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Conclusion

Collectively, the Kimberley, Top End, Northern Deserts and western Gulf Country make up a vast and remote area of tropical northern Australia (about 16 per cent of the continent). Until now, this region was arguably the most poorly known area of the Australian continent for butterflies and diurnal moths in terms of basic natural history. Thus, a major goal of this atlas was to address this knowledge gap by compiling a detailed inventory of the species known to occur in the region based on review of the scientific literature, examination of material in museum collections, field surveys and incidental observations.

Our data indicate that 166 taxa representing 163 species (132 butterflies and 31 diurnal moths) have been recorded from the study region, of which 151 (91 per cent) are resident, three (2 per cent) are immigrant and 12 (7 per cent) are vagrant or infrequent visitors. Overall, the fauna has a relatively low level of endemism: 17 species (10 per cent, including seven undescribed diurnal moths) and 35 subspecies (21 per cent, including six undescribed butterflies) are endemic to the region. Most of the endemic species are restricted to the higher rainfall areas of the Top End, or the Top End and northern Kimberley, where they occur predominantly in savannah landscapes, especially woodland or open woodland associated with sandstone. Within the study region, the Top End is substantially richer than the other subregions, with 150 species (93 per cent of the total fauna), compared with the Kimberley (105 species), western Gulf Country (82 species) and Northern Deserts (53 species). These broad patterns of species richness and endemism suggest the Top End has been important in the evolution and historical assembly of the butterfly and diurnal moth fauna.

Within the Top End, available data indicate the north-western corner, which includes the Arnhem Land Plateau, is a biodiversity 'hotspot' based on the concentration of mesic-adapted taxa or lineages with restricted geographic ranges. The Arnhem Land Plateau supports five taxa (*Taractrocera ilia*, *Protographium leosthenes geimbia*, *Candalides geminus gagadju*, *Idalima* sp. 'Arnhem Land' and *Hecatesia* sp. 'Arnhem Land') that are endemic to it, plus a further two species (*Taractrocera psammopetra* and *Radinocera* sp. 'Sandstone') that occur elsewhere only in the northern Kimberley. All of these endemics are associated with sandstone plateaus and escarpments. Further analysis of fine-scale distribution patterns and population genetics (phylogeographic structure) is needed to determine whether putative biodiversity hotspots occur elsewhere within the Top End and Kimberley. These hotspots are likely to coincide with evolutionary refugia, enabling species to persist during past (and potentially future) climatic extremes, and thus represent

important areas for biodiversity conservation (Pepper and Keogh 2014; Rosauer et al. 2016; Oliver et al. 2017).

Monsoon forests comprise a very small fraction (less than 1 per cent) of the landscape in the study region, yet they support a disproportionally high number of butterfly and diurnal moth species. More than 50 species (31 per cent) breed, or are suspected to breed, in various types of monsoon forest, and 34 (21 per cent) of these species are obligatorily dependent on these habitats, in that they do not breed in other habitats. Interestingly, despite the high proportion of monsoon forest specialists, few of these taxa are actually endemic to the study region; only one species (*Ctimene* sp. 'Top End') and 16 subspecies are endemic to northern Australia. Four of these monsoon forest specialists (*Leptosia nina*, *Cethosia penthesilea*, *Phalanta phalantha* and *Deudorix smilis*) represent the only known Australian occurrences of species that are predominantly distributed in South-East Asia. A fifth monsoon specialist, the predominantly South-East Asian pierid *Appias albina*, also has its main occurrence within Australia in the study region. In addition, several species (particularly Danainae) use monsoon forest as refuges during the dry season, further highlighting the high biodiversity value of this habitat type.

Northern Australia is one of the few tropical places left on Earth in which biodiversity and the ecological processes underpinning that biodiversity are still relatively intact. Yet, paradoxically, at a time when the region is under increasing threat from development (pastoral, agricultural/horticultural and mining industries), invasive species (feral animals and weeds), inappropriate fire regimes (especially an increase in the frequency and scale of fires) and climate change (especially elevated carbon dioxide levels), scientific knowledge of the invertebrate biodiversity is still in its infancy. Even for a popular insect group such as butterflies and diurnal moths, there are still, for some species, substantial knowledge gaps in taxonomic status, spatial distribution and ecology, such as larval food plant associations. It is hoped this work—particularly the geographic range maps, relative abundance charts and conservation status assessments—will not only provide the foundation for further research, but also provide the baseline against which the extent and direction of change can be assessed in future. It should also serve to help identify the region's biological assets to set priorities for biodiversity conservation. The fact that 79 per cent of the butterfly and diurnal moth fauna is presently evaluated as LC is encouraging; it tells us not only that the fauna is in relatively good health, but also what stands to be lost if the north is opened up for wholesale development.

While the fauna, overall, may be considered to be in reasonably good condition, with more than three-quarters of the species presently secure (LC), the need for further survey and monitoring will be crucial to reevaluate the conservation status of those species that are threatened (VU), Near Threatened (NT) or Data Deficient (DD), as well as those that are currently inadequately represented in the National Reserve System. Further research on these species should focus on clarifying the extent of their geographic distribution, determining their ecological resources (e.g. larval food plants), monitoring adult abundance and occupancy of critical habitats and managing threats from fire, as well as determining any other key threatening processes. More generally, in addition to understanding broad-scale distributional patterns, there is a complementary need to understand abundance and population trends for the fauna as a whole. Long-term monitoring of butterfly populations (and/or their larval food plants) is needed to determine whether species are stable or declining, and to help identify threats and management priorities and their effectiveness. The impact on the butterfly and diurnal moth fauna as a whole from developmental and management processes such as fire management, the intensification of pastoralism and selective clearing of native vegetation from the most fertile and productive land systems should be assessed as a high priority.

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