A New Method of Studying the Wing Veins of the Mayflies and Some Results Therefrom (Ephemerida).

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The wing of a mayfly as in other insects consists essentially of a saccular out-pocketing of the body wall, into which during the immature stages tracheae, blood vessels, and nerves penetrate. In the adult, this sac becomes flattened, greatly extended, and very thin, and veins are laid down. The mayfly wing is characterized (1) by the concave-convex placement of the wing veins, i.e., concave (or "down") and convex (or "up") veins alternating regularly with each other, and (2) by the triadic type of branching, i.e., whenever a vein forks there is always an interpolated vein of opposite position between the two branches. Thus a concave vein will fork into two concave branches; the interpolated vein is convex; and the regular alternation of convex and concave veins is preserved.

By soaking an adult wing in a 10-15% caustic soda solution for 24 to 48 hours, the connections between the two sides of the wing are broken and the wing separates into its component dorsal and ventral parts. The two surfaces can be cut apart at the margins and mounted on a slide for study.

The striking feature to be noted on a wing which has been treated thus is that all the convex veins belong to the dorsal surface of the wing and the concave veins to the ventral surface of the wing. The cross veins belong principally to the dorsal surface. Only at the base, where they join the concave veins which are on the ventral surface, is a stump of the cross vein to be found, while on the dorsal surface the cross veins are always complete and vigorously developed. The single exception to this condition is in the area between the costal edge of the wing and the sub-costal vein. Here the cross veins are better developed on the ventral wing surface, or at least developed equally on both surfaces of the wing. It is important to note that veinlets at the edge of the wings are always restricted to the dorsal surface.

Comstock and Needham in *Wings of Insects*[1] published a nomenclature which homologized the mayfly wing venation with that of other orders. Morgan[2] (1912) interpreted the

median and radial sector in the same manner as Comstock and Needham had interpreted them in Odonata. Tillyard [3] (1922) reworked the whole subject in correlation with his well known work on the veins of the Odonata. Lameere [4] (1922), dealing with the Paleodictyoptera, Odonata and Ephemerida, advanced the hypothesis that in the ancestors of these groups the medial and cubital veins each presented a configuration similar to that of the radial and its branch the radial sector, i.e., a convex (radial) followed by a concave (radial sector). He terms these the anterior median (convex), posterior median (concave), anterior cubital (convex), and posterior cubital (concave). He also extended this hypothesis to the anal veins. In living mayflies he contended that anterior medial and anterior cubital were lacking. Martynov'[5] (1922, published 1924) holds a view similar to that of Lameere but considered only the anterior median to have been lost.

Study of the two separated wing parts shows clearly that the vein Miss Morgan interpreted as Rs is not the radial sector but that the radial sector is in reality the concave vein just behind R.

According to Lameere's hypothesis it would be necessary, in order to maintain the regular alternation of convex and concave veins, which is invariably the condition found in the mayflies, that the posterior median had changed from a concave vein to a convex vein.

The loss of the anterior median, as hypothesized by Martynov, would necessitate all concave veins posterior to the radial sector to have changed to convex veins and vice versa.

Such changes as these would necessitate the "jumping" of a convex vein from the dorsal surface to the ventral wing surface and vice versa. Study of the separated wing parts shows that in no case is there any indication that any vein has ever changed from the dorsal to the ventral surface of the wing. Thus we are safe in assuming that the mayfly possesses a complete and archaic set of costal, radial, medial, and cubital veins, i.e., an anterior convex vein followed by a posterior concave member.

Tillyard [6] (1926), influenced by Lameere's hypothesis, modified his earlier nomenclature and to avoid confusion I have followed his system.

It is hoped that this method of study can be used by workers in other groups. For a fuller discussion of the Ephemerid wing veins, the reader is referred to my forthcoming paper on the *Phylogeny of Some Mayfly Genera.*

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