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The global distribution of tetrapods reveals a need for targeted reptile conservation

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The distributions of amphibians, birds and mammals have underpinned global and local conservation priorities, and have been fundamental to our understanding of the determinants of global biodiversity. In contrast, the global distributions of reptiles, representing a third of terrestrial vertebrate diversity, have been unavailable. This prevented the incorporation of reptiles into conservation planning and biased our understanding of the underlying processes governing global vertebrate biodiversity. Here, we present and analyse the global distribution of 10,064 reptile species (99% of extant terrestrial species). We show that richness patterns of the other three tetrapod classes are good spatial surrogates for species richness of all reptiles combined and of snakes, but characterize diversity patterns of lizards and turtles poorly. Hotspots of total and endemic lizard richness overlap very little with those of other taxa. Moreover, existing protected areas, sites of biodiversity significance and global conservation schemes represent birds and mammals better than reptiles. We show that additional conservation actions are needed to effectively protect reptiles, particularly lizards and turtles. Adding reptile knowledge to a global complementarity conservation priority scheme identifies many locations that consequently become important. Notably, investing resources in some of the world's arid, grassland and savannah habitats might be necessary to represent all terrestrial vertebrates efficiently.

Our knowledge of the distributions of a broad variety of organisms has improved greatly in the past decade[1–3], in turn aiding our efforts to conserve biodiversity[4–6] and significantly enhance our grasp of broad-scale evolutionary and ecological processes[7–12]. Nevertheless, despite comprising one third of terrestrial vertebrate species, knowledge of reptile distributions remained poor and unsystematic. This represented a major gap in our understanding of the global structure of biodiversity and our ability to conserve nature. Historically, broad-scale efforts towards the protection of land vertebrates (and thus also of reptiles) have been based predominantly on data from plants, birds, mammals and to a lesser degree amphibians[13–15]. Here we present complete species-level global distributions of nearly all reptiles: 10,064 known, extant, terrestrial species for which we could identify precise distribution information. These distributions cover the Sauria (lizards, 6,110 species), Serpentes (snakes, 3,414 species), Testudines (turtles, 322 species), Amphisbaenia ('worm lizards', 193 species), Crocodylia (crocodiles, 24 species) and Rhynchocephalia (the tuatara, 1 species).

This dataset completes the global distribution mapping of all described, extant, terrestrial vertebrates (Fig. 1a), providing information that has been missing from much of the global conservation planning and prioritization schemes constructed over the past twenty years[4]. We use our reptile distribution data to: (a) examine the congruence in general, hotspot and endemism richness patterns across all tetrapod classes and among reptile groups; (b) explore how current conservation networks and priorities represent reptiles; and (c) suggest regions in need of additional conservation attention to target full terrestrial vertebrate representation and highlight current surrogacy gaps, using a formal conservation prioritization technique.

Results and discussion

Species richness of reptiles compared to other tetrapods. The global pattern of reptile species richness (Fig. 1b) is largely congruent with that of all other terrestrial vertebrates combined ($r = 0.824$, e.d.f. = 31.2, $p \ll 0.0001$; Fig. 2a, Supplementary Fig. 1, Supplementary Table 1). However, the major reptile groups (Figs. 1c–e, 2b,c Supplementary Fig. 1, Supplementary Table 1) show differing degrees of congruence with the other tetrapod taxa. The richness distribution of snakes (Fig. 1d) is very similar to that of other tetrapods (Fig. 2c) in showing pan-tropical dominance ($r = 0.873$, e.d.f. = 30.2, $p \ll 0.0001$). Lizard richness is much less similar to non-reptilian tetrapod richness ($r = 0.501$, e.d.f. = 38.3, $p \ll 0.001$, Fig. 2b). It is high in both tropical and arid regions, and notably in Australia (Fig. 1c, Supplementary Fig. 1). Turtle richness is also less congruent with diversity patterns of the other tetrapods ($r = 0.673$, e.d.f. = 55.2, $p \ll 0.001$), and peaks in the southeastern USA, the Ganges Delta, and Southeast Asia (Fig. 1e).

Snakes dominate reptile richness patterns due to their much larger range sizes compared with lizards, even though lizards are about twice as speciose (median range size for 3,414 snake species: 62,646 km^2; for 6,415 lizard species: 11,502 km^2; Supplementary Fig. 2). Therefore snakes disproportionally influence global reptile richness patterns[16,17] (Supplementary Table 1, Supplementary Fig. 1).