The Oriental Region: the last frontier paradise for black flies

The Oriental Region is perhaps the last frontier paradise explored by black flies. It is shown by the comparison of the fauna of black flies in the Oriental Region, which is relatively young and rich, with those of the five other zoogeographical regions.

Black flies are tiny, two-winged, biting insects of medical and veterinary importance. They are distributed in many areas throughout the world, where there are clean, running waters suitable for breeding sites of their pupae and larvae.

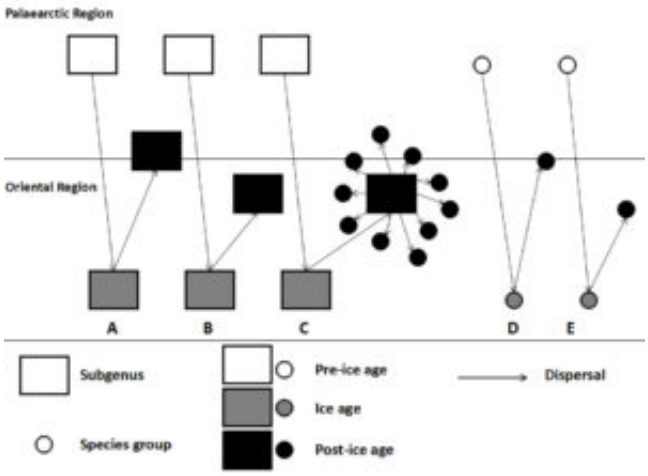

Fig. 1.

The number of extant species around the world is 2,204, of which 707 are from the Palaearctic, 524 from the Oriental, 326 from the Neotropical, 265 from the Nearctic, 204 from the Australasian and 216 from the Ethiopian Regions. All 524 Oriental species are classified in the genus *Simulium,* the largest among the 26 genera of the family Simuliidae. All the 25 other genera, which are regarded as more primitive than the genus *Simulium*, are absent in the Oriental Region. Under the genus *Simulium*, Oriental black fly species are further classified in 10 subgenera, of which four are cosmopolitan, two are of Palaearctic elements, one is semi-endemic and three are endemic. The subgenus *Simulium* is dominant, having 232 species (44.3%), followed by *Gomphostilbia* with 193 species (36.8%) and *Nevermannia* with 55 species (10.5%), while seven other subgenera consist of 1–16 species. The three dominant subgenera (*Gomphostilbia*, *Nevermannia* and *Simulium*) are composed of 11, 3 and 13 species-groups, respectively.

The numbers of species in each zoogeographical region might have been determined by the number of phylogenetic segregates and their capabilities to undergo speciation. The number of segregates in the Oriental Region is moderate, 34, whereas it is 57 in the Palaearctic, 46 in the

Neotropical, 37 in the Nearctic, 30 in the Australasian and 22 in the Ethiopian Regions. On the other hand, the speciation index is the highest, 15.4, in the Oriental Region, followed by 12.4 in the Palaearctic, 9.8 in the Ethiopian, 8.8 in the Neotropical, 6.8 in the Australasian, and 5.8 in the Nearctic Regions. The result shows the high rate of speciation is a main driving force for the rich fauna of the Oriental Region. In fact, it is associated with high speciation rates of the two dominant subgenera, *Simulium* and *Gomphostilbia*. The Oriental Region might have been remarkably suitable in its climatic and environmental conditions for both subgenera to undergo speciation. Perhaps, it was advantageous to be in no competition with other genera. The existence of these two large subgenera might have played a significant role in forming the current simuliid fauna in the Oriental Region.

At the segregate level, the highest affinity index, 31.9, is obtained between the Oriental and Palaearctic Regions, followed by 24.1 between the Nearctic and Palaearctic Regions; the index for the Oriental and Australasian Regions is low, 6.7. The Oriental Region has the strongest relationship with the Palaearctic Region, supporting the hypothesis of the northern origin of all segregates of black flies in the Oriental Region.

From the current geographical distributions and other data including specialized morphological characters, it is inferred that eight of 10 Oriental subgenera moved during the ice ages from the Palaearctic to the Oriental Regions; the subgenus *Gomphostilbia* evolved into 11 species-groups and underwent speciation in the Oriental Region. On the other hand, two other subgenera, *Nevermannia* and *Simulium*, moved southward during the ice ages after evolving into species-groups. In the post-ice ages, most segregates retreated northward, with different portions of species left in the Oriental Region, although some segregates failed to retreat and survived as relict in the Oriental Region (Fig. 1).

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