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First fossil dragonfly from India

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well-preserved head, thorax and a long cylindrical abdomen with terminalia and four wings with longitudinal veins, cross-veins and characteristic small pterostigma at the apex. These significant morphological attributes reveal a close resemblance of the fossil specimen with modern dragonflies of the family Libellulidae (order: Odonata, sub-order: Anisoptera). To the best of our knowledge, there is no reliable occurrence of dragonfly in the Indian fossil record. The core distribution of the dragonfly, suggests that it thrived under a tropical, warm, humid climate during the depositional period. The fossil specimen was found associated with prolific and diversified tropical angiospermic plant remains, vertebrates and invertebrates that provided a suitable palaeoniche for the dragonfly to survive. In addition, the fossil material and associated angiospermic flora indicate the terrestrial as well as freshwater lacustrine environment in Chotanagpur plateau during the depositional period.

Keywords: Chotanagpur plateau, fossil dragonfly, Neogene deposits, palaeoenvironment, tropical climate.

ODONATA are one of the ancient orders of insects that appeared during the Permian. The odonates are widely distributed in all geographical realms, but their diversity is highest in the tropics with nearly about 6000 species being reported from all over the world. They act as good bio-indicators of a healthy riverine system. Dragonflies constitute about half of the living species of Odonata. Their aquatic larvae are among the predominant invertebrate predators in streams, rivers, springs, lakeshores, ponds and marshes. They feed upon a wide range of insects that are normally captured in flight. Some dragonflies migrate to follow favourable seasonal conditions. Some are known as flyers, spending most of their active life in flying and some are perchers, spending more time at rest. A number of Mesozoic and Cenozoic deposits worldwide bear dragonfly fossils, but no fossil dragonfly has been previously reported from India. From this point of view, the present fossil evidence of dragonfly from late Neogene of Chotanagpur plateau, Jharkhand, India is significant.

Recently, during a palaeontological fieldwork, a well-preserved dragonfly impression was collected from the river-cutting sections (Rajdanda Formation) along Mahudan Valley (23.40°N, 84.11°E; altitude 353 m asl), Jharkhand (Figure 1 a). The Rajdanda Formation represents late Neogene sedimentary deposits of fluvial origin. Earlier some workers have considered the age of the Rajdanda Formation to be Pliocene, but till date there is no definitive evidence for this. The fossiliferous sedimentary section in the present study comprises sandstone and shale (Figure 1 b). The shaly horizon also contained abundant fossil biota, including angiosperm leaves, fruit remains, flowers, wood, insect and fish remains. The fossil dragonfly specimen (Figure 2 a) was carefully recovered using chisel and shovel. After cleaning, the morphographic features of the specimen were thoroughly studied and photographed using a digital camera (Canon Power Shot A720IS). The line drawing of the specimen was done using Corel Draw ver. 19 (Figure 2 b). Terms used to describe the present fossil dragonfly specimen are in conformity with the standard terminologies for architectural description of fossil dragonflies. The fossil specimen (SKBUH/PPL/JH/I2) is kept at the Herbarium of the Department of Botany, Birsa University, Purulia, India. A thorough morphological description of the fossil specimen is presented below.

Specimen well-preserved and almost complete; total body length 28–30 mm, body width 7–8 mm; wings four, two fore wings and two hind wings preserved, hyaline, membranous, wing nodes black, both wings with small pterostigma near their apex, five longitudinal veins, viz. costa, sub-costa, radius (R1 and R2), media and cubitus with characteristic cross-veins present on both fore and hind wings, inter radius 1 and 2 are also visible on the hind wing, fore wings preserved, length 17–23 mm, width 5–5.8 mm, margin with a slight curvature, hind wings preserved, length 15–21 mm, width 6.9–12 mm, margin slightly bending to the hind margin distally; head 6 mm, well-preserved; compound eyes not confluent; thorax well-preserved, present between head and abdomen, about 7.8 mm long and 6 mm wide, rather indiscernible; abdomen long, bulky, and cylindrical with three visible segments; terminalia present, very short; two hind legs preserved, femur and tibia visible on hind leg, femur 6 mm and tibia 9 mm in length respectively, no fore leg preserved in the fossil specimen.

The above-mentioned morphological features (viz. body size, shape of thorax, nodes, pterostigma, longitudinal veins and cross veins of wings, shape and length of the abdomen, shape of terminalia) of the specimen suggest its closest resemblance to those of the modern dragonfly members of the family Libellulidae. The present fossil specimen resembles the Recent Libellula depressa L., a common inhabitant of lakes and ponds. We need more samples and morphometric analyses to confirm their generic affinity. Libellulidae ranks among the most diverse and widespread groups of dragonflies with only few fossil records, and is apparently the youngest anisopteran family of dragonflies. Libellulidae dragonflies are known as perchers as they spend more time at rest, basking in the sun, and take short flights for food or mate. The oldest fossil Libellulidae was reported from the Upper Cretaceous of Kazakhstan. It is also recorded from early Middle Miocene of Heggbach in southern Germany, and Miocene (Lower-Sarmatian) of the Tunjice Hills, Slovenia.

The dragonfly prefers to live in tropical, warm, humid climate. In this context, the present fossil evidence suggests the existence of a tropical, warm and humid climatic...
condition during the depositional period. Earlier palaeontological evidence also suggested that Chotanagpur plateau experienced a tropical climate 10,18–20. Recently, the past climate of Chotanagpur plateau was estimated using CLAMP (Climate Leaf Analysis Multivariate Program) based on recovered fossil leaf architectural signatures 11. CLAMP data also suggested a monsoonal, tropical, warm, humid climate in this region during the late Neogene.

The life cycle of the dragonfly begins in a pond. Dragonflies are known as ‘guardians of the watershed’ and ‘wetland bio-indicators’ 21,22. They are carnivorous and feed on other insects like moths, flies, mosquitoes, bugs, midges, eye gnats, beetles, butterflies, damselflies and also on other dragonflies 23. They perch on the rocks and sand near water bodies 24. So, the fossil evidence of dragonfly in the sediments of Rajdanda Formation of Chotanagpur plateau suggests a freshwater lacustrine environment at the time of its deposition. The earlier record of fossil fishes and insects from the same sediments also suggests the same environment 10,25. So, the earlier fossil evidence of diversified angiospermic plant
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remains, vertebrate and invertebrate remains suggests mixing of fauna and flora in fully shallow freshwater conditions. The presence of fossil flies, midges and butterflies in the fossil locality suggests that the dragonflies probably fed on these insects at that time. Thus, the late Neogene tropical forests of Jharkhand comprising abundant flora and fauna provided a suitable palaeoniche for the libellulid dragonfly to survive.

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