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EDITORIAL

Research needs in insect conservation and diversity

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As the newest addition to the Senior Editors of *Insect Conservation and Diversity* (*ICD*), it is a great pleasure for R.K.D. to be able to lead off this first issue of the journal for 2010. Throughout the second year of operation, our new journal has been growing and developing beyond all expectations, with continued high quality submissions by authors, and effective and timely handling of manuscripts by an exceptional team of Associate Editors. This success has been attributable, in no small measure, to the hard work and commitment of Brad Hawkins as a Senior Editor over the last 2 years, and it is with great reluctance that we bid farewell to Brad from the journal and wish him every success in his future role as Editor-in-Chief of the *Journal of Biogeography*. With Brad's support, we saw a substantial increase in the number of submissions of high quality manuscripts to the journal in 2009, and a dramatic increase in the dissemination and uptake of *ICD* articles by the wider scientific community. Online access to articles increased 70% over 2008 values, with an impressive annual average of over 200 abstract views and almost 150 downloads *per article* in 2009 (as estimated from data for January–September 2009, at the time of writing this editorial). Citation rates of articles on Thompson Reuters ISI Web of Science also increased dramatically in 2009, and although it is perhaps too early to judge how these will equate to future citation metrics for the journal, it is highly encouraging that current rates are approximately 65% higher than those achieved for articles in comparable journals, such as the *Journal of Insect Conservation*, at the same point in their citation history. This strongly suggests to us that the wider fields of insect conservation and diversity are burgeoning areas of scientific research, and that *ICD* is meeting the need for a high quality platform for authors to highlight their findings, and express their views.

Although the journal is only in its infancy, it should be possible (at least to some extent) to determine the main research areas driving this dramatic increase in 2009 metrics based on the most downloaded and most cited articles of 2008. In this regard, we have been interested to note the emerging strengths that readers are drawing from *ICD*. The top four papers contributing directly to the 'foetal' *h*-index (Hirsch, 2005) of our emerging journal, and collectively amounting to 50% of the total journal citations in 2009 (Basset *et al*., 2008; Cardoso *et al*., 2008; Fraser *et al*., 2008; Thomas *et al*., 2008), all sit very clearly at the intersection of two overlapping themes: (i) refinement of sampling and analytical methods for biodiversity assessment and monitoring (Basset *et al*., 2008; Cardoso *et al*., 2008; Fraser *et al*., 2008), and (ii) assessment of the impact of land use change and habitat disturbance on arthropod communities (Basset *et al*., 2008; Fraser *et al*., 2008; Thomas *et al*., 2008). We interpret this as *prima facie* vindication of the journal's mandate to promote research that 'explicitly associates the two concepts of insect diversity and insect conservation for the benefit of invertebrate conservation' (Leather *et al*., 2008).

In 2009, these two key themes have been similarly well represented in manuscript submissions, with significant new papers published both on sampling and analytical methodology (e.g., DeVries *et al*., 2009; Guevara & Avilés, 2009; Hayes *et al*., 2009; Jones *et al*., 2009; Novotny, 2009; Nufio *et al*., 2009), and on the effects of habitat disturbance on arthropods (e.g., Dupont *et al*., 2009; Hayes *et al*., 2009; Marini *et al*., 2009; Nufio *et al*., 2009; Reece & McIntyre, 2009; Uehara-Prado & Freitas, 2009), amongst a wide range of other themes. Importantly, when we analysed the distribution of articles focusing on different themes in 2009, we were pleased to find that *ICD* has achieved a strong balance in the relative ratios of tropical studies versus temperate studies (42% vs. 58%, respectively), and in studies focusing on the distribution, diversity or composition of invertebrate communities in natural systems vs. studies focusing on issues surrounding anthropogenic modification of systems (55% vs. 45%, respectively). This is particularly unusual in the former case, and *ICD* will continue to work hard to maintain these high quality submissions from (or about) tropical countries. In the latter case, the balance might suggest that studies of insect conservation and insect diversity are being addressed representatively. Crucially, however, a finer-scale analysis of publications in 2009 highlights some important gaps in coverage that we feel desperately need to be addressed. First, in terms of the scale of approach, most studies addressed variation across spatial scales (88%), whereas studies on temporal variation in insect community structure were poorly represented (Bourguignon *et al*., 2009; Graham-Taylor *et al*., 2009; Shortall *et al*., 2009; Stefanescu *et al*., 2009). Second, in terms of the focal ecosystem sampled, most studies were terrestrial (91%), whereas studies on invertebrate conservation and diversity in aquatic or riparian systems were poorly

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represented (Gutiérrez-Chacon *et al*., 2009; Reece & McIntyre, 2009; Williams *et al*., 2009). Third, in terms of the major global change drivers considered to be affecting insect communities, most studies focused on the impact of land use change (particularly agricultural intensification, habitat disturbance and habitat fragmentation) or the restoration management of invertebrate communities following land use change (75% of the studies focusing on anthropogenically modified systems), whereas there were a surprisingly low number of climate-related studies (Anderson *et al*., 2009; Graham-Taylor *et al*., 2009; Roy *et al*., 2009) and only limited (if any) studies addressing the impacts of invasive species on native invertebrate communities (Louzada & Carvalho e Silva, 2009), the impacts of urbanisation (Daniels, 2009), or the impacts of atmospheric CO_2 increase, nitrogen deposition, pollution, over-harvesting of invertebrate populations, or other anthropogenic drivers of global environmental change, which have been the subject of considerable research effort elsewhere (Tylianakis *et al*., 2008). Finally, in terms of the level of biological organisation targeted, most studies focused on patterns of variation in community composition (44%) or species diversity (22%), and to a lesser extent population-level variation (16%), but very few studies addressed issues of insect conservation and diversity at the molecular level (Dupont *et al*., 2009; Knight *et al*., 2009) or at the level of species interactions (Brower *et al*., 2009; Novotny, 2009; Roy *et al*., 2009), or the relationship to ecosystem process rates and the provision of ecosystem services (Guevara & Avilés, 2009; Roy *et al*., 2009). Some of these gaps might very well stem from genuine limitations on the types and quantities of such studies being carried out by researchers, but the gaps might represent simply a lack of submission of such studies to the journal. In these cases, we will be actively seeking to encourage such submissions in the coming year.

Naturally, all of these identified gaps would benefit from increased research and increased submission rates to *ICD*, but if asked to choose the most important area for future research development, we would make a particular plea here for greater benchmarking of how altered invertebrate diversity and composition translate into changes in ecosystem functioning or the provision of ecosystem services (e.g., pollination, pest control, nutrient cycling, seed dispersal, and so on). As many insect-mediated ecosystem processes are inherently driven by alterations of consumer-resource dynamics, it follows that a greater understanding of spatio-temporal variation in the structure of species interaction networks would go a long way towards addressing why a loss of insect biodiversity, or a change in insect community composition, really matters for ecosystem dynamics. Of course, there is nothing particularly novel in these concepts, and similar pleas have been made for decades (e.g., Didham *et al*., 1996), but they have never really been matched by a greater linking of structure and function within the same studies. What is different now is that over the past 5 years, we have seen dramatic advances in the tools and conceptual framework needed to quantify interaction networks (Bascompte, 2007), and we can more effectively bridge the gap between community changes and functional outcomes than ever before. Notably, we would highlight for readers the conceptual framework proposed by Vojtech Novotny in the first issue of *ICD* in 2009, in which he provides a novel method of linking community structure and food web interactions. Essentially, Novotny (2009) uses standard multivariate methods, derived from community analyses, for simultaneously partitioning the relative contribution of both host plant distributions and herbivore distributions to the degree of beta diversity (turnover) of host–herbivore interactions between different sites. At small spatial scales, Novotny (2009) found that changes in interaction structure between sites were due to primarily changes in herbivore species composition and altered host preferences, while at larger spatial scales changes in interaction structure were mainly due to the variation in host plant assemblages. The next step will be to determine what direct and indirect effects this might have on levels of plant herbivory.

Ultimately, such interaction network approaches raise the real prospect of being able to link directly the spatial changes in host and/or herbivore community structure resulting from global environmental change (or habitat restoration, for that matter), with changes in functional interactions that affect herbivory rates, nutrient cycling and plant productivity (Belovsky & Slade, 2000; Hunter, 2001). The crucial step that must be taken is to map the change in occurrence or frequency of a species against its associated trophic (e.g., host–herbivore, predator–prey, parasitoid–host, and so on) or non-trophic (e.g., plant–pollinator, plant–seed disperser, and so on) interactions with other organisms, to benchmark the functional consequences of community change. Already, Novotny's (2009) multivariate approach to partitioning the beta diversity of interaction structure has been more broadly generalised by Laliberté and Tylianakis (2010) to incorporate not only the presence or absence of particular consumer–resource interactions, but also quantitative variation in their relative frequencies across space and time, using a flexible approach based on multivariate dispersion (in the relative frequency of consumer–resource interactions) between sites or times. As Tylianakis (2008) points out, the value of the network approach lies in the ability to detect subtle shifts in community structure better than coarse metrics such as species diversity (e.g., Tylianakis *et al*., 2007), or even species composition (i.e., changes in species composition may only explain a small component of the shift in network interaction structure; Laliberté & Tylianakis, 2010). This is because interactions are vulnerable to the presence, identity, phenology, physiology, behaviour and diversity of different species, so changes in interaction structure are likely to act as an 'early-warning' of system-wide effects before a loss of species becomes apparent (Tylianakis, 2008; Tylianakis *et al*., 2008). It is rapidly becoming apparent that the quantitative network approach is ideally suited for testing the functional consequences of multiple components of global environmental change for the conservation of invertebrate communities, including the impacts of habitat loss (Tylianakis *et al*., 2007), species invasions (Aizen *et al*., 2008; Tylianakis, 2008) and climate change (Memmott *et al*., 2007; Tylianakis, 2009) on invertebrates, not to mention potential interactions between multiple drivers of global change (Didham *et al*., 2007; Tylianakis *et al*., 2008).

Looking to the future at *ICD*, we would encourage further high quality submissions in our prominent core areas of sampling and analytical methods for biodiversity assessment and monitoring, as well as the impacts of global environmental change on arthropod communities. Meanwhile, we hope for increased manuscript submission rates in the identified gaps that we have highlighted above. Prospective authors will be heartened to know that their submissions will be rewarded with a consistent, rapid turn-around time on manuscripts (of <6 weeks to review and first decision, and just 12 weeks from receipt of manuscript to publication), high rates of dissemination, and a predicted inaugural Thompson Reuters ISI impact factor (IF) of over 1.4 (based on current rates of citation; *ca* 46 cites in 2009 on 32 articles in 2008), which is in the same range as the current impact factor of other well-established mainstream conservation journals, such as *Biodiversity and Conservation* (IF = 1.473), and over twice as high as the inaugural impact factor of journals with a similar scope, such as the *Journal of Insect Conservation* (IF = 0.690 in 2007) after almost 10 years of operation. We freely acknowledge the exceptional groundwork that Tim New, Michael Samways, Tim Shreeve and the editorial team at *Journal of Insect Conservation* have laid in developing these shared areas of research interest, and we are enthusiastic about the complementary strengths and the wider publishing platform that the two journals bring to the field. The editorial team at *ICD* could not be more pleased with the early performance of our journal, but ultimately this success is down to the continued support of you, the readers, and prospective authors, and we hope that you will help us share in the future successes of the journal.

References

Aizen, M.A., Morales, C.L. & Morales, J.M. (2008) Invasive mutualists erode native pollination webs. *PLoS Biology*, **6**(2), e31. doi:10.1371/journal.pbio.0060031.

Anderson, B.J., Bai, Y., Thomas, C.D. & Oxford, G.S. (2009) Predicting range overlap in two closely related species of spiders. *Insect Conservation and Diversity*, **2**, 135–141.

Bascompte, J. (2007) Networks in ecology. *Basic and Applied Ecology*, **8**, 485–490.

Basset, Y., Missa, O., Alonso, A., Miller, S.E., Curletti, G., De Meyer, M., Eardley, C., Lewis, O.T., Mansell, M.W., Novotny, V. & Wagner, T. (2008) Choice of metrics for studying arthropod responses to habitat disturbance: one example from Gabon. *Insect Conservation and Diversity*, **1**, 55–66.

Belovsky, G.E. & Slade, J.B. (2000) Insect herbivory accelerates nutrient cycling and increases plant production. *Proceedings of the National Academy of Sciences of the United States of America*, **97**, 14412–14417.

Bourguignon, T., Leponce, M. & Roisin, Y. (2009) Insights into the termite assemblage of a neotropical rainforest from the spatio-temporal distribution of flying alates. *Insect Conservation and Diversity*, **2**, 153–162.

Brower, L.P., Williams, E.H., Slayback, D.A., Fink, L.S., Ramírez, M.I., Zubieta, R.R., Garcia, M.I.L., Gier, P., Lear, J.A. & van Hook, T. (2009) Oyamel fir forest trunks provide thermal advantages for overwintering monarch butterflies in Mexico. *Insect Conservation and Diversity*, **2**, 163–175.

Cardoso, P., Scharff, N., Gaspar, C., Henriques, S.S., Carvalho, R., Castro, P.H., Schmidt, J.B., Silva, I., Szüts, T., de Castro, A. & Crespo, L.C. (2008) Rapid biodiversity assessment of spiders (Araneae) using semi-quantitative sampling: a case study in a Mediterranean forest. *Insect Conservation and Diversity*, **1**, 71–84.

Daniels, J.C. (2009) Cooperative conservation efforts to help recover an endangered south Florida butterfly. *Insect Conservation and Diversity*, **2**, 62–64.

DeVries, P.J., Austin, G.T. & Martin, N.H. (2009) Estimating species diversity in a guild of Neotropical skippers (Lepidoptera: Hesperiidae) with artificial lures is a sampling problem. *Insect Conservation and Diversity*, **2**, 125–134.

Didham, R.K., Ghazoul, J., Stork, N.E. & Davis, A.J. (1996) Insects in fragmented forests: a functional approach. *Trends in Ecology & Evolution*, **11**, 255–260.

Didham, R.K., Tylianakis, J.M., Gemmell, N.J., Rand, T.A. & Ewers, R.M. (2007) Interactive effects of habitat modification and species invasion on native species decline. *Trends in Ecology & Evolution*, **22**, 489–496.

Dupont, L., Roy, V., Bakkali, A. & Harry, M. (2009) Genetic variability of the soil-feeding termite *Labiotermes labralis* (Termitidae, Nasutitermitinae) in the Amazonian primary forest and remnant patches. *Insect Conservation and Diversity*, **2**, 53–61.

Fraser, S.E.M., Dytham, C. & Mayhew, P.J. (2008) The effectiveness and optimal use of Malaise traps for monitoring parasitoid wasps. *Insect Conservation and Diversity*, **1**, 22–31.

Graham-Taylor, L.G., Stubbs, A.E. & Brooke, M.de.L. (2009) Changes in phenology of hoverflies in a central England garden. *Insect Conservation and Diversity*, **2**, 29–35.

Guevara, J. & Avilés, L. (2009) Elevational changes in the composition of insects and other terrestrial arthropods at tropical latitudes: a comparison of multiple sampling methods and social spider diets. *Insect Conservation and Diversity*, **2**, 142–152.

Gutiérrez-Chacon, C., Zúñiga, M.C., van Bodegom, P.M., Chará, J. & Giraldo, L.P. (2009) Rove beetles (Coleoptera: Staphylinidae) in Neotropical riverine landscapes: characterising their distribution. *Insect Conservation and Diversity*, **2**, 106–115.

Hayes, L., Mann, D.J., Monastyrskii, A.L. & Lewis, O.T. (2009) Rapid assessments of tropical dung beetle and butterfly assemblages: contrasting trends along a forest disturbance gradient. *Insect Conservation and Diversity*, **2**, 194–203.

Hirsch, J.E. (2005) An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America*, **102**, 16569–16572.

Hunter, M.D. (2001) Insect population dynamics meets ecosystem ecology: effects of herbivory on soil nutrient dynamics. *Agricultural and Forest Entomology*, **3**, 77–84.

Jones, O.R., Purvis, A., Baumgart, E. & Quicke, D.L.J. (2009) Using taxonomic revision data to estimate the geographic and taxonomic distribution of undescribed species richness in the Braconidae (Hymenoptera: Ichneumonoidea). *Insect Conservation and Diversity*, **2**, 204–212.

Knight, M.E., Osborne, J.L., Sanderson, R.A., Hale, R.J., Martin, A.P. & Goulson, D. (2009) Bumblebee nest density and the scale of available forage in arable landscapes. *Insect Conservation and Diversity*, **2**, 116–124.

Laliberté, E. & Tylianakis, J.M. (2010) Deforestation homogenizes tropical parasitoid-host networks. *Ecology*, in press.

Leather, S.R., Basset, Y. & Hawkins, B.A. (2008) Insect Conservation and Diversity – a new journal for the Royal Entomological Society. *Insect Conservation and Diversity*, **1**, 1.

Louzada, J.N.C. & Carvalho e Silva, P.R. (2009) Utilisation of Brazilian pastures ecosystems by native dung beetles: diversity patterns and resource use. *Insect Conservation and Diversity*, **2**, 45–52.

Marini, L., Fontana, P., Battisti, A. & Gaston, K.J. (2009) Agricultural management, vegetation traits and landscape drive orthopteran and butterfly diversity in a grassland–forest mosaic: a multi-scale approach. *Insect Conservation and Diversity*, **2**, 213–220.

Memmott, J., Craze, P.G., Waser, N.M. & Price, M.V. (2007) Global warming and the disruption of plant–pollinator interactions. *Ecology Letters*, **10**, 710–717.

Novotny, V. (2009) Beta diversity of plant–insect food webs in tropical forests: a conceptual framework. *Insect Conservation and Diversity*, **2**, 5–9.

Nufio, C.R., McClenahan, J.L. & Thurston, E.G. (2009) Determining the effects of habitat fragment area on grasshopper species density and richness: a comparison of proportional and uniform sampling methods. *Insect Conservation and Diversity*, **2**, 295–304.

Reece, B.A. & McIntyre, N.E. (2009) Community assemblage patterns of odonates inhabiting a wetland complex influenced by anthropogenic disturbance. *Insect Conservation and Diversity*, **2**, 73–80.

Roy, H.E., Hails, R.S., Hesketh, H., Roy, D.B. & Pell, J.K. (2009) Beyond biological control: non-pest insects and their pathogens in a changing world. *Insect Conservation and Diversity*, **2**, 65–72.

Shortall, C.R., Moore, A., Smith, E. *et al*. (2009) Long-term changes in the abundance of flying insects. *Insect Conservation and Diversity*, **2**, 251–260.

Stefanescu, C., Peñuelas, J. & Filella, I. (2009) Rapid changes in butterfly communities following the abandonment of grasslands: a case study. *Insect Conservation and Diversity*, **2**, 261–269.

Thomas, C.D., Bulman, C.R. & Wilson, R.J. (2008) Where within a species geographical range do species survive best? A matter of scale. *Insect Conservation and Diversity*, **1**, 2–8.

Tylianakis, J.M. (2008) Understanding the web of life: the birds, the bees, and sex with aliens. *PLoS Biology*, **6**(2), e47. doi:10.1371/journal.pbio.0060047.

Tylianakis, J.M. (2009) Warming up food webs. *Science*, **323**, 1300–1301.

Tylianakis, J.M., Didham, R.K., Bascompte, J. & Wardle, D.A. (2008) Global change and species interactions in terrestrial ecosystems. *Ecology Letters*, **11**, 1351–1363.

Tylianakis, J.M., Tscharntke, T. & Lewis, O.T. (2007) Habitat modification alters the structure of tropical host-parasitoid food webs. *Nature*, **445**, 202–205.

Uehara-Prado, M. & Freitas, A.V.L. (2009) The effect of rainforest fragmentation on species diversity and mimicry ring composition of ithomiine butterflies. *Insect Conservation and Diversity*, **2**, 23–28.

Williams, C.D., Sheahan, J. & Gormally, M.J. (2009) Hydrology and management of turloughs (temporary lakes) affect marsh fly (Sciomyzidae: Diptera) communities. *Insect Conservation and Diversity*, **2**, 270–283.