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Conference Abstract

Global patterns of Lepidoptera invasions revealed through large-scale data integration

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Abstract

The availability of invasion-related data has increased substantially over the past decade, driven by technological advances and growing concern about the impacts of biological invasions. However, the integration of these data into consistent and interoperable formats suitable for geographically and taxonomically comprehensive analyses remains a major challenge. This difficulty stems from the high fragmentation of data sources, inconsistencies in reporting practices and terminology, and differences in geographic and taxonomic standardization (Castro et al. 2023, Seebens et al. 2025). These challenges are particularly pronounced in highly diverse groups with unresolved or rapidly evolving taxonomy, where species identification can be complex.

Efforts to integrate data on the global distribution and trends of biological invasions in Lepidoptera (moths and butterflies) exemplify these issues. Lepidoptera is one of the most diverse insect orders, yet previous data integration efforts have been fragmented, often focusing on specific regions, taxonomic subsets, or species of particular concern (e.g., agricultural pests), and relying on inconsistent terminology and taxonomic frameworks.

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Here, we present a comprehensive global database of the regional distribution of non-native, established Lepidoptera species. We compiled information from 1,167 sources, including peer-reviewed literature, regional databases (e.g., USDA Invasive Species Database; APASD – Asian Pacific Alien Species Database), global repositories (e.g., CABI Compendium; GRIIS – Global Register of Introduced and Invasive Species), and technical reports. For each record, we extracted species identity, geographic location, native range, introduction pathway (intentional, natural dispersal, or accidental/ unknown), year of first observation, and establishment status, resulting in 18,289 unique records.

To ensure adherence to FAIR principles (Findable, Accessible, Interoperable, and Reusable), we harmonized geographic data to internationally recognized countries and insular regions, and standardized taxonomy through cross-validation using the GBIF Backbone Taxonomy and the Global Names Verifier. The database will be made publicly available through an R package and a SQLite database to facilitate reuse and integration.

We identified 986 Lepidoptera species with non-native established populations, representing approximately 0.64% of the total richness of the order. Records date back to the 16th century, with a marked increase throughout the 20th century, particularly after 1960. Most species are restricted to one or two regions, although 67 species are established in ten or more regions out of 258 regions. Asia and Europe emerge as the primary source regions, while most documented establishments occur in temperate, economically developed regions, especially in Europe and North America.

These results highlight both the global extent of Lepidoptera invasions and the critical importance of standardized, large-scale data integration for advancing our understanding of invasion dynamics in the context of rapid environmental change and expanding data availability.

Keywords

data integration, FAIR principles, global database, Lepidoptera, taxonomic harmonization.

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Conflicts of interest

The authors have declared that no competing interests exist.

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