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Entomology and nature conservation*

TIMOTHY R. NEW

School of Zoology, La Trobe University, Bundoora, Victoria 3083, Australia; e-mail: zootn@zoo.latrobe.edu.au

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Abstract. Interest in insects as conservation foci and as tools in broader conservation assessment has accelerated markedly in recent years, but the diversity and complexity of insect life demands a more focussed and structured approach to "biodiversity" and inventory studies than has commonly occurred. Strategies for insect conservation are reviewed, together with the variety of uses for insects as ecological tools in broader monitoring of environmental quality. Principles for selecting optimal focal groups are discussed, and the importance of developing standard protocols to sample and interpret insect assemblages emphasised. The global values and relevance of the pioneering lessons in insect conservation developed in Europe are summarised.

INTRODUCTION

The rise of public and political appreciation of biodiversity issues during the last decade reflects widespread and increasing concerns for the well-being and sustainability of our natural world, of the influences of burgeoning human populations, and for the security of the multitude of taxa and ecosystems that our descendants may never see as a consequence of our activities. The practical, ethical and emotional ramifications of this renders the rapidly-emerging science of conservation biology, and its integration with social, economic and cultural frameworks throughout the world, one of the most vital areas of endeavour for the current human generation.

For the most part, however, this endeavour is proceeding in an environment of almost unfathomable ignorance of the predominant components of that biodiversity, and how these both affect human survival and, in turn, are influenced by us. Much of the conventional wisdom of conservation, and much of the emphasis on practical issues, continues to emphasise warm-blooded vertebrates, harvestable or other economically selected taxa, and vascular plants. The vast arenas of unicellular organisms, fungi, non-vascular plants and invertebrate animals tend either to be ignored or consciously dismissed because of their daunting biological and taxonomic complexity, coupled with lack of appreciation of their functional roles and importance.

There are, of course, important exceptions to this. Among the invertebrates, some groups of insects have traditionally been accepted as "worthy" or have attracted notice because of aesthetic, cultural or practical advantages. Many species of butterflies, for example, are important "flagships" for promoting insect conservation, and this has fostered progressively the listing of a wide variety of insect taxa on schedules of protected fauna in many parts of the world.

The values of lists of threatened species, if carefully documented, are considerable. They can help to demonstrate the scale of genuine conservation concern, the variety of taxa at risk, and be resource documents for conservation, foci for research and augmentation by new information, and information sources (McIntyre, 1992). But, historically, most species are listed because of their vulnerability and, commonly, demonstrated decline, so that listings tend to convey the need for "crisis management". Our resources are grossly insufficient to meet the ethical and practical committments which formal schedules of protected species engender. In practice, the selection of the most deserving taxa from lists of demonstrably needy taxa must then occur (Bean, 1996), and it is here that more objective appraisal of vulnerability and other values must emerge. As Machado (1997) noted, for Europe, official lists can sometimes signal the automatic direction to start recovery action. Such schedules, though – even if they lead to practical conservation of the species listed, rather than simply alienate interests – will always be too long, or insufficiently representative (that is, too short: Haslett, 1998) to support the entire recovery actions needed and, indeed, to which we become practically or morally committed by the very act of "listing". Despite the progressive and widespread acceptance of the worthiness of individual insect species as targets for conservation, this can not be the main strategy to pursue; it is one strand in an ever-diversifying web of conservation strategies.

The major traditional alternative, or complement, namely habitat reservation to provide an increasingly representative suite of "protected areas" as sanctuaries for biological diversity, is becoming ever more difficult as human demands become more complex and urgent. A major problem in selecting priority areas for additional reserves, based on principles of complementarity and knowledge of critical faunas (Vane-Wright et al., 1991) is that for the most part we have no inventory listings of

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most of the invertebrate taxa already secured (or, at least, represented) in existing reserves, or reported from them. For national parks in the United States, Stohlgren et al. (1995) noted that information on invertebrates is "generally poor to non-existent", and development of an optimal reserve system would logically go hand-in-hand with finding out which species are secured there as a basis for assessing complementarity of additional areas. At present, inventory studies of insects, in many places even of butterflies or dragonflies, simply do not exist, and are unlikely to accrue in any concerted form. The assumption that habitat reservation guarantees species survival is often questionable, and there are numerous records of butterflies having become extirpated in reserves, including reserves designated especially for them (Thomas, 1984), as a reflection of ignorance of specific management needs. Even in Britain, a number of resident butterfly species are still not represented in high quality reserve areas (Warren, 1994).

In many places, we can not afford the luxury of "choice" of reserves because loss of pristine habitat has already been so severe that the emphasis must, rather, be to conserve as much as possible of the remaining remnants (Larsen, 1995, for example). There are two main additional keys to the future of insects in broader conservation issues:

1. Improving strategies for conservation outside reserves, especially on agricultural and other private lands.

2. Detecting and communicating the values and roles of insects as tools for broader conservation assessment, thereby gaining support for their safety over a broad variety of freshwater and terrestrial habitats, as an integral part of monitoring human influences.

CONSERVATION OUTSIDE RESERVES

We live in a suite of anthropogenic landscapes. In Europe, virtually all land except the most inaccessible has been changed dramatically over many centuries of human influence and occupation. Thus, Speight (1985) noted the apparent total clearing of pine forests in Ireland during the seventeenth century, with the consequent extinction of characteristic "Caledonian" saproxylic insects. In Australia, dramatic changes have occurred over much of the continent during only 200 years, with most of this in the last century or so. Much of what we regard as "natural" in any part of the world is the creation of people. But, whatever the rate and extent of clearing of natural vegetation and attendant loss or diminution of native biota, enclosures or remnant habitats are now of immense value for insects, not least because many of them can thrive in areas far smaller than those needed to sustain viable populations of larger animals. The theme of integrated plant and insect conservation has recently been revisited by Keesing & Wratten (1997), who reiterated the high numbers of insects associated with forests, and the widespread loss of forests in many parts of the world. Protection of vegetation is a key aspect of protecting such coexisting and dependent organisms.

In Australia, the most widespread threats to native insects (and other biota) have been, and continue to be (1) alienation of natural habitats with loss of native vegetation and (2) the wide variety of exotic, often invasive, species which have been introduced since European settlement. Two examples from eastern Australia demonstrate the scale of these effects. Native grasslands in lowland Victoria have been diminished by around 99% of their original area, so that high quality native grasslands are now one of the most threatened ecosystems in the region (Kirkpatrick et al., 1995). Many insects which depended on them have also declined. One flagship taxon, the Golden Sun Moth (*Synemon plana* Walker: Castniidae), for example, has disappeared from many of the sites in Victoria and New South Wales where it formerly occurred. Second, forest clearance over the same region has also led to large scale habitat loss, with more than half of Australia's forests lost or highly modified (RAC, 1992). In both cases, vegetation of much of the area has been replaced by exotic species – by introduced pasture grasses, a variety of crops, and softwood plantations, particularly of *Pinus radiata*. Remaining "natural" habitat fragments are often simply patches of terrain which were not immediately amenable to such changes. They include steep slopes, rocky outcrops, and the like, but the extent of change varies greatly. In some places it provides a mosaic of remnant fragments surrounded by vastly different habitat; in others it is more akin to a variegated landscape which may be hospitable to at least some of the original inhabitants.

Altogether, about 36% of global land surface is devoted to agriculture (Gerard, 1995), so that agriculture is perhaps the single most important activity affecting conservation of biological diversity (Gall & Orians, 1992). Survival of many species will depend on the forms and intensity of agricultural management – including pesticide applications, stocking rates, tillage practices, rotations and a variety of others. In many parts of the world, high input agricultural systems have almost entirely replaced less damaging lower input systems, and these depend increasingly on chemical and other technological interventions. Such systems commonly comprise large areas of monoculture, and areas such as conservation headlands (Dover, 1991) and boundaries (such as hedgerows) provide virtually the only reservoirs for natural biota. Nevertheless, the diversity of insects in many agricultural systems is surprisingly high (Horne & Edward, 1997). Development of reservoirs for other taxa, together with other strategies to increase natural or seminatural habitat on agricultural lands, and improving the connectivity between these by suitable restoration must be one of the major conservation hopes for such large areas.

The needs for conservation outside reserves reflect that:

1. Many of our present reserves were not erected primarily for nature conservation, but for other purposes, and often for multiple use.

2. Many species occur only outside protected areas, a trait accentuated by selective land acquisition in the past excluding adequate examples of many major habitats

from reserves (Bennett, 1995). Thus, for the south east Australian native grasslands noted above most of the 29 main communities are not adequately reserved and none is unthreatened (McDougall & Kirkpatrick, 1994).

3. Properly planned areas around reserves can augment the effectiveness of small "core" areas by providing buffers to reduce edge effects or facilitate dispersal by providing corridors between reserves.

4. Many species utilise both reserves and non-reserve areas.

5. Many agricultural and other landscapes can indeed support many insect species, including those adapted to survival in particular disturbance regimes, but these are usually only a small subset of the former natural fauna of the area, which can persist only if suitable resources are provided.

With changes in agricultural markets and land use, opportunities for restoration of degraded landscapes are becoming more frequent. Optimal principles of landscape design are starting to incorporate considerations of invertebrates in many places. Australia, like New Zealand (Keesing & Wratten, 1997) tends to have "polarised landscapes", with great differences between indigenous and exotic landscapes. In both countries until recently, conservation has been confined largely to the former category. This is changing as the values of disturbed habitats and agricultural landscapes for biodiversity become ever more apparent.

Studies on the "permeability" of various edge habitats on arable farms have demonstrated clearly that many butterflies are reluctant to cross boundaries (Fry et al., 1992), and many epigaeic insects (such as carabid beetles: Mader et al., 1990) are likewise impeded by roads and other seemingly insignificant interruptions to a landscape. The lessons from such observations on insects have wide ramifications in conservation management. The roles of connectivity in altered landscapes urgently need more appraisal: as Fry & Main (1993) remarked "it is dangerous to generalise about corridors", because a landscape feature which can function well as a corridor for one species may be a barrier to movement of another. Restriction of movement of *Parnassius mnemosyne* in Norway between fields in a valley system has lead to detectable genetic isolation (Aaregard, cited in Fry & Main, 1993). Likewise, clarifications of the roles of corridors as modes of passage and residency habitats are needed in many studies on connectivity and the extent of population isolation.

The great diversity of habitat restoration strategies employed in Europe to control land degradation problems provides some useful lessons for other parts of the world. Deciduous forest, as the main climax vegetation over much of Europe and toward which most abandoned agricultural land will succeed, is perhaps the most important regional community set to consider. Establishment of woodland on farms in Australia has similar purpose, and there are various forms of this – from establishing windbreaks and boundaries, as riparian woods for water or nutrient uptake, for stock feed or timber, or more specifically as "natural habitat". Likewise, restoration of grasslands is urgent in Australia, and such habitats are often overlooked as vitally important for endemic invertebrates in many parts of the world. One of the important lessons from studies on relationships between insects and their habitats is the fine scales on which such small animals operate (Samways, 1994), and the need to incorporate a variety of scales into practical management. Thus, in addition to the gross features of vegetation in a habitat, fine details of topography or sward height on which some lycaenid butterflies depend near the fringes of their range (BUTT, 1986; Thomas, 1984) reflect narrow and specific thermal requirements in the landscape. In any conservation programme, restorative or otherwise, considering such details will be increasingly necessary to recreate an adequate mosaic of microhabitats and ensure that a high degree of environmental heterogeneity is itself incorporated as a factor of critical importance in conserving diversity. Much insect conservation therefore depends on the maintenance of disturbance regimes to facilitate the continuity of metapopulations in the broader landscape. The same considerations render adoption of broad indicator taxa difficult in many terrestrial environments, because of the uncertainties of establishing valid baseline data other than on specific sites.

INSECTS AS TOOLS IN CONSERVATION

The increasing interests in habitat management and restoration have wide ramifications for biodiversity conservation, but it is also widely appreciated that some form of monitoring of many such exercises is vital. The general aim is to approach some degree of "naturalness", providing habitats which will allow colonisation and persistence of native species. Many such exercises are necessarily long term, but opportunities to monitor changes in communities over extended periods are frustratingly few. The natural recolonisation of Krakatau, as one example of a longterm natural experiment following the devastating eruption of 1883, has demonstrated that considerable complexity can indeed reestablish (Thornton & New, 1988; Thornton, 1996). Indeed, with continuing degradation of nearby parts of Java and Sumatra, it is not inconceivable that the Krakatau archipelago will eventually support species extirpated from these regions whence, presumably, they colonised the Krakataus.

Despite such evidence of resilience, though, continued loss of natural habitat is the prime threat to myriads of ecologically specialised insect taxa, and anthropogenic activities may be far more damaging to insects than the localised influences of Krakatau, not least because their geographical spread may erode or remove any possible recolonisation of restored habitats. Without reservoirs, the potential for colonisation simply does not exist. There are clearly differences in effects on insects between some relatively low impact changes, such as small scale shifting agriculture, where forest edges can be an important component of the overall habitat mosaic (Brown, 1997), and the high intensity changes we noted earlier.

In terms of simple loss and erosion of diversity, the species-rich areas of the tropics and southern temperate regions offer rather different concerns from those of the northern temperate regions. It is likely that the insect faunas of Europe, in particular, have already suffered levels of extirpation and impact of the kinds which now concern us in Australia, for example – where we still have some opportunity to counter these. In much of the northern hemisphere, we are already dealing with a residual, impoverished biota, and prevention of other regions attaining this unenviable state is a major concern in insect conservation. Many specialist taxa have been eliminated over much of their range, and the remnant habitats in which they persist are among the highest priorities for insect conservation. A high proportion of the insects listed in protection schedules in Europe, other than some bland listings of Lepidoptera which reduce the credibility of this approach as a serious conservation tool (Collins, 1987), appear to be taxa whose ranges have been severely reduced already, and many have suffered extirpations throughout their range.

Practical conservation management is actively making the transition from ad hoc exercise to predictive and reliable science based on sound ecological theory and trial. Underpinning much of this progress is the need to monitor success of management and the impacts of change in the most effective ways, using a variety of tools as indicators and harbingers. Insects have major roles to play in this diverse progress, because their large numbers, high species richness, and great variety of ecological responses render them collectively the most accessible, informative and assessable animal group in most places where they occur. Indeed, perhaps no other group has comparable, harnessable potential to contribute to more effective understanding of environmental change and quality: a fact reflected in Kremen et al.'s (1993) implication that terrestrial arthropods collectively can be the effective core of broad monitoring programmes. Their appraisal of the advantages of arthropods largely reflect those of insects alone, and the extensive use of insects in freshwater monitoring programmes also attests to their value.

FOCAL GROUPS

The immense variety of insects, which continues to challenge our ingenuity to enumerate and define, underpins much current thinking about biodiversity – the templates of species richness, incidence, distribution, endemism and other features which form much of the rationale of setting conservation priorities, and the baselines against which changes can be measured or appraised. It is no accident that the best-known insect groups are those most used as conservation tools, and improved understanding of an insect group goes hand-in-hand with such employment. Kremen et al.'s (1993) focus on target taxon analysis explicitly includes testing to determine some aspects of indicator values in selecting such groups.

Simple numbers of species are indeed important as the basis of many such indices and appraisals. However desirable, the aim of totally documenting insect diversity at the named species level is unlikely to be achieved within the next few decades and, whereas we should continue to strive toward this end, advances in conservation are most likely to come from closer focus on a more restricted suite of insect orders and families known or suspected to have values as ecological informants, including capability as indicators or predictors. Desirable features of such groups have been discussed extensively (New, 1993, 1994; Pearson, 1994; Yen & Butcher, 1997, as examples). New (1999) suggested that, for conservation values, three broad categories of invertebrate groups could be recognised:

1. Well known groups. These are those for which there is substantial knowledge of taxonomy, ecology and distribution, so that they are harnessable for reliable measures of diversity, their responses to environmental change are understood at the species or near species level, they are amenable to standard evaluation techniques, and can be identified by non-specialists. Butterflies and dragonflies, as groups with a long history of amateur interest, readily available handbooks or field guides for many countries, and a history of prior conservation interest which has helped to hone the information available, are prime examples. In general, such groups are "instantly available" for conservation assessment from a basis of sound understanding or knowledge of the patterns they manifest.

2. Catch-up groups. Many insect groups are "moderately well known", but still contain important gaps in knowledge, such as the need to clarify important species complexes, more survey to establish basic distributional patterns and the factors which influence these. Some are employed commonly at the genus or family level in diversity measurements, and species level analyses could refine their use considerably. Essentially, these are insect groups for which a relatively small amount of attention could dramatically increase their values in conservation.

3. Black hole groups. The least known groups of invertebrates, including many families in most of the larger insect orders, can at present not be evaluated clearly. The numbers of taxa are uncertain; species separations are laborious, unreliable and command specialist evaluation; biological and distributional knowledge is fragmentary; ecological responses are unknown or hypothetical, extrapolated from few examples; and they may be difficult to collect or sample in standard ways.

The contrasts between these groups may be helpful in setting priorities for the work needed to improve our use of insects in conservation assessment. Acknowledging that any suggestions of triage can be undesirable if taken out of context, not least because recommendations to relatively "demote" particular taxonomic groups for one purpose can be taken as a more general sentiment that they are unimportant and lead to loss of funding for excellent research on other aspects of their systematics or biology, this approach can provide a basis for debate on the optimal ways to proceed for enhancement of values of insects in conservation. One constructive approach would be:

1. to refine knowledge of the well known groups, targeting specific applications of these for experimental investigation and trial;

2. to increase work on selected catch up groups, to accelerate their transformation to "well known" and increase the taxonomic and ecological variety of these, so that suites of complementary groups could be evaluated meaningfully in a variety of habitats;

3. to recognise that most black hole groups are unlikely to be employed at species or near species level in conservation assessment in the foreseeable future, so that they are a low priority for immediately conservation-orientated research, unless particular relevant situations present.

Using focal groups in this way may help us to deploy scarce resources for greatest conservation benefit in providing reliable species level information to help determine patterns of distribution and richness, and of change, and in evaluating objectively the conservation status of taxa targeted for specific attention. The particular groups will vary for different major habitats but, ideally should include overlapping ones when comparisons between these are involved. Speight's (1986) suggestion of "foundation" and "auxiliary" groups for incorporation into insect surveys merits more attention in pursuing comparative surveys. An extension of this is illustrated by a recent international initiative, GLOBENET, which seeks for the first time to establish and compare patterns of a single group of insects (carabid beetles) sampled by a single technique (pitfall trapping) along similar gradients in many parts of the world, and thus to determine the possible wide generalities from group focus in a broad ecological context (Niemela et al., in prep.).

The approach reflects the reality that most invertebrate surveys yield vast numbers of specimens which are never fully appraised. Almost invariably, workers pick out only particular families or orders for more detailed appraisal, these reflecting personal preference or interests, availability of taxonomic expertise, or the "worth" of the group in a particular context. The suggested route here leads toward standardisation of focal groups, to help create a more comprehensive basis for comparative studies of insect biodiversity. It is important also that sampling protocols are standardised (New, 1998), with adoption of agreed sampling sets (Disney, 1986), and comparable sampling effort. Ideally, incorporation of additional focal groups should not markedly increase sampling effort, though sorting and analysis costs will inevitably rise.

LESSONS

Those of us trying to promote insect conservation in distant parts of the world have benefited greatly from the lessons and tradition of European endeavours over the last century or so. Without these examples, our efforts would be impoverished and less effective, but the European experience provides both object lessons and caveats. It was here that insect extinctions were first convincingly documented (*Lycaena dispar dispar* in Britain, for example), that long term ecological studies revealed the subtle resource needs and complexity of good management for species, and that concern both for species and habitats in altered landscapes has been fostered. It was also here that the minefields of protective legislation became apparent, and the consequent conflicts between biological realities and political boundaries entered the insect conservation arena. It remains sobering that such longterm motivation and endeavour, with many people seeking to conserve such well defined and rather small faunas, leaves still so much to do and has not developed a more holistic and politically coordinated strategy for use of insects in broader monitoring involving truly European or global cooperations. Not least, it is not generally feasible to determine whether national trends in insect abundance are engendered by local or continental scale influences (Speight, 1996).

However, some recent broader enterprises are significant in indicating some of the ways toward more holistic and effective working with species and habitats, in particular relating key insect species more firmly to key habitats and helping to overcome the frustrations of small scale political boundaries. Both are lessons with very wide applications because, although much insect conservation has very narrow focus (and, of course, many of the support systems raised to protect local flagship taxa are not likely to be otherwise available for any form of conservation), most such exercises have an ad hoc element when viewed more dispassionately. For butterflies, van Swaay et al. (1998) have developed criteria to identify "Species of European Conservation Concern", so that although all countries reviewed had butterfly species of high conservation interest 13 species were of especial significance as "European endemics considered globally threatened", so demonstrating a clear regional priority among this best-known insect group.

Another enhancement of species focus is to seek those species which can confer "inclusive benefits" (Carroll et al., 1996) from their ecological roles, and thus incorporate also considerations of key habitats. This path in Europe was flagged by the European Habitats Directive (1992), but Haslett's recent (1998) suggestions of focussed additions to the Bern Convention listings as representatives of particularly threatened groups provide tangible cases for exploration and enhancement. In such ways, listings of species of conservation interest can transcend simple indication of need for individual crisis management, become valuable tools for broader planning and be seen to have broader relevance in practical conservation. The mandatory monitoring requirement of the Habitats Directive has not been undertaken effectively, and runs the risk of being ineffective as a conservation aid (Speight, 1996), largely because of lack of international-level cooperation.

Insects will continue to tantalise us. To the outsider, it is remarkable that notable discoveries of unrecorded taxa can still be made in the best documented of all insect faunas; for example the recent discovery of a thriving colony of antlions (Neuroptera: Myrmeleontidae: *Euroleon nostras*) in Britain (Mendel, 1996). Such incidences apparently reflect the dynamism of insect distribution, for it seems almost inconceivable that such a striking insect could have escaped detection as a resident in eastern England for so long.

We envy the amount of expertise available in Europe, and the general tangibility of the insect fauna. Although Lovejoy's recent (1997) comment on birds in Britain (to the effect that "it is impossible for a bird to lay an egg without three people, including at least one cleric, recording it") may be (slightly) exaggerated, it encapsulates well the principles and outcomes of considerable amateur and professional interests in natural history and relatively comprehensive documentation. The entomological literature of Europe contains vast distributional, phenological and biological data on many of the better-known insect groups, so that relatively comprehensive syntheses and handbooks for these are not only authoritative but largely definitive for some countries. Yet, for example, around half of the British Hymenoptera have not yet been treated in the Royal Entomological Society's "Handbooks" series, and remain effectively impossible for non-specialists to identify. Programmes such as the European Invertebrate Survey, leading to succession of Atlases for groups such as carabid beetles, could not be undertaken other than in fragmentary form elsewhere – despite valiant advocacy for these.

The uses of such data in broader perspective can be exemplified by considering the recommendations of the recent European Working Group on Research and Biodiversity (1997), whose goal was to "identify the main needs and priorities in the future of biodiversity research, in order to provide the knowledge and the main tools to achieve an effective protection and management of biodiversity in a European context". Insects have major roles to play in most aspects of the Agenda specified, from "putting value on biodiversity" and "use of existing knowledge" to "biodiversity indicators" and "biodiversity management". Indeed, clear cases could be made for such agenda items being inadequate and severely impoverished without entomological data. Many groups of insects could be valuable tools in such promotions.

Thus, by comparison with most of the tropics and the southern continental regions, the amount of reliable information on insects available for construction of species-level templates for conservation planning is formidable. Equivalent levels of appraisal for most megadiverse areas, with few resident entomologists, little tradition of amateur involvement in natural history, little (and largely outdated) reference material, and much of the necessary comparative collections far away, remain largely a dream. Janzen (1997) provided illuminating comment on the practical problems of documenting insect diversity in the tropics.

It is difficult for many European entomologists to appreciate the frustrations of working in countries with faunas where only a small proportion of the species have been described or can be recognised unambiguously, where species level biological data are rudimentary, distribution patterns simply reflect serendipity of collection, for which field guides or comprehensive technical synopses do not exist, where reference collections are largely unavailable and/or uncurated, and where there are no nearby experts to ask for help, but where problems of conservation manifest on scales far exceeding those which are familiar, through large scale destruction of largely unexplored habitats. To entomologists striving to promote insect conservation in the Neotropics or south east Asian countries, the luxuries and reference standards taken for granted in Europe (albeit with occasional frustrations!) are utopian. It is here that the lessons of European insect conservation have their greatest testing. To back these up, education and training programmes have a critical role to play, in disciplines ranging from basic recognition and identification of insect groups to specimen treatment and survey methodologies for inventory and conservation (Janzen, 1997).

Our greatest challenges arise, therefore, in environments where the need is for adaptability, where entomologists who cannot recognise species, read much about the local fauna and have few avenues to seek advice – but where these lacunae can be accepted and realistically addressed – have much to contribute. Our methods may seem unsophisticated because of the taxonomic impediments faced: analyses at order or family level rather than enumerating species in inventory surveys, for example. Use of "morphospecies" rather than named species is, necessarily, widespread in Australia (and elsewhere). These strategies do not detract from disciplined and focussed analyses in using insects in conservation assessments. Insect conservation is developing rapidly, and critical evaluation of any possible shortcuts (such as surrogacy values of higher taxonomic groupings, and rapid biodiversity assessment) is an urgent facet of employing the best science at our disposal, and of continually improving its applications. The synergisms of the species level focus and management which has long dominated much insect conservation activity in Europe and the broader paradigms necessary elsewhere are leading to a more holistic understanding of the roles of insects in conservation – roles which provide one of our greatest hopes and strengths for understanding the ecosystems on which we all depend.

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