ON THE FUNCTION OF THE SUB-ELYTRAL CAVITY IN DESERT TENEBRIONIDAE (COL.)

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Desert beetles of the family Tenebrionidae are usually black in colour with long legs which carry their bodies above the hot sand surface. They are characteristically wingless with thick, fused elytra beneath which there is often a large air-filled cavity. According to Buxton (1923), loss of flight in these beetles is not confined to species which inhabit deserts but is much more common amongst them than among others. 'That it is due solely to the wind and not to any other influence is apparent from the fact that a similar loss of the power of flight occurs in many other environments which are exposed to violent winds, but do not in any other respect resemble deserts: the insects of mountain tops and of small isolated islands furnish examples.' (p. 113).

The majority of Tenebrionidae in the Sudan, such as *Pimelia grandis* Klug and *Ocnera hispida* Forsk. are nocturnal in habit although a few, of which *Adesmia antiqua* Klug is an example, are diurnally active (Cloudsley-Thompson, 1963). Various species from the Tunisian desert have been arranged in a series according to their rates of water-loss by transpiration which is, to some extent, correlated with their time of activity as observed in the field (Cloudsley-Thompson, 1956).

It has been suggested that the presence of a large sub-elytral cavity in Tenebrionid beetles implies protection from heat or drought, as the air used for respiration passes through this cavity into which the spiracles open and is thus possibly cooled and moistened before entering the tracheae. However, Koch (1961) points out that increases and reductions in the volume of the sub-elytral cavity are found in both diurnal and nocturnal species of the Namib desert. For example, an increase is found in the day-active *Onymacris plana plana* Péringuey and in the nocturnal *Epiphysa louwrensi* Koch and a reduction in the diurnal *Calognathus chevrolatii eberlanzi* Koch and in the night active *Stips stali* (Haag).

Onymacris unguicularis Haag shows extreme convexity of the elytra and a consequent increase of the sub-elytral cavity, whilst the complanate *Stips stali* which occurs with it in the barchan dunes of the southern Namib has a reduced sub-elytral cavity. In both species, the convexity or flattening of the body are primitive features peculiar to the respective tribes, Adesmiini and Eurychorini; but there are also cases in which reduction of the sub-elytral cavity in dune-dwellers is a secondary adaptive feature, as in the male *Onymacris plana*. This day-active species is dimorphic, for the female retains a high degree of primitive convexity whilst the male shows an umbrella-like complanation of the elytra and consequent reduction of the sub-elytral cavity.

From the above, it can be seen that there is little morphological evidence for the assumption that increases in the volume of the sub-elytral cavity are directly related to protection from heat and transpiration, as suggested by Marcuzzi (1960), since such a cavity may often be non-existent in day-active species and extremely large in nocturnal forms that enjoy a comparatively higher degree of coolness and humidity.

Bolwig (1957) exposed day-active desert Tenebrionidae to an electric heater and recorded by means of a thermo-couple, their body temperatures and the temperature of the air under the elytra. He found little evidence that the temperature was lower under the white elytra of *Onymacris bicolor marshalli* Koch than under the black elytra of *O. multistriata* Haag or that it differed much from that of the body. When body temperatures approached 40°C., however, the air temperature under the elytra of *O. bicolor marshalli* showed fluctuations due to ventilation of the sub-elytral cavity by rhythmic protraction and retraction of the head. *O. multistriata* does not ventilate its sub-elytral cavity to the same extent, with the result that the temperature of the air within closely followed that of the body in this species.

Another cooling device used when the body temperature rose rapidly was to expose the genital apparatus, but there appeared to be no fixed temperatures at which either of the two mechanisms was employed. Bolwig concluded from his experiments that diurnal Tenebrionid beetles are adapted to tolerate high temperatures for short periods and have an active mechanism which makes it possible for them to maintain a body temperature at 40°C. long enough to cross exposed sand from one sheltering place to another, even in the hottest part of the day. They cannot, however, survive exposure to the heat over a prolonged period of time.

This agrees with the observation that the lethal temperature over 24 hours' exposure at 10 per cent. relative humidity is 43°C. for *Pimelia grandis* and 45°C. for *Ocnera hispida*. These, although higher than the lethal temperatures of cockroaches, crickets and other insects, are far below that of the 'camel-spider' *Galeodes granti* Pocock (Solifugae) which is 50°C. or that of the scorpion *Leiurus quinquestriatus* (H. & E.) which is 47°C. (Cloudsley-Thompson, 1962).

The air within the sub-elytral cavity of *P. grandis* and *O. hispida* is not appreciably more humid than the air outside. This was ascertained by experiments in which a small slit was cut through the elytra and a piece of cobalt thiocyanate paper inserted into the sub-elytral cavity. No difference in colour could be distinguished between that portion of the paper inside the sub-elytral cavity and the part which projected outside. Approximately 5 per cent relative humidity was recorded in both situations in each species, at ground level both in the shade and full sunlight, at air temperatures around 35°C. and relative humidities of 15 per cent measured with a whirling hygrometer 5 ft. above the ground.

By means of an electrical resistance thermometer incorporating thermistors (Cloudsley-Thompson, 1956) I found that the temperature inside the sub-elytral cavity of *P. grandis* was, at the same time, about 37°C., the same as on the outside surface. It was not possible, however, accurately to measure the temperature of the elytral surfaces and no estimate at all could be obtained in the case of *O. hispida* as the hairy projections of this species prevented the thermistors from making proper contact. Nevertheless, a temperature of 40°C. was recorded inside the sub-elytral cavity when beetles of this species were placed in sunlight at an air temperature of 37°C. and relative humidity of 15 per cent. Readings were taken after 15 minutes exposure and the beetles were dead within half an hour.

A series of experiments was carried out in which the lethal temperatures of groups of normal control *O. hispida* exposed to high temperatures for 24 hours in an incubator at 10 per cent relative humidity, were compared with those of beetles from which a piece of the fused elytra, about one cm. in diameter, had been removed to expose the abdominal tergites. No difference in survival was noted, however, between the control and the experimental beetles and neither group suffered an excessive degree of water-loss by transpiration. Therefore either the presence of a sub-elytral cavity conferred no thermal advantage or the increased transpiration afforded by its removal was not sufficiently great to engender a significant degree of cooling, or the two factors cancelled each other out. In view of the low transpiration rate even after removal of part of the elytral covering of the abdomen, it would seem most probable that the results of this experiment merely indicate that the thermal effect of the sub-elytral cavity is negligible in either respect.

Although the air inside the sub-elytral cavity did not appear to be appreciably cooler or moister than the air outside, whether the beetles were in sun or shade, it seemed possible that the presence of a sub-elytral space into which the spiracles open, might help to reduce the amount of water normally lost by transpiration. To test this, I removed pieces of fused elytra from a number of *P. grandis*, again exposing the abdominal tergites. The beetles were left for at least two days to recover from any adverse effects of the operation. They were then weighed individually on a single-pan balance to the nearest 0.0001 gm. and placed, in groups of five, in desiccators over anhydrous calcium chloride at a room temperature of 30 ± 1°C.

Five experimental beetles, weighing initially a total of 8.208 gm., lost weight at a rate of 0.261, 0.174, 0.145 and 0.137 gm. on four subsequent days, whilst control beetles, weighing a total of 7.931 gm. lost 0.076, 0.081, 0.050 and 0.072 gm. at the same time.

It is clear from this and the results of similar experiments that the presence of the elytra significantly reduces the rate of water-loss by transpiration even though the sub-elytral air-space appears to have no appreciable cooling effect.

If, as seems most probable, the sub-elytral cavity reduces water-loss by transpiration merely because the spiracles open into it and not directly to the exterior, it will not matter whether it is large or small in size, since its function is merely to prevent air currents from moving across the entrance to the spiracles. Consequently the size of the sub-elytral air space should not be regarded as an adaptive feature as regards heat or water-relations. This view corresponds with its haphazard occurrence amongst desert beetles which is not in any way correlated with habitat or time of daily activity.

I am grateful to Dr. A. Eve for reading this paper and for his helpful comments.

References

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April 1st, 1964.

Since this note was written, I have seen the paper by Yu. B. Dizer (1955, On the physiological role of the elytra and sub-elytral cavity of steppe and desert Tenebrionidae, *Zool. zh. S.S.S.R.*, **34**: 319–22. In Russian.). By means of experiments somewhat similar to mine, Dizer showed that the sub-elytral cavity is a morpho-physiological adaptation to conditions of extreme aridity. It lowers water-loss through transpiration and, together with other adaptations, enables Tenebrionidae to live in extremely dry regions of central Asia and Africa.—J. L. C.-T., 15.xii.64.

Hypotheses as to the foodplant of Myiolia caesio Harris (*Dipt., Trypetidae*).—A. A. Allen (1963, *Ent. mon. Mag.*, **99**: 214) suggests, on the most tenuous evidence, that *Myiolia caesio* Harris may be a leaf-miner attacking coltsfoot (*Tussilago farfara* L.) and refers to similar hypotheses of other authors.

In my opinion, the generic taxonomy of trypetid flies is in no condition to permit the habits of the larvae to be safely predicted from those of superficially similar species in this tribe. It is unlikely that the conspicuous leafmines of a trypetid would have passed unnoticed in Britain for so long, though it must be admitted that *Spilographa spinifrons* Schroeder remained undetected on *Solidago* until fairly recently.

However, Allen and others overlook the very remarkable fact that this fly is rare, yet distributed over the whole of the British Isles. Adult Trypetidae are not of obscure habits, so the cause must be sought in the biology of the early stages, which at once makes leaf-mining in any common plant unlikely. The likely answer is to be found in Hendel (1927, *Die Fliegen der Palaearktischen Region*, 49 Trypetidae, p. 104), where *Myiolia lucida* Fallén is recorded on Loew's authority as having been reared by Roser from the berries of the honeysuckle *Lonicera xylosteum* L. Kieffer is on record as having witnessed a female of that fly boring into a fruit of the same honeysuckle. Now *Lonicera periclymenum* L. is abundant in suitable places throughout Britain, but reproduces mainly vegetatively. In Surrey woodlands on the London Clay or clay-with-flints, for example, the plant is often a dominant element of the ground flora, whilst some plants climb strongly over bushes to a height of 3 metres or more. Such areas are almost completely barren of flower, which may be restricted to a few plants in a hedgerow outside the wood.

Honeysuckle is not the only berry-bearing plant whose barrenness in Britain could account for the rarity of a fruit fly, but it is the most likely one to have occurred as a common feature in the vicinity of all the captures of *Myiolia caesio* that have been reported.—R. W. J. Uffen, 4 Vaughan Avenue, London, W.6. *September 14th*, 1964.

International Commission on Zoological Nomenclature.—Notice is given of the possible use by the International Commission on Zoological Nomenclature of its plenary powers in connection with the following cases, full details of which will be found in *Bull. Zool. Nomencl.*, 21, Part 5, published on November 26th, 1964.

Designation of a neotype for *Lygaeus quadratus* Fabricius, 1798 (Hemiptera). Z.N. (S.) 1560.

Suppression of *Laemophloeus immundus* Reitter, 1874 (Coleoptera). Z.N. (S.) 1649.

Comments, bearing the reference number, should be sent in duplicate, before May 26th, 1965, to The Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), London, S.W.7.—Eds.