

## RESPONSE

**Positive regional species–people correlations: a sampling artefact or a key issue for sustainable development?**A. M. Barbosa<sup>1,2</sup>, D. Fontaneto<sup>3</sup>, L. Marini<sup>4</sup> & M. Pautasso<sup>2</sup>

1 'Rui Nabeiro' Biodiversity Chair, CIBIO – University of Évora, Évora, Portugal

2 Division of Biology, Imperial College London, Ascot, UK

3 Department of Invertebrate Zoology, Swedish Museum of Natural History, Stockholm, Sweden

4 Department of Environmental Agronomy and Crop Production, University of Padova, Padova, Italy

**Correspondence**

Marco Pautasso, Division of Biology, Imperial College London, Silwood Campus, Buckhurst Rd, Ascot, SL5 7PY, UK. Tel: +44 020 759 42533

Email: m.pautasso@ic.ac.uk

doi:10.1111/j.1469-1795.2010.00402.x

Many studies are documenting positive large-scale species–people correlations (Luck, 2007; Schuldt & Assmann, 2010). The issue is scale dependent: the local association of species richness and people is in many cases a negative one (Pautasso, 2007; Pecher *et al.*, 2010). This biogeographical pattern is thus important for conservation. If species-rich regions are also densely populated, preserving biodiversity becomes more difficult, *ceteris paribus*, than if species-rich regions were sparsely populated. At the same time, positive, regional species–people correlations are an opportunity for the biodiversity education of the majority of the human population and underline the importance of conservation in human-modified landscapes (e.g. Sheil & Meijaard, 2010; Ward, 2010).

In our study (Barbosa *et al.*, 2010), we tested whether a sampling artefact applies to the species–people correlation for carabids in Italy at three spatial grains of analysis. As the commentaries by Luck (2010) and McKinney (2010) point out, there has been little consideration of variation in sampling effort in previous regional studies of the co-existence of biodiversity and people. If sampling effort is positively associated with both species richness and human population, it could explain the correlation between the two (Cantarello *et al.*, 2010).

We agree with Luck (2010) that there is a need to further study the correlation of biodiversity and people for taxa other than vertebrates and plants, as this pattern is now well-documented for such well-studied taxa (recently, e.g. Fjeldså, 2007; Pidgeon *et al.*, 2007; Fjeldså & Burgess, 2008; Lepczyk *et al.*, 2008; Moreno-Rueda & Pizarro, 2009). At the level of European countries, a positive species–people correlation was found for ants, aphids, grasshoppers and stream macro-invertebrates (Pautasso & Fontaneto, 2008; Schlick-Steiner *et al.*, 2008; Steck & Pautasso, 2008; Pautasso & Powell, 2009), but the data did not allow the inclusion

of sampling effort in those studies. Apart from invertebrates, species-rich groups such as bacteria and fungi have been almost completely neglected from the point of view of the large-scale correlation with people (Pautasso & Zotti, 2009; Nemergut *et al.*, 2010).

We concur with Luck (2010) and McKinney (2010) that it is important not just to document whether or not regional species–people correlations are present and artefactual, but also to investigate potential mechanisms and to study how the issue fits with the spatial distribution of protected areas. Unfortunately, protected areas have tended to be located far away from human settlements, thus ending up disproportionately located in relatively species-poor regions (e.g. Pautasso & Dinetti 2009). Regardless of the mechanisms underlying such three-way relationships among biodiversity, people and parks, positive regional species–people correlations imply that biodiversity conservation has to happen over the entire landscape, not just in wilderness areas. At the same time, the few existing protected areas in urbanized landscapes need to be defended as a matter of priority, not swapped with cheaper land away from civilization.

In addition, research priorities related to the large-scale correlation of species and people include moving from species richness to other measures of biodiversity (e.g. abundance, genetic and phylogenetic diversity; Knapp *et al.*, 2008; Pautasso & Chiarucci, 2008; Noël & Lapointe, 2010). Further, we need to know how the pattern is likely to develop over the next decades under various demographical, climate change and assisted migration (both for species and people) scenarios (Hoymann, 2010; Pautasso *et al.*, 2010). Ultimately, if the large-scale correlation of biodiversity and people will be generally found not to be artefactual and to be present also for biodiversity measures other than species richness, we will have to make sure that news about this

applied conservation issue reaches land-use policy makers, stakeholders and NGOs. Ecosystem services, particularly those delivered to the exploding megalopolis in (sub) tropical countries, are essential for a transition to a sustainable humanity (Alberti, 2010). We thus need to preserve the remaining biodiversity within and around urbanizing landscapes.

## References

- Alberti, M. (2010). Maintaining ecological integrity and sustaining ecosystem function in urban areas. *Curr. Opin. Environ. Sustainabil.*, in press (Online DOI:10.1016/j.cosust.2010.07.002).
- Barbosa, A.M., Fontaneto, D., Marini, L. & Pautasso, M. (2010). Is human population a large-scale indicator of the species richness of ground beetles? *Anim. Conserv.* **13**, 432–441.
- Cantarello, E., Steck, C.E., Fontana, P., Fontaneto, D., Marini, L. & Pautasso, M. (2010). A multi-scale study of Orthoptera species richness and human population size controlling for sampling effort. *Naturwissenschaften* **97**, 265–271.
- Fjeldså, J. (2007). The relationship between biodiversity and population centres: the high Andes region as an example. *Biodivers. Conserv.* **16**, 2739–2751.
- Fjeldså, J. & Burgess, N.D. (2008). The coincidence of biodiversity patterns and human settlement in Africa. *Afr. J. Ecol.* **46**, 33–42.
- Hoymann, J. (2010). Accelerating urban sprawl in depopulating regions: a scenario analysis for the Elbe River Basin. *Reg. Environ. Change*, in press (Online DOI:10.1007/s10113-010-0120-x).
- Knapp, S., Kühn, I., Schweiger, O. & Klotz, S. (2008). Challenging urban species diversity: contrasting phylogenetic patterns across plant functional groups in Germany. *Ecol. Lett.* **11**, 1054–1064.
- Lepczyk, C.A., Flather, C.H., Radeloff, V.C., Pidgeon, A.M., Hammer, R.B. & Liu, J.G. (2008). Human impacts on regional avian diversity and abundance. *Conserv. Biol.* **22**, 405–416.
- Luck, G.W. (2007). A review of the relationships between human population density and biodiversity. *Biol. Rev.* **82**, 607–645.
- Luck, G.W. (2010). Why is species richness often higher in more densely populated regions? *Anim. Conserv.* **13**, 442–443.
- McKinney, M.L. (2010). Shedding some light on people and biodiversity. *Anim. Conserv.* **13**, 444–445.
- Moreno-Rueda, G. & Pizarro, M. (2009). Relative influence of habitat heterogeneity, climate, human disturbance, and spatial structure on vertebrate species richness in Spain. *Ecol. Res.* **24**, 335–344.
- Nemergut, D.R., Costello, E.K., Hamady, M., Lozupone, C., Jiang, L., Schmidt, S.K., Fierer, N., Townsend, A.R., Cleveland, C.C., Stanish, L. & Knight, R. (2010). Global patterns in the biogeography of bacterial taxa. *Environ. Microbiol.*, in press (Online DOI:10.1111/j.1462-2920.2010.02315.x).
- Noël, S. & Lapointe, F.-J. (2010). Urban conservation genetics: study of a terrestrial salamander in the city. *Biol. Conserv.*, in press (Online DOI:10.1016/j.biocon.2010.07.033).
- Pautasso, M. (2007). Scale-dependence of the correlation between human presence and plant and vertebrate species richness. *Ecol. Lett.* **10**, 16–24.
- Pautasso, M. & Chiarucci, A. (2008). A test of the scale-dependence of the species abundance–people for veteran trees in Italy. *Ann. Bot.* **101**, 709–715.
- Pautasso, M., Dehnen-Schmutz, K., Holdenrieder, O., Pietravalle, S., Salama, N., Jeger, M.J., Lange, E. & Hehl-Lange, S. (2010). Plant health and global change – some implications for landscape management. *Biol. Rev.*, in press (Online DOI:10.1111/j.1469-185X.2010.00123.x).
- Pautasso, M. & Dinetti, M. (2009). Avian species richness, human population and protected areas across Italy's regions. *Environ. Conserv.* **36**, 22–31.
- Pautasso, M. & Fontaneto, D. (2008). A test of the species–people correlation for stream macro-invertebrates in European countries. *Ecol. Appl.* **18**, 1842–1849.
- Pautasso, M. & Powell, G. (2009). Aphid biodiversity is correlated with human population in European countries. *Oecologia* **160**, 839–846.
- Pautasso, M. & Zotti, M. (2009). Macrofungal taxa and human population in Italy's regions. *Biodivers. Conserv.* **18**, 473–485.
- Pecher, C., Fritz, S.A., Marini, L., Fontaneto, D. & Pautasso, M. (2010). Scale-dependence of the correlation between human population and the species richness of stream macro-invertebrates. *Basic Appl. Ecol.* **11**, 272–280.
- Pidgeon, A.M., Radeloff, V.C., Flather, C.H., Lepczyk, C.A., Clayton, M.K., Hawbaker, T.J. & Hammer, R.B. (2007). Associations of forest bird species richness with housing and landscape patterns across the USA. *Ecol. Appl.* **17**, 1989–2010.
- Schlick-Steiner, B., Steiner, F. & Pautasso, M. (2008). Ants and people: a test of two mechanisms behind the large-scale human-biodiversity correlation for Formicidae in Europe. *J. Biogeogr.* **35**, 2195–2206.
- Schuldt, A. & Assmann, T. (2010). Invertebrate diversity and national responsibility for species conservation across Europe – a multi-taxon approach. *Biol. Conserv.*, in press (Online DOI:10.1016/j.biocon.2010.07.022).
- Sheil, D. & Meijaard, E. (2010). Purity and prejudice: deluding ourselves about biodiversity conservation. *Biotropica*, in press (Online DOI:10.1111/j.1744-7429.2010.00687.x).
- Steck, C.E. & Pautasso, M. (2008). Human population, grasshopper and plant species richness in European countries. *Acta Oecol.* **34**, 303–310.
- Ward, J.H. (2010). Recruiting future talent in ecology and evolutionary biology. *Trends Ecol. Evol.* **25**, 487.