

Notes on *Opifex fuscus* Hutton (Diptera: Culicidae) and the Scope for Further Research On It

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New Zealand's remarkable mosquito, *Opifex fuscus*, described by Hutton (1902) as a Tipulid, was placed in the Culicidae by Edwards (1921), who redescribed both sexes and drew attention to the peculiar modifications of the antennae and forelegs of the male. Miller (1922) gave more detailed descriptions, including also the larva and pupa, and Kirk (1923) gave a very full account of its unique mating habits. The pupa has since been figured in greater detail by Knight and Chamberlain (1948). Miller and Phillips (undated) give the range of *O. fuscus* as the rocky coast line of the North Island and the northern part of the South Island; it breeds in saline pools above high water. No precise locality records appear to have been published, other than the original one of Wellington, and the sites marked on Graham's (1939) map. The genus *Opifex* is monotypic and confined to New Zealand. Miller (1922) erected a separate tribe for it, but Edwards (1924) did not regard this as justified. It shows strong affinities with the genus *Aedes*.

These notes have resulted from the examination of specimens in the Auckland Museum, and an evening spent collecting *O. fuscus* at Wellington and watching its behaviour in a cage.

DISTRIBUTION. The known range of *O. fuscus* is extended both north and south by the following specimens in the Auckland Museum collection. Three Kings: Great I., April 17, 1946, 3 ♀♀ "biting sp. at landing (common)"; May 6, 1946, 2 ♀♀ "at camp"; January 11, 1951; 1 ♀ "beatings of *Coprosma* in gull colony", all coll. E. G. Turbott; Tasman Valley, Great I., January 5, 1953, 1 ♀ coll. G. Archey. Otago: Cape Saunders, February 24, 1918, 1 ♀. (Dr. E. P. Hodgkin and Mr. B. V. Fennessey informed me that they had seen mosquito larvae in rock pools on the outer coast of the Otago Peninsula in January, 1957; in view of the preceding record, it is likely that these were *O. fuscus*.)

BEHAVIOUR. On January 24, 1957, in rock pools at Island Bay, Wellington, adults of *O. fuscus* were collected just before dusk, skimming along the water surface, occasionally jumping or flying a short distance. These were placed in a 9in x 9in x 9in cage, with a bowl of pupae from the same site, and under artificial light, males

were observed to alight on the water and seize pupae. Kirk did not point out the great struggle that ensues between the male and the pupa, in which the male may lose his captive and be turned upside down on the water surface. He is able to right himself and sits on the water, the mid legs acting as the chief supports, while he removes the excess moisture by wiping the hind legs against one another, wiping the antennae, palps, proboscis and sometimes the hind legs with the fore legs, and wiping the wings with the hind legs. A pair in copula parted, and another male paired with the female on the water; she was also seized by two additional males, one gripping her neck with his claspers, and in the process the female was tumbled about on the water, but appeared to be able to right herself and dry herself also. In flight *O. fuscus* makes a sound more like the buzz of a fly than the usual high pitched note of a mosquito.

MORPHOLOGY. Neither Edwards nor Miller remarked on the strong development of the scape and small size of the pedicel of the male antenna as compared with other species. In both sexes of *O. fuscus* proboscis, palps, antennae and tarsi are densely clothed with fine short hairs. Attention has not previously been drawn to a difference between the sexes—the femora and tibia of the female lack this vestiture but it is present on the fore femur and all tibiae of the male. The male terminalia are much more heavily sclerotised than in most mosquitoes.

P. F. Mattingly (1957) has recently observed that among *O. fuscus* larvae in the British Museum collection, received in 1921 from G. V. Hudson and collected at Wellington, some have pectinate hairs in the mouth brushes instead of all simple hairs as described by Miller. He suggests that this might be a case of balanced polymorphism leading to a fuller exploitation of the breeding places, and if so would be of considerable interest to geneticists. The total collection of larvae from Island Bay, Wellington, January 24, 1957, was examined, and found to comprise: (a) specimens with simple mouthbrushes, 44 4th instar (including 4 skins), 56 3rd instar, 28 2nd instar, 4 1st instar. (b) Specimens with pectinate mouthbrushes 17 4th instar, 7 3rd instar, 1 2nd instar. Of 4 4th instar larvae from Breaker Bay, Wellington, March 23, 1944, Coll. W. J. Phillipps, 1 had simple and 3 had pectinate mouthbrushes. The different instars can be recognised by the width of the head capsule, which approximates 1.4 mm in 4th instar, 0.9 mm in 3rd instar, 0.5 mm in 2nd instar, and 0.3 mm in 1st instar.

SOME SUGGESTIONS FOR FURTHER RESEARCH

1. *Function of Male Antennae.* The male antennae in most mosquitoes are plumose and are the organs which enable the male

to locate the female in flight; the sound of her flight stimulates him to copulate (see Roth, 1948). The male antenna of *O. fuscus* lacks long hairs, but the second, third and fourth segment of the flagellum each bears a dorsal spine-like bristle; the pedicel, which contains the auditory organ, Johnston's organ, is reduced in size. Kirk describes males thrusting their heads below the surface to get a clearer view of the pupae. Does the antenna play any part in locating pupae by detecting vibrations in the water, and if so do mature pupae produce different vibrations from immature ones? Are males attracted to pupae of other species? In the laboratory, males may be attracted to fully emerged females resting on the water—what is the stimulus here?

2. Function of the glandular sac at the tip of the male palps (apparently this is not present in other genera).

3. *Rotation of male terminalia.* The terminalia of male mosquitoes rotate through 180° after emergence from the pupa; this usually takes 15—24 hours and mating cannot be successful until it has occurred. Kirk describes males of *O. fuscus* commencing to hunt pupae within 20 minutes of emergence. How long does rotation of the terminalia take and does it occur during or after emergence?

4. *Rate of wing beat.* From the sound made, it seems likely that this differs from most mosquitoes.

5. *Prevention of wetting.* Most mosquitoes would be drowned if subjected to a small amount of the tumbling in the water that adults of *O. fuscus* can survive, no doubt due to their hairiness, particularly of head, legs and abdomen. Is the action of these hairs mechanical, or have they any special hydrofuge properties?

6. *Source of energy.* *O. fuscus* males, soon after emergence, very actively seek mates and often have great struggles with the pupae they seize. Do they, as seems likely, require much greater reserves of energy than the average male mosquito, and if so what is the source (presumably in larval food) and method of storage of that energy.

7. *Morphology.* The peculiar modifications of the male antennae and forelegs, and the power required in the claspers for seizing and tearing the pupa suggest an interesting comparison of the musculature with that of a normal mosquito.

8. *Cannibalistic larvae.* Miller did not amplify his statement that the larvae were cannibalistic. Do they feed only on dead bodies of other larvae (not an uncommon habit in mosquito larvae) or attack living larvae (a comparatively rare habit)? If the latter, what is the method of seizing and devouring their prey? In other

species which do this either the mouthbrushes, the mandibles or the maxillae may be adapted for seizing; the mouth-parts of *O. fuscus* do not appear to be specially modified. Do larvae of both types (of mouthbrushes) have the same cannibalistic habits?

9. *Two types of larvae.* What are the feeding habits of larvae with pectinate and with simple mouthbrushes? Is there any evidence that this is an example of balanced polymorphism? Do the proportions of the two types vary from pool to pool, or in different localities, or with the seasons, and if so can this be related to available foods?

10. *Relationships.* A detailed comparison of the chaetotaxy of all larval instars and of the pupa with representatives of the subgenera of *Aedes* that occur in the Australian region might throw light on the ancestral stock from which *Opifex* is derived and indicate in particular whether resemblances to *A. (Pseudo-skusea) australis* are due to common ancestry or to convergence, possibly resulting from their similar habitats. The terminology for such a study has been provided by Belkin (1950, 1952, 1953, 1954).

11. *Behaviour.* A film of the mating behaviour of *O. fuscus* would be particularly instructive and should determine the range of functions of the modified forelegs and the reason for the differential distribution of hairs on the legs of the two sexes.

12. *Breeding places.* What is the range of salinity that the larva of *O. fuscus* can tolerate? Does it breed only on exposed shores or can it breed also in sheltered estuaries? (cf. *A. australis*).

DISCUSSION. *O. fuscus* breeds all the year round in sites reasonably accessible to most of the major research institutions in New Zealand and is amenable to laboratory study. It therefore provides an excellent opportunity for further research. Any comparison of it with other mosquitoes would best be made with species of *Aedes*, the genus to which it appears most closely allied. As regards species from other habitats, *Aedes notoscriptus* (Skuse) and *Aedes antipodeus* Edwards are available in New Zealand, but a very interesting comparison could be made with *Aedes australis* (Erichson) (= *concolor* Taylor), which inhabits corresponding breeding sites on the rocky shores of Australia (distribution and references in Mattingly and Marks (1955)). Woodhill (1936) has shown *A. australis* to be suitable for laboratory study.

Previous authors have not suggested the significance of the modifications in structure and behaviour of *O. fuscus*. They appear to be adaptations to life on wind and spray swept rocky coasts where males emerging 24 hours before the females, or adults mating in flight might be blown far from their breeding places. *A. australis*, which shows no such specialisation, inhabits similar sites in Aus-

tralia but can breed also in sheltered estuaries and in water of low salinity.

The literature does not indicate whether *O. fuscus* ever breeds in sheltered sites. There might also be a difference in the amount of shelter for adults provided by vegetation in the vicinity of breeding places of the two species, which would help to account for the different degrees of specialisation to the habitat.

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