Diversities of Hymenoptera and Diptera during the Triassic: why so different?

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Triassic is the time of origin of two hyperdiverse orders comparable in their recent diversity: Diptera, known since the Anisian, with over 150 extant families and 160,000 species, and Hymenoptera, known since the Ladinian–Carnian, with 130 extant families and 152,000 species. For the Triassic, a single hymenopteran and about twenty dipteran families have been recorded. We explain this contrast by different ecological strategies of early representatives of the two orders.

Immature Diptera are currently more diverse and abundant in fresh water than any other insect order. Zherichin and Sinichenkova demonstrated that the Triassic was the time of considerable radiation of aquatic insects, both lotic and lentic. Dipterans were part of this process from the very beginning, and at least half of their Triassic diversity had resulted from such radiation. During the Triassic, deltaic areas were environments with unstable and occasionally harsh conditions, with numerous shallow drying pools widely varying in temperature and oxygenation. The tracheal systems of Anisian dipteran immatures facilitated colonization of low-oxygen environments: such diverse immatures were restricted to edges of pools and streams, reaching the atmospheric air by larval spiracles at the abdomen apex or pupal long respiratory horns. In the Late Triassic, the semi-aquatic, strictly aquatic, and advanced rheophilic midges occurred, demonstrating expansion from near-shore habitats to deeper waters.

In contrast, the Triassic Hymenoptera were not diverse. We are aware of 73 fossils in six Late (or Mid to Late) Triassic insect sites in Kyrgyzstan, Japan, Australia, South Africa, Argentina, and Germany. All the Triassic Hymenoptera represent the same basal family, Xyelidae, with one possible exception: one insufficiently known fossil may have belonged to another relavtively basal family, Sepulcidae. More importantly, all involved Xyelidae (Archexyelinae, Madygellinae, and possibly Xyelinae) and Sepulcidae (Parapamphiliinae and Xyelulinae) are similar in general appearance and demonstrate a sword-like elongate, flat, serrate ovipositor characteristic of extant Xyelinae. Female *Xyela* use it to oviposit inside developing male cones of pine trees, where their larvae feed. Apparently, all known Triassic Hymenoptera fed, during the larval stage, on unripe contents of gymnosperm microsporangia. This ecological uniformity, coupled with seemingly permanent avaiability of the food resource, may explain the slow diversification of Hymenoptera during the Triassic.