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DOI
10.1163/18759866-07702002

Publication date
2008

Document Version
Final published version

Published in
Contributions to Zoology

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Link to publication

Citation for published version (APA):
Nijman, V., & Vonk, R. (2008). Blurring the picture: Introductions, invasions, extinctions - Biogeography in a global world. *Contributions to Zoology*, *77*(2), 67-70. https://doi.org/10.1163/18759866-07702002

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Download date:30 Nov 2022

Contributions to Zoology, 77 (2) 67-70 (2008)

Blurring the picture: introductions, invasions, extinctions – biogeography in a global world

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Key words**:** extinction, globalization, invasions, reintroductions, zoogeography

Abstract

Global biogeography and phylogeography have gained importance as research topics in zoology, as attested by the steady increase in the number of journals devoted to this topic and the number of papers published. Yet, in a globalising world, with species reintroductions, invasions of alien species, and large-scale extinctions, unravelling the true biogeographic relationships between areas and species may become increasingly difficult. We present an introduction to the symposium 'Biogeography: explaining and predicting species distributions in space and time' held in Amsterdam in 2007, and the resulting papers as published in this special issue, including papers on crustaceans, birds and mammals.

Global biogeography is the study of the natural distributions of plants and animals over the globe. Research in this discipline must reckon with the profound impact made by humans on the distribution of living organisms of which some impacts date back to historic times and others are more recent. Introductions nowadays occur almost everywhere, sometimes by deliberate action as part of conservation initiatives. One might say that these types of introductions take place on the 'good side' of human interference, but even then the effort of restoring the evolutionary balance may be counterproductive (see for instance the reintroduction of the 'wrong' species of lorises throughout Southeast Asia – Nekaris and Jaffe, 2007). A long list could be made of species re-introductions, rehabilitation, and restocking in Europe (wolves, beaver, red kite, e.g. Gorman, 2007; South *et al*., 2000; Nolet and Baveco, 1996; Evans *et al*., 1999) and North America (black-footed ferret, wolf; Reading and Kellert, 1993; Ripple and Beschta, 2003), but also South America (golden lion tamarind; Kierulff and De Oliveira, 1996), Africa (African wild dog; Gusset *et al*., 2008), South Asia (lions: Johnsingh *et al*., 2007), and Southeast Asia (orangutan, gibbon, leopard: Yeager, 1997; Nijman, 2006; Gippoliti and Meijaard, 2007). The only continent where no species have been introduced as part of a conservation programme seems to be Antarctica but surely this is only a matter of time.

Other phenomena that use human vectors are invasions, such as those of dreissenid mussels in the North American Great Lakes (e.g. Johnson and Padilla, 1996), or of Ponto-Caspian amphipods in Northwestern Europe's freshwaters (Platvoet, 2007), sometimes greatly altering the balance and bringing along huge economic losses. Indeed, the impact of these non-native species can take on numerous forms, including predation and grazing impacts that are often strikingly apparent, while changes can also be more cryptic, but nonetheless profound, such as alterations to pollination and dispersal networks, or hybridisation (Whittaker and Fernandez-Palacios, 2007). While in time, these 'additions' to any given faunal assembly may blur our picture on the biogeography ('…represents a newly discovered population of a species at a far-flung locality part of a relict distribution or was it simply transported there aided by humans?'), this is much more apparent when human-induced extinctions are involved. The lemurs from Madagascar (Burney *et al*., 2004), many large terrestrial vertebrates of North America and Australia (Flannery, 1994, 2001), birds of the Pacific (Steadman and Olson, 1985), and primates from China (Geissmann, 1995), were all wiped out by humans over a relatively short time period, and greatly alter our perspective of what animals 'naturally' are supposed to occur in any given area.

In our paper (Vonk and Nijman, 2007) analysing the topics of papers published in *Contributions to Zoology* in the last quarter of a century we noted that over this period the journal has changed from a

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largely alpha taxonomic journal to one that is, again, truly general in scope. The subject of Systematic Biology, in which we included topics such as biogeography, evolutionary biology, phylogenetics, and phylogeography, and Comparative Morphology nowadays make up about half of the papers published. Import papers in recent years dealt with the biogeography of well-known groups in much-studied regions such as amphibians in the West Palearctic (Arntzen *et al*., 2007; Veith *et al*., 2006) but also of lesser-known species from regions largely unstudied (isopods from the northern Sahara or pycnogonida from Socotra (Boughrous *et al*., 2007; Bartolino and Krapp, 2007). Biogeography and phylogeography have gained importance as research topics in zoology as is attested by the steady increase in both the number of journals devoted to this topic, such as *the Journal of Biogeography* (established in 1974), *Ecography* (1978), *Global Ecology and Biogeography* (1991) and *Diversity and Distributions* (1998), and the number of papers they publish (Fig.1).

Recognising these aforementioned impacts on the natural movements of species over the earth, with humans drastically changing the species compositions in many parts of the world, we can ask ourselves whether or not it still makes sense to study biogeography – as a science of emerging patterns with a deep historical background – in a world interconnected by ways of fast moving air, road, and shipping traffic. How much can we still explain and what can we predict about species distributions in space and time? This question is one of the underlying themes of a series of papers that is published in this special symposium issue of *Contributions to Zoology*. The papers were presented during the 2007 'Biogeography: explaining and predicting species distributions in space and time' symposium in Amsterdam, that followed the PhD defence of three students (M. Aliabadian, S.A.E. Marijnissen, and D. Platvoet) from the Zoological Museum Amsterdam and the Institute of Biodiversity and Ecosystem Dynamics.

The series is opened by Neil Cumberlidge, studying Afrotropical freshwater crabs. The fact that freshwater crabs, that are limited in there dispersal capacities, still occur on islands that are far away from continents requires well documented explanations of which this research offers clear examples. The second paper is on Asian crabs. Looking on the population level of gecarcinucid freshwater crabs in equally isolated habitats such as the ancient Malili lakes on Sulawesi, Christoph Schubart concludes

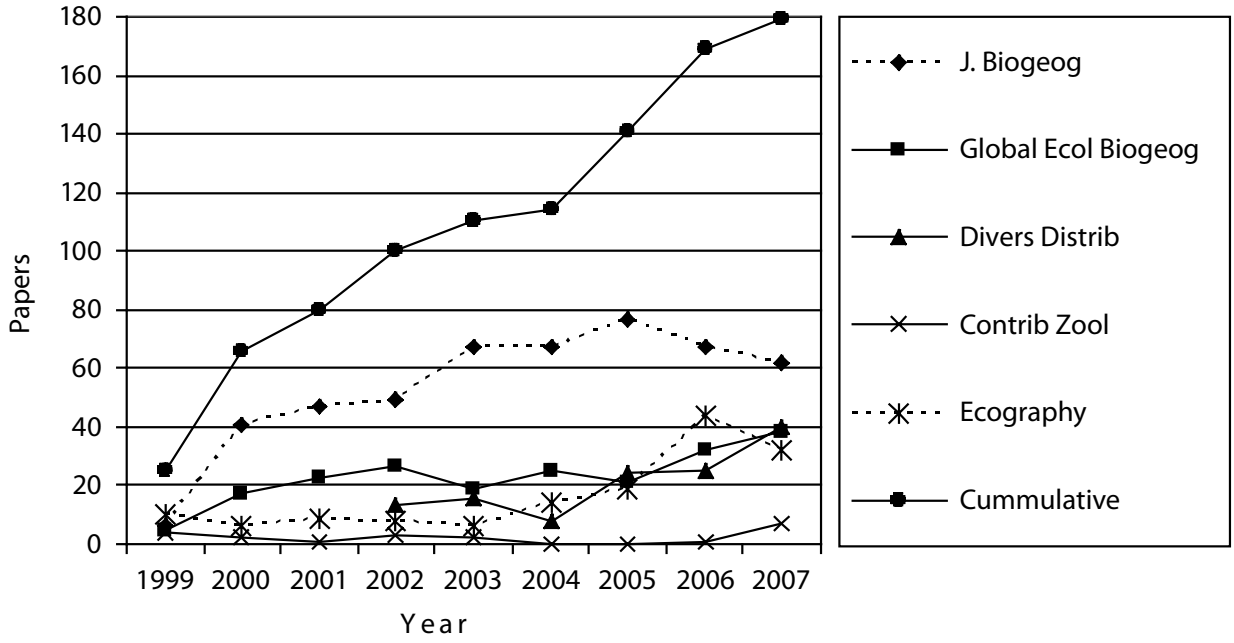

Fig. 1. Number of zoogeographical papers that have appeared in four biogeographical journals (*Journal of Biogeography*, *Global Ecology and Biogeography*, *Ecography*, and *Diversity and Distributions*) and *Contributions to Zoology* during the last nine years, showing a steady increase in numbers (source Thomson Scientific Web of Science)

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there is a greater diversification of species according to mitochondrial genetic data than the morphology of these crabs indicated. In the third paper Jaimie Dick shows that in explaining biogeographical patterns of invasive amphipod crustaceans in freshwaters of Europe the old idea of interspecific competition can be refined and attributed to behavioural differences between invaders and residents. The fourth paper by Mansour Aliabadian *et al*. tests the merits of the geometric constraint model MDE (mid-domain effect) and shows that there is little empirical evidence for overall species richness of Palearctic songbirds. Major hotspots were located south of the area where MDE predicted highest species richness, while some of the coldspots were in the centre of the Palearctic Region. Dealing with more than 2000 taxa of songbirds over immense areas, their work has important consequences on the application of MDE. In the fifth paper Per Ericson reviews the current perspectives on the evolution of birds. He summarizes the fossil record and its implication on the recent distribution on the globe and provides a resume on the latest insights on genome characteristics. The sixth paper by Vincent Nijman and Erik Meijaard uses primates to demonstrate the interrelationships of species richness, island area and isolation. Southeast Asian islands are merely highpoints of an immense shallow continental shelf which during Pleistocene glacial periods was exposed periodically as dry land, connecting the now isolated islands with one another. They conclude that for primates those islands are probably less isolated than previously recognised. The seventh and last research paper connected with the symposium turns our view away from the human-induced distributions to the less studied, but potentially most preserved faunas, namely the marginal species populations of inaccessible environments. Fred Schram uses two examples of syncarid crustaceans to illustrate his point and convincingly presents ancient distributions and also extracts information on the timing of evolutionary events. The series ends with a review of a recent book on primate biogeography that highlights the connection between primates and humans on their crossing paths leading to new frontiers.

Acknowledgements

We thank the staff of the Zoological Museum Amsterdam and the Institute for Biodiversity and Ecosystem Dynamics of the University of Amsterdam for their support in organising the symposium. In addition to the contributors we want to express our thanks to the reviewers who, often on short notice, provided feed-back on the papers included in this issue.

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Received: 18 April 2008
Accepted: 2 July 2008

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