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EDITORIAL

Visions for insect conservation and diversity: spanning the gap between practice and theory

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Insect Conservation & Diversity has now successfully completed its first year in print, and we wish to extend our thanks to our Associate Editors, referees and contributors, as well as to our publishers for helping us achieve this milestone. We have all enjoyed the process of launching a new journal, although it has been, and continues to be, very hard work. We have published a variety of papers covering the general themes encompassed in the title of the journal and we hope that you, the readers and authors, have been engaged and intrigued by the papers we have presented to you. We also hope that you have been stimulated to submit your work to the journal. With that in mind, what would we, as editors of *Insect Conservation and Diversity* (*ICD*), like to read in the pages of *ICD*? Of course, top quality papers focusing on insect conservation and diversity and promoting the science of entomology at large are our brief. Needless to say, the topics to be tackled under this umbrella are many! Since it is our privilege to use a small space in this journal as editorial, we would like to take the opportunity to share with our readers our visions regarding what represents timely material for submission to *ICD*. These are of course, only examples and are not restrictive as to which material may be submitted to and printed in the pages of *ICD*!

One of us (Y.B.) is a tropical entomologist with a current interest in arthropod monitoring. The usual goal of a species inventory is to document as completely as possible the taxonomy and ecology of taxa within a certain area. In contrast, biological monitoring seeks to repeat sampling over time to identify population patterns (Yoccoz *et al.*, 2001). The significance of biological monitoring to obtain reliable data on the vulnerability of species to extinction and their extinction threats cannot be stressed enough. One effort of large-scale biological monitoring so far focused on tropical trees is the network of the Center for Tropical Forest Science, soon to be transformed into a network of 'Global Earth Observatories' to include the monitoring of other organisms (http://biogeodb.stri.si.edu/bioinformatics/sigeo/; Losos & Leigh, 2004).

It is well known that because of their short generation time, invertebrates respond quickly to modifications of their environment (Kremen *et al.*, 1993) and may be more discriminating in this regard than vertebrates (Moritz *et al.*, 2001). Furthermore, our contention is that early warning systems based on short-lived invertebrates may be more efficient than those based on long-lived tropical trees, for example. In this case, the challenge is to implement long-term protocols, suitable for often numerous and vagile species. While applied ecologists have been quite successful in devising sound recipes based on the biological monitoring of invertebrates in aquatic systems (e.g., Karr, 1991), such recipes are few for terrestrial arthropods, particularly in the tropics.

Apart from monitoring directed to specific pests, we nevertheless have admirable examples of long-term arthropod monitoring in temperate regions. Those are based, for example, on butterfly walking transects, suction or light trap programmes (Thomas, 2005; Conrad *et al.*, 2006; Harrington & Woiwod, 2007). Similar monitoring programmes in the tropics are much rarer (e.g., Wolda, 1992; Roubik, 2001). Furthermore, successful monitoring programmes including multiple and diverse arthropod assemblages are infrequent in the tropics. For example, in the Neotropics, some of these monitoring programmes partly abandoned their arthropod focus after an optimistic phase (e.g., Biological Diversity in Tropical Latin America: Erwin, 1991; Conservation International – TEAM: TEAM, 2006) or they never targeted specifically and in the long-term the largest share of biodiversity, arthropods (Biological Dynamics of Forest Fragments Project: Ferraz *et al.*, 2008), but only subsets of their assemblages and those, not particularly species rich (e.g., Vasconcelos *et al.*, 2006). This means that existing examples of arthropod species responding to climate change are so far drawn entirely from temperate regions (Wilson *et al.*, 2007).

The main challenges awaiting any would-be arthropod-monitoring programme in the tropics can be grouped into four issues. First, the purpose of the monitoring programme should be clear. From the onset, it should be apparent that monitoring arthropod populations or assemblages per se is of interest, as opposed to assessing habitat quality with arthropods, which is often trivial (Basset *et al.*, 1998; Watt, 1998). Furthermore, and by far, arthropod monitoring is not a species inventory. Rather, long-term monitoring implies specific protocols, and is best achieved with non-destructive, non-disturbing methods producing seasonal and annual replicates of the same sampling units. Both the system state and response variables should be clearly identified, as well as the spatial and

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temporal framework in which the monitoring programme will be implemented (Yoccoz *et al*., 2001; Underwood & Fisher, 2006). For example, one recent paper published in our pages reviews the suitability of different arthropod variables in response to forest disturbance in Gabon (Basset *et al*., 2008). And, of course, we must clearly articulate what the goal of a particular monitoring scheme is in relation to its management context. Monitoring must be conducted in the context of adaptive management. This will improve the value of any scheme, as the monitoring strategy is much more likely to be efficiently designed if a specific outcome is stated with the ability to modify the programme accordingly.

Second, there is a clear taxonomic challenge, particularly in the tropics. The short answer to this challenge may be to focus on the adult stages of species reasonably well collected with specific protocols of the monitoring programme, providing that their taxonomy is rather stable. Many arthropod groups may be discounted at this stage, but a strict taxonomic focus may greatly help to develop the design of the monitoring programme.

Third, the monitoring protocols should also be suitable and easy to replicate in a variety of situations. This is perhaps the easiest of the four issues listed here to deal with, as many protocols are well established for particular arthropod groups and have been modified to suit tropical conditions (e.g., Agosti *et al*., 2000; Kitching *et al*., 2001; Caldas & Robbins, 2003). Again, a clear distinction between monitoring and inventory will help in designing particular protocols.

Last, the timely processing of the information is also crucial to evaluate from the onset the results of the monitoring programme. For many biodiversity programmes in the tropics, one of the main challenges is the long-term processing and identification of countless number of species, which tend to deplete the resources of both staff and budget of even the largest institutions (T. Erwin, pers. comm.). Clear research focus and local assistance (Basset *et al*., 2004) may help to alleviate this challenge, which remains considerable.

Clearly, all of the above represents a lot of ground to cover, all the more when considering arthropod monitoring in aquatic or terrestrial habitats, or in temperate or tropical regions. We note that 12% of articles published in *ICD* in 2008 were directly related to arthropod monitoring. This is a welcome trend and we hope that future articles submitted and published in *ICD* will clarify, for example, some of the issues mentioned here.

One of us (B.A.H.) is focused on broad-scale issues related to species richness patterns and macro-ecology, motivated by the belief that understanding geographical patterns of diversity and the underlying ecological and evolutionary mechanisms is of both basic and applied importance. Knowing how we got to where we are now *vis-à-vis* diversity gradients is a major goal of ecology, biogeography and evolutionary biology, and understanding insect diversity will go a long way towards understanding the pattern of life on this planet. It is also difficult to conserve something we do not understand. So far, we have published only a paper dealing with the relationship between dragonfly richness and climate in Europe (Keil *et al*., 2008), but we hope to see more broad-scale work submitted and published in *ICD*. On the other hand, insects represent a problem when compared against the much better known vertebrates, as detailed distribution data for most insect groups are restricted to a few places, such as North America, Europe and Australia. And for the majority of groups we lack range maps anywhere. So, how can we address global scale issues in ecology, evolution and conservation if we do not even know how target species are distributed?

Generating detailed and accurate distribution data in the field is extremely difficult and time-consuming for any major insect group, especially in the hyper-rich tropics that are under immediate threat from human impacts and climate change. If we have to wait until complete field data are available for places like Africa, eastern Asia or South America to know how insect diversity hotspots arise and are maintained, it will be too late. But recent advances in converting occurrence records into distribution maps, which can then be used to study broad-scale diversity and other macro-ecological patterns, provide a method that allow us to document diversity sooner rather than later. Gaps in knowledge of species' distributions can be filled using 'bioclimatic envelopes' and 'niche modelling', which has lead to a very active research community (Guisan & Zimmermann, 2000; Pearson & Dawson, 2003; Pearson *et al*., 2006; Araújo & New, 2007; Guisan *et al*., 2007) dedicated to generating range maps for a wide range of taxa in both extra-tropical and tropical regions (e.g., Buckland & Elston, 1993; Peterson, *et al*., 2002; Thuiller *et al*., 2003; Chefaoui *et al*., 2005). As these maps become available, they can be converted into richness data and subject to the full range of biodiversity analyses (see e.g., Williams *et al*., 2003 for an example involving plants). Of course, niche modelling is not a panacea, and generating reliable distribution maps is not easy, but *ICD* represents an eminently suitable venue for the publication of papers dealing with both the development of improved methods and their application with respect to insects.

One of us (S.R.L.) is a temperate entomologist who has spent most of his working life in environments that have been heavily influenced by the activities of man, e.g., forest and agro-ecosystems. His goal has been to attempt to retain, enhance and promote as much insect diversity as possible within these systems, while allowing a living to be made by foresters, farmers and landowners in general (Leather & Kidd, 1998; Woodcock *et al*., 2003; Nunes *et al*., 2006; Fuller *et al*., 2008). In addition, he has attempted to highlight the proper use of green spaces within urban environments as sources of biodiversity (Helden & Leather, 2004) and to bring this important role of urban green spaces to a wider audience (Leather & Helden, 2005a,b).

We would thus like to highlight the recent work that has been conducted in and around urban areas in a number of countries, such as Kevin Gaston's monumental research in city gardens (e.g. Gaston *et al.*, 2005a,b), the work of Ed Connor and colleagues in the San Francisco area (Connor *et al*., 2002), and that of John Spence and colleagues in Canada (e.g., Hartley *et al*., 2007). Thus, we very much welcomed the recent contribution by the Hunters (Hunter, 2002; Hunter & Hunter, 2008) who have highlighted the dangers of habitat fragmentation and the need to engage the public and design professions to consider the needs of insects when providing living and working space for humans.

Allied with the problems of the urban environment is the effect that humans have on insect diversity while trying to feed and sustain their populations. Our sister journal, *Agricultural & Forest Entomology* regularly reports on the ingenious ways in which we attempt to control and regulate insect pest populations (e.g., Warner *et al*., 2008) and we welcome the fact that many of these methods are increasingly directed towards non-pesticide use. From our point of view, we would welcome studies that encourage the management of agricultural and forest resources so as to maximise the conservation value of these environments (e.g., Hassall *et al*., 1992; Parviainen, 1994; Kaila *et al*., 1997; Hill, 1999). Linked to agricultural and forest production is the deliberate and accidental introduction of alien insects to native ecosystems (Louda *et al*., 2003; Oliver *et al*., 2008) and the impact that these may or may not have on native insects and their hosts and natural enemies (e.g., Stiling, 2002). Above all, we need to encourage the practitioners and the researchers to talk to each other and even more importantly, listen to each other. Thus, we welcome articles in our *Focus On* series that highlight such issues, e.g. the paper by Jaret Daniels in the current issue.

In summary, as editors we are naturally interested in seeing *ICD* take a leading role in disseminating research across a broad spectrum in pure and applied ecology, evolution and conservation. Of course, our success in achieving that goal ultimately depends on the continuing efforts of submitting authors and reviewers, but we feel that we are off to a good start. We look forward to receiving a flood of articles including the topics outlined above, as well as any high quality work that advances the science and conservation of insect diversity.

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