Taxonomic chauvinism threatens the future of entomology

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Title image: Unidentified *Neuroptera* found in mountain rainforests of Ecuador, one of the most diverse terrestrial ecosystem. (Photo: Maurice Leponce)

Entomologists are like endangered mammals such as tigers and polar bears in that they and their habitats are on the verge of extinction (Leather, 2007) and this is likely to have a profound negative effect on science in general.

I have identified three potential threats to Entomology in Britain – taxonomic bias, funding bias (possibly fuelled by journal impact factors) and lack of formal training. It has been recognised for some time that taxonomic bias within vertebrate research is widespread, and skewed towards birds and mammals (e.g. Bonnet *et al*, 2002). Clark and May (2002), examining the papers published in *Conservation Biology* and *Biological Conservation,* showed that 69% of the papers published over a 15-year period focused on vertebrates with only 11% on insects, compared with a global diversity estimate of 3% and 79% respectively!

It seemed appropriate to further examine the publishing bias, so I searched the contents of four prestigious ecological journals for 2006 and 2007, covering the UK, mainland Europe and the USA – *Journal of Animal Ecology*, *Journal of Applied Ecology*, *Oecologia* and *Ecology* – assigning each paper to either vertebrate, invertebrate (further sub-dividing into insect) and plants. Those papers that truly took a cross-taxonomic approach I

classified as mixed, while those that had, for example, some elements of a cross-taxonomy approach, I classified according to the research interests of the principal investigator and the originating laboratory. As can be seen (Table 1), vertebrates are extremely over-represented and insects average out at just over 17% of the papers published by these four journals. The bias is thus not as great as that shown by conservationists but is still far from absent!

Papers published may be a function of funding granted. I therefore searched the databases of grants awarded by the two major Government research funding bodies in the UK – NERC (Natural Environment Research Council) and BBSRC (Biotechnology and Biological Sciences Research Council) – using a common set of keywords, i.e. vertebrates, mammal, birds, fish, insects, reptiles and combinations thereof. In addition, I wanted to know the proportion of applications in each category so that I could estimate the relative success rate of applications in relation to subject taxon: when approached, neither BBSRC or NERC were able to supply these data, though. The results that I did discover, however, provide food for thought (Table 2)! As an international comparison, I also searched the National Science Foundation of the USA (NSF) database using the same search terms.

A startling imbalance

Once again, we see a startling imbalance in the ratio of funding afforded to minority taxa (invertebrates). The most shocking result is that NERC, whose remit specifically includes the study and conservation of biodiversity, appears to be ignoring a huge proportion of it! This may be related to the fact that the composition of recent NERC grant awarding panels has been heavily biased in favour of vertebrate ecologists (38%) compared with entomologists (13%).

As well as funding being dependent on the composition of the grant panels, the profile of the researcher is also a consideration, and this is largely predicated on the dissemination of their research, i.e. the impact factor of the journals in which they publish. As we have already seen (Table 1), there is a distinct bias towards vertebrates in the leading ecological journals. Entomologists are therefore 'ghettoised' and forced to publish in specialist journals. It will come as no surprise to see that the top entomology journals fare badly, even when compared with ecological journals outside the top ten e.g. *Journal of Animal Ecology* and *Oecologia* (Table 3).

This is yet another disservice to entomology as a discipline and a career choice in academia and, as I pointed out earlier, a threat to the conservation of biodiversity and also crop protection. Given that some of the biggest names in ecology in the past were entomologists e.g. Hassell, Hollings, Janzen, Lawton, Price, Simberloff, Southwood, Wilson, this line of argument leads on logically to a consideration of formal entomological training, or rather, the lack of it. When I was an undergraduate in the

Figure 1. *Thysania agrippina* observed during IBISCA-Panama, a large-scale biodiversity inventory which aims at documenting the spatio-temporal distribution of half a million arthropods in a tropical rainforest. (Photo: Yves Roisin)

Table 1. Taxonomic distribution of papers published in *Journal of Animal Ecology*, *Journal of Applied Ecology*, *Oecologia* and *Ecology* in 2006 and 2007.

Taxonomic grouping	Number of papers published in:			
	J. Anim. Ecol.	*J. Appl. Ecol.*	*Oecologia*	*Ecology*
Vertebrates	178	102	179	185
Plants	n/a	63	179	228
Invertebrates (inc. insects)	85	63	158	179
Insects	58	51	98	90
Mixed	6	16	6	86
Total	269	244	522	678
% insects	**22**	**21**	**19**	**13**

Table 2. Number of grants awarded by BBSRC and NERC in relation to subject taxon.

Taxonomic grouping	Research Council		
	BBSRC	NERC	NSF
Birds	166	122	324
Mammals	198	72	377
Fish	157	214	573
Reptiles	6	6	52
Vertebrate total	**527**	**414**	**1326**
Insects (including spiders)	321	76	502
Mites (Acari)	13	6	9
Insect and allies: Total	**334**	**82**	**511**

mid-1970s, although there was only one Entomology Department in the UK and one BSc Entomology degree (Imperial College), there were seven UK universities that offered a degree in Agricultural Zoology, which were essentially degrees where the specialisation was entomology and parasitology (including plant nematology) and these included in-depth taxonomic training or at least the ability to identify a wide range of insects. These courses produced approximately 70 graduates a year. There were also three MSc Entomology degrees available in the UK. In addition, even pure zoology degrees exposed their students to a year of invertebrate zoology.

This compares very badly with the situation now, when there are no entomology departments, no undergraduate entomology degrees and only one MSc in Entomology (again Imperial College). Typically, students registered for zoology or biology degrees will cover the whole of the invertebrates in 12 lectures; a massive reduction compared with 30 years ago. There were seven students on the MSc Entomology course for 2007-2008 at Imperial, compared with the 30 students registered

Figure 2. Founding queen of the ant *Pachycondyla dianae* inside a *Cecropia* tree in Panama. In this highly specialized association, the only food sources for the ant colony are the purple food bodies produced by the plant at the base of the leaves. (Photo: Maurice Leponce)

Table 3. Journal impact factors 2006.

Ecology	4.82
Journal of Applied Ecology	4.22
Journal of Animal Ecology	3.75
Oecologia	2.97
Insect Molecular Biology	2.78
Systematic Entomology	2.42
Journal of Insect Physiology	2.29
Ecological Entomology	1.96
Biological Control	1.57

for the MSc in Conservation Science (vertebrate dominated) which is run on the same campus. Interestingly, given the bias shown by the NSF against entomologists, we find that in the USA there are 16 universities with Departments of Entomology offering BSc and MSc degrees in Entomology and an additional 22 universities that offer entomology minors!

The problem in the UK is not unique in Europe. In France, concern was recently expressed about the shortage of medical and veterinary entomologists in that country (Cuisance and Rioux, 2004). Apparently there are currently approximately 100 medical and veterinary entomologists – of whom half are over 50!

Not a problem?

We are often told that the lack of formal training in entomology and the rarity of insect taxonomists in universities is not a problem as the amateurs will always be there to fill the gaps – much as in the bird world – or that DNA barcoding will do the job for us (Godfray 2002; Godfray and Knapp, 2004). What seems to be overlooked is that the number of insect species is unknown and relatively undescribed, whilst that of terrestrial vertebrates is almost completely known (Leather *et al*, 2008) and that the number of amateur entomologists and taxonomists is in steep decline (Hopkins and Freckleton, 2002) with the membership of the Amateur Entomological Society showing a 35% decline over the last five years (Livermore, *pers comm*). Without people able to identify living specimens *in situ*, how can we make proper inventories for conservation purposes, or identify new and current pests that threaten our crops and livestock?

What does the future hold for entomology as a discipline? At the moment it would appear to be shrinking: PhD students and young researchers working with insects have too narrow a focus, they can identify their study organisms but little else. There is a dearth of group experts and entomological generalists – and most are over 50. As old experts and general ento-

mologists die or retire, they are not being replaced because training and funding opportunities have not allowed new experts or generalists to flourish.

In the UK, although mini-beasts and school wildlife areas are a common feature of the primary school curricula and generate some enthusiasm amongst pupils, the secondary school syllabus is concerned with cells, molecules and human biology; ecology-based field courses are the exception rather than the rule. A recent survey commissioned by the Royal Entomological Society shows that whilst over half of school children under the age of 11 feel that they know enough about insects to talk about them for three minutes, only 27% of 11-18 year olds feel as confident!

Given that the biology departments of UK universities are now bereft of entomologists and undergraduate training in invertebrate zoology is in decline, it is not surprising that large numbers of students are opting to take postgraduate courses focusing on large charismatic vertebrates. In addition, the public are either apathetic or fearful where insects are concerned, largely preferring to steer their financial donations towards the conservation of polar bears, tigers or elephants and using their rolled up newspapers to stamp out insects and their allies!

Should we care?

Should we care that entomology appears to be in decline? Yes, most emphatically: biodiversity is largely invertebrate and unknown. Without invertebrates the ecosystems of the world would collapse; the demise of a substantial number of vertebrate species would not have such an effect. Climate change is predicted to cause significant changes in the distribution and impacts of insect pests and vectors on human livelihoods and health (Blashki *et al*, 2007; DeLucia *et al*, 2008). We need entomologists to identify invaders and counter their effects.

Are there reasons to be cheerful? Precious few. Yes, we still have students wishing to study entomology in the UK while entomology in the US, despite its funding profile (Table 2), is still seen as an important discipline and NERC does appear to have some concerns about taxonomy. At primary school level, pupils are still being enthused and efforts continue to encourage this aspect of education. However, we do need to continue banging the drum for entomology and its allied subjects.

Entomologists have to do more to publicise the current crisis and university academics have to encourage the teaching of invertebrate zoology. The funding bodies must lead the way by positive discrimination – i.e. fund areas in relation to their taxonomic representation rather than by the number of researchers studying a particular field and balance their peer review panels accordingly. Journals must also balance their editorial boards taxonomically and, if necessary, ghettoise vertebrate zoologists and ecologists. Without these measures I see a gloomy future for entomology and massive problems arising in conservation, crop protection and human health in general.

Perhaps one solution is to convince vertebrate zoologists and ecologists at the beginning of their careers that insects and their allies make ideal model organisms. They are fast breeding, easy to culture, amenable to field and laboratory experimentation and, if not rare, occur in large numbers. Many have complex and intriguing life histories and if you look closely at insects they are truly beautiful.

Entomology has much to offer the scientific world, not least the thrill of the unknown and large sample sizes!

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