical styles, the right one shorter (fig. 49). Genitalia as in fig. 49: hook on the right side with a preapical incision; median phallomere with a spur and two unequal rods arising before the middle, the shorter one lightly sclerotized and arising on the ventral surface (therefore may be hidden), the longer one darkly sclerotized and oblique; distal end of the phallomere is enlarged and setose; left phallomere consisting of several dark and light sclerites.

Colour. – Head occiput brownish with a pair of narrow longitudinal orangish stripes; region above the antennal sockets, with a poorly defined curved, whitish band which blends into the yellowish orange face, labrum brownish (fig. 46); third maxillary palpomere with dorsal margin dark, remainder pale, fourth segment whitish, terminal segment black. Pronotal disk macula reddish brown, the margins not sharply defined, with a broad yellowish margin anteriorly and a narrower one posteriorly; laterally the dark macula is incompletely margined with yellow, remaining lateral zones hyaline (fig. 47). Tegmina hyaline, light brown, this colour laterally delineated by a yellowish stripe which is a continuation of the pronotal yellow, but which begins a short distance from the hind margin of the pronotum. Hind wing



Figs. 53-57. *Pseudophyllodromia poiensis* Hanitsch, females. 54, 55 from lectotype, all others from paralectotype: 53, head; 54, pronotum; 55, subgenital plate (ventral); 56, hind wing; 57, supraanal plate, paraprocts and genitalia (ventral); a, supraanal plate; b, right paraproct; c, intercalary sclerite; d, first valve; ? spermathecal plate; f, ? laterosternal shelf.

with costal region yellowish, distal region of anterior field darkly infuscated, cubitus veins and its branches dark, posterior field more lightly infuscated (fig. 48). Abdominal terga yellow. Abdominal sterna lightly infuscated. Cerci dorsally with three basal segments brown, remaining cercomeres pale, ventrally dark, the penultimate segment pale.

Female: Legs as in male with a pulvillus only on the fourth tarsomere of the hind leg, but present on all proximal tarsomeres of the front and mid legs. Cubitus vein of hind wing with three complete and no incomplete branches, apical triangle absent (fig. 51). Supraanal plate strongly transverse, narrow, hind margin and paraprocts similar to *poiensis* (see fig. 57). Genitalia similar to *poiensis* (see fig. 57). Head with occiput reddish brown, narrow longitudinal stripes absent. Abdominal terga yellowish with some lateral infuscation, terminal segments darker, the supraanal plate with a lateral hyaline, pale spot, partly hidden under the ninth segment. Abdominal sterna lightly infuscated, subgenital plate yellowish without distinct dark markings (fig. 52).

Measurements (mm) (♀ in parentheses). Length, 7.0-8.7 (8.5); pronotum length × width, 2.3-2.4 ×3.7-4.1 (2.5 ×3.7); tegmen length, 8.7-8.8 (8.4); interocular width, 0.6 (0.6).

Remarks. – Although Hanitsch considered this taxon to be a subspecies of *poiensis*, I believe that the differences in the pronotal, and subgenital plate markings warrant its being raised to specific rank in spite of the similarity of the female genitalia in both taxa. It is unfortunate that the male of *poiensis* is unknown for an examination of this sex, when it is found, may show whether or not my interpretation of these species is correct.

Pseudophyllodromia poiensis Hanitsch
(figs. 53-57)

Pseudophyllodromia poiensis poiensis Hanitsch, 1933a: 313, fig. 7 (♀); Bruijning, 1948: 90; Princis, 1969: 933.

Material examined. – Lectotype (here designated): ♀, Mt. Poi [Sarawak], 4500 ft., E. Mjöberg, 1924; in HECO. Paralectotype: Sarawak. HECO: ♀ (terminalia slide 245), same locality and collector as lectotype, 5350 ft.

Redescription. – Female: Head exposed, interocular space less than distance between very small antennal sockets, ocellar spots absent; eyes do not extend below the antennal sockets (fig. 53). Pronotum with anterior margin straight, hind margin rounded, lateral margins convex, widest about the middle (fig. 54). Tegmina and wings fully developed, extending beyond end of abdomen, discoidal sectors of former oblique. Hind wing with radial and media veins simple, cubitus vein weakly curved, with four complete and no incomplete branches, apical triangle absent (fig. 56). Legs badly damaged or missing. Supraanal plate transverse, hind margin with a small medial excision (fig. 57). Genitalia as in fig. 57: not seen are a pair of slender, apically rounded, colourless spermathecae (visible under the compound microscope).

Colour. – Head with occiput reddish brown, and only a weak indication of three light red longitudinal stripes; a distinctly defined yellowish band curves between the eyes above the antennal sockets, rest of face dark reddish to the clypeus, or somewhat lighter from below the antennal sockets to the clypeus, labrum dark brown (fig. 53); fourth maxillary palpomere pale, segment five black. Pronotal disk with a sharply delineated, suboval, black macula, completely surrounded by a yellow band, outer lateral zones subhyaline yellowish (fig. 54). Tegmina reddish brown, humeral, and most of costal vein area yellow (continuation of pronotal yellow). Abdominal sterna black with a yellow medial area on the penultimate segment; subgenital plate with a large, black, medial area and smaller ones laterally on basal half (fig. 55).

Male: Unknown.

Measurements (mm). – Length, 8.4-9.2; pronotum length × width, 2.4-2.6 × 4.0-4.2; tegmen length, 8.3-8.7; interocular space, 0.6-0.7.

Remarks. – See remarks under *laeta*.

Allacta Saussure & Zehntner

Allacta Saussure & Zehntner, 1895: 45. – Roth 1991: 996 (diagnosis and synonymy); 1993: 361; 1995: 51. – Type species: *Abrodiaeta modesta* Brunner, by selection by Hebard.

Euhanitschia Princis, 1950: 178. – Type species: *Phyllodromia diagrammatica* Hanitsch, by monotypy. **syn. n.**

Compsosilpha Princis, 1950: 180. – Type species: *Chorisoblatta karnyi* Hanitsch, by monotypy. **syn. n.**

Remarks. – Recently, most of the known taxa of *Allacta* have been redescribed and new species have been added (Roth 1991: 996; 1993: 361; 1995: 51).

Allacta diagrammatica (Hanitsch) **comb. n.**
(figs. 58-64)

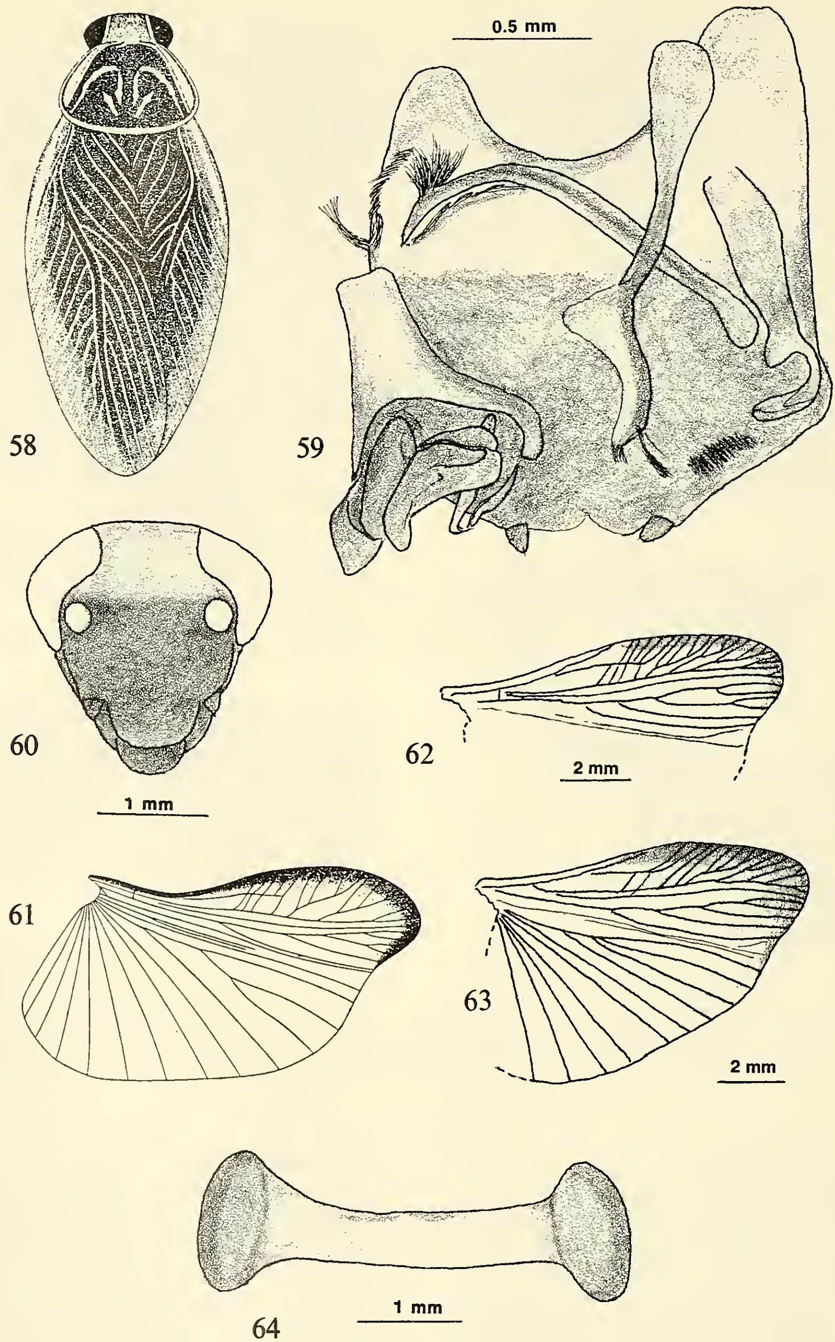
Phyllodromia diagrammatica Hanitsch, 1923b: 198, figs. 1-3 (♀). – 1923a: 404, figs. 6-8 (♂); Hebard 1929: 11; Bruijning 1948: 38, fig. 44.

Chorisoblatta diagrammatica (Hanitsch). – Hanitsch 1928: 27; 1929: 15.

Euhanitschia diagrammatica (Hanitsch). – Princis 1950: 180.

Material examined. – Lectotype, ♂ (terminalia slide 301), Selangor F.M.S., Kuala Lumpur, i.1918, C. Boden Kloss (with written label *Cretographa diagrammatica* Han. (♂); Type Orth. 278½ in HCEO. Paralectotype. HCEO: 1♂, same data as lectotype, Type Orth. 278²/₂ (the specimen is badly fragmented and parts are mounted on cardboard). – Additional material. – JAVA. ZILS: Soekaboemi, 1♀, xii.1937, Mrs. M.E. Walsh (this specimen was reported by Princis when he described *Euhanitschia*).

Redescription. – Male: Head with eyes extending below the antennal sockets, interocular space less than the distance between the sockets (fig. 60). Pronotum subparabolic, hind margin curved (fig. 58). Tegmina and wings fully developed, the former with oblique discoidal sectors. Hind wing with costal margin almost straight (see remarks), radial and media veins simple, cubitus vein with four or five complete (one may be forked), and no incomplete branches, apical triangle small (figs. 61-63). Front femur Type B_2 with two or three large proximal spines (lectotype; see remarks); pulvilli present only on the fourth proximal tarsomere, tarsal claws symmetrical, simple, arolia present. Abdominal terga unspecialized; supraanal plate transverse, hind margin convex, intercercal processes absent, right and left paraprocts similar sclerotized plates. First abdominal sternum with lateral thickenings in the shape of tegmina-like lobes (fig. 64). Subgenital plate symmetrical with a pair of very small, similar styles, interstylar margin shallowly incised (fig. 59; in the drawing, coverslip pressure spread the styles wider apart than they are in the



Figs. 58-64. *Allacta diagrammatica* (Hanitsch): 58, 59, male holotype, habitus (from Hanitsch, 1923b: fig. 1), and subgenital plate and genitalia (dorsal); 60, female (from Java), head; 61, right hind wing of male paralectotype (from Hanitsch, 1923b: fig. 2); 62, anterior field of right hind wing of male paralectotype (camera lucida drawing of same specimen shown in fig. 61); 63, female (from Java), right hind wing; 64, male holotype, first abdominal sternum showing the lateral swellings (slide preparation).

pinned specimen). Genitalia as in fig. 59: hook on the right side, with a preapical incision; median phallomere with distal region enlarged, apex with some small setae; lying under the median phallomere is a curved rod that terminates in a setal modification on the left side; left phallomere very large consisting of several nonsetose sclerites.

Female: Habitus similar to male. Head as in fig. 60. Cubitus vein of hind wing with four complete and no incomplete branches, apical triangle subobsolete (fig. 63). Right front femur with two large proximal spines succeeded by a row of piliform spinules (Type B), left front femur apparently without large proximal spines (Type C); pulvilli only on the fourth proximal tarsomere, tarsal claws symmetrical, simple, arolia present. First abdominal sternum without lateral swellings (i.e., not as in male). Supraanal plate transverse, hind margin convex with a medial excavation (similar to that shown in fig. 67).

Colour. – Head with region anterior to the antennal sockets red, remainder black (fig. 60). Pronotum with the outer margin narrowly white, the disk black narrowly edged with white, and with two large curved and two small oblique white lines (fig. 58). Tegmina black proximally, becoming brownish distad, veins white (fig. 58). Hind wing clear, or weakly infuscated, transparent, the costal vein area darker (Figs. 61-63). Abdomen brown with dark areas laterally. Coxae, femora, and tibiae black, tarsi pale.

Measurements (mm) (♀ in parentheses). – Length, 8.5-9.2 (10.5); pronotum length × width, 2.1-2.3 ×3.2-3.3 (2.5 × 3.6); tegmen length, 9.8-10.0 (10.5); interocular width, 0.7 (1.0).

Remarks. – Hanitsch had five specimens, one without locality data from the Buitenzorg Museum, two from Singapore (one in the Raffles Museum, the other in HCEO), and two from Kuala Lumpur (the syntypes). His description was based on one of the specimens from Kuala Lumpur.

Hanitsch's drawings of the right and left wings of the paralectotype exaggerates the curvature of the costal vein which is no different from species whose costal veins are straight (cf. figs. 61 and 62). Based on Hanitsch's description and drawing, Princis described the anterior margin of the wing as strongly sigmoid and made it a distinguishing character of his genus *Euhanitschia*. Princis apparently did not examine the syntypes, or at least did not indicate that he had seen them. He listed one specimen in his description but didn't make a slide of the hind wing. I have examined that specimen and the wing, after mounting (fig. 63) shows that the shape of the costal vein is not unusual as described by Hanitsch.

Hanitsch was correct in describing the front femur of his specimens as Type B2. Princis (1950: 179) disagreed and stated that the stout proximal spines were nothing but slender setae and the femur is Type C; however his specimen apparently had a Type C right femur, but the left femur had two stout proximal spines (Type B) that were adpressed to the very dark femur and were difficult to see.

The subgenital plate, styles and genitalia of *Euhanitschia* clearly show that it is an *Allacta*, having all the important characters of that genus. The lateral tegmina-like pads on the first abdominal sternum in the male (absent in the female) seems to be unique for the species, and in addition to the striking colour patterns of the pronotum and tegmina readily identifies it.

The colour pattern of the head (fig. 60) is characteristic of some members of the *funebris* species group (Roth 1995: 53). However, the pronotum of the species in this group do not have colour patterns and usually are entirely dark or with lateral regions or posterolateral corners narrowly yellowish or yellowish white. The genitalia of *diagrammatica* strongly resemble those species in the *funebris* group.

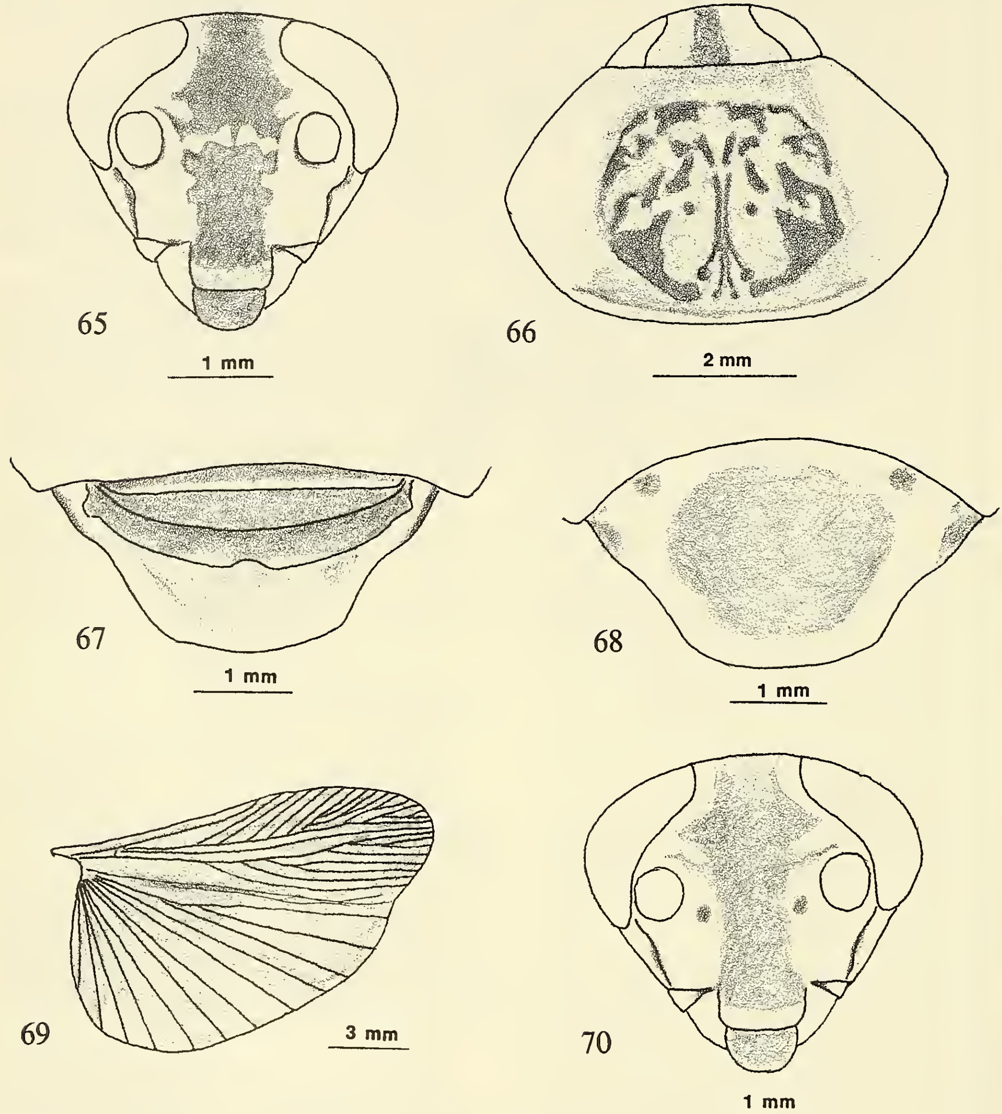
Hanitsch (1928: 27) recorded *diagrammatica* from Singapore, Sumatra (Pakan Baroe, and Medan), and Indonesia (Siberut Island). He had one female from Siberut that was carrying an ootheca in the vertical position, which is characteristic of the Pseudophyllodromiinae.

Allacta karnyi (Hanitsch) comb. n.
(figs. 65-70)

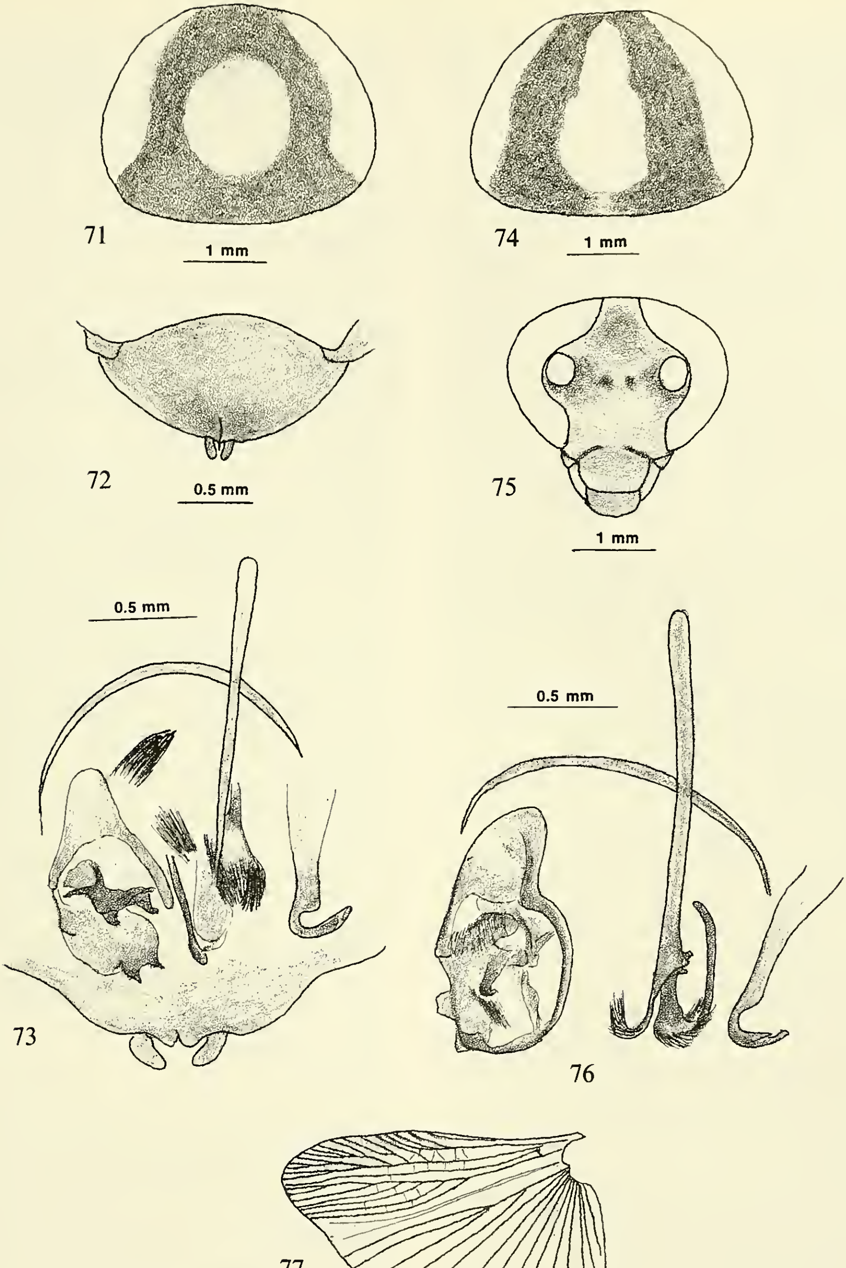
Chorisoblatta karnyi Hanitsch, 1928: 27, pl. I, fig. 8 (♀).
? *Pseudochorisoblatta karnyi* (Hanitsch). – Bruijning 1948: 92.
Compsosilpha karnyi (Hanitsch). – Princis 1950: 180; 1969: 931.

Material examined. – Holotype ♀, Mentawe[a]i, Siberoet, 25.ix.1924 with a handwritten label, genotype: *Maculoblatta karnyi* Han.); Type Orth. 336 in HCEO. Additional material. – SUMATRA. ZILS: Benkoelen, Boekit Itam, 1800 ft., 2♀, v.1935, Mrs. M.E. Walsh [these two specimens were reported by Princis 1950: 180, in his description of *Compsosilpha*].

Redescription. – Female: Head with eyes not extending below the antennal sockets, interocular space less than the distance between the antennal sockets (figs. 65, 70). Pronotum subelliptical, anterior margin straight (fig. 66). Tegmina and wings fully developed extending beyond the end of the abdomen, the former with oblique discoidal sectors. Hind wing with simple radial and median veins, cubitus vein with four to six complete (one or two may be forked) and no incomplete branches, apical triangle subobsolete (Fig. 69). Front femur Type B_2 with one, two (Type B), or no (Type C) small stout proximal spines (see remarks); pulvilli on the fourth proximal tar-



Figs. 65-70. *Allacta karnyi* (Hanitsch), females. 65-69, holotype: 65, 66, head and pronotum; 67, abdominal terga 8 to 10, and subgenital plate; 68, subgenital plate (ventral); 69, right hind wing; 70, female from Sumatra, head.



Figs. 71-77. *Allacta* spp., males from Sri Lanka. 71-73, *A. figurata* (Walker): A, pronotum; B, subgenital plate (ventral; pinned specimen); C, genitalia and distal end of subgenital plate (dorsal; the styles are wider apart than seen in the pinned specimen, because of pressure of the coverslip). 74-77, *A. diluta* (Saussure): 74, pronotum; 75, head; 76, genitalia (dorsal); 77, hind wing.

somere only, tarsal claws symmetrical, simple, arolia small. Supraanal plate strongly transverse, hind margin convexly rounded, with a shallow indentation medially (fig. 67).

Male: Unknown.

Colour. – Head brownish yellow, the occiput with a longitudinal black uneven stripe that is interrupted between the antennal sockets, continuing to the clypeus, labrum dark (fig. 65), or the longitudinal stripe is not distinctly separated between the antennal sockets (fig. 70); maxillary palpi pale; antennae reddish. Pronotal disk base colour brownish yellow with black picturing, broad lateral borders whitish-hyaline without dark dots (fig. 66). Tegmina with subcostal area and most of the anterior field whitish-hyaline, remainder with dark brown irregular blotches, veins white. Hind wing practically uniformly infuscated (fig. 69). Abdominal terga shiny, dark brown to black, with lateral brownish-yelllow spots. Abdominal sterna black with sublateral yellowish maculae, subgenital plate with a large, dark macula surrounded by yellow, the anterior lateral corners black (fig. 68). Cerci dorsally dark basally and partially dark on the inner halves, the remainder yellowish; ventrally with middle segments pale on their outer halves, the remainder dark. Coxae brownish-yellow, femora dark along the dorsal margin, pale on the ventral halves; tibiae pale with dark bands.

Measurements (mm). – Length, 13.5-15.6; pronotum length × width, 3.3-3.7 × 5.7-5.9; tegmen length, 14.3-14.8; interocular width, 0.9.

Remarks. – Hanitsch was correct in stating that the front femur is Type B, whereas Princis claimed it is Type C. They apparently are both correct. The holotype has one minute stout proximal spine succeeded by a row of piliform spinules (Type B). Princis had two specimens which I have examined: the front femora of one of them has two minute stout proximal spines, and the second specimen has two small stout proximal spines on the right femur (Type B) and zero stout spines succeeded by piliform spinules (Type C) on the left femur. The stout proximal spines are very small (about the same length as the piliform spinules, but stouter).

Hanitsch correctly stated that this species is related to *Blatta polygrapha* Walker and *Blatta megaspila* Walker which he placed under *Chorisoblatta*, and which I am here synonymizing with *Allacta*. Hanitsch pointed out that *megaspila* and *polygrapha*, show a striking similarity to *karnyi* in the markings both of the pronotum and of the tegmina [in Roth 1993, figs. 8B, C, and 10B, D]; *polygrapha* is distinguished by the markings of its head which run transverse [see fig.8A, in Roth 1993), not longitudinal as in *karnyi*, whilst in *megaspila* there are two narrow longitudinal lines on the occiput which join on the vertex and are continued down the face as a broad chestnut band [see fig. 10A, in Roth 1993].

The longitudinal facial markings and pronotal picturing place *karnyi* in the *polygrapha* species group.

Allacta figurata (Walker)
(figs. 71-73)

Blatta figurata Walker, 1871: 24 (male).
Allacta figurata (Walker). – Roth 1993: 370, figs. 5A-D (male, redescription, synonymy).

Material examined. – sri lanka. zils: Ceylon, N. Centr. Prov. Willpattu, N.P., Maradan Maduwa, 23 miles W. of Anurhadapura, under bark, 1♂ (terminalia slide 430), 2.ii.1962, Loc. 48, Lund Univ. Ceylon Exped. 1962, Brinck, Andersson, & Cederholm.

Remarks. – I (Roth 1993: 370) redescribed this species from the holotype from Bombay, India. However, the specimen was badly damaged and a pin had been pushed through the abdomen so that a genitalia slide could not be made. The following can be added to my earlier description, based on the male specimen from Sri Lanka: Abdominal terga unspecialized. Supraanal plate transverse, hind margin convexly rounded, entire. Subgenital plate symmetrical with a shallow incision medially, the margins of the excision forming a small keel on each side of which is a small style (figs. 72, 73). Genitalia as in fig. 73. The phallomeres are very similar to those of *Allacta interrupa* (Hanitsch) from Java (cf. fig.73 with fig. 4E in Roth 1993) and show that these two species are very close to one another; the habitus (color patterns) of *interrupta* also is similar to *figurata*. Princis (1965: 151) treated *figurata* as a synonym of *Allacta diluta* (Saussure), which is also from Sri Lanka. Although I have not seen the type of *diluta*, a specimen which I believe is that species, described below, shows that the two species are distinct.

Allacta diluta (Saussure)
(figs. 74-77)

Blatta diluta Saussure, 1863: 153 (female). – Walker 1868: 89; Saussure & Zehntner 1895: 31.
Phyllodromia diluta (Saussure). – Kirby 1904: 91; Shelford 1908: 12;
Pseudochorisoblatta diluta (Saussure). – Princis 1951: 90; 1959: 132.
Allacta diluta (Saussure). – Princis 1965: 151; Roth 1993: 371.

Material examined. – sri lanka. zils: Ceylon, W. Prov. Yakkala, 18 miles NE. of Colombo, at light, 1♂ (terminalia slide 431), 1-28.ii.1962, loc. 10, Brinck-Andersson-Cederholm, Lund Univ. Ceylon Expedition, 1962.

Description. – Male (previously undescribed): Head with interocular space considerably less than the distance between the antennal sockets, eyes extending well below the sockets, almost reaching the mandibles (fig. 75). Pronotum suboval, widest behind the middle (fig. 74). Tegmina and wings fully developed extending beyond the end of the abdomen, the former with oblique discoidal sectors. Hind wing with radial and media veins simple, cubitus vein with six simple, complete branches, apical triangle small (fig. 77). Front femur Type B_3, with five large proximal spines; pulvilli only on the fourth proximal tarsomere of all legs, tarsal claws symmetrical, simple, arolia present. Abdominal terga unspecialized; supraanal plate transverse, hind margin convex, entire, paraprocts simple, similar plates. Subgenital plate symmetrical, medially incised, the margins of the excision forming a keel, on each side of which is a small style (similar to fig. 72; the styles were broken off and lost in slide preparation). Genitalia as in fig. 76: hook on the right side with a preapical incision; median phallomere modified apically; left phallomere large consisting of several sclerites, at least two of them with setal brushes.

Colour. – Head reddish-brown with a weak dark spot on the vertex, a pair of more distinct spots between the darkly-ringed antennal sockets and a medially interrupted dark line on the anterior margin of the clypeus, posterior half of the clypeus lighter (fig. 75); maxillary palpi pale; antennae light brown. Pronotum with a dark reddish-brown-blackish macula, its bottle-shaped center, and lateral borders yellowish (fig. 74). Tegmina light reddish with darkened regions in the anal area and mid region. Hind wing lightly infuscated. Abdominal terga brown, the lateral edges yellowish. Abdominal sterna brownish yellow, lateral regions dark. Cerci dorsally with a brown longitudinal stripe, ventrally all dark.

Female: Not seen.

Measurements (mm). – Length, 12.0; pronotum length × width, 3.0 × 4.0; tegmen length, 12.0; interocular width, 0.3.

Remarks. – Princis considered *figurata* a synonym of *diluta*. I (Roth 1933: 370, 371) treated both species as distinct, based on Saussure's description of the latter; he described the head as brownish and the pronotal disk with a testaceous, longitudinal macula (in *figurata*, the pale macula is oval, fig. 71). In the present specimen, the colour is close to Saussure's description, and the macula in the center of the pronotum is longitudional (fig. 74). If my identification of *diluta* is correct, then there is no doubt that these two species are distinct, and closely related.

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REFERENCES

Bey-Bienko, G.Y., 1938. Blattodea and Dermaptera collected by Mr. R.J.H. Kaulback's expedition to Tibet. – Proceedings of the Entomological Society of London Series B7: 121-125.

Bruijning, C.F.A., 1948. Studies on Malayan Blattidae. – Zoologische Mededelingen Leiden 29: 1-174.

Brunner von Wattenwyl, C. 1865. Nouveau Système des Blattaires. – G. Braumüller: Vienna, 426 pp.

Brunner von Wattenwyl, C. 1898. Orthopteren des Malayischen Archipels, gesammelt von Prof. Dr. W. Kükenthal in den Jahren 1893 und 1894. – Abhandlungen herausgegeben von der Senckenbergischen Naturforschenden Gesellschaft 24: 193-288.

Hanitsch, R., 1915. Malayan Blattidae. – Journal of the Straits Branch Royal Asiatic Society 69: 17-178.

Hanitsch, R., 1919. Blattidae. collected in Korinchi, West Sumatra by Messrs. H.C. Robinson and C. Boden Kloss. – Journal of the Federated Malay States Museums 8: 67-72.

Hanitsch, R., 1923a. Malayan Blattidae. Part II. – Journal of the Malayan Branch, Royal Asiatic Society 1: 393-474.

Hanitsch, R., 1923b. On a collection of Blattidae from the Buitenzorg Museum. – Treubia 3: 197-221.

Hanitsch, R., 1925. On a collection of Blattidae from northern Sarawak, chiefly Mt. Murud and Mt. Dulit. – Sarawak Museum Journal 3 (1): 75-106.

Hanitsch, R., 1928. Spolia Mentawiensia. Blattidae. – Bulletin of the Raffles Museum Singapore, Straits Settlements 1: 1-44.

Hanitsch, R., 1929. Dr. E. Mjöberg's zoological collections from Sumatra. – Arkiv för Zoologi 21A (2): 1-20.

Hanitsch, R., 1931. Résultats scientifiques du voyage aux Indes Orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. Blattidae. – Mémoires du Musée Royal d'Histoire Naturelle de Belgique IV (1): 39-63.

Hanitsch, R., 1932a. Beccari and Modigliani's collection of Sumatran Blattidae in the Museo Civico, Genoa. – Annali del Museo civico di Storia naturale di Genova 56: 48-92.

Hanitsch, R., 1932b. On a collection of blattids from the east coast of Sumatra. – Miscellanea Zoologica Sumatrana 62: 1-8.

Hanitsch, R., 1933a. The Blattidae of Mt. Kinabalu, British North Borneo. – Journal of the Federated Malay States Museums, Singapore 17: 297-337.

Hanitsch, R., 1933b. On a collection of Bornean and other oriental Blattidae from the Stockholm Museum. – Entomologisk Tidskrift 54: 230-245.

Hebard, M., 1929. Studies in Malayan Blattidae (Orthoptera). – Proceedings of the Academy of Natural Sciences of Philadelphia 81: 1-109.

Kirby, W.F., 1904. A synonymic catalogue of Orthoptera. Orthoptera Euplexoptera, Cursoria, et Gressoria. (Forficulidae, Hemimeridae, Blattidae, Mantidae,

Phasmidae). – British Museum: London 1, 501 pp.
Princis, K., 1950. Indomalaiische und australische Blattarien aus dem Entomologischen Museum der Universitat in Lund. – Opuscula Entomologica 15: 161-188.
Princis, K., 1951. Kleine Beiträge zur Kenntnis der Blattarien und ihrer Verbreitung. IV. – Opuscula Entomologica 16: 89-93.
Princis, K., 1959. Revision der Walkerschen und Kirbyschen Blattarientypen im British Museum of Natural History, London. III. – Opuscula Entomologica 24: 125-150.
Princis, K., 1965. Kleine Beiträge zur Kenntnis der Blattarien und ihrer Verbreitung. VIII. (Orthoptera). – Eos, Madrid 41: 135-156.
Princis, K., 1969. Blattariae: Subordo Epilamproidea, Fam.: Blattellidae. – in Beier (ed.), Orthopterorum Catalogus. 13: 711-1038, 's-Gravenhage.
Roth, L.M., 1991. New combinations, synonymies, redescriptions, and new species of cockroaches, mostly Indo-Australian Blattellidae. – Invertebrate Taxonomy 5: 953-1021.
Roth, L.M., 1993. The cockroach genus *Allacta* Saussure & Zehntner (Blattaria, Blattellidae: Pseudophyllodromiinae). – Entomologica Scandinavica 23 (1992): 361-389.
Roth, L.M., 1995. New species of *Allacta* Saussure and Zehntner from Papua New Guinea, Irian Jaya and Sarawak (Blattaria, Blattellidae: Pseudophyllodromiinae). – Papua New Guinea Journal of Agriculture, Forestry and Fisheries 38: 51-71.
Saussure, H. de, 1863. Mélanges orthoptérologiques, Première Fascicule. Blattides. – Mémoires de la Société de Physique et d'Histoire naturelle de Genève 17: 129-172.
Saussure, H. de & L. Zehntner, 1895. Histoire naturelle des Orthoptères. Blattides et Mantides. – In: A. Grandidier, Histoire physique, naturelle et politique de Madagascar. Paris: 23 + 244 pp.
Shelford, R., 1906. Studies of the Blattidae. – Transactions of the Entomological Society of London 1906 (Part II): 231-280.
Shelford, R., 1907. Studies of the Blattidae (continued). – Transactions of the Entomological Society of London (1906): 487-519.
Shelford, R., 1908. Orthoptera. Fam. Blattidae, Subfam. Phyllodromiinae. – In Wytsman (ed.): Genera Insectorum 73: 1-28.
Walker, F., 1868. Catalogue of the specimens of Blattariae in the collection of the British Museum, London, 239 pp.
Walker, F., 1869. Catalogue of the specimens of Dermaptera Saltatoria and supplement to the Blattariae in the collection of the British Museum. I. Supplement to the catalogue of Blattariae, London, pp. 119-156.
Walker, F., 1871. Catalogue of the specimens of Dermaptera Saltatoria and supplement to the Blattariae in the collection of the British Museum. V. Supplement to the catalogue of the Blattariae. pp. 1-43. London.

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FIRST AFROTROPICAL RECORDS OF *DOITHRIX* AND *GEORTHOCLADIUS*, WITH NOTES ON THE *PSEUDORTHOCLADIUS* GROUP (DIPTERA: CHIRONOMIDAE)

Sæther, O. A. & Andersen, T., 1996. First Afrotropical records of *Doithrix* and *Georthocladius*, with notes on the *Pseudorthocladius* group (Diptera: Chironomidae). - Tijdschrift voor Entomologie 139: 243-256, figs 1-29 [ISSN 0040-7496]. Published 18 December 1996.
The diagnoses of the genera *Doithrix* Sæther et Sublette and *Georthocladius* Strenzke are emended. *Toyamayusurika* Sasa et Kawai is shown to be a junior synonym of *Georthocladius*. The male imagines of the new species *Doithrix longipes*, *Doithrix amegabei*, *Georthocladius longicalcaneum*, and *Georthocladius amakyei*, all from Ghana, are described. Eight new combinations are given: *Doithrix fujiseptimus* (Sasa) comb. n., *Doithrix togateformis* (Sasa, Watanabe et Arakawa) comb. n., *Georthocladius asamasextus* (Sasa et Hirabayashi) comb. n., *Georthocladius fujiquinta* (Sasa) comb. n., *Georthocladius shiotanii* (Sasa et Kawai) comb. n., *Pseudorthocladius amamikonaseus* (Sasa et Suzuki) comb. n., *Pseudorthocladius kurobesugoidus* (Sasa et Okazawa) comb. n., and *Pseudorthocladius togakuroidus* (Sasa, Watanabe et Arakawa) comb. n.
The morphological expressions of adaptations by chironomid male imagines to tropical areas are discussed. These adaptations often, but not always, consist in considerably smaller size and associated lower number of setae, reduction of eye elongation, considerably shorter antennal ratio, loss or reduction of the anal lobe of the wing, loss of setae on squama, longer costal extension, longer front metatarsus resulting in higher front leg ratio and, at least in orthoclads, reduction of the inferior volsella.
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Keywords. - Chironomidae, Afrotropical, new species, *Doithrix*, *Georthocladius*, adaptations.

The *Pseudorthocladius* group consists of the four closely related genera *Parachaetocladius* Wülker, *Doithrix* Sæther et Sublette, *Georthocladius* Strenzke, and *Pseudorthocladius* Goetghebuer. While the immatures of the first of these genera, *Parachaetocladius*, live in springs, streams and rivers, the other three genera all are semiterrestrial to semiaquatic living in a variety of damp habitats including mosses, hygropetric regions, seepages and floodplains along stream banks (Strenzke 1950, Sæther & Sublette 1983, Cranston et al. 1989).

The genus group was revised by Sæther & Sublette (1983) showing that it forms a well delineated monophyletic group with *Metriocnemus* v.d. Wulp plus *Thienemannia* Kieffer as the likely sister group. The genus *Doithrix* was emended slightly by Cranston & Oliver (1988). Within the *Pseudorthocladius* group *Doithrix* plus *Georthocladius* apparently form the sister group of *Pseudorthocladius* plus *Parachaetocladius*. The presence of well developed pulvilli, naked eyes, an apical antennal seta, acrostichals absent or long and beginning near the antepronotum, curved Cu_1 and an anal point with strong setae and microtrichiae to apex or nearly to apex will separate the *Pseudorthocladius* group from other orthoclad genera.

In connection with a project in Ghana supported by the Norwegian Universities' Commitee for Development, Research and Education (NUFU), four new species belonging to the *Pseudorthocladius* group were found. These finds are interesting not only because they represent the first Afrotropical finds of the genera *Doithrix* and *Georthocladius*, but also because their morphology indicate some common trends of adaptations to tropical rain forests.

Methods and morphology

The mounting procedure used is outlined by Sæther (1969). Morphological nomenclature follows Sæther (1980). The measurements are given as ranges followed by a mean when four or more measurements are made, followed by the number measured in parentheses (n).

The holotypes of the new species are deposited at the Museum of Zoology (ZMBN), University of Bergen, Bergen, Norway.

Doithrix Sæther et Sublette

Doithrix Sæther et Sublette, 1983: 6.

Type species. – *Doithrix villosa* Sæther et Sublette, 1983: 9.

Diagnosis of male imago. – As in Sæther & Sublette (1983: 6) and Cranston et al. (1989: 191) with the following emendations: Minute to moderately small species, wing length 0.7-2.0 mm. Antennal ratio between 0.2 and 2.0. Eyes without or with very slight eye elongation. Antepronotum moderately to well developed. Dorsocentrals extending well forward, single to triple in front; acrostichals extending to one third to half the length of scutum from antepronotum; prealars few to numerous, when few in anterior and posterior group. Scutellum with setae in uni - biserial transverse row. Anal lobe of wing well developed to very weak, usually protruding. Virga consisting of at most about 6 very fine spines or occasionally absent. Gonocoxite with strong, posteriorly directed, apically pointed or rounded inferior volsella or occasionally inferior volsella broad based, relatively low and subtriangular or reduced. Gonostylus with or without expanded base, apically strongly attenuate to truncate or slender and approximately evenly wide for its full length; with a few to numerous long setae on inner margin.

Included species. – In addition to the four species described by Sæther & Sublette (1983) and *Doithrix dillonae* Cranston et Oliver described by Cranston & Oliver (1988), Wang (1994) described *Doithrix emeiensis* Wang from China (examined by the senior author), and two species described from Japan in other genera clearly belong to *Doithrix*, namely *Doithrix fujiseptimus* (Sasa), comb. n. described as *Pseudorthocladius fujiseptimus* in Sasa (1985: 126); and *Doithrix togateformis* (Sasa, Watanabe et Arakawa) **comb. n.** described as *Toyamayusurika togateformis* in Sasa, Watanabe et Arakawa (1992: 235). Both are typical *Doithrix*, the first nearly identical to *D. emeiensis* and possibly close to *D. hamiltoni* Sæther et Sublette and *D. barberi* Sæther et Sublette, all four sharing synapomorphies in the hook-like inferior volsellae and other details; and the second probably close to *D. ensifer* Sæther et Sublette sharing a synapomorphy in the basal swelling of the gonostylus. Ueno & Iwakuma (1996) recorded *D. villosa* Sæther et Sublette from the Miyatoko mire in Japan.

Doithrix longipes **sp. n.**
(figs. 1-7)

Type material. – Holotype •, Ghana: Western region, Ankasa Game Production Reserve, 6-12.xii.1993, NUFU project (ZMBN No. 173). – Paratypes: 3 • as holotype.

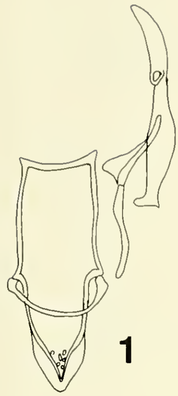
Diagnostic characters. – The small size (wing length 0.7-0.8 mm), extremely long metatarsus giving an LR_1 of 1.01-1.04, the very long costal extension, absence of setae on squama and the evenly wide gonostylus will separate the species from all other *Doithrix* except *D. amegabei* sp. n. described below. The short antennal ratio (0.2-0.3), the subtriangular inferior volsella, and the shorter and less sclerotized phallapodeme will separate *D. longipes* from *D. amegabei*.

Male imago (n = 4 except when otherwise stated). – Total length 1.41-1.54, 1.47 mm. Wing length 0.73-0.77, 0.74 mm. Total length / wing length 1.90-2.01, 1.98. Wing length / length of profemur 2.62-2.75, 2.68. Coloration pale brown with vittae, median anepisternum II, ventral part of preepisternum and postnotum dark brown.

Head (figs. 1-3). AR 0.23-0.27, 0.25. Ultimate flagellomere 77-109, 87 µm long; apical seta 30-45, 37 µm long. Flagellomere 2 with 1 sensilla chaetica, 29-36 µm long; flagellomere 3 with 2 sensilla chaetica, 28-36 and 33-38 µm long, the longest about 3 µm wide. Temporal setae 8-19, 9; including 3-4, 4 inner verticals; 2-3, 3 outer verticals; and 2-4, 3 postorbitals. Clypeus with 6 setae. Tentorium 77-86, 84 µm long; 8-13, 10 µm wide. Stipes 60-71, 66 µm long, 15-23, 19 µm wide. Palp with 5 palpomeres, lengths (in µm): 15-23, 18; 23-30, 25; 45-49, 47; 56-71, 62; 75-94, 82. Third palpomere with about 6-7 sensilla clavata in 2-3 groups; fourth palpomere with 0-1 apical sensillum clavatum.

Thorax (fig. 4). Antepronotum with 4 setae. Dorsocentrals 8-11, 10; acrostichals about 6-8; prealars 4-5, 5, including 2-3, 3 posterior and 1-3, 2 anterior prealars. Scutellum with 4 setae.

Figs 1-8. *Doithrix longipes* sp. n., male imago. - 1, Cibarial pump, tentorium and stipes; 2, Third palpomere; 3, Flagellomere 1 to 5, showing the sensilla chaetica on flagellomeres 2 and 3; 4, Thorax; 5, Wing; 6, Anal point and dorsal aspect of left gonocoxite and gonostylus; 7, Hypopygium with anal point and laterosternite IX removed, left dorsal aspect, right ventral aspect; 8, Gonostylus, ventral aspect.



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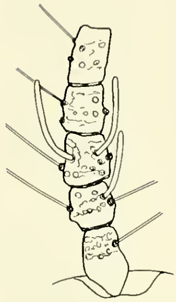

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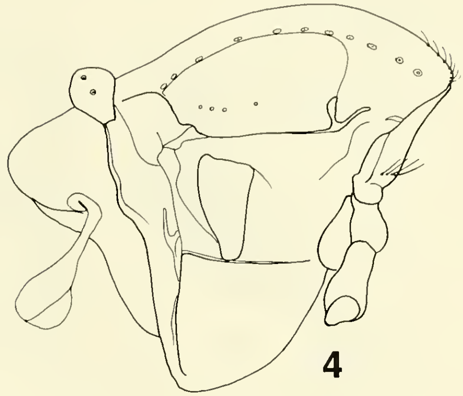

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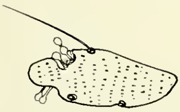

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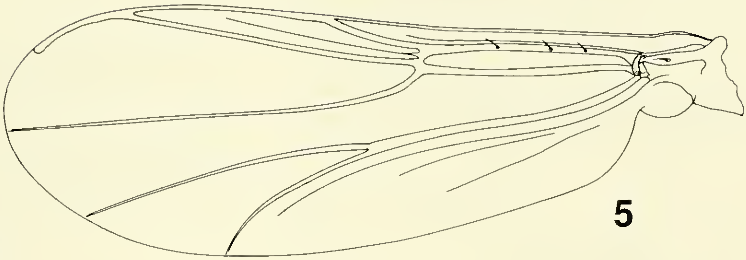

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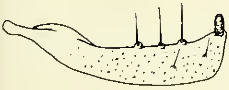

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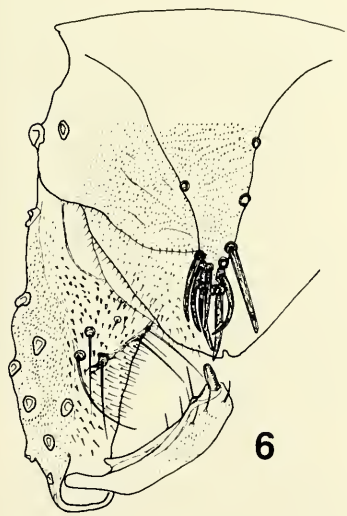

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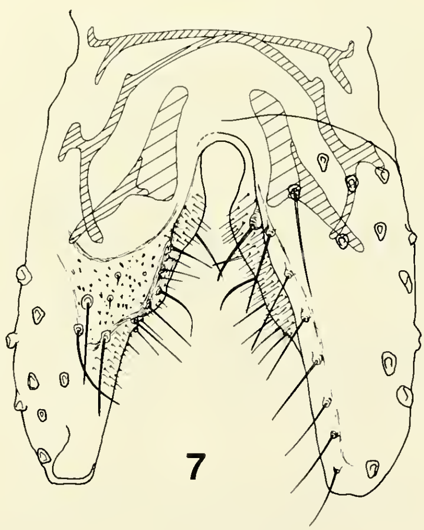

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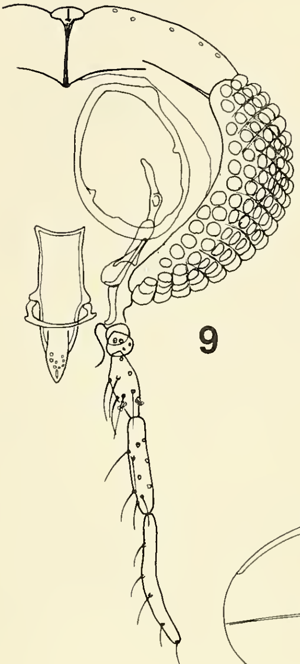

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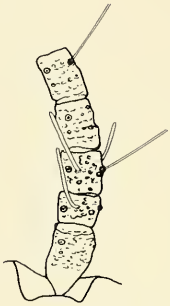

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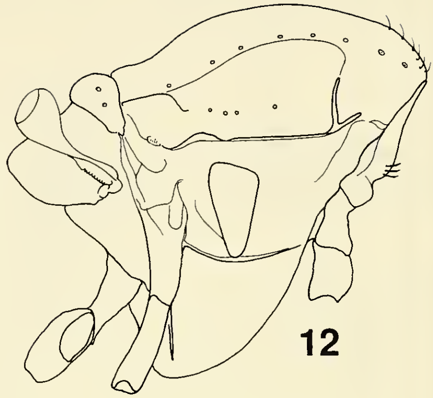

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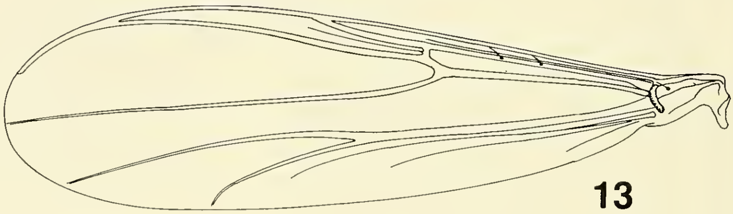

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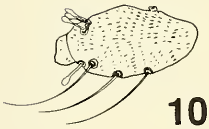

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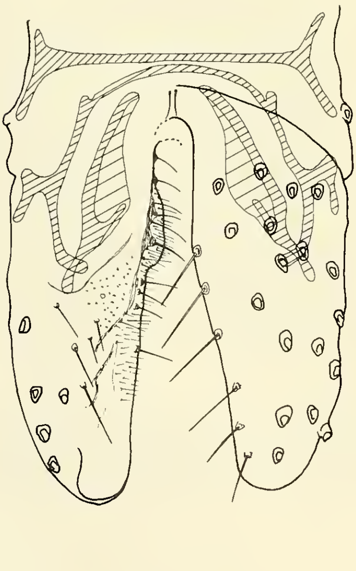

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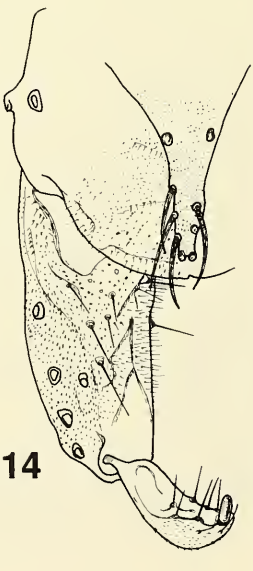


14

Table 1. Lengths (in µm) and proportions of legs of male imago of *Doithrix longipes* sp. n.

	fe	ti	ta_1	ta_2
p_1	274-278, 277	255-263, 258	259-266, 264	113-120, 117
p_2	281-285, 283	283-295, 292	112-114, 113	53-60, 56
p_3	274-285, 280	315-319, 317	182-184, 183	83-84, 84
	ta_3	ta_4	ta_5	LR
p_1	77-84, 81	49-51, 50	34-39, 37	1.01-1.04, 1.02
p_2	41-43, 42	24-30, 27	24-28, 26	0.38-0.39, 0.39
p_3	86-90, 88	34-38, 36	30-38, 33	0.56-0.58, 0.57
	BV	SV	BR	
p_1	2.78-287, 2.82	1.99-2.06, 2.02	2.1-3.0, 2.6	
p_2	4.31-4.70, 4.56	5.07-5.13, 5.11	2.3-3.1, 2.8	
p_3	3.12-3.34, 3.24	3.20-3.40, 3.29	2.9-3.7, 3.4	

Wing (fig. 5). VR 1.36-1.50 (3). Anal lobe weak, not projecting. C extension 83-101, 91 µm long. Brachiolum with 1 seta; R with 3-4, 4 setae; other veins bare. Squama bare.

Legs. Spur of front tibia 34 µm long; spurs of middle tibia 23-26, 24 µm and 15-19, 18 µm long; of hind tibia 38-41, 39 µm and 17-19, 19 µm long. Width at apex of front tibia 21-23, 23 µm; of middle tibia 21-23, 22 µm; of hind tibia 28-30, 29 µm. Hind tibial comb with 11 setae; shortest setae 19-26, 24 µm long; longest setae 32-34, 34 µm long. Lengths and proportions of legs as in table 1.

Hypopygium (figs. 6-8). Anal point 34-43, 40 µm long; with 12-15, 14 lamellate setae; longest setae 17-21, 20 µm long. Laterosternite IX with 2 setae. Phallapodeme 38-49, 45 µm long; transverse sternapodeme 36-41, 39 µm long. Virga absent or perhaps minute virga indicated in some specimens. Gonocoxite 98-100, 99 µm long; inferior volsella relatively low, subtriangular, without posterior projection. Gonostylus 51-53, 52 µm long; evenly wide; with about 3 strong preapical setae on inner margin; megaseta 6-9, 7 µm long. HR 1.86-1.93, 1.90; HV 2.76-2.91, 2.82.

Etymology. – From Latin, *longus*, long, and *pes*, gen. *pedis*, foot, referring to the extremely long metatarsus of the front leg.

Remarks. – *D. longipes* sp. n. and *D. amegabei* sp. n. differ in very many aspects from the previously described members of the genus and may eventually deserve their own subgenus or even a separate genus. However, most of these differences can be seen as a result of the tiny size and of adaptations to a life in tropical rain forests. Similar adaptations seem to occur also in other tropical chironomids including those described below.

Distribution. – The species is known only from a rain forest in western Ghana close to the border with the Ivory Coast.

Doithrix amegabei sp. n.
(figs. 9-15)

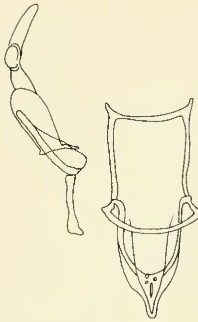
Type material. – Holotype ♂, Ghana: Western region, Ankasa Game Production Reserve, 6-12.xii.1993, NUFU project (ZMBN No. 174).

Diagnostic characters. – The species differs from *D. longipes* sp. n. by having a higher AR (0.47), reduced inferior volsella of the hypopygium and a longer and more sclerotized phallapodeme. It also appears to have some rudiments of a virga.

Male imago (n = 1). – Total length 1.50 mm. Wing length 0.77 mm. Total length / wing length 1.95. Wing length / length of profemur 2.70. Coloration pale brown with vittae, median anepisternum II, ventral part of preepisternum and postnotum blackish brown.

Head (figs. 9-11). AR 0.47. Ultimate flagellomere 154 µm long, apical seta 38 µm long. Flagellomere 2 with 1 sensilla chaetica, 22 µm long; flagellomere 3

Figs 9-15. *Doithrix amegabei* sp. n., male imago. - 9, Head; 10, Third palpomere; 11, Flagellomere 1 to 5, showing the sensilla chaetica on flagellomeres 2 and 3; 12, Thorax; 13, Wing; 14, Anal point and dorsal aspect of left gonocoxite and gonostylus; 15, Hypopygium with anal point and laterosternite IX removed, left dorsal aspect, right ventral aspect.



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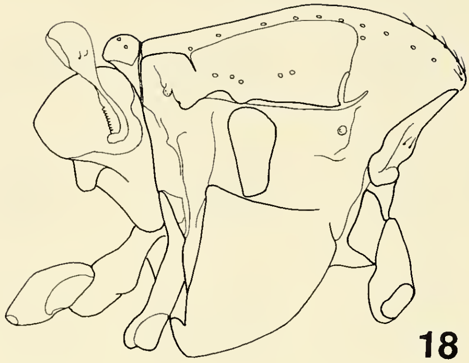

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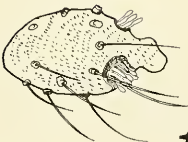

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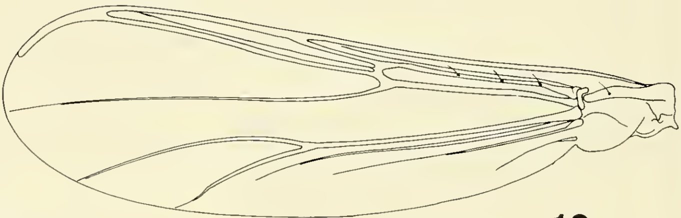

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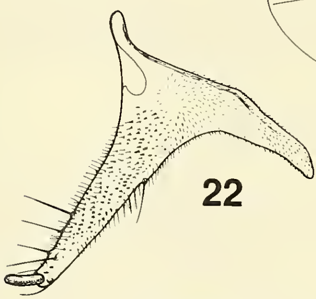

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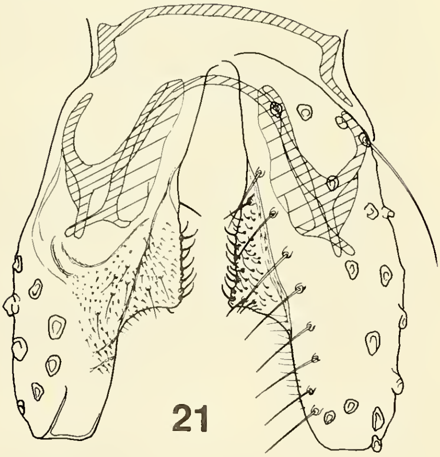

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Table 2. Lengths (in µm) and proportions of legs of male imago of *Doithrix amegabei* sp. n.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR	BV	SV	BR
p_1	285	270	278	163	120	73	41	1.03	2.10	2.00	3.0
p_2	293	296	126	68	45	28	30	0.42	4.19	4.69	-
p_3	293	330	191	98	90	39	32	0.58	2.68	3.16	3.3

with 2 sensilla chaetica, 21 and 25 µm long, the longest less than 2 µm wide. Temporal setae 8, including 3 inner verticals, 2 outer verticals, and 3 postorbitals. Clypeus with 6 setae. Tentorium 71 µm long, 8 µm wide. Stipes 64 µm long, 15 µm wide. Palp with 5 palpomeres, lengths (in µm): 19, 23, 41, 45, 84. Third palpomere with about 6 sensilla clavata in 2 groups, fourth palpomere apparently without apical sensillum clavatum.

Thorax (fig. 12). Antepronotum with 3 setae. Dorsocentrals 8; acrostichals about 6; prealars 4, including 3 posterior and 1 anterior prealar. Scutellum with 4 setae.

Wing (fig. 13). VR 1.40. Anal lobe reduced, not projecting. C extension 83 µm long. Brachiolum with 1 seta, R with 2 setae, other veins bare. Squama bare.

Legs. Spur of front tibia 41 µm long, spurs of middle tibia 17 µm and 23 µm long, of hind tibia 38 µm and 21 µm long. Width at apex of front tibia 19 µm, of middle tibia 21 µm, of hind tibia 24 µm. Comb with 11 setae, 23-30 µm long. Lengths and proportions of legs as in table 2.

Hypopygium (figs. 14, 15). Anal point 38 µm long; with 9 lamellate setae, setae about 24 µm long; laterosternite IX with 2 setae. Phallapodeme 56 µm long, aedeagal lobe well sclerotized; transverse sternapodeme 43 µm long. Virga apparently indicated by 2 very weak spines. Gonocoxite 98 µm long; inferior volsella very weak and low. Gonostylus 53 µm long, megaseta 11 µm long. HR 1.86, HV 2.84.

Etymology. – Named in honour of Godwin Amegabe, technician at Institute of Aquatic Biology, Achimota, Ghana, who participated in the collection of these new species.

Remarks. – *D. amegabei* sp. **n.** is very similar to *D. longipes* sp. n. described above. It has, however, a higher antennal ratio, stronger phallapodeme, and a more reduced inferior volsella. Since it also occurs together with *D. longipes* the two species are unlikely to be conspecific.

Distribution. – The species is known only from a rain forest in western Ghana close to the border with the Ivory Coast.

Georthocladius Strenzke

Georthocladius Strenzke, 1941: 185.
Orthocladius Goetghebuer *in* Strenzke, 1941: 177, nec v. d. Wulp.
Georthocladius subgen. *Atelopodella* Sæther, 1982: 488.
Toyamayusurika Sasa et Kawai, 1987: 62, syn. **n.**

Type species

Georthocladius luteicornis (Goetghebuer in Strenzke 1941: 177) by monotypy.

Diagnosis of male imago

As in Sæther & Sublette (1983: 23) and Cranston et al. (1989: 198) with the following emendations: Minute to moderately sized species; wing length 0.7-2.6 mm. Antennal ratio between 0.3 and 2.0. Antepronotum moderately to well developed. Anal lobe of wing reduced, nearly absent; squama fully fringed to bare; costa moderately to strongly extended. Gonostylus with bluntly pointed to rounded more or less pronounced outer corner; with sharply pointed, triangular outer heel; or with a very long pointed, slightly curved outer heel.

Included species. – In addition to the six species included in the key in Sæther & Sublette (1983) three species described from Japan in other genera clearly belong to *Georthocladius,* namely *Georthocladius asamasextus* (Sasa et Hirabayashi), **comb. n.** described as *Toyamayusurika asamasexta* by Sasa & Hirabayashi (1991: 125); *Georthocladius fujiquintus* (Sasa) **comb. n.** described as *Orthosmittia fujiquinta* by Sasa (1985: 125) and as *Toyamayusurika fujiquinta* by Sasa (1989: 133); and *Georthocladius shiotanii* (Sasa et Kawai), **comb. n.** described as *Toyamayusurika shiotanii* by Sasa & Kawai (1987: 62). *G. fujiquintus* is, in the original description, said to be lacking apical seta on the antenna as well as pulvilli. However, the similarities between *G. asamasextus* and *G. fujiquintus* are too

Figs 16-22. *Georthocladius longicalcaneum* sp. n., male imago. - 16, Cibarial pump, tentorium and stipes; 17, Third palpomere; 18, Thorax; 19, Wing; 20, Anal point and dorsal aspect of left gonocoxite and gonostylus; 21, Hypopygium with anal point and laterosternite IX removed, left dorsal aspect, right ventral aspect; 22, Gonostylus, ventral aspect.

great to be coincidental and the two species may be conspecific. *G. shiotanii* is very similar to *G. longicalcaneum* sp. n. described below, sharing for instance a unique synapomorphy in the triangular and curved outer heel of the gonostylus, and appear to form its sister species; while *G. fujiquintus (asamasextus)* is close to *G. amakyei* sp. n., the other *Georthocladius* described here. The two species described here as well as the Japanese species all differ from previously described species in the male hypopygium. They could represent the unknown males of the subgenus *Atelopodella,* but without knowledge of the immatures such a subgeneric placement is premature.

Georthocladius longicalcaneum sp. n.
(figs. 16-22)

Type material. – Holotype ♂, Ghana: Western region, Ankasa Game Production Reserve, 6-12.xii.1993, NUFU project (ZMBN No. 220).- Paratypes: 3 ♂, as holotype.

Diagnostic characters. – The small size (wing length 0.7-0.8 mm), absence of setae on squama, low antennal ratio (0.3-0.4), and the extremely long outer heel of the gonostylus will separate the species from all other *Doithrix.*

Male imago (n = 4 except when otherwise stated). – Total length 1.54-1.64, 1.61 mm. Wing length 0.71-0.76, 0.73 mm. Total length / wing length 2.15-2.25, 2.19. Wing length / length of profemur 2.34-2.43, 2.37. Coloration pale brown with vittae, median anepisternum II, ventral part of preepisternum and postnotum dark brown.

Head (figs. 16, 17). AR 0.36-0.44, 0.40. Ultimate flagellomere 105-150, 126 µm long; apical seta 26-34, 29 µm long. Temporal setae 7-12, 10; including 3-6, 5 inner verticals; 2-4, 3 outer verticals; and 2 postorbitals. Clypeus with 4-5, 5 setae. Tentorium 75-94, 85 µm long; 15-17, 16 µm wide. Stipes 64-75, 71 µm long; 15-19, 17 µm wide. Palp with 5 palpomeres, lengths (in µm): 15-21, 19; 21-30, 25; 53-58, 54; 68-83, 73; 64-83, 72. Third palpomere apically swollen, with about 6-7 sensilla clavata in 2-3 groups; fourth palpomere without apical sensillum clavatum.

Thorax (fig. 18). Antepronotum with 2-4, 3 setae. Dorsocentrals 11-13, 12; acrostichals about 6-8; prealars 5-6, 6, including 2-3, 3 posterior and 2-4, 3 anterior prealars. Scutellum with 4 setae.

Wing (fig. 19). VR 1.33-1.46 (3). Anal lobe reduced, not projecting. C extension 79-90, 86 µm long. Brachiolum with 1 seta; R with 2-4, 3 setae; other veins bare. Squama bare.

Legs. Spur of front tibia 26-30, 29 µm long; spurs of middle tibia 19-26, 21 µm and 17-19, 18 µm long; of hind tibia 34-41, 38 µm and 17-19, 19 µm long. Width at apex of front tibia 21-23, 23 µm; of middle tibia 21-23, 23 µm; of hind tibia 26-28, 27 µm. Hind tibial comb of 10-11, 11 setae; shortest setae 19-23, 22 µm long; longest setae 30-34, 32 µm long. Lengths and proportions of legs as in Table 3.

Hypopygium (figs. 20-22). Anal point 15-21, 19 µm long; with 9-12, 10 strong setae; laterosternite IX with 2-3, 3 setae. Phallapodeme 45-51, 49 µm long; transverse sternapodeme 26-34, 29 µm long. Gonocoxite 109-120, 116 µm long; inferior volsella triangular, with strong anteriomedially directed microtrichiae along median margin. Gonostylus 54-75, 66 µm long; with long, slightly curved outer heel; distance from base to apex of heel 56-75, 68 µm; to outer furcation between gonostylus and heel 36-41, 40 µm from base; gonostylus beyond heel tapering to apex; megaseta 8-11, 9 µm long. HR 1.60-2.00, 1.76; HV 2.19-2.98, 2.46.

Etymology. – From Latin, *longus,* long, and *calcaneum,* the heel, as a noun in apposition, referring to the long outer heel of the male gonostylus.

Remarks. – *G. longicalcaneum* sp. n. is very similar to *G. shiotanii* from Japan in the male hypopygium and appear to form its sister species. It is, however, only about half the size, have much lower chaetotaxy, lower antennal ratio, higher LR_1 and VR etc., all possible adaptations to a tropical climate.

Distribution. – The species is known only from a rain forest in western Ghana close to the border with the Ivory Coast.

Georthocladius amakyei sp. n.
(figs. 23-29)

Type material. – Holotype ♂, Ghana: Western region, Ankasa Game Production Reserve, 6-12. xii. 1993, NUFU project (ZMBN No. 219).

Diagnostic characters. – The species is similar to the preceding species in the small size, lack of setae on squama, and the low antennal ratio, but differ in having a shorter, triangular outer heel of the gonostylus.

Male imago (n = 1). – Total length 1.67 mm. Wing length 0.79 mm. Total length / wing length 2.11. Wing length / length of profemur 2.23. Coloration pale brown with vittae, median anepisternum II, ventral part of preepisternum and postnotum blackish brown.

Head (figs. 23, 24). AR 0.46. Ultimate flagellomere 154 µm long, apical seta 26 µm long. Temporal setae 7, including 4 inner verticals, 2 outer verticals, and 2 postorbitals. Clypeus with 7 setae. Tentorium 79 µm long, 17 µm wide. Stipes 77 µm long, 26 µm wide. Palp with 5 palpomeres, lengths (in µm): 19, 26, 54, 81, 86. Third palpomere apically swollen,

Table 3. Lengths (in µm) and proportions of legs of male imago of *Georthocladius longicalcaneum* sp. n.

	fe	ti	ta_1	ta_2
p_1	293-323, 310	315-338, 332	221-236, 230	139-158, 146
p_2	278-300, 289	285-308, 300	113-120, 116	60-71, 63
p_3	278-293, 286	304-347, 328	171-195, 184	79-98, 88
	ta_3	ta_4	ta_5	LR
p_1	105-120, 111	64-71, 67	41-45, 42	0.69-0.70, 0.69
p_2	47-56, 51	30-34, 33	26-30, 29	0.39
p_3	64-105, 87	34-43, 38	32-38, 35	0.55-0.56, 0.56
	BV	SV	BR	
p_1	2.29-2.57, 2.44	2.73-2.82, 2.79	2.0-3.0, 2.4	
p_2	3.80-4.28, 4.03	5.00-5.25, 5.09	2.0-2.7, 2.3	
p_3	2.95-3.55, 3.35	3.28-3.41, 3.35	2.7-3.7, 3.2	

with about 8 sensilla clavata in 2-3 groups; fourth palpomere without apical sensillum clavatum.

Thorax (fig. 25). Antepronotum with 3 setae. Dorsocentrals 11, acrostichals about 4, prealars 5, including 3 posterior and 2 anterior prealars. Scutellum with 4 setae.

Wing (fig. 26). VR 1.40. Anal lobe reduced, not projecting. C extension 83 µm long. Brachiolum with 1 seta, R with 2 setae, other veins bare. Squama bare.

Legs. Spur of front tibia 38 µm long, spurs of middle tibia 19 µm and 23 µm long, of hind tibia 41 µm and 19 µm long. Width at apex of front tibia 21 µm, of middle tibia 23 µm, of hind tibia 30 µm. Comb with 9 setae, 23-34 µm long. Lengths and proportions of legs as in Table 4.

Hypopygium (figs. 27-29). Anal point 19 µm long, with 14 strong setae, laterosternite IX with 3 setae. Phallapodeme 41 µm long, transverse sternapodeme 68 µm long. Gonocoxite 113 µm long; inferior volsella weak and low, rounded. Gonostylus 60 µm long; with short, sharply triangular outer heel; distance from base to apex of heel 38 µm; to outer furcation between gonostylus and heel 36 µm from base; gonostylus beyond heel tapering to apex; megaseta 8 µm long. HR 1.91; HV 2.79.

Etymology. – Named in honour of Joseph Somua Amakye, Senior research officer, Institute of Aquatic Biology, Achiomota, Ghana, who participated in the collection of these new species and is the liaison between the NUFU project and the Institute of Aquatic Biology.

Remarks. – *G. amakyei* sp. n. is similar to *G. fujiquintus* and *G. asamasextus* from Japan in the male hypopygium and may form their sister species. It is, however, only about half the size, have much lower chaetotaxy, lower antennal ratio, higher LR_1 and VR etc., all possible adaptations to a tropical climate.

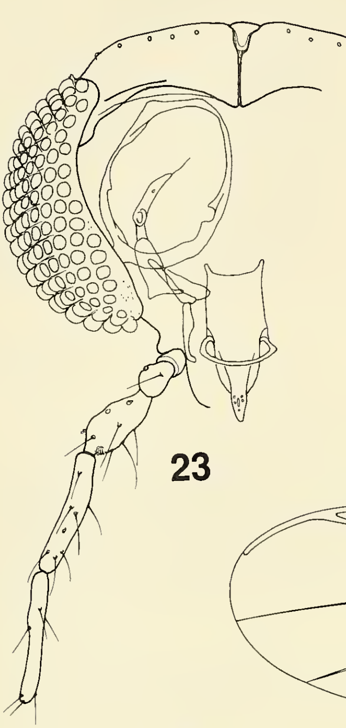
Distribution. – The species is known only from a rain forest in western Ghana close to the border with the Ivory Coast.

Notes on *Pseudorthocladius* Goetghebuer

In addition to the 22 species mentioned in Sæther & Sublette (1983); including the Afrotropical *P. nigerrimus* Kieffer (Kieffer 1918), *P. similis* Freeman (Freeman 1953), and *P. bernadetti* Lehmann (Lehmann 1979), the following species have been described since the revision: *P. akanseptimus* Sasa et Kamimura, 1987, Japan; *P. amamikonaseus* (Sasa et Suzuki, 1993 as *Psectrocladius*) **comb. n.**, Japan; *P.*

Table 4. Lengths (in µm) and proportions of legs of male imago of *Georthocladius amakyei* sp. n.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR	BV	SV	BR
p_1	356	341	268	173	122	79	53	0.79	2.27	2.60	2.7
p_2	285	304	113	64	53	30	32	0.37	3.93	5.23	2.3
p_3	315	368	214	105	109	45	41	0.58	2.99	3.19	1.8



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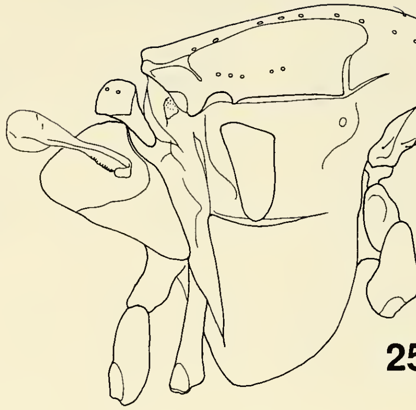

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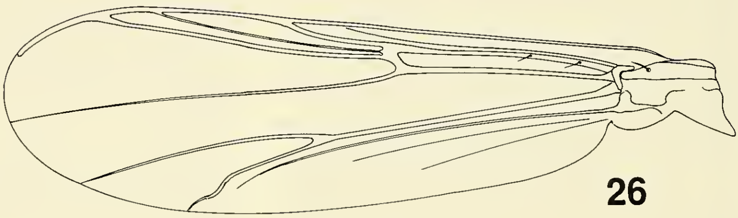

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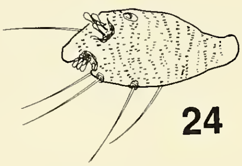

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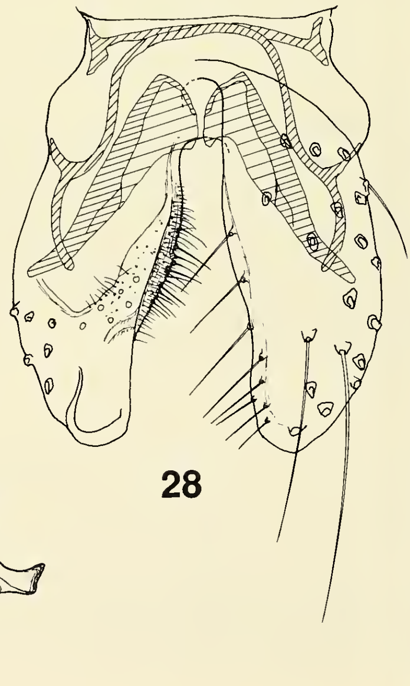

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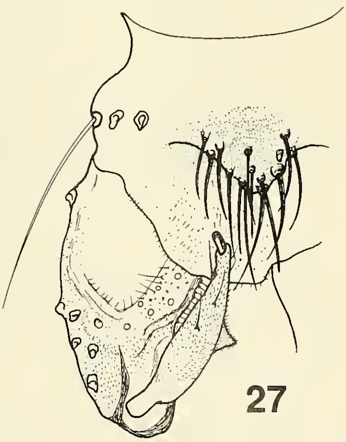

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barthelemyi Mobayed, 1989, Bulgaria, France, Spain, Turkey, Morocco; *P. fujioctavus* Sasa, 1985, Japan; *P. kurobesugoidus* (Sasa et Okazawa, 1992 as *Psectrocladius*) **comb. n.**, Japan; *P. matusecundus* Sasa et Kawai, 1987, Japan; *P. rectangilobus* Caspers & Siebert, 1980, Germany, Norway; and *P. togakuroidus* (Sasa, Watanabe et Arakawa, 1992 as *Trissocladius*) **comb. n.**, Japan.

As mentioned by Sæther & Sublette (1983) the Afrotropical species are in need of revision and may not belong in the genus. *P. bernadetti* is stated to lack acrostichals and to have tiny pulvilli. If this is correct the species does not even belong in the *Pseudorthocladius* group. Sæther (1996) transferred *nigerrimus* to the genus *Mesosmittia* Brundin. *Pseudorthocladius similis* Freeman undoubtedly belongs in *Pseudorthocladius*. However, the redescription by Freeman (1956) may contain more than one species.

Adaptations of chironomids to tropical areas

Chironomid wing length was used by McLachlan (1985) to describe habitat characteristics. He suggested a negative relationship between wing length of most abundant species and duration or predictability of its habitat. This hypothesis was criticized by Vepsäläinen (1986) who argued that extrapolation of concepts on wing length and dispersal ability from intraspecific to the interspecific level was not valid. When studying terrestrial orthoclads inhabiting heathlands in Brittany in France Delettre (1988) found that two species which populations are strengthened or re-established by immigrants each year, did not have longer wings than two species with permanent larval populations. However, of the two former species migrant specimens had longer wings than resident specimens.

Sæther (1981) noted the small size, including the wing length, and the reduction of the anal lobe of the wing of the orthoclads from the West Indies compared with their closest relatives. Other apparent adaptations of tropical chironomids are loss of setae on squama, elongation of the costal extension, reduction of dorsomedian eye extension, narrowing of the tentorium, generally lower chaetotaxy, increased length of the front metatarsus resulting in a higher leg ratio, and often a reduction of the volsellae. However, not all these changes appear to take place in all species and certainly not always concurrently. Several of the characters in which changes take place are important in keys and phylogenies, and it is necessary to take the climatic conditions of where the species were collected into consideration when judging whether a character shows homoplasy or not. In order to judge whether a character is caused by such adaptation to a tropical climate or a tropical rain forest it is necessary to compare a species with its closest relative or relatives from more temperate areas. This is possible for the species described here and for a few other chironomids. Some comparisons are given in Table 5, where the bold characters indicate apparent adaptations to tropical areas, while those in italics show the inverse. Only comparison between species where the phylogenetic relationships has been elucidated, or clearly monophyletic genera where one species is from a tropical region, all the rest from the temperate region, are included.

As it will appear from table 5 tropical chironomids are smaller or of the same size as their closest relatives in temperate areas. Likewise the anal lobe is more reduced or of the same size, there are fewer or the same number of setae on the squama, the VR is higher or the same, the costal extension is longer or of the same length, the antennal ratio is lower or the same, the front leg ratio is higher or the same, and the inferior volsella is more reduced or equally developed. There are just two minor exceptions to this. In *Tokyobrillia anderseni* Sæther et Wang the antennal ratio is slightly higher than in *T. tamamegaseta* Kobayashi et Sasa, and in *Antillocladius zhengi* Wang et Sæther the antennal ratio is higher and the leg ratio lower than in *A. scalpellatus* Wang et Sæther. However, both these genera probably are of Gondwanian origin and primarily subtropical to tropical.

Coloration, size, and sometimes setal counts varies with temperature. When there are several generations a year the summer generations nearly always are smaller. As recently shown by Matena (1995) at increased development temperature an emerged adult is brighter and paler, and with variation in setal count and other morphometric features. But that is within the same species. The morphological features that go together with variation in development temperature (and therefore larval development temperature) coupled with isolation of populations through different phenology of cohorts could be (and probably is) the mechanism with which the tropical chironomids differentiated from their closest related more temperate species in the first place. On Madeira, for instance, the variation of nearly all the species also present on

Figs 23-29. *Georthocladius amakyei* sp. n., male imago. – 23, Head; 24, Third palpomere; 25, Thorax; 26, Wing; 27, Anal point and dorsal aspect of left gonocoxite and gonostylus; 28, Hypopygium with anal point and laterosternite IX removed, left dorsal aspect, right ventral aspect; 29, Gonostylus, ventral aspect.

Table 5. Comparison between some tropical orthoclads (Trop.) and their closest related temperate or subtropical (Temp.) species or species groups. (Data from Hirvenoja 1973; Kobayashi & Sasa 1991; Oliver 1977; Sæther 1981, 1982, 1985a, 1985b,1988; Sæther & Wang 1992, 1995; Wang & Sæther 1993) (abs= absent, flag.= flagellomeres, mod= moderately developed, red= reduced, str= strong, w= weak).

Name	Area	Wing length (mm)	Anal lobe	Squamal setae	VR	C extension, µm	AR	LR$_1$	Inferior volsellae
Doithrix longipes sp.n.	Trop.	1.3-2.0	red	0	1.4-1.5	83-110	0.2-0.3	1.01-1.04	low
D. amegabei sp.n.	Trop.	0.8	red	0	1.5	83	0.5	1.03	red
Doithrix spp.	Temp.	1.3-2.0	w-str	0-14	1.1-1.2	32-78	0.6-1.8	0.53-0.67	str
Georthocladius longicalcanus sp.n.	Trop.	0.7-0.8	red	0	1.3-1.5	79-90	0.4	0.69-0.70	mod
G. amakyei sp.n.	Trop.	0.8	red	0	1.4	83	0.5	0.79	red
Georthocladius spp.	Temp.	1.5-2.6	str	1-37	1.1-1.2	33-75	1.5-2.3	0.50-0.71	mod-str
Cricotopus nudisquamus Sæther	Trop.	0.9	red	0	1.1	43	-	0.50	str
C. mackenziensis Oliver	Temp.	1.1-1.6	str	4-9	1.1-1.2	-	1.1-1.4	0.53-0.62	str
C. canditibia Sæther	Trop.	1.4	-	1	1.1	59	-	0.64	str
C. festivellus gr.	Temp.	1.2-2.5	mod	5-10	1.0-1.4	shorter	1.0-1.6	0.52-0.66	str
Tokyobrillia anderseni Særher et Wang	Trop.	*1.4-1.9*	w	3-6	1.5-1.8	71-113	*1.4-1.8*	0.85-0.86	str
T. tamamegaseta Kobayashi et Sasa	Temp.	1.3-1.7	w	4-10	1.6-1.7	-	1.2-1.6	0.48-0.52	str
Lipurometriocnemus glabalus Sæther	Trop.	0.9-1.3	mod	8-15	1.3-1.5	31-55	-	0.59-0.62	abs
L. vixlobatus Sæther	Temp.	1.2-1.6	mod	12-15	1.3-1.4	41-53	1.6-1.8	0.62	low
Mesosmittia truncata Sæther	Trop.	0.9	w	4	1.4	116	0.8	-	w
Mesosmittia spp.	Temp.	0.9-1.8	w	1-10	1.2-1.4	0-50	1.2-1.8	0.43-0.51	w-str
Diplosmittia harrisoni Sæther	Trop.	0.8-1.1	mod	0	1.3-1.4	0	0.6	0.31-0.34	red
D. recisus Sæther	Trop.	0.79	red	0	1.4	68	9 flag.	0.36	red
D. carinata Sæther	Temp.	1.1-1.3	mod	0	1.3-1.4	0	0.8	0.35-0.37	red
Antillocladius zhengi Wang et Sæther	Trop.	1.3	str	9	1.3	51	*1.7*	*0.68*	str
A. scalpellatus Wang et Sæther	Temp.	1.3-1.6	str	8-13	1.2-1.3	23-44	1.2-1.6	0.75-0.85	str
A. antecalvus Sæther	Trop.	0.9-1.1	w	1-3	1.4-1.5	47-61	-	0.74-0.77	str
A. arcuatus Sæther	Temp.	1.1-1.3	str	2-3	1.4	38-45	1.0-1.2	0.65-0.71	str
Paraphaenocladius									
impensus albusalatus Sæther et Wang	Trop.	1.2-1.6	w	4-6	1.1-1.2	34-68	0.4-0.5	0.78-0.81	str
P. impensus (Walker) *s.str.*	Temp.	1.3-1.9	w	7-10	1.1-1.2	38-81	0.8-1.0	0.68-0.72	str
P. exagitans longipes Sæther et Wang	Trop.	1.1-1.2	abs	3-7	1.2	45-60	0.4-0.6	0.90-0.98	str
P. exagitans (Johannsen) *s.str.*	Temp.	1.0-1.8	w	2-7	1.1-1.2	30-70	0.4-0.9	0.76-0.86	str
P. cuneipennis (Freeman)	Trop.	0.8-0.9	abs	2	1.1	44-56	0.5	0.72-0.73	str
P. dewulfi (Goetghebuer)	Trop.	0.9-1.2	red	1-3	1.1-1.2	56-81	0.5-0.6	0.74	str
P. crassicaudatus Sæther et Wang	Trop.	1.1-1.2	w	3-4	1.2	81-88	0.7	-	str
P. irritus group	Temp.	1.1-2.0	w- str	2-15	1.1-1.3	41-96	0.7-1.2	0.52-0.72	str

the European continent are within the total variation, but within a narrow range at the lower end of variation. They appear to be incipient species.

However, temperature alone cannot explain the difference between tropical species and their closest related temperate species. Rain forest populations of cosmopolitan or nearly cosmopolitan species such as *Limnophyes natalensis* (Kieffer) and *Harnischia curtilamellata* (Malloch), both present in the Ghanaian rain forest, although at the lower end of the range of morphological variation do not fall outside the total range of variation in temperate populations. In *L. natalensis* two populations differ in being smaller in nearly all measurements from other populations, one is from the rain forest of Zaïre, the other from Central Norway! Also in the comparisons made by us the temperate species often are from an equally hot climate as that found at least in the Ghanaian rain forest.

Certainly the habitat predictability of semiaquatic chironomids is high in a tropical rain forest with available habitats permanently present. This habitat predictability appears to be reflected in the smaller range of variation in morphological features in tropical species when compared to the very variable populations of the same species or to the sister species in temperate areas. When comparing species within a monophyletic group MacLachlan's theory thus appear to hold.

The table above includes orthoclads only. However, the adaptations to tropical areas are the same for other subfamilies perhaps with the exception of the reduction of volsellae. Preliminary examinations of several new species from Ghana of the genus *Rheotanytarsus* Thienemann et Bause, each with close European sister species, show that the reduction in size and antennal ratio here may be at least as pronounced.

Acknowledgements

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References

Caspers, N. & M. Siebert, 1980. *Pseudorthocladius rectangilobus* sp. n. eine neue Chironomide aus dem Hunsrück (Deutschland) (Diptera: Chironomidae). – Mitteilungen der Schweizerische entomologischen Gesellschaft 53: 181-183.

Cranston, P. S. & D. R. Oliver, 1988. Additions and corrections to the Nearctic Orthocladiinae (Diptera: Chironomidae). – Canadian Entomologist 120: 425-462.

Cranston, P. S., D. R. Oliver & O. A. Sæther, 1989. The adult males of Orthocladiinae (Diptera: Chironomidae) of the Holarctic region – Keys and diagnoses. Pp. 165-352 *In:* Wiederholm, T. (ed.): Chironomidae of the Holarctic region. Keys and diagnoses. Part 3. Adult males. – Entomologica scandinavica, Supplement 34, 532 pp.

Delettre, Y. R., 1988. Chironomid wing length, dispersal ability and habitat predictability. – Holarctic Ecology 11: 166-170.

Freeman, P., 1953. Chironomidae (Diptera) from Western Cape Province I. – Proceedings of the Royal entomological Society of London 22: 127-135.

Freeman, P., 1956. A study of the Chironomidae (Diptera) of Africa south of the Sahara. Part II. – Bulletin of the British Museum (Natural History), Entomology 4: 287-368.

Hirvenoja, M., 1973. Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera, Chironomidae). – Annales zoologici fennici 10: 1-363.

Kieffer, J. J., 1918. Chironomides d'Afrique et d'Asie conservé au Muséum National Hongrois de Budapest. – Annales historico-naturales Musei nationalis Hungarici 16: 31-136.

Kobayashi, T. & M. Sasa, 1991. Description of two new species of the chironomid midges collected from the Tama River, Tokyo (Diptera, Chironomidae). – Japanese Journal of sanitary Zoology 42: 71-75.

Lehmann, J., 1979. Chironomidae (Diptera) aus Fliessgewässern Zentralafrikas (Systematik, Ökologie, Verbreitung und Produktionsbiologie). Teil I: Kivu-Gebiet, Ostzaire. – Spixiana, Supplement 3, 144 pp.

Matena, J. 1995. Polymorphism of *Chironomus plumosus* (L.) (Diptera: Chironomidae) males from a temperate fish-pond population. – European Journal of entomology 92: 699-703.

McLachlan, A., 1985. The relationship between habitat predictability and wing length in midges (Chironomidae). – Oikos 44: 391-397.

Mobayed, Z., 1989. Description de *Pseudorthocladius (Pseudorthocladius) berthelemyi* n. sp. (Dipt. Chironomidae, Orthocladiinae). – Bulletin de la Société d'Histoire naturelle de Toulouse 125: 27-29.

Oliver, D. R., 1977. *Bicinctus* - group of the genus *Cricotopus* van der Wulp (Diptera: Chironomidae) in the Nearctic with a description of a new species. – Journal of the Fisheries Research Board of Canada 34: 98-104.

Sæther, O. A., 1969. Some Nearctic Podonominae, Diamesinae and Orthocladiinae (Diptera: Chironomidae). – Bulletin of the Fisheries Research Board of Canada 170, 154 pp.

Sæther, O. A., 1980. Glossary of chironomid morphology terminology (Chironomidae: Diptera). – Entomologica scandinavica, Supplement 14, 51 pp.

Sæther, O. A., 1981. Orthocladiinae (Diptera: Chironomidae) from the British West Indies, with descriptions of *Antillocladius* n. gen., *Lipurometriocnemus* n. gen., *Compterosmittia* n. gen. and *Diplosmittia* n. gen. – Entomologica scandinavica, Supplement 16, 46 pp.

Sæther, O. A., 1982. Orthocladiinae (Diptera: Chironomidae) from S.E. USA, with descriptions of *Plhudsonia, Unniella, Platysmittia* n. genera and *Atelopodella* n. subgen. – Entomologica scandinavica 13: 465-510.

Sæther, O. A., 1985a. The imagines of *Mesosmittia* Brundin, 1956, with the description of seven new species (Diptera, Chironomidae). – Spixiana, Supplement 11: 37-54.

Sæther, O. A., 1985b. *Diplosmittia carinata* spec. nov. from Michigan (Diptera, Chironomidae). – Spixiana, Supplement 11: 55-57.

Sæther, O. A., 1988. *Diplosmittia recisus* spec. nov. from Peru (Diptera, Chironomidae). – Spixiana, Supplement 14: 45-47.

Sæther, O. A., 1996. Afrotropical records of the orthoclad genus *Mesosmittia* Brundin (Diptera: Chironomidae). – Spixiana (in press).

Sæther, O. A. & J. E. Sublette, 1983. A review of the genera *Doithrix* n. gen., *Georthocladius* Strenzke, *Parachaetocladius* Wülker and *Pseudorthocladius* Goetghebuer (Diptera: Chironomidae, Orthocladiinae). – Entomologica scandinavica, Supplement 20, 100 pp.

Sæther, O. A. & X. Wang, 1992. *Euryhapsis fuscipropes* sp. n. from China and *Tokyobrillia anderseni* sp. n. from Tanzania, with a review of genera near *Irisobrillia* Oliver (Diptera: Chironomidae). – Annales de Limnologie 28: 209-223.

Sæther, O. A. & X. Wang, 1995. Revision of the genus *Paraphaenocladius* Thienemann, 1924 (Diptera: Chiro-

nomidae). – Entomologica scandinavica, Supplement 48, 69 pp.
Sasa, M., 1985. Studies on the chironomids collected from lakes in the Mount Fuji area. – Research Report from the National Institute for environmental Studies 83: 101-160.
Sasa, M., 1989. Chironomidae of Japan: Checklist of species recorded, key to males and taxonomic notes. – Research Report from the National Institute for environmental Studies 125: 1-177.
Sasa, M. & K. Hirabayashi, 1991. Studies on the chironomid midges (Diptera, Chironomidae) collected at Kamikochi and Asama-Onsen, Nagano Prefecture. – Japanese Journal of sanitary Zoology 42: 109-128.
Sasa, M. & K. Kamimura, 1987. Chironomid midges collected on the shore of lakes in the Akan National Park, Hokkaido (Diptera, Chironomidae). – Research Report from the National Institute for environmental Studies 104: 9-61.
Sasa, M. & K. Kawai, 1987. Studies on the chironomid midges of the stream Itachigawa, Toyama. – Bulletin of Toyama Science Museum 10: 25-72.
Sasa, M. & T. Okazawa, 1992. Studies on the chironomid midges (yusurika) of Kurobe River. – Research Report from the Toyama Prefectural environmental Pollution Research Center 1992: 40-91.
Sasa, M. & H. Suzuki, 1993. Additional records of Chironomidae from Amami Island. – Research Report from the Toyama Prefectural environmental Pollution Research Center 1993: 110-124.
Sasa, M., M. Watanabe & R. Arakawa, 1992. Additional records of Chironomidae from Toga-Mura, 1992. – Research Report from the Toyama Prefectural environmental Pollution Research Center 1992: 231-246.
Strenzke, K. 1941. Terrestrische Chironomiden X: *Georthocladius luteicornis* Goetgh. – Zoologischer Anzeiger 135: 177-185.
Strenzke, K., 1950. Systematik, Morphologie und Ökologie der terrestrischen Chironomiden. – Archiv für Hydrobiologie, Supplement 18: 209-414.
Ueno, R. & T. Iwakuma, 1996. Chironomid fauna of the Miyatoko mire. – Pp. 59-62. In: T. Iwakuma (ed.), Mires of Japan. Ecosystems and monitoring of Miyatoko, Akaiyachi and Kushiro mires. – National Institute for Environmental Studies, Tsukuba, 127 pp.
Vepsäläinen, K., 1986. Chironomid wing length: a measure of habitat duration and predictability? - Oikos 46: 269-271.
Wang, X., 1994. *Doithrix emeiensis* sp. nov. from China (Diptera: Chironomidae). – Acta scientarum naturalium Universitatis Nankaiensis 1: 68-70.
Wang, X. & O. A. Sæther, 1993. First Palaearctic and Oriental records of the orthoclad genus *Antillocladius* Sæther (Diptera: Chironomidae). – Entomologica scandinavica. 24: 227-230.

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TWO NEW GENERA OF ECCRITOTARSINI (HETEROPTERA: MIRIDAE: BRYOCORINAE) FROM SOUTHEAST ASIA

Stonedahl, G. M. & L. M. Hernández Triana, 1996. Two new genera of Eccritotarsini (Heteroptera: Miridae: Bryocorinae) from Southeast Asia. – Tijdschrift voor Entomologie 139: 257-266, figs. 1-25. [ISSN 0040-7496]. Published 18 December 1996.

The new genera *Diocleroides* and *Gressittiana* are described to accommodate three new species of eccritotarsine Miridae from southeast Asia. *Diocleroides sulawesi* and *D. philippinensis* are described from material collected in Sulawesi, Indonesia and the Philippines, respectively, and *Gressittiana kuchingensis* is described from specimens collected in Sabah and Sarawak, East Malaysia. The structures of the male genitalia are illustrated for all species, and dorsal habitus views are given for type species, *D. sulawesi* and *G. kuchingensis*. Scanning electron micrographs of the head and pronotum, metathoracic scent efferent system, and the pretarsus also are provided for the type species. The relationships of *Diocleroides* and *Gressittiana* to other genera of Old World Eccritotarsini are discussed.

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Key words. – Heteroptera; Miridae; Bryocorinae; Eccritotarsini; *Diocleroides*; *Gressittiana*; new genera; new species; Philippines; Indonesia; East Malaysia.

Continuing studies of the Eccritotarsini of the Old World by the senior author have revealed three undescribed species that cannot be placed in any known genus of the tribe. The new genera *Diocleroides* and *Gressittiana* are here described to accommodate these species and to make the generic names and character information available for an ensuing paper on the cladistic relationships of the Old World genera of the tribe.

Terminology for external characters and structures of the male genitalia follows that of Stonedahl (1988). References to position regarding the vesica of the male genitalia (e.g., left versus right, basal versus distal) are made from dissected preparations with the inner (anterodorsal relative to its position within the genital capsule) surface of the vesica facing upward and the apex orientated away from the observer (figs. 11, 15). All measurements are given in millimeters. Body length is measured from the tip of the tylus to apex of the hemelytral membrane. Abbreviations used in the locality data to denote specimen depositories correspond to the institutions listed in the acknowledgments.

Systematic part

Diocleroides gen. n.

Diagnosis. – Similar to *Dioclerus* Distant but distinguished by the more elongate body; strongly concave posterior margin of head; narrower anterior collar of pronotum; entire anterolateral margins of hemelytra, without strong serrations; and by the structure of the male genitalia, especially the strongly produced sensory lobe of the left paramere (figs. 7, 8, 13) and more extensively sclerotized vesica (figs. 11, 15)

Description of male. – Macropterous, length 3.45-3.60; pale grayish white ground colour, sometimes with brown to fuscous markings on pronotum, scutellum, hemelytra and venter; pronotum, scutellum and hemelytra, except embolium and outer half of cuneus, punctate; dorsum with moderately dense covering of pale, suberect, simple setae, length of setae 1.0-1.5 times greatest diameter of antennal segment I. Head: Much broader than long in dorsal view; posterodorsal margin strongly concave, carinate between eyes; vertex slightly depressed anterior to ca-

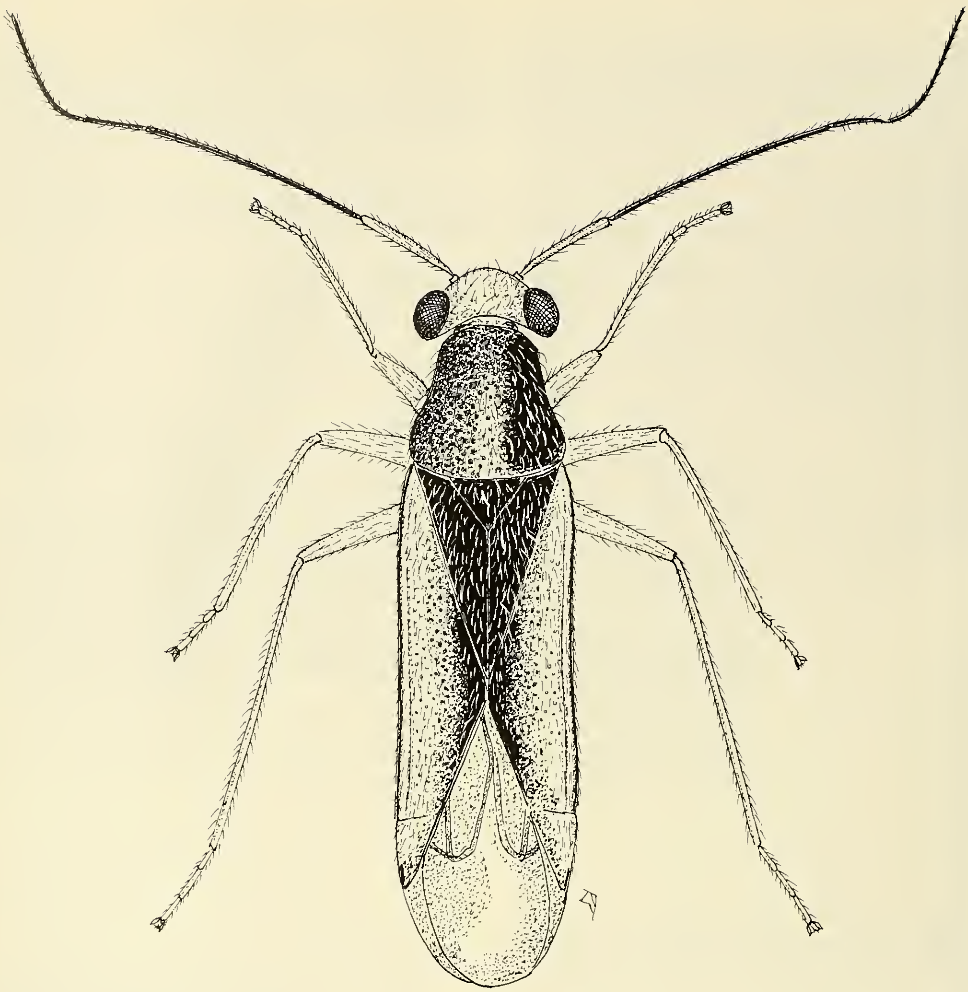
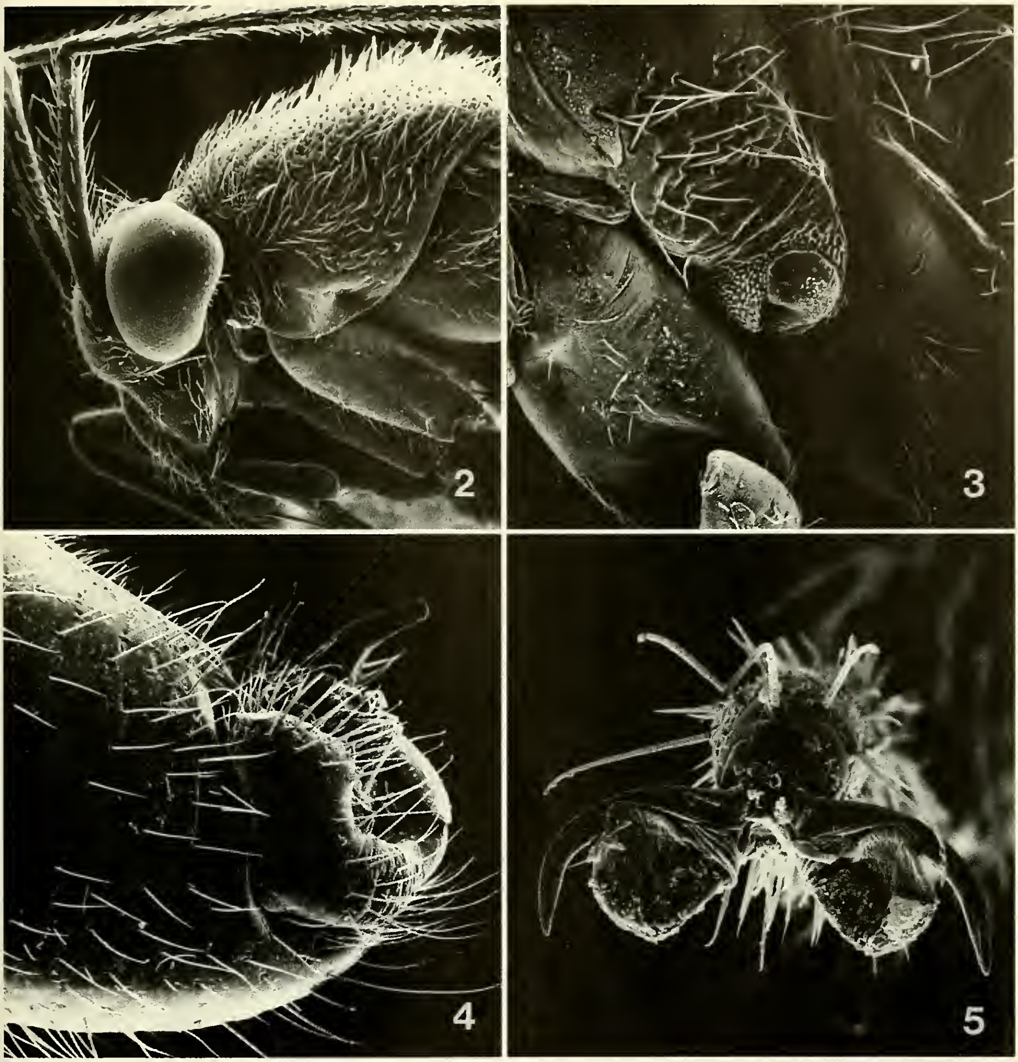


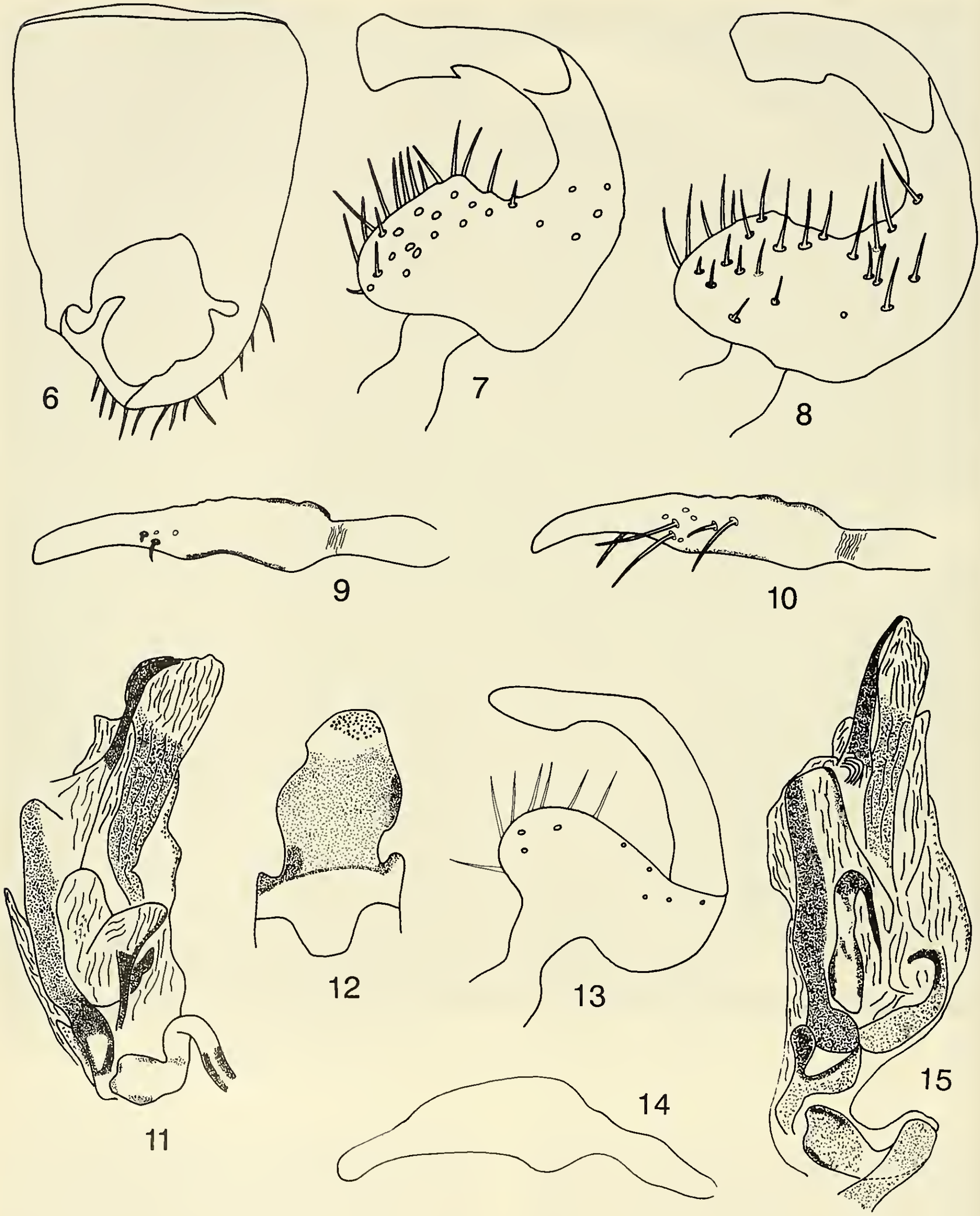
Fig. 1. *Diocleroides sulawesi*, dorsal habitus male.

rina; frons moderately convex, only slightly produced anterior to antennal fossae, meeting tylus along broad depression; maxillary and mandibular plates weakly swollen; genae broadly developed; bucculae short; buccal cavity small, subspherical; gula elongate, slightly convex; labium reaching between mesocoxae, segment I much thicker than remaining segments; eyes prominent, projecting laterally beyond and slightly behind anterolateral angles of pronotum, weakly elevated above dorsal surface of head, posterior margin conforming to posterior curvature of head, occupying approximately half of head height in lateral view; antennal fossa nearly contiguous with anterior margin of eye. Antennae: Cylindrical, linear, inserted slightly below middle of eye in lateral view (fig. 2); segment I weakly bowed; segments II and III slightly narrower than I; segment IV slightly narrower than III; all segments with pale, reclining, simple setae of length 1.0-1.5 times diameter of corresponding segment; segment I also with series of heavier, pale, bristlelike setae on dorsal and lateral surfaces. Pronotum: Trapeziform, posterior width of disk about 1.5 times anterior width; anterior margin with well-developed, weakly convex collar, width of collar equal to or slightly greater than diameter of antennal segment I; calli moderately convex, rising abruptly



Figs. 2-5. Scanning electron micrographs of *Diocleroides sulawesi*. – 2, lateral view of head and pronotum; 3, peritreme and evaporative area of metathoracic scent efferent system; 4, apex of genital capsule, left lateral view; 5, pretarsus.

from collar, occupying most of anterior lobe of disk and reaching its lateral margins, confluent medially, posterior borders weakly defined; lateral margins of disk straight or slightly concave, posterior margin straight or very weakly concave medially. Mesoscutum: Narrowly exposed. Scutellum: Weakly elevated; dorsal surface flattened anteromedially, otherwise very weakly convex. Metathoracic scent efferent system: Evaporative area well-developed; peritreme bulbous, mostly smooth (fig. 3). Hemelytra: Parallel-sided with lateral margins slightly convex, or sometimes weakly concave medially; embolium cylindrical, similar in thickness to antennal segment I; cuneus 1.5-2.0 times as long as broad; cuneal incisure shallow, fracture strongly oblique; membrane with two distinct cells, primary cell elongate, narrowed apically, secondary cell narrowly triangular. Legs: Femora narrowly elongate; metafemora with points of insertion of trichobothria 2-4 not noticeably swollen; tibiae cylindrical, with pale spines and several rows of minute, dark spinules; tarsi elongate, linear or with segment III very slightly swollen distally; pre-



Figs. 6-15. Male genitalia of *Diocleroides* species. – 6-12. *Diocleroides sulawesi.* – 6, genital capsule, dorsal view; 7, left paramere, dorsal view; 8, left paramere, dorsal view, variation; 9, right paramere, lateral view; 10, right paramere, lateral view, variation; 11, vesica, anterodorsal view; 12, phallotheca. – 13-15. *Diocleroides philippinensis.* – 13, left paramere, dorsal view; 14, right paramere, lateral view; 15, vesica, anterodorsal view.

tarsus as in figure 5; pulvillus without comblike row of trichia on posteroventral margin. Genitalia: Genital capsule (fig. 6): Longer than broad, slightly narrowed and rounded to apex; aperture subovate, primarily dorsal in orientation; right margin of aperture distal to paramere socket elevated, flangelike, weakly reflexed; left distal margin of aperture deeply excavated; right paramere socket well below left socket in posterior view; inner margins of paramere sockets produced. Left paramere (figs. 7, 8, 13): Sensory lobe greatly expanded; angle broadly curved; shaft as long as or longer than arm, dorsoventrally flattened especially apically, sometimes with broad acute protuberance on dorsal surface and smaller notch on inner distal margin; apex rounded or truncate, sometimes broadly spatulate in dorsal view; sensory lobe and outer surface of arm with long, stout setae. Right paramere (figs. 9, 10, 14): Elongate, gradually narrowed distally, sometimes more strongly narrowed preapically, with rounded or blunt apex. Phallobase: Large, dorsoventrally flattened, strongly produced posteriorly. Phallotheca (fig. 12): Stongly sclerotized, with distinct basolateral notches; slightly compressed distally with weakly concave innerdistal surface and narrow elongate opening apically. Vesica (figs. 11, 15): Mostly membranous, with elongate sclerite along left basal margin and smaller, narrower sclerite apically; membranous regions weakly sclerotized in part medially and distally, and with patches of small spines posteriorly; ductus seminis sclerotized, weakly expanded distally.

Female. – Macropterous, length 3.45-4.05; similar to male in colour, structure and vestiture except as noted in species descriptions.

Etymology. – Named for its similarity of appearance to *Dioclerus* Distant.

Type species. – *Diocleroides sulawesi* sp. n.

Distribution. – Philippine Islands and Sulawesi.

Discussion. – Within the Eccritotarsini, *Diocleroides* belongs to a group of genera recognized by the following diagnostic features: posterior margin of head strongly carinate; calli inflated and medially confluent; embolium broadly explanate; hemelytral membrane with two well-developed cells; metathoracic scent efferent system with bulbous peritreme and well-developed evaporative area; pretarsal pulvilli without comblike row of trichia on posteroventral margin; and male genitalia with large flattened phallobase, heavily sclerotized phallotheca, and extensively membranous vesica. The genera placed in this group by Stonedahl (1988) are *Bunsua* Carvalho (tropical Africa), *Bryocorellisca* Carvalho, *Carinimiris* Carvalho, and *Crassiembolius* Carvalho (all New Guinea), and *Dioclerus* (Sri Lanka, India, Indochina, East and West Malaysia). *Diocleroides* is easily distinguished from these genera by its elongate body form, thickened embolium, strongly concave posterior margin of the head, and by the structure of the male genitalia. The condition of the costal margin in *Diocleroides* is atypical of the group. Since a broad, flattened embolium appears to be synapomorphic for the *Dioclerus* complex, its narrow, thickened condition in *Diocleroides* most likely represents a reversal to the plesiomorphic character state.

Diocleroides sulawesi sp. n.
(figs. 1-12)

Type material. – Holotype ♂, Indonesia, Sulawesi Utara, Dumoga-Bone National Park, 8.II.1985 (Plot B, Fog 3, 315 m), Project Wallace Expedition (BMNH). – Paratypes: 4♂ and 4♀, same data as holotype (AMNH, BISH, BMNH).

Additional specimens. – 4♂ and 1♀, same data as holotype (BMNH).

Diagnosis. – Distinguished from *D. philippinensis* by the extensively darkened body (fig. 1), antennal segment II much longer than width of head across eyes, elongate right paramere of male genitalia (figs. 9, 10), and left paramere with prominent notch on dorsal surface of arm and distinct subquadrate apex (figs. 7, 8).

Description of male (n=4). – Length 3.45-3.60; dark brown and dirty white general coloration. Head: Length 0.15; width across eyes 0.72-0.76; width of vertex 0.29-0.31; brown dorsally, paler yellowish brown ventrad of antennal fossae; antennal segment I pale yellow, segments II-IV dark brown; length of antennal segment I 0.60, II 1.20, III 0.30, IV 0.60-0.75; labium pale yellowish brown, apex of segment IV fuscous, length 0.77-1.02. Pronotum: Median length 0.75; posterior width 0.90-1.05; brown to dark brown; humeral angles and median stripe behind calli pale grayish white; lateral margins weakly concave; posterior margin nearly straight. Scutellum: Length 0.30; dark brown to nearly black. Hemelytra: Clavus, inner portion of corium mostly distal to apex of clavus, embolium, and inner margin and apex of cuneus brown or dark brown; remaining portions of corium and cuneus pale grayish white; membrane strongly suffused with fuscous, veins dark. Legs: Dirty white to pale brownish yellow. Venter: Mostly dark brown. Genitalia: As in figures 6-12.

Female (n=4). – Similar to male in colour and structure, except darkened portions of hemelytra nearly black. Total length 3.50-4.05. Head: Length 0.15; width across eyes 0.75; width of vertex 0.30; length of antennal segments I 0.60, II 1.20, III 0.30, IV 0.60-0.75. Pronotum: Median length 0.76, posterior width 0.90-1.05. Scutellum: Length 0.30.

Etymology. – Named for its occurrence in

Sulawesi; a noun in apposition.

Distribution. – Indonesia, Sulawesi.

Discussion. – Five specimens were examined from the type locality that differ from the holotype in the colour of the second antennal segment (basal one-third pale, distal two-thirds dark brown), darkened humeral angles of the pronotum, and more extensively darkened corium. Two males from this group also had the left paramere of the genitalia with a more pronounced, subquadrate sensory lobe, and the shaft with a broader apex and deeper notch on the inner distal margin (fig. 7). The genitalic structures of the other males were found to be intermediate in form. Since the external differences in colour are not supported by consistent differences in either external morphology or the structure of the male genitalia, we are treating all five specimens as conspecific with the holotype, but are not included them as paratypes.

Diocleroides philippinensis sp. n.
(figs. 13-15)

Type material. – Holotype ♂, Philippine Islands, Negros Island, Camp Lookout, Dumaguete, 1600 ft, 7.IV.1961, Schneirla and Reyes (AMNH). – Paratype ♀, same data as holotype, except 15.II-15.IV.1961 (AMNH).

Diagnosis. – Recognized by the uniform pale grayish white colour, antennal segment II only slightly longer than width of head across eyes, and by the structure of the parameres of the male genitalia (figs. 13, 14).

Description of male (n=1). – Length 3.45; grayish white general coloration. Head: Length 0.15, width across eyes 0.80; vertex pale yellow, width 0.30; antennal segment I pale yellow, slightly darker distally, length 0.60; segment II light brown, length 0.88; segments III and IV missing; labium pale yellowish brown, apex of segment IV brown; length 0.97. Pronotum: Median length 0.75, posterior width 0.90; pale grayish white; center of disk tinged with brown; lateral margins straight; posterior margin very weakly concave medially. Scutellum: Short, pale yellow, length 0.37. Hemelytra: Pale grayish white; commissure slightly more than twice as long as scutellum; membrane lightly suffused with fuscous along outer margin, veins pale. Legs: Uniformly pale yellow; pretarsal claws brown. Venter: Pale, abdominal segment IX fuscous. Genitalia: As in figures 13-15.

Female (n=1). – Similar to male in colour and structure, except antennal segment I more broadly suffused with fuscous dorsally. Total length 3.45. Head: Length 0.18; width across eyes 0.85; width of vertex 0.39; antennal segment I mostly brown dorsally, length 0.55; segment II uniformly dark brown, length 0.80; segment III brown, length 0.44; segment IV missing. Pronotum: Median length 0.75; posterior width 0.90. Scutellum: Length 0.37. Venter: Abdominal segments VIII and IX fuscous.

Etymology. – Named for its occurrence in the Philippine Islands.

Distribution. – Philippine Islands, Negros Island.

Gressittiana gen. n.

Diagnosis. – Recognized by the elongate body form (fig. 16); prominent eyes with weakly concave posterior margin; coarsely punctate pronotal disk with broad, flattened anterior collar, and deep notch anterolaterally (fig. 16); posterior lobe of pronotal disk projecting over base of scutellum; hemelytra with sinuate lateral margins, poorly defined cuneal fracture, and elongate cuneus; broad right paramere (lateral view) with bifurcate apex (figs. 21, 22); and vesica with single, elongate membranous sac apically (fig. 25).

Description of male. – Macropterous, length 3.15-3.30; dark brown general coloration; legs and antennae mostly pale yellow; pronotum coarsely punctate; scutellum and hemelytra with shallow, irregular punctures producing a roughened appearance; dorsum with moderately dense covering of pale, suberect, simple setae, length of setae 1.0-1.5 times greatest diameter of antennal segment I. Head: Short, weakly produced and nearly vertical anterior to antennal fossae; posterior margin, excluding eyes, straight; vertex weakly convex, twice as broad as eye in dorsal view; frons moderately convex, meeting tylus along distinct depression; tylus moderately produced; maxillary and mandibular plates weakly convex; genae and gula well-developed; bucculae short; buccal cavity small, subspherical; labium reaching between mesocoxae, segment I much thicker than remaining segments; eyes prominent, projecting laterally beyond and slightly behind anterolateral angles of pronotum in dorsal view, weakly elevated above dorsal surface of head, posterodorsal margin weakly concave and conforming to anterior margin of pronotum, occupying about half of head height and strongly narrowed posteriorly in lateral view; antennal fossa nearly contiguous with anterior margin of eye. Antennae: Cylindrical, linear, inserted slightly below level of dorsal margin of eye in lateral view (fig. 17); segment I slightly thicker subbasally, about as long as width of vertex; segment II weakly enlarged apically, slightly more than twice as long as segment I; segment III broken or missing; segment IV missing; all observed segments with pale, reclining, simple setae of length 1.0-1.5 times diameter of corresponding segment. Pronotum: Trapeziform, slightly broader than long, posterior width of disk about twice anteri-

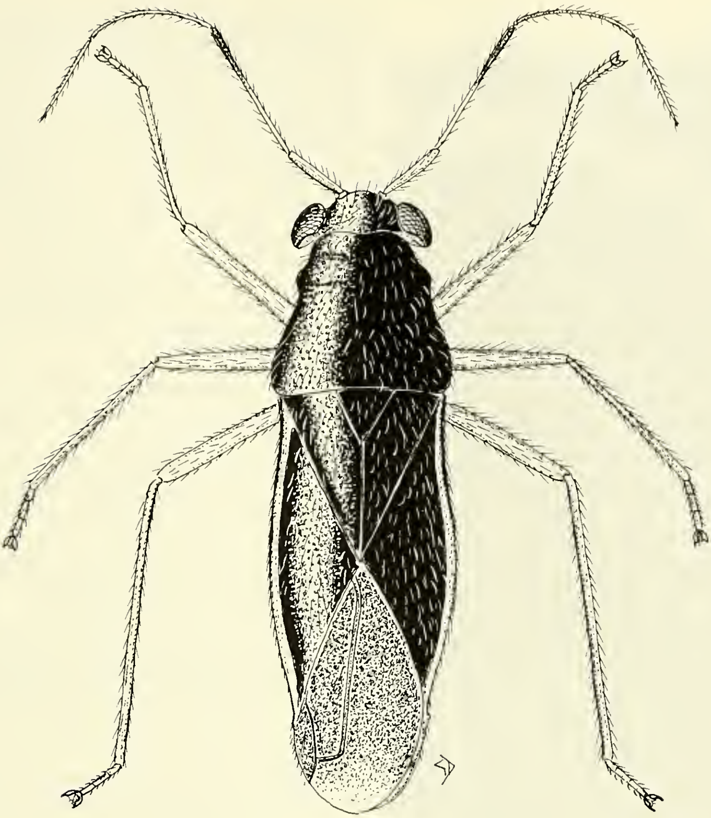


Fig. 16. *Gressittiana kuchingensis*, dorsal habitus ♂.

or width; anterior margin with broad, flattened collar of width more than twice the diameter of antennal segment I; calli weakly convex, with poorly defined anterior and posterior borders, reaching to lateral margins of disk, separated anteromedially by deep subspherical depression; lateral margin of disk with prominent notch at level of posterior margin of calli corresponding to deep propleural excavation; posterior lobe of disk weakly swollen, projecting over base of scutellum; posterior margin of disk weakly concave medially. Propleuron: Coarsely punctate; proepisternum broadly developed; propleural and tergopleural sutures strongly depressed, meeting in a deep excavation. Mesoscutum: Concealed by overlaying pronotal disk. Scutellum: Weakly elevated; compressed midlaterally; distinctly flattened anteromedially. Metathoracic scent efferent system: Peritreme narrowly tonguelike, with series of stout setae along posterior margin; evaporative area narrowly developed anterior to peritreme (fig. 18). Hemelytra: Elongate; costal margin sinuate; embolium cylindrical, of near uniform width throughout; cuneus three times longer than broad, less heavily sclerotized than corium with inner margin weakly differentiated from membrane; cuneal incisure shallow, fracture strongly angled anteriorly; membrane with single, elongate primary cell, secondary cell obsolete. Legs: Femora narrow, elongate, nearly cylindrical; metafemora with points of insertion of trichobothria 2-4 swollen; tibiae cylindrical, with pale spines and several rows of minute, pale spinules; tarsi dilated distally; pretarsus as in figure 19; all legs with pale, reclining or semierect, simple setae. Genitalia: Genital capsule (fig. 20): Slightly broader than long, slightly narrowed distally, with broadly rounded apex; aperture broad, subovate, posterodorsal in orientation; paramere sockets close set, left socket slightly below right socket in posterior view; inner margins of paramere sockets enlarged,

platelike; aperture anterior to paramere insertions spanned by irregular sclerite. Left paramere (figs. 23, 24): Sensory lobe broad, weakly elevated; angle evenly curved; shaft shorter than arm, gradually narrowed distally, slightly expanded before apex; outer surface of arm with several stout setae; apex narrowly rounded. Right paramere (figs. 21, 22): Relatively short and broad; outer surface with long, stout setae; apex bifurcate. Phallobase: Small, compact. Phallotheca: Entirely membranous. Vesica (fig. 25): Tubular, weakly curved, extensively sclerotized; posterodistal surface membranous; posterobasal surface with field of small spines; apex of tubular sclerite with single, elongate membranous sac.

Female. – Macropterous, length 3.37-3.45; similar to male in colour, structure and vestiture except as noted in species description.

Etymology. – Named in honour of G. L. Gressitt, collector of many new species of Miridae and other insects throughout Southeast Asia and the Pacific Islands.

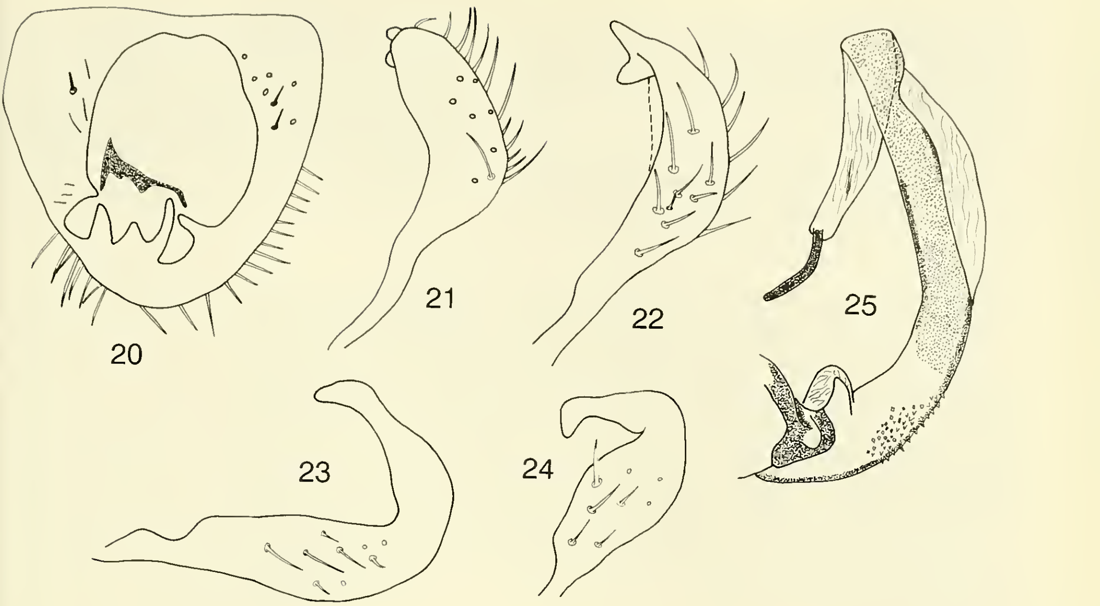
Type species. – *Gressittiana kuchingensis* sp. n.

Discussion. – Characters of the external morphology and male genitalia support the placement of *Gressittiana* in a group of genera recognized by the following diagnostic features: (1) small body size, length 2.5-4.6 mm; (2) moderately to strongly inflated posterior lobe of pronotal disk that projects over base of scutellum; (3) paramere sockets with prominent, sometimes inflated, processes on inner margins; and (4) right paramere short and broad. The genera placed in this group by Stonedahl (1986, 1988) are *Eofurius* Poppius, *Ernestinus* Distant, *Microbryocoris* Poppius, *Myiocapsus* Poppius, *Palaeofurius* Poppius, and *Stylopomiris* Stonedahl. *Gressittiana* is easily distinguished from these genera by the broad, flattened pronotal collar, hemelytra with sinuate lateral margins and obsolete cuneus, and by the structure of the vesica.

Gressittiana kuchingensis sp. n.
(figs. 16-25)

Type material. – Holotype ♂, Borneo, Sarawak, Kuching, Matang, 450-894 m, 15.IX.1958, ex *Alpinia*, J. L. Gressitt (BISH). – Paratypes: Sabah: 1♂, 1♀, Gomantong Caves, 22-26.XI.1958, T. C. Maa (BISH); 1♂, Sandakan Bay (SW), Sapagaya Lumber

Figs. 17-19. Scanning electron micrographs of *Gressittiana kuchingensis*. – 17, lateral view of head and pronotum; 18, peritreme and evaporative area of metathoracic scent efferent system; 19, pretarsus.



Figs. 20-25. Male genitalia of *Gressittiana kuchingensis*. – 20, genital capsule, posterodorsal view; 21, right paramere, dorsal view; 22, right paramere, ventral view; 23, left paramere, dorsal view; 24, left paramere, dorsolateral view; 25, vesica, right lateral view.

Camp, 2-20 m, 6.XI.1957, ex *Alpinia*, J. L. Gressitt (BISH). Sarawak: 1♂, 1♀, same data as holotype (AMNH, BISH); 1♂, Kuching, J. Hewitt (BMNH).

Diagnosis. – Recognized by the characters given in the generic diagnosis.

Description of male (n=3). – Length 3.15-3.30; general coloration, surface texture and dorsal vestiture as in generic description. Head: Length 0.15; width acrosss eyes 0.75; width of vertex 0.30, dark yellowish brown; clypeus dirty white; maxillary plate, mandibular plate and gula pale yellow; antennal segment I pale yellow, length 0.45-0.55; segment II pale yellow, apical one-fourth brown; segments III and IV missing; labium pale yellow, segment IV narrowly darkened apically, length 0.77-0.91. Pronotum. Median length 0.90; posterior width 0.90-0.97, uniformly dark brown. Scutellum: Length 0.30, dark brown. Hemelytra: Basal half of clavus dark brown, distal half of clavus and all of corium lighter brown; embolium pale yellowish brown; cuneus brown or pale grayish brown, outer margin weakly convex; membrane strongly suffused with fuscous, veins dark. Legs: Uniformly pale yellow. Venter: Dark brown. Genitalia: As is figures 20-25.

Female (n=2). – Similar to male in colour and structure, except hemelytra darker brown distally. Total length 3.37-3.45. Head: Length 0.18-0.22; width across eyes 0.60; width of vertex 0.60; antennal segments III and IV linear, slightly thinner than segment II, uniformly pale yellow; length of antennal segments I 0.37-0.45, II 0.86, II 0.74, IV 0.55. Pronotum: Median length 0.90; posterior width 0.90. Scutellum: Length 0.30.

Etymology. – Named for the type locality, Kuching, Sarawak.

Distribution. – East Malaysia.

Discussion. – Four specimens of the type series were collected on a species of *Alpinia* Roxb. (Zingiberaceae). Several species of this plant genus are used as food condiments and/or for medicinal purposes in parts of Southeast Asia and the Pacific.

ACKNOWLEDGEMENTS

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References

Stonedahl, G. M., 1986. *Stylopomiris*, a new genus and three species of Eccritotarsini (Heteroptera: Miridae: Bryocorinae) from Viet Nam and Malaya. – Journal of New York Entomological Society 94: 226-234

Stonedahl, G. M., 1988. Revisions of *Dioclerus*, *Harpedona*, *Mertila*, *Myiocapsus*, *Prodromus*, and *Thaumastomiris* (Heteroptera: Miridae: Bryocorinae: Eccritotarsini). – Bulletin of the American Museum of Natural History 187: 1-99.

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REVIEW OF *LYGOCORIDES* YASUNAGA (HETEROPTERA: MIRIDAE) *

Yasunaga, T., 1996. Review of *Lygocorides* Yasunaga (Heteroptera: Miridae). – Tijdschrift voor Entomologie 139: 267-275, figs. 1-23. [ISSN 0040-7496]. Published 18 December 1996.
Lygocorides Yasunaga, 1991, proposed as a subgenus of the genus *Lygocoris* Reuter, is upgraded to the generic level, and redefined as a distinctive monophyletic group, based on the conspicuously elongate interramal lobes of the female genitalia. Two additional species, *L. izjaslavi* from the Primorskij Kraj, Russia and *L. rubricans* from Taiwan and the Ryukyus, Japan, are described. A new subgenus, *Ryukyulygus,* is proposed to accommodate *rubricans. Lygocorides rubronasutus* (Linnavuori) is transferred from *Lygocoris,* and diagnosed with description of the last-instar nymph. The zoogeography and phylogeny of the genus are discussed, based on the distributional records and host preference of each species.
T. Yasunaga, Biological Laboratory, Hokkaido University of Education, Ainosato 5-3-1, Sapporo, 002 Japan.
Key words. - Heteroptera; Miridae; *Lygocorides;* new subgenus; new species; Japan; Taiwan; Russian Far East.

* Contribution from the Russia/Japan Cooperative East Asian Entomological Program, No. 46.

Linnavuori (1961) described *Lygus rubronasutus* from Hokkaido, northern Japan. Subsequently, Miyamoto (1965) placed it in the subgenus *Neolygus* of the genus *Lygus* (= *Lygocoris* Reuter, 1875, not *Lygus* Hahn sensu stricto; see Carvalho et al. 1961 and China 1963). Kerzhner (1988a, b) recorded this species as *Lygocoris* (*Neolygus*) *rubronasutus* from the southern Primorskij Kraj of the Continental Russian Far East, while Yasunaga (1991) proposed a new subgenus, *Lygocorides,* to accommodate it, because the male genital structure significantly differs from those exhibited in *Neolygus* and other known subgenera of *Lygocoris.*

However, I recently examined both male and female genitalia more closely, and became aware that *Lygocorides* had better be regarded as a distinctive genus. I also had an opportunity to examine several specimens from the Primorskij Kraj, identified as *rubronasutus* by Kerzhner, and recognized that they are not conspecific with Japanese ones. In addition, a third, undescribed species, which in general appearance resembles *rubronasutus,* has been found in good number in the Ryukyus, southern Japan and Taiwan.

In the present paper, *Lygocorides* is redefined as a monophyletic genus. The type species of the genus, *L. rubronasutus,* is also diagnosed, and its last-instar nymph is described and figured. Two additional species, *L. izjaslavi and L. rubricans,* are described. Since *rubricans* is found to differ sufficiently from *rubronasutus* in the structure of the male and female genitalia, a new subgenus, *Ryukyulygus,* is proposed to accommodate it properly. The zoogeography and phylogeny of the genus are discussed.

All measurements in the text are given in millimeters. Terminology of the male and female genitalia mainly follows Kelton (1955) and Yasunaga (1991). Depositories of specimens examined are abbreviated as follows: Biological Laboratory, Hokkaido University of Education, Sapporo: (HUES); Mr. Ichita's personal collection, Kuroishi, Aomori: (IC); Dr. Miyamoto's personal collection, Fukuoka: (MC); Department of Zoology, National Science Museum, Tokyo: (NSMT); Zoological Institute, Russian Academy of Sciences, St. Petersburg: (ZMAS).

Systematic part

Lygocorides Yasunaga stat. n.

Lygocoris (*Lygocorides*) Yasunaga, 1991: 446. Type species: *Lygus rubronasutus* Linnavuori, 1961, monotypic. – Yasunaga 1992a: 528; 1992b: 18, 20.
Lygocoris (*Lygocoroides*) [sic!]. - Schuh 1995: 793.

Redescription

Body subovate, moderate in size, brownish or reddish in general coloration; dorsal surface shining, clothed with silky pubescence. Head vertical, sparsely with erect, short, silky hairs; eye almost contiguous to pronotal collar; vertex smooth, lacking basal transverse carina. Antenna slender; segment I shorter than width of head including eyes; segment II longer than basal width of pronotum, slightly incrassate toward apex; segments III and IV filiform. Rostrum reaching hind coxa.

Pronotum shining, sparsely and minutely punctate, covered with suberect silky pubescence; collar comparatively thick, about as broad as apex of antennal segment II. Scutellum rather flat, weakly shagreened, clothed with suberect silky pubescence. Hemelytra irregularly and finely punctate, densely clothed with silky pubescence, obliquely declivous at cuneal fracture. Hind femur with several long trichobothria; tibial spines pale; tarsomere I shortest; tarsomere II about as long as tarsomere III.

Male genitalia (figs. 3-13). – Right paramere straight, with broad sensory lobe and small pointed hypophysis. Sensory lobe of left paramere noticeably widened, with subbasal protuberance; hypophysis rather short. Vesica with two apical elongate sclerites (= apical sclerites I and II), ventrally hooked gonoporal sclerite and spinulate basal selerite; gonopore thick rimmed; ejaculatory duct somewhat expanded apically.

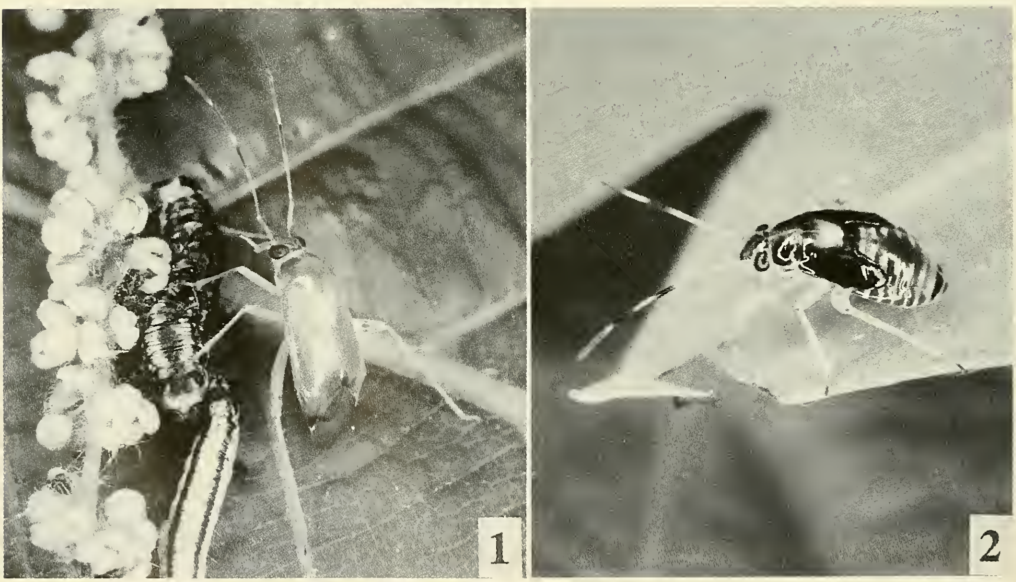
Female genitalia (figs. 14-19). – Selerotized rings subovate, removed mesally one another. Posterior wall of bursa copulatrix with considerably elongate and minutely spinulate interramal lobes; interramal scterite v-shaped, divided mesad; dorsal structure projected and curved.

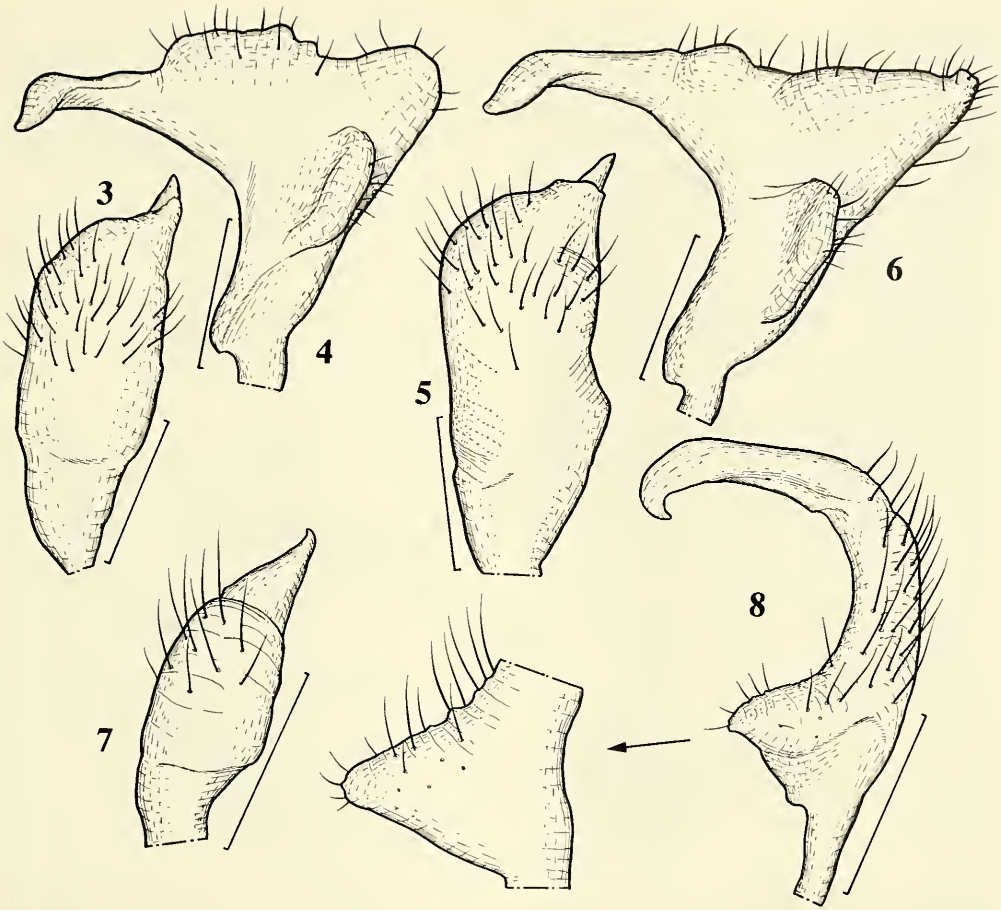
Discussion

Lygocorides and Lygocoris exhibit similarity in external appearance, but the former is sufficiently different from the latter in the structure of the male and female genitalia, such as the remarkably widened sensory lobe of the left paramere, two noticeable apical sclerites and developed gonoporal selerite presenting on the vesica, smaller selerotized rings, that are not contiguous mesally, and very long interramal lobe and projected dorsal structure of the posterior wall of bursa copulatrix. Especially, the extremely long interramal lobes of the female genitalia, that is considered as a distinct autapomorphy of *Lygocorides,* is never found in any subgenera of *Lygocoris* and any related genera (see figs. 17-19). Thus, *Lygocorides* should be regarded as a distinctive monophyletic genus.

Lygocorides is known by three oak-inhabiting species occurring in the eastern Asia.

Figs. 1-2. *Lygocorides rubronasutus* on the host plant, *Quercus dentata.* – 1, male adult sucking on a lepidopteran larva; 2, last-instar nymph.





Figs. 3-8. Parameres of *Lygocorides* spp. – 3-4, *L. rubronasutus*; 5-6, *L. izjaslavi*; 7-8, *L. rubricans*. – 3, 5 & 7, right paramere; 4, 6 & 8, left paramere. Scales: 0.2 mm.

Lygocorides rubronasutus **(Linnavuori) comb. n.**
(figs. 1-4, 9, 14, 17, 23)

Lygus rubronasutus Linnavuori, 1961: 158.
Lygus (*Neolygus*) *rubronasutus*. – Miyamoto 1965: 100, pl. 50; Miyamoto & Yasunaga 1989: 160.
Lygocoris (*Lygocorides*) *rubronasutus*. – Yasunaga 1991: 446; 1992b: 20; Yasunaga et al. 1993: 152, pl. 12.
Lygocoris (*Lygocoroides*) *rubronasutus* [sic !]. – Schuh 1995: 803.

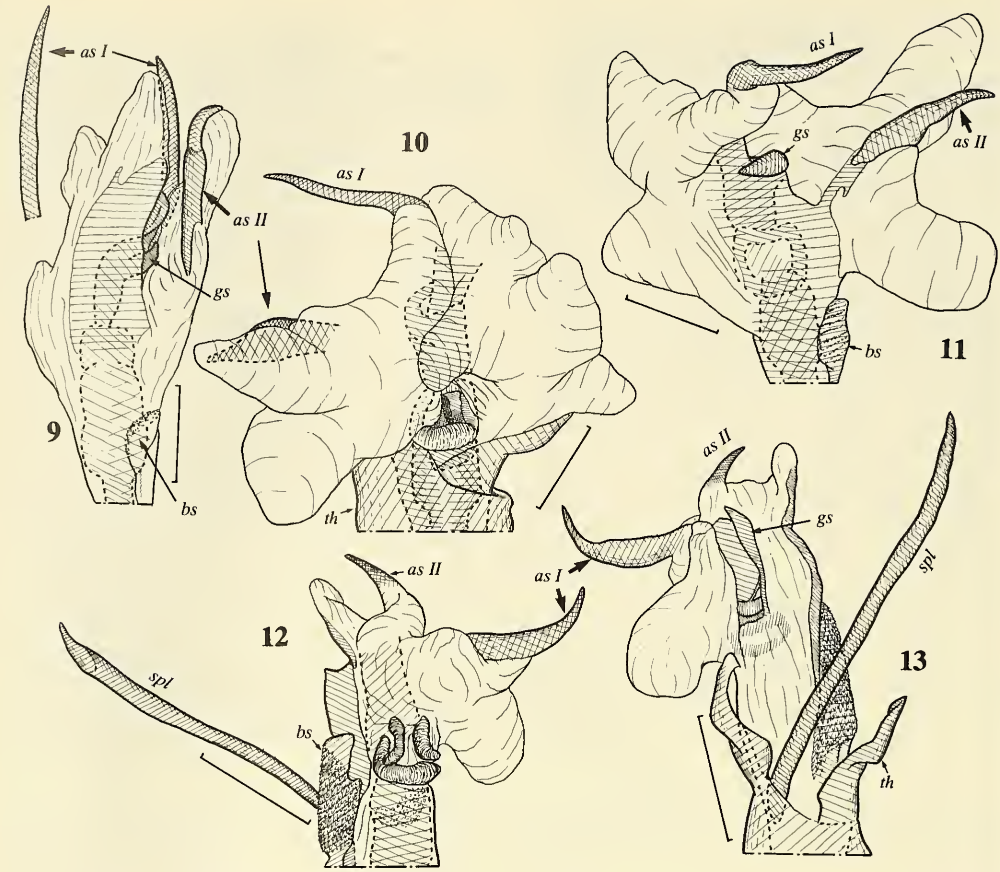
Diagnosis of adult (fig. 1).

Recognized by the shiny brownish general coloration with reddish tinge, dark reddish brown tylus and apex of the cuneus, and characters as mentioned in generic redescription. Detailed redescription including male genital structure was provided by Yasunaga (1991).

Male genitalia. – Parameres as in figures 3-4. Vesical basal sclerite weak, not strongly sclerotized; ventral projection of gonoporal sclerite weak; apical sclerite II with hooked apex(fig. 9).

Female genitalia. – Sclerotized ring comparatively small (fig. 14). Posterior wall of bursa copulatrix relatively narrow, with rather widened interramal sclerites (fig. 17).

Dimensions. – ♂ (♀): Body length 4.85-5.75 (5.90-6.40), head width 1.09-1.18 (1.18-1.20), length of antennal segment I 0.75-0.95 (0.85-0.95), II 1.95-2.40 (2.25-2.35), III 1.08-1.23 (1.18-1.25), IV 0.74-0.75 (0.75-0.85), rostral length 2.25-2.43 (2.33-2.45), mesal pronotal length incl. collar 1.08-1.25 (1.25-1.28), basal pronotal width 1.83-2.00 (2.03-2.05), length of hind femur 2.20-2.25 (2.20-



Figs. 9-13. Vesicae of *Lygocorides* spp. – 9, *L. rubronasutus*; 10-11, *L. izjaslavi*; 12-13, *L. rubricans*. – 9, 11 & 13, ventral view; 10 & 12, dorsal view. Scales: 0.2 mm. Abbreviations: *as I* = apical sclerite I; *as II* = apical sclerite II; *bs* = basal sclerite; *gs* = gonoporal sclerite; *th* = theca.

2.25), tibia 3.03-3.37 (3.30-3.33), tarsus 0.58-0.68 (0.68-0.70) and width across hemelytra 2.30-2.50 (2.68-2.70).

Material examined. – JAPAN: [Hokkaido] 1♂, Ikeda, Tokachi, on *Quercus dentata,* 2.vii.1958, S. Miyamoto (paratype, MC); 1♂, Bannaguro, Ishikari T., nr. Ishikari Bay, on *Q. dentata,* 25.v.1996 (first-instar nymph when collected and emerging on 8.vi.), A. Hiranuma (HUES); 1♂, 2♀, same locality, on *Q. dentata,* 4.vii.1996, T. Yasunaga (HUES). [Honshu] 1♂, 1♀, Hiratakinuma, Kizukuri-machi, Aomori Pref., 16.vii.1988, T. Ichita (IC); 2♂, 3♀, Mt. Kakezu, Geihoku, Hiroshima Pref., on *Q. dentata,* T. Yasunaga (HUES); 1♂, Chojabaru, Geihoku T., Hiroshima Pref., 10-11.vii.1994, light trap, S. Yoshizawa (HUES).

Description of last-instar nymph
(fig. 2)

Body oblong-oval; dorsal surface brownish, shining, with sparse vestiture. Head shiny pale brown, partly sanguineous, with reddish brown inner margin of eye, sparsely clothed with erect setae; vertex and frons widely and symmetrically reddish chestnut brown; tylus entirely shiny chestnut brown. Antenna yellowish brown, generally covered with brown suberect setae; segment I provided with several dark erect bristles; apical 1/3 of segment II, apical half of segment III and segment IV except extreme base dark reddish brown; lengths of segments I-IV: 0.54, 1.29, 0.98 and 0.75. Rostrum pale brown, reaching middle coxa; apical half of segment IV darkened.

Pronotum chestnut brown, shining, with yellowish anterior margin and longitudinal mesal stripe, sparsely clothed with suberect short setae, anterolateral and posterolateral angles each with a dark erect spine; thoracic side pale brown, except reddish or brownish ventral half; wing pads shiny dark brown, with pale mesoscutal part, sparsely clothed with short hairs. Legs pale brown, generally clothed with suberect brownish setae; apical part of femur with irregular sanguineous ring and bearing a few dark suberect spines; tibial spines pale brown; apical 1/3 of tarsus darkened; lengths of hind femur, tibia and tarsus: 1.50, 2.25 and 0.52. Abdomen pale red or sanguineous, except pale posterior margin of each segment and darkened segments IX and X, sparsely clothed with indistinct short hairs; dorsal scent gland opening infuscate; apical segments bearing brown setae.

Dimensions. – Body length 4.30, head width 0.98, vertex width 0.48, total rostral length 1.75, pronotal width 1.03, width across wing pads 1.78 and maximum abdominal width 1.95.

Material examined. – 1 ♂, Bannaguro, Ishikari T., nr. Ishikari Bay, Hokkaido, on flower of *Quercus dentata,* first-instar when collected on 25.v.1996, last-instar on 3.vi., A. Hiranuma (HUES).

Distribution. – Japan (restricted areas of Hokkaido and Honshu, where *Quercus dentata* grows).

Remarks. – It seems to be associated strictly with *Quercus dentata* (Fagaceae), because no specimens have been collected from any other species of the deciduous *Quercus* (e.g., *Q. mongolica* var. *grosserrata, Q. serrata*). Predation on an unidentified lepidopteran larva was observed in the laboratory (fig. 1).

Although the last-instar nymph of this species exhibits reddish or brownish coloration as described above, more immature nymphs (up to 2nd-instar) are almost uniformly pale green.

Lygocorides izjaslavi sp. n.
(figs. 5-6, 10-11, 15, 18, 23)

Lygocoris (*Neolygus?*) *rubronasutus.* – Kerzhner 1988a: 68.
Lygocoris (*Neolygus*) *rubronasutus.* – Kerzhner 1988b: 804.
Lygocoris (*Lygocorides*) *rubronasutus.* – Miyamoto et al. 1994: 248.

Type material. – Holotype: ♂, Rjazanovka, 10 km NE of Sukhanovka, Khasanskij Dist., S. Primorskij Kraj, Russia, 7.vii.1982, I.M. Kerzhner (the data written in Russian, ZMAS). – Paratypes: 1♂, 1♀, same data as for holotype (ZMAS); 4♂, 2♀, same locality, light trap, 26-27.vii.1993, T. Yasunaga (HUES).

Description

Body generally brownish, partly tinged with red, oblong-oval in dorsal view; dorsal surface shining, clothed with silky decumbent or suberect pubescence. Head pale reddish brown, shining, sparsely with silky erect short pubescence; vertex 0.37-0.38 times as wide as head including eyes in ♂, 0.39-0.42 in ♀, lacking basal transverse carina; tylus chestnut brown, with darker apex. Antenna dark brown; segment I pale brown; segment II sometimes pale basally, slightly thickened toward apex; bases of segments III and IV pale, filiform; segment III longer than pronotum including collar; length of segments I-IV: 1.00-1.13, 2.50-2.75, 1.25-1.43 and 0.80-0.88 in ♂, 0.95-1.08, 2.38-2.73, 1.25-1.48 and 0.83-0.93 in ♀. Rostrum pale brown, reaching hind coxa; apical half of segment IV darkened.

Pronotum shiny pale brown, with reddish calli, shallowly and finely punctate, uniformly clothed with silky suberect pubescence, basal margin narrowly carinate; collar yellowish, about as broad as apex of antennal segment II, bearing several brownish erect setae. Scutellum flat, weakly rugose. Ostiolar peritreme yellow. Hemelytra pale brown, somewhat tinged with red, shallowly and irregularly punctate, densely covered with silky decumbent pubescence, not strongly declivous at cuneal fracture; anal ridge and apical 1/3 of cuneus darkened. Leg pale brown; hind femur with one or two obscure rings apically; tibial spines brown; tarsomere III infuscate; length of hind femur, tibia and tarsus: 2.30-2.43, 3.45-3.50 and 0.69-0.75 in ♂, 2.27-2.53, 3.45-3.73 and 0.70-0.75 in ♀; that of hind tarsomeres I-III: 0.21-0.25, 0.31-0.36 and 0.29-0.33 in ♂, 0.24-0.25, 0.33-0.39 and 0.31-0.36 in ♀. Abdomen pale brown to brown, in ♂ with darkened parameres.

Male genitalia. – Parameres as in figures 5-6. Right paramere with ventromedially and triangularly produced sensory lobe and tapered, small hypophysis (fig. 5); left paramere with a strongly projected apical protuberance and rather long hypophysis (fig. 6). Vesical basal sclerite distinct; gonoporal sclerite with a noticeable ventral hook; apical sclerite II with broad base, gradually tapered apically (figs. 10-11).

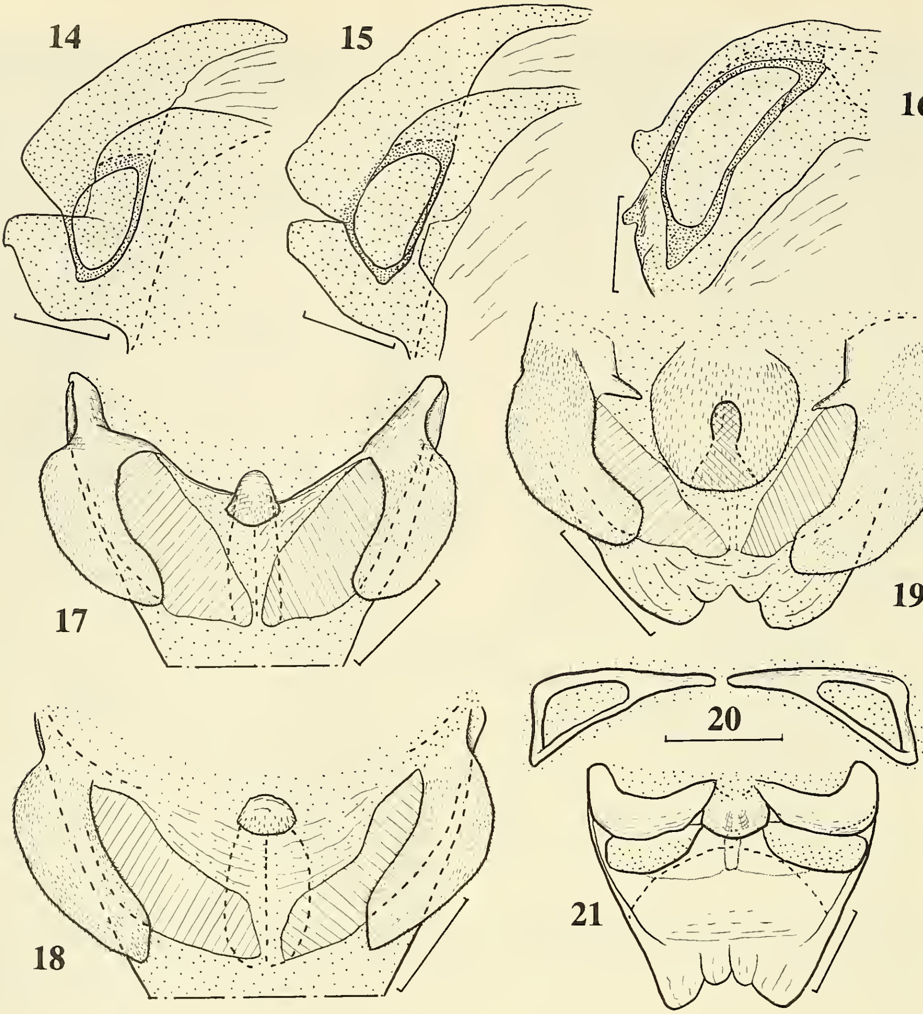
Female genitalia. – Selerotized ring oval (fig. 15). Posterior wall of bursa copulatrix wide, with elongate interramal lobes and narrow interramal selerite (fig. 18).

Dimensions. ♂ (♀): Body length 5.60-6.45 (6.00-6.70), head width 1.14-1.19 (1.15-1.21), rostral length 2.40-2.50 (2.50-2.68), mesal pronotal length incl. collar 1.25-1.30 (1.23-1.32), basal pronotal width 2.00-2.09 (2.01-2.20), and width across hemelytra 2.50-2.63 (2.49-2.83).

Etymology. – Named after Dr. Izjaslav M. Kerzhner, who first collected this species.

Distribution. – Continental Russian Far East (southern Primorskij District).

Remarks. – Kerzhner (1988a, b) and Miyamoto et al. (1994) regarded the specimens from the



Figs. 14-21. Female genitalia of *Lygocorides* spp. (14-19) and *Lygocoris pabulinus* (type species of *Lygocoris*, 20-21). – 14 & 17, *L. rubronasutus*; 15 & 18, *L. izjaslavi*; 16 & 19, *L. rubricans*. – 14-16 & 20, sclerotized ring; 17-19 & 21, posterior wall of bursa copulatrix. Scales: 0.2 mm.

Continental Russian Far East to be conspecific with *rubronasutus* of Japan. But they have the following features different from Japanese *rubronasutus*: the generally larger size, wider vertex, longer antennal segment III that is longer than the mesal pronotum including collar, and different structure of the male and female genitalia.

Kerzhner (1988b) recognized *Quercus dentata* as its host plant.

Ryukyulygus subgen. n.

Type species. – *Lygocorides rubricans* Yasunaga, new species.

Description

Almost similar in general appearance to *Lygocorides* s. str., but differing in the following characters: body more oval; vertex with weak, but visible basal transverse carina; antenna generally shorter; hemelytra strongly declivous at cuneal fracture; hind tarsomere III longer than I or II; right paramere with long and basally broadened hypophysis (fig. 7); left paramere not strongly widened, with basally produced sensory lobe; vesica with a distinct spiculum, developed basal sclerite, not ventrally projected gonoporal sclerite and shorter apical sclerites (figs. 12-13); theca slender and elongate apicad (fig. 13); female sclerotized ring enlarged, elongate-oval (fig. 16); posterior wall of bursa copulatrix with large dorsal structure and widened interramal lobes that are each accompanied with a pointed process at inner base (fig. 19).

Etymology. – Named after the type locality, the Ryukyus, in combination with the generic name *Lygus* Hahn; gender masculine.

Discussion

The present new subgenus and nominotypical subgenus share such characters in the genitalia as the basal sclerite and two apical sclerites on the vesica, and spinulate, extremely projected interramal lobes and V-shaped interramal sclerite of the posterior wall. But *Ryukyulygus* is readily distinguished by the structures as described above.

Ryukyulygus is represented by a single subtropical species.

Fig. 22. Female of *Lygocorides rubricans.*

Lygocorides (*Ryukyulygus*) *rubricans* sp. n.
(figs. 7-8, 12-13, 16, 19, 22-23)

Type material. – Holotype: ♂, Mt. Yuwan-dake, Uken vl., Amami-Oshima Is., the Ryukyus, Japan, 29-30.v.1993, T. Yasunaga (HUES). – Paratypes: JAPAN: [Amami-Oshima Is.] 1♂, Nishinakama, Sumiyo vl., 29.v.1993, T. Yasunaga (HUES); 18♂, 5♀, same data as for holotype (HUES); 2♂, 3♀, same locality, 30.v.1993, S. Yoshizawa (HUES); 1♂, same locality and collector, 21.iv.1996 (HUES); 1♂, 2♀, same locality and collector, 22.iv.1996 (HUES); 2♂, 2♀, same locality, 27.v.1996, M. Takai(HUES); 1♂, Akaoki, Tatsugo T., 1.vi.1993, T. Yasunaga (HUES); 1♂, Mt. Yuidake, Setouchi T., 22.iv.1996, S. Yoshizawa (HUES). [Okinawa Is.] 1♂, 1♀, Yona, Kunigami vl., light trap, 20-25.v.1993, T. Yasunaga (HUES). [Ishigaki Is.] 6♂, 3♀, Mt. Banna-dake, 18.iii.1991, M. Owada (NSMT); 1♂, 1♀, Omoto-Takeda, on flowers of evergreen *Quercus* sp., 24.i.1996, M. Takai (HUES). [Iriomote Is.] 1♂, Maryudo Waterfall, Urauchi River, 12.iv.1986, T. Yasunaga (HUES); 1♂, Funaura, at light, 11.v.1993, M. Hayashi (HUES); 1♂, 1♀, Mt. Komidake, 23.iv.1981, K. Baba (NSMT); 1♀, Monbanare, nr. Otomi, on flower of *Schima wallichii,* 13.v.1993, T. Yasunaga (HUES). – TAIWAN: 1♀, Sanping, nr. Liukuei, S. Taiwan, 21-23.vi.1985, M. Miyazaki (NSMT).

Description

Body pale brown to reddish brown, oval; dorsal surface shining, uniformly with silky pubescence. Head pale brown, somewhat tinged with red, vertical, with erect pubescence; vertex 0.32-0.35 times as wide as head including eyes in ♂, 0.34-0.37 in ♀, with visible basal transverse carina that is obsolete mesally; tylus dark brown. Antennal segment I pale brown; segment II pale brown, with darkened apical part, somewhat incrassate toward apex; segments III and IV dark brown, filiform; basal 3/4 of segment III and extreme base of IV pale brown; length of segments I-IV: 0.78-0.83, 1.96-2.18, 1.02-1.19 and 0.63-0.78 in ♂, 0.78-0.88, 2.06-2.33, 1.15-1.38 and 0.73-0.75 in ♀. Rostrum reddish pale brown, reaching hind coxa; apical half of segment IV infuscate.

Pronotum shiny pale brown or reddish brown, finely and sparsely punctate, uniformly clothed with silky suberect pubescence; collar narrower than apex of antennal segment II. Scutellum flat, very weakly shagreened and wrinkled. Hemelytra concolorously pale brown to reddish brown, shallowly and irregularly punctate, uniformly covered with silky pubescence, declivous at cuneal fracture; membrane pale grayish brown, with partly reddish veins. Leg pale reddish brown; hind femur with two sanguineous rings apically; tibial spines pale reddish brown; apex of tarsomere III darkened; length of hind femur, tibia and tarsus: 1.98-2.25, 2.58-3.08 and 0.59-0.65 in ♂, 2.05-2.35, 2.83-3.23 and 0.63-0.73 in ♀; that of hind tarsomere I-III: 0.16-0.19, 0.24-0.28 and 0.26-0.31 in ♂, 0.20-0.24, 0.26 and 0.29-0.31 in ♀.

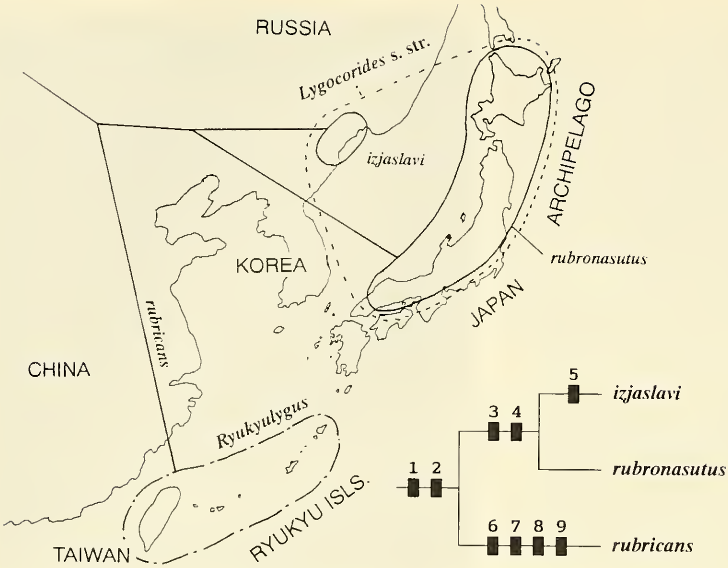


Fig. 23. Distribution map and phylogenetic relationships of *Lygocorides* spp. Numbers of the aut- and synapomorphies corresponding with those mentioned in the text.

Abdomen pale reddish brown; ventromedian part of male genital segment (pygophore) and parameres widely dark chestnut brown.

Male and female genitalia as mentioned in subgeneric description.

Dimensions. – ♂ (♀): Body length 5.60-6.45 (6.00-6.70), head width 1.14-1.19 (1.15-1.21), rostral length 2.40-2.50 (2.50-2.68), mesal pronotal length incl. collar 1.25-1.30 (1.23-1.32), basal pronotal width 2.00-2.09 (2.01-2.20), and width across hemelytra 2.50-2.63 (2.49-2.83).

Etymology. – From the Latin, referring to the reddish general coloration.

Distribution. – Japan (the Ryukyus: Amami-Oshima, Okinawa, Ishigaki and Iriomote Isles); Taiwan.

Remarks. – This new species has been found on several evergreen broadleaved trees and flowers of the Saxifragaceae and Theaceae. It is occasionally attracted to light. The only confirmed host plant is evergreen species of *Quercus* (subgen. *Lepidobalanus*), from which several teneral adults were collected.

Zoogeography and phylogeny
(fig. 23)

Aut- and synapomorphies shown in figure 23 are as follows: 1, the interramal lobe conspicuously projected; 2, vesica with a pair of apical sclerites (I and II); 3, left paramere with noticeably widened sensory lobe; 4, gonoporal sclerite with a ventral process; 5, ventral process of gonoporal sclerite distinct and strongly hooked; 6, vesica with a distinct, long spiculum; 7, basal sclerite of vesica well developed; 8, sclerotized ring enlarged; 9, basal part of interramal lobe with an inner pointed process.

As mentioned in the generic discussion, presence of the extremely projected interramal lobes in the female genitalia is considered as an autapomorphy of the genus *Lygocorides* (1). In addition, all the species of this genus exhibit great similarity in external appearance and, without exception, are oak-inhabitants. Two species of the nominotypical subgenus are restricted to deciduous *Quercus dentata,* and *L. rubricans* is confirmed to be associated with evergreen *Quercus.* Although *Lygocorides* is similar to *Lygocoris,* I conclude that any relationships between the two genera are superficial. For example, the shiny, finely punctate dorsum uniformly provided with a simple vestiture and reduced basal transverse carina of the vertex are not unique to *Lygocoris* and *Lygocorides,* but are frequently found in other groups of the tribe Mirini. Any mirine genera confidently related to *Lygocorides* have not been determined yet. The mirine plant bug fauna of the eastern Eurasia is said to be still in great need of investigation, and a much broader survey on taxa and characters is required to establish the phylogenetic relationships of *Lygocorides* and other superficially similar mirine genera. I herein discuss only the zoogeography and ingroup phylogeny.

Lygocorides rubronasutus and *L. izjaslavi* are more closely related one another, and are included in the nominotypical subgenus, sharing the characters 3-4. They are considered to be derived from a common ancestor occurring in the eastern part of Continental Eurasia. In the Quaternary Ice Age, its population invaded to Japan through the landbridges that connected Japan with the continent. They have been allopatrically speciated from one another since the Japan Archipelago was isolated by the Straits from the Continental Eurasia at the end of the Würm Glaciation. Similar zoogeographical distribution and speciation patterns were indicated in the lycaenid butterflies, *Japonica* spp., that are also associated with deciduous *Quercus* (Saigusa 1993).

On the other hand, *L. rubricans* seems to have been speciated in the eastern Continental Eurasia earlier than *rubronasutus* and *izjaslavi*, becoming associated with evergreen species *of Quercus,* presumably before the Quaternary Ice Age when the climate was even warmer. Then, *rubricans* spread in the continent, but only the population that invaded the Ryukyu Islands via Taiwan through a landbridge during the Würm Glaciation has survived on evergreen *Quercus* of these areas. The placement of *rubricans* in the subgenus *Ryukyulygus is* supported by the apomorphic states of characters 6-9.

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References

Carvalho, J. C. M., H. H. Knight, & R. L. Usinger, 1961. *Lygus* Hahn, 1833 (Insecta: Hemiptera); proposed designation under plenary powers of a type species in harmony with accustomed usage. – Bulletin of zoological Nomenclature 18: 281-284.

China, W. E., 1963. Opinion 667. *Lygus* Hahn, 1833 (Insecta: Hemiptera): Designation of a type species under the plenary powers. – Bulletin of zoological Nomenclature 20: 270-271.

Kerzhner, I. M., 1988a (1987). Novye i maloizvestnye poluzhestkokrylye Nasekomye s Dal'nego Vostoka SSSR [New and little known heteropterous insects from the Soviet Far East]. – p. 1-83. Akademija Nauk SSSR, Vladivostok. [In Russian].

Kerzhner, I. M., 1988b. Sem. Miridae (Capsidae) - Slepnjaki. – Opredelitel' Nasekomykh Dal'nego Vostoka SSSR [Keys to the Insects of the Soviet Far East] 2: 778-857. Nauka, Leningrad. [In Russian].

Kelton, L. A., 1955. Genera and subgenera of the *Lygus* complex (Hemiptera: Miridae). – Canadian Entomologist, 87: 277-301.

Linnavuori, R., 1961. Contributions to the Miridae fauna of the Far East. – Annales entomologici Fennici 27: 155-169.

Miyamoto, S., 1965. Heteroptera. – In Asahina, S. et al. (eds.), Iconographia Insectorum Japonicorum Colore naturali Edita. Vol. III. pp. 75-100, pls. 38-50. Hokuryukan, Tokyo. [In Japanese].

Miyamoto, S., & T. Yasunaga, 1989. Hemiptera, Heteroptera. – In Hirashima, Y. (ed.), A Check List of Japanese Insects. pp. 151-188. Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka.

Miyamoto, S., T. Yasunaga, & T. Salgusa, 1994. Heteroptera from the Russian Far East collected by T. Saigusa in 1990, with descriptions of two new mirine species. – Japanese Journal of Entomology 62: 243-251.

Saigusa, T., 1993. A study on new subspecies of the tribe Theclini from Eastern Asia (Lepidoptera, Lycaenidae). – Zephyrus Researches, Fukuoka, 1: 12-22.

Schuh, R. T., 1995. Plant bugs of the world (Insecta: Heteroptera: Miridae). Systematic catalog, distributions, host list and bibliography. xii+1329 pp. The New York Entomological Society.

Yasunaga, T., 1991. A revision of the plant bug genus *Lygocoris* Reuter from Japan, Part 1 (Heteroptera, Miridae, Lygus-complex). – Japanese Journal of Entomology 59: 435-448.

Yasunaga, T., 1992a. A revision of the plant bug genus *Lygocoris* Reuter from Japan, Part VI (Heteroptera, Miridae, *Lygus*-complex). – Japanese Joumal of Entomology 60: 521-538.

Yasunaga, T., 1992b. Proposition of the Japanese names of *Lygocoris* spp. (Miridae), with a note of each species (1). On the subgenera *Lygocoris, Lygocorides and Neolygus.* – Rostria (42): 17-25. [In Japanese with English summary].

Yasunaga, T., M. Takai, I. Yamashita, M. Kawamura, & T. Kawasawa, 1993. A field guide to Japanese Bugs. Terrestrial Heteropterans (Tomokuni, M., ed.). 380 pp. Zenkoku Noson Kyoiku Kyokai, Tokyo. [In Japanese].

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Contents of volume **139**

Articles

Book reviews

156 A.T. Barrion & J.A. Litsinger, 1995. Riceland spiders of South and Southeast Asia. - CAB International [A. Noordam].

180 H.-J. Hannemann, 1995. Kleinschmetterlinge oder Microlepidoptera IV. Flachleibmotten (Depressariidae). – Die Tierwelt Deutschlands, 69. [E. J. van Nieukerken].

214 Eivind Palm, 1996. Nordeuropas Snudebiller. 1. De kortsnudede arter (Coleoptera: Curculionidae) - med saerligt henblik på den danske fauna. – Danmarks Dyreliv 7 [E. J. van Nieukerken].

Reviewers for volume 139

B. Aukema (Wageningen), D. B. Baker (Ewell, U.K.), P. Beuk (Amsterdam), H. Bohn (München), H. R. Bolland (Amsterdam), P. S. Cranston (Canberra), K. G. Heller (Erlangen), D. A. Roff (Montreal), M. Hämäläinen (Espoo, Finland), I. M. Kerzhner (St. Petersburg), J. F. Landry (Ottawa), R. E. Linnavuori (Raisio, Finland), N. Møller Andersen (Copenhagen), E. S. Nielsen (Canberra), I. Togashi (Japan), T. Yasunaga (Sapporo), H. Wolda (Seattle)

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NEW TAXA DESCRIBED IN TIJDSCHRIFT VOOR ENTOMOLOGIE, VOLUME 139

INSTRUCTIONS TO AUTHORS

The *Tijdschrift voor Entomologie* publishes original papers dealing with systematic and evolutionary entomology. The editors particularly invite papers on the insect fauna of the Palaearctic and Indo-Australian regions, especially those including evolutionary aspects e.g. phylogeny and biogeography, or ethology and ecology as far as meaningful for insect taxonomy. Authors wishing to submit papers on disciplines related to taxonomy, e.g. descriptive aspects of morphology, ethology, ecology and applied entomology, are requested to contact the editorial board before submitting. Usually such papers will only be accepted when space allows.

Papers in English are preferred, but papers written in French or German will also be considered. It is our policy that papers are reviewed by an external referee. Authors will generally be notified of acceptance within two months.

For the first submission two printed copies are required, including photocopies of figures, reduced to A4 format. Diskette and original artwork should not be sent until the paper is accepted. Manuscripts should preferably be printed on A4 size paper, on one side only, double spaced, with a left margin of at least 4 cm. After acceptance of a paper, authors are requested to prepare a manuscript according to standards given in a separate style-sheet. These instructions include e.g. the wordprocessing programs we can handle and the codes that should be included or are allowed in your files. The editors can handle the most common wordprocessing programs for Windows, MS-DOS and Macintosh systems, but prefer Wordperfect (any version) or MS-Word. It is also possible to submit papers via e-mail, preferably as UUENCODED wordprocessing file.

Lengthy papers (more than 40 pages in print) are only accepted when space allows. Publication can be speeded up by paying a page-charge of NLG 50. Otherwise no page-charge is asked. Membership of the 'Netherlands Entomological Society' is not obligatory.

Text preparation

A cover page should provide the names of the authors and a proposal for a running title. The second page starts with author names (in all capitals), use & for 'and', on a new line the name of institute (as short as possible), with multiple authors using superscript [1] [2] etc. The title is brief and informative, typed in all capitals, with order and family of the taxon treated in parentheses.

The abstract starts with a bibliographical reference (authors, year, title), see recent issues for layout. Then the abstract follows, without the word 'abstract' and without indentation. The abstract, written in English, should be concise, yet cover the main results of the paper, including new taxa and nomenclatorial changes. The name and address of one and only one of the authors follows, if needed preceded by the word 'Correspondence:'. This should also be the address for the galley proofs. The abstract ends with a list of key-words.

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Boer, P. J. den, 1970. On the significance of dispersal power for populations of carabid-beetles (Coleoptera, Carabidae). – Oecologia 4: 1-28.

Karsholt, O. & E. S. Nielsen, 1976. Systematisk fortegnelse over Danmarks sommerfugle. – Scandinavian Science press, Klampenborg, 128 pp.

Johansson, R. & E. S. Nielsen, 1990. Tribus Nepticulini. – In: Johansson, R. et al. The Nepticulidae and Opostegidae (Lepidoptera) of NW Europe. – Fauna entomologica scandinavica 23: 111-238, pls.

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Data for primary types of previously described species follow directly the reference to the original description as:

Elachista subnitidella Duponchel, [1843]: 326, pl. 77: 8. Lectotype ♂ [designated by van Nieukerken & Johansson 1987: 471]: [Austria, Vienna region], Duponchel coll., Genitalia slide EvN 2522 (MNHN) [examined].

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Articles

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Contents on inside back cover