

Tetrigidae (Orthoptera) With Partly Exposed Wings

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Abstract

Long series of some species of Tetrigidae from south Asia show that the wings regularly project beyond the pronotal shield by some 15-35 percent of their length, depending on the species. There is little intraspecific variation and alary polymorphism is not normally detectable. The role of such exposed wings is discussed and one new species is described. Most such species probably owe their evident relationship to evolution prior to the disintegration of the Gondwanaland super-continent.

Introduction

The overwhelming majority of species of Tetrigidae have the wings shorter than, or ending close to, the caudal projection of the pronotum. There are, however, several apparently closely related species, mainly in south-east Asia, whose wings exceed the pronotal shield by some 15 - 35 percent of their length. There has been an understandable reluctance to recognize this peculiarity, probably because isolated individuals in collections could be examples of alary polymorphism. This view is taken by Tinkham (1937) who commented that "long and shortwinged forms of the same species are commonly encountered in the Acrydiinae and since they live side by side and are identical in all other respects they are not worthy of specific or subspecific recognition."

Nevertheless, long series from south-east Asia made available to me through the kindness of their Museum curators show little variation

in this respect, and it is no longer reasonable to be satisfied with putative alary polymorphism as an explanation of the phenomenon of exposed wings. Where alary polymorphism exists, as in *Hedotettix gracilis* Bolivar, we still need to address the question of why such exposed wings are built in as one pole of the polymorphism.

For instance, 119 Taiwanese specimens of *Paratettix cingalensis* (Walker) from the Lyman Entomological Museum of McGill University, Montreal, show extraordinary uniformity in the length of exposed wings. For some reason, conceivably common descent or common deployment in normally wind-free habitats, or both, there is a regional trend toward long wings projecting beyond the pronotal shield. Opinion as to the taxonomic value of relative wing-length in carefully circumscribed groups has sometimes been more favorable. Kirby (1914) notes that *Euparatettix interruptus* (Brunner von Wattenwyl) has the wings 2 mm (about 20 percent of the length) clear of the pronotum and he uses this character in his key to the Indian species of the genus. Hancock (1912) uses essentially the same character in his key to the genus *Saussurella* Bolivar, 1887. The extension beyond the pronotal shield has recently been used by Liang and Zhen (1984) as one of several characters differentiating two tetrigid genera. Nevertheless, unless sufficiently long series are available to establish stability of relative wing-length, reliance on this character could mislead.

Of the 250 drawings by Günther (1939) of tetrigids falling into his "sectio Amorphopi" (= *Metrodorae* auctt.) only three show exposed wings. In defining his concept of this group Günther (1939) says that in one instance the

flight organs considerably exceed the hind femora, whilst the wings extend almost or quite up to the end of the pronotum, not however projecting beyond it by more than 1 mm. The conviction that tetrigid wings do not substantially project beyond the pronotum may have led Günther into misconstruing Hancock's drawing of *Orthotettix obliquifrons* Hancock (1908) from Sarawak, Borneo, which shows the wings exceeding the pronotum by some 28 percent. Günther (1939) states of another male from Sumatra, which he refers to this species "die Flügel überragen nicht das Pronotumende", (the wings do not exceed the end of the pronotum) but this specimen has the vertex substantially broader than the eye, whereas Hancock's type has the vertex "subnarrower than the eye". Günther, however, correctly notes that Hancock erred in stating that the antennae were inserted distinctly between the eyes, as the drawing shows the point of insertion to lie below the eyes.

The genus *Probolotettix* Günther 1939 was described as including very characteristic elongate, elegant, smooth, and often rather large species with large eyes. I have, however, reservations about the status of *Probolotettix* as well as of *Pseudoparatettix* Günther 1937, and *Mazarredia* Bolivar 1887 as being generically distinct from *Paratettix* Bolivar, 1887. I also observe that the species originally described as *Paratettix angulobus* Hancock, 1907 in his Tettiginae was transferred by him (Hancock, 1913) to *Criotettix* Bolivar, 1887 (in a different informal division of roughly subfamily rank, the "scelimnae spuriae") back to *Paratettix* by Beibienko (1935), by Günther (1937) to *Pseudoparatettix* Günther, 1937, and eventually to *Probolotettix* by Günther (1939). This is a poignant reflection of the problem of generic assignment in this group of Tetrigidae.

Probolotettix exilis

new species

Fig. 1

Diagnosis. Very close to *P. corticolus* Blackith, 1987 from which it differs in having the metazonal crest clearly visible in profile, whereas

that of *P. corticolus* is visible only in dorsal view as a swelling on either side of the dorsal carina (Fig. 2). Moreover, the eyes of *P. corticolus* have a fringe of short sensilla between the facets, but only on the hind margin of the eyes; there is none in *P. exilis*. A key to the described species of *Probolotettix* is provided.

Holotype male. Papua-New Guinea: N.E. of Goroka, 22.iv.1973 at light (Ströder). Lyman Entomological Museum. Antennae 3.4 mm long. Vertex 0.2 mm narrower than eye (0.45 mm). Mottled light and dark brown. Lateral carina of vertex terminating against eye as slightly blackened protuberance. Median ocellus wide, 0.13 mm, filling intercarinal space. Eye prominent, median carina compressed. Clypeus medially ivory white, laterally dark brown. Upper labium ivory white, lower part dark brown. Prozona upturned against occiput. Metazonal crest visible in profile as raised crescent. Internal apodeme for protergal muscle(s) visible externally as open pit in mesonotum. This pit, though present as an indentation in all species of the genus seen, is broader and deeper in *P. exilis*. (N.B. This pit may become filled with extraneous matter and thus obscured.) Pronotal disc slightly rugose, tegmina broad elliptical (1.3 x 0.5 mm). Wing exceeding pronotum by about 2.6 mm (24 percent). Transverse suture on mesepisternum weakly developed. Foretibiae with 3 light and 3 dark rings. Forefemora not lobed on ventral carina. Ventral carinae of middle and hindfemora with sparse (ca. 7) setal fringe. Hind femora with cluster of about 5 whitish sensilla proximal to internal genicular area. Hind femora each externally with ca. 12 fragae on upper surface, ca. 4 fragae on lower surface which is without callosities. Hind tibiae with ca. 8 teeth on outer lower carinae, ca. 6 on inner. Metatarsus subequal in length to hind tarsomere. Length of pronotum 9.3 mm, width at shoulder 1.6 mm.

Allotype female. Papua-New Guinea: Sipegul School, 12 mi. Kundiawa. 16.vi.1972 (Ströder). Lyman Entomological Museum. Color as for holotype, but clypeus and labium mottled. Vertex width 0.4 mm; eye width 0.5 mm. Median ocellus 0.1 mm wide, not fully filling

intercarinal space. Exposed wing length 3 mm (29 percent). Upper ovipositor valves with 8 teeth, lower with 7 teeth. Length of pronotum 9.6 mm; width at shoulders 2.5 mm.

Paratypes: Papua-New Guinea: 1 male, Sipagul School, 12 mi. Kundiawa. 16.vi.1972, (Ströder); 1 male, 1 female, Lae, 9.x.1973, (Ströder); 1 female. Lae, 3.iii.1973, (Ströder); 2 males, 2 females, Morobe District, Wau, 15-17.viii.1972 at light, (Scudder); 2 males, 1 female, Goroka, 22.iv.1973, at light, (Ströder); 1 male, Goroka, 14.iii.1973. (Ströder). Lyman Entomological Museum.

Key to the described species
of the genus *Probolotettix* Günther, 1939

1. Vertex in strict profile visible 2
- 1'. Vertex not visible in profile 3

- 2(1). Median ocellus touching frontal carina 8
- 2'. Median ocellus not touching frontal carina (Sulawesi) *corticulus* Blackith

- 3(1'). Wings not exceeding pronotum (Sarawak) *centrosotettigoides* Günther
- 3'. Wings exceeding pronotum 4

- 4(3'). Head strongly exserted 5
- 4'. Head not, or weakly, exserted 6

- 5(4). Antennae inserted between eyes (Philippines) *languidus* (Bolivar)
- 5'. Antennae inserted below eyes (Philippines) *semperi* (Bolivar)

- 6(4'). Wings exceeding pronotum by more than 1 mm (East Asia, see note) *sundaicus* Günther
- 6'. Wings exceeding pronotum by less than 1 mm (Borneo and Sumatra) *angulobus* (Hancock)

- 7(2). Metazonal crest convex in profile (Sulawesi) *kevani* Blackith
- 7'. Metazonal crest concave in profile (Papua-New Guinea) *exilis* n.sp.

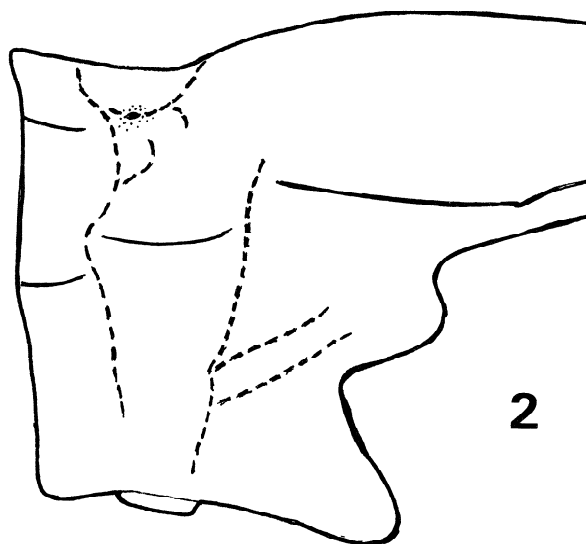
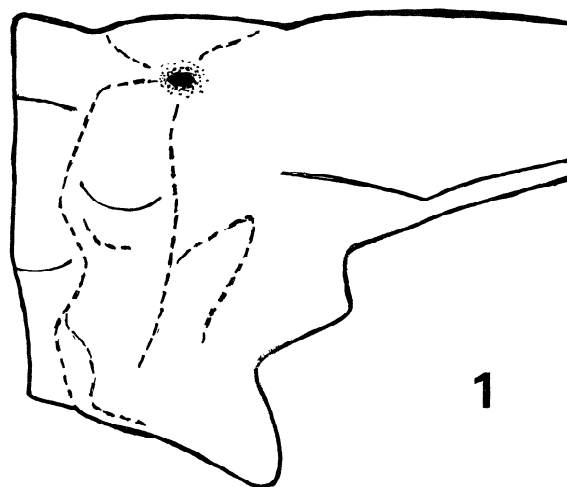


Figure 1-2. *Probolotettix* species, lateral view of pronotum. 1) *P. exilis*, n.sp., male holotype; 2) *P. corticulus* Blackith, male paratype.

Discussion

Table 1 lists several species centred on south-east Asia whose wings exceed the

Table 1. Percentage of wing exposure of Tetrigidae with partly exposed wings.

Species	Locality	Wing exposure %
<i>Probolotettix kevani</i> Blackith, 1987	Sulawesi	16
<i>Euparatettix interruptus</i> (Brunner, 1893)	Burma	20
<i>Mazarredia bolivari</i> Blackith, 1987	Sulawesi	20
<i>Paratettix cingalensis</i> (Walker, 1871)	Taiwan	20
<i>Probolotettix corticolus</i> Blackith, 1987	Sulawesi	20
<i>Paratettix femoralis</i> Bolivar, 1887	Sulawesi	22
<i>Probolotettix exilis</i> sp.n.	Papua-New Guinea	24
<i>Pseudoparatettix macrophthalmus</i> Günther, 1937	South Melanesia	26
<i>Orthotettix obliquifrons</i> Hancock, 1907	Sarawak	30
<i>Paratettix pullus</i> Bolivar, 1887	Fiji	31
<i>Andriana tertia</i> Günther, 1974	Madagascar	33

pronotal shield by amounts substantially greater than the 1 mm indicated by Günther (1939).

Questions that arise include that of the possible common origin or relationship of some or all of these species, and for the possible common environmental factor(s) leading to the development of this trait. Among the facts which need to be borne in mind when considering these problems is that wings exposed to this extent are so rare in Old World tetrigids away from the region in question, that we may suspect strong selection against such a trait under normal circumstances. The protective function of the caudal extension of the tetrigid pronotum is an inference, but appears plausible (Rodendorf, 1949).

Some tropical grasshoppers of the family Eumastacidae, among others, share the deep rain forest environment with tetrigids although they tend to be tree-canopy inhabitants. Some of the rain-forest tetrigid fauna appears, however, to be associated with micro-habitats on the trunks of trees, and to take to the wing fairly readily as shown by widespread records of their being taken "at light". Nevertheless, the interior of mature rain-forest is dark during the day, with about 1 percent of the incident light penetrating to the forest floor, and pitch-black at

night; we know little of what tetrigids do then. Bright lights are a wholly unnatural and intrusive stimulus which may trigger reactions only sparingly relevant to studies of tetrigid behaviour. In these circumstances it may be more relevant that eumastacids, and possibly tetrigids, living in rain-forests use the wings to sail-plane down towards the ground rather than to fly in any very positive sense (Blackith, 1973). Several tetrigid species, including *P. corticolus*, live mainly on the bark of forest tree trunks (Blackith and Blackith, 1987). The Queensland rain-forest species *Vingselina brunneri* (Bolivar) ascend the trunks of trees after dark (Key, 1974).

Damage to the exposed wings is likely to be minimal during such activity because the wind-speed in rain forests can be as little as 1 percent of that above the canopy (Blackith and Disney, 1988). All the species listed in Table 1 now live in areas covered, at least until recently, by rain-forest, and presumably evolved in such a habitat. Moreover, all the regions where exposed wings are found once formed part of the Gondwanaland super-continent which split up ca. 100 million years ago, by which time tetrigids had evolved to something approaching present forms (Sharov, 1968).

It seems at least plausible that many of the species with exposed wings are linked by common ancestry as well as by common habitat. In some instances differences between species are slight and there seem to be no clear means by which we can be sure that we are indeed dealing with distinct species rather than with infra-specific distinctions at least until there is a successful outcome to further research on the concealed genitalic structures involved. The large Sri Lankan species *Scelimena gavialis* (Saussure) and a number of allied species have intensely purple, curved, median glands issuing from the spermatheca. Several species more distantly related to *S. gavialis*, differing from those with purple glands at roughly subfamily level, have simple, straight, white, glands in this position (Ruth M. Blackith, unpublished observations).

Geographical separation is not, of itself, adequate grounds for creating supra-specific categories, since there are well-authenticated instances of closely similar species e. g. of *Xistra* Bolivar, occurring in Sri Lanka and in Taiwan, some thousands of kilometers apart, with no known representative of the genus in the intervening regions (Günther, 1938). It seems far more plausible that *Xistra* is a genus that evolved before the disintegration of Gondwanaland than that strong convergence is primarily responsible. For example, the genera *Archaeotettix* Sharov and *Prototettix* Sharov are found in the Lower Cretaceous of Transbaikalia (Sharov, 1968). Tetrigids appear to have evolved from the Triassic/Jurassic Locustopidae well before the disintegration of Gondwanaland.

Apparently closely related species of highly characteristic genera, most notably *Xistra* Bolivar, although not involved in the exposed wing problem, also occur as far apart as Sri Lanka and the Philippines. I can confirm Hancock's (1907) record of a single female *Xistra stylata* Hancock from Sri Lanka as there is a previously unidentified male specimen in the Danish National collection which I have examined. This specimen is labelled "Ceylon"/"Mus. Westerm." in writing consistent with other labels dated around 1810.

We do not understand the full range of selective forces acting to mediate wing-length in tetrigids. Some Palaearctic species have long wings, some have short, but although we know what habitats they occupy now, we do not usually know what habitats they evolved in. Within the last decade, some rain-forest tetrigids in South - East Asia have adapted to life in newly established padi rice fields, and are so apparently successful there that one might never guess that the transition was so recent (Blackith and Blackith, 1987). Future biologists may puzzle over the many adaptations to life in rain-forests that they discover in such insects particularly if forests are no longer to be found in the vicinity.

The evolution of exposed wings in rain-forests would form the opposite polarity of a continuum of wing-lengths culminating in apterism in highly exposed mountain areas, such as the high plateau of Qinghai-Xinjiang in Tibet (Yin Xiang-chu, 1981). We might speculate that such selective forces could counter the reproductive penalty associated with flight in some insects with alary polymorphism, a topic recently reviewed by Denno *et al.* (1989) although the application of this idea to tetrigids is conjectural.

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Literature Cited

- Bei-Benko, G. Ya.** 1935. Acridiidae and Tettigoniidae from Luzon, Philippine Islands. *Philippines Journal of Science* 57:377-407.
- Blackith, R.E.** 1973. A new eumastacid grasshopper. *Acrida* 2:109-118.
- Blackith, R.E. & R.M. Blackith.** 1987. Tridactylids and tetrigids (Orthoptera) from Sulawesi (Indonesia). *Tijdschrift voor Entomologie* 130:1-10.
- Blackith, R.E., & R.H.L. Disney.** 1988. Passive aerial dispersal during moulting in tropical Collembola. *Malay Nature Journal* 41: 529-531.
- Denno, R.F., K.L. Olmstead, & E.S. McCloud.** 1989. Reproductive cost of flight capability: a comparison of life history in wing dimorphic planthoppers. *Ecological Entomology*, 14(1):31-44.
- Günther, K.G.** 1937. Orthoptera Celebesica Sarasiniana, Fam. Acrididae, subfam. Acrydiinae. *Treubia* 16(2):165-195.
- Günther, K.G.** 1939. Revision der Acrydiinae (Orthoptera). III. Sectio Amorphopi (Metrodoraе aucctt.) Abhandlungen und Berichte der Museum für Tierkunde und Volkerkunde zu Dresden. 20 (A):1-335.
- Günther, K.G.** 1972. Die Tetrigidae (Orthoptera, Caelifera) von Sud-Melanesien. *Zoologische Beiträge*, 18(1):251-292.
- Hancock, J.L.** 1907. Studies of the Tetrigidae (Orthoptera) in the Oxford Museum. *Transactions of the Entomological Society of London*. 1907:213-244.
- Hancock, J.L.** 1908. Further studies of the Tetriginae (Orthoptera) in the Oxford Museum. *Transactions of the Entomological Society of London*, 1908:377-426.
- Hancock, J.L.** 1912. Tetriginae (Acridiinae) in the Agricultural Research Institute, Pusa, Bihar, with descriptions of new species. *Memoirs of the Agricultural Research Institute, Pusa*, 4(2):132-216.
- Hancock, J.L.** 1913. Studies of Tetriginae (Acrydiinae) from the Sarawak Museum, Borneo. *Sarawak Museum Journal* 1(3):35-54.
- Key, K.H.** 1974. Orthoptera. Ch. 21 in *The Insects of Australia (Supplement)*, 45-47, Melbourne University Press.
- Kirby, F.W.** 1914. Orthoptera, Acridiidae. In *The Fauna of British India, including Burma and Ceylon*. London. 11-80.
- Liang Ge-qiu & Zheng Zhe-min.** 1984. A new genus and a new species of Tetrigidae from Guandong Province (Orthoptera: Tetrigidae). *Acta entomologica sinica* 27:430-432.
- Rodendorf, B.B.** 1949. Evolutsiya i Klassifikatsi letatel'nogo Apparata Nasekomnykh (Evolution and Classification of the Flight Apparatus of Insects). *Trudy Palontologicheskogo Instituta Akademiya Nauk CCCP, Leningrad* 16:3-176.
- Sharov, A.G.** 1968. Filogeniya ortopteroidnykh nasekomykh (Phylogeny of the Orthopteroidea). *Transactions of the Institute of Palaeontology, Academy of Sciences, USSR/Israel Program for Scientific Translation, Jerusalem*. 1971.
- Tinkham, E.W.** 1937. Notes on the identity of Formosan Acrydiinae with descriptions of a new genus and two new species (Orthoptera, Acrididae). *Transactions of the Natural History Society of Formosa* 27:229-243.
- Yin Xiang-chu.** 1981. Adaptation of grasshoppers and locusts in Qinghai Plateau. In *Geological and ecological studies of Qinghai-Xizang plateau*. vol. 2, pp. 1079-1086. (In Mandarin, with English summary)