

Linnean shortfall still a major concern in India: as evident by the micromoth family Tortricidae (Lepidoptera)

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Anthropogenic activities influence rapid environmental changes on earth and the reality of climate change is a significant feature in implementing conservation action plans in many countries. The knowledge of biodiversity data is an increasingly important source of information in studies of biogeography and conservation. Presence of temporal, spatial and taxonomical gaps in biodiversity documentation is a major concern. One of the major gaps or shortfalls is the lack of taxonomic work, i.e. species descriptions called Linnean shortfall. Here we evaluate patterns of species description in a major micromoth family Tortricidae from India during 1775 to 2018. We found that a total of 392 species of tortricid moths have been described from the country. Among all the authors who have contributed to the species description, eight have described more than 85% of tortricid species from India. The cumulative curve of the tortricid species described showed the highest peak during 1901–1925, wherein 226 species were described from the country. Among the biogeographic zones, the North East Zone recorded the highest species descriptions (47.19%) followed by the Deccan Peninsula (10.71%). Our analysis shows Linnean shortfall in this group and the taxonomic expeditions are skewed towards only a few regions. Accordingly, practices to increase taxonomic expeditions, including increased funding in exploratory research and increasing species discovery rate are the need of the hour in many insect groups.

Keywords: Biogeographic zones, conservation, shortfalls in biodiversity, species description, tortricid moths.

THE earth is undergoing rapid environmental changes due to anthropogenic activities. As most of the scientific community considers climate change to be real¹, the priority of implementing conservation action plans is indispensable for many countries. Researchers on biodiversity around the world are dealing with very large data from the past decade. However, our knowledge about biodiversity is still inadequate and we are uncertain about how many species there are on our planet; and for those species described, knowledge about their ecology and distribution is scanty. These gaps or shortfalls can be linked to the lack of taxonomic work, i.e. species descrip-

tions called Linnean shortfall², or absence of data regarding their distribution, i.e. Wallacean shortfall³, or data on species abundance and population dynamics in space and time, i.e. Prestonian shortfall⁴. Together these lead to a fourth gap in our knowledge, i.e. the lack of information on phylogenetic relationships and thus on the evolutionary history of life on earth known as Darwinian shortfall⁵. Recently, another three new shortfalls have been proposed, viz. Raunkiaeran (lack of knowledge about species traits and their ecological functions), Hutchinsonian (lack of knowledge about the responses and tolerances of species to abiotic conditions) and Eltonian (lack of knowledge on species interactions and the effects of these interactions on the survival and fitness of individuals) by Hortal *et al.*⁶ with a general framework for the combined impacts and consequences of shortfalls of large-scale biodiversity knowledge for evolutionary and ecological research.

India is one of the signatories of the Convention on Biological Diversity with specific goals to be achieved through national strategies, plans or programmes for conservation and sustainable use of biodiversity. The conservation actions and assessments rely on priority setting due to paucity of time and funding⁷. Any conservation effort will start with assessing species or taxonomic groups which are threatened worldwide. However, many developing countries are planning to prepare a fresh priority list of species for conservation efforts. The major hindrances in global conservation status assessment are the so-called Linnean and Wallacean shortfalls, as demonstrated by Whittaker *et al.*⁸. Lepidoptera (moths and butterflies) conservation in recent years has grown from an arcane topic to everyday concern⁹. In India, awareness on conservation of butterflies and some macromoths is gaining momentum¹⁰. However, numerous smaller moths have been largely ignored; this may be due to limited taxonomic studies in these groups. To understand the status of taxonomic studies in micromoths, we have selected the family Tortricidae.

Tortricidae includes over 1000 genera and nearly 10,000 named species in the world¹¹. Tortricidae is the only family under the superfamily Tortricoidea. Tortricoidea is second only to the Gelechioidea in species diversity within the micromoths¹². They are diverse and abundant components of tropical, subtropical and temperate forest ecosystems, and are economically significant because many species are pests of agriculturally important crops¹³. However, there are no data on Indian Tortricidae, except the world checklist in which many species from India are not included¹⁴. The main purpose of the present study is to reveal pattern of species description of family Tortricidae from India.

The relevant articles related to description of tortricid moths from India were collected using different data sources, viz. world catalogues, checklists, zoological records, CABI Abstracts, biological abstracts and isolated

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