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Preface

From systematics to conservation – carabidologists do it all

Jari Niemelä

Diversity of carabid research

'An inordinate fondness for beetles', replied J. B. S. Haldane when asked what could be inferred of the work of the Creator from studies of nature (Fisher 1988). This exclamation is very fitting indeed as beetles make up some 40% of the estimated 950 000 insect species described (Hammond 1992). With ca. 40 000 species described (Noonan 1985, Lövei & Sunderland 1996) Carabidae is one of the most diverse families of beetles (Gaston 1991). There are about ten times more species in one single family of beetles, the Carabidae, than in the whole class Mammalia (Hammond 1992). Thus, it is evident that insects, and carabids among them, are the little things that run the world (Wilson 1987). The taxonomic diversity of carabids is excellently illustrated by Terry Erwin's work on the fascinating neotropical genus *Agra*, which includes over 2 000 species, representing ca. 5% of the known species of the entire family Carabidae. This extraordinary species richness makes the genus the largest monophyletic lineage at the generic level of any known group of predatory beetles (Erwin 1996, Thacker 1996).

These extraordinary figures also highlight the difficulties of entomological research: the inordinate number of species causes problems for classification and for consequent ecological research (Stork 1988, Mound & Gaston 1993, Samways 1994). However, thanks to the handsome appearance displayed by many of the more noticeable species, as noted by Hammond (1990), carabids have been intensively studied by generations of coleopterists and they are currently one of the best known invertebrate families (Desender *et al*. 1994). The substantial knowledge accumulated, especially in Europe, during a long tradition of research renders carabids suitable for testing evolutionary and ecological hypotheses (Lindroth 1949, Den Boer 1986, Loreau 1994). More recently, carabids have been used for various applied studies, such as conservation evaluation (Desender *et al*. 1994, Thacker 1996). Carabids appear to be exceptionally suitable for applied research; they are abundant, speciose and ecologically well-known.

An important additional advantage is that carabids can be fairly reliably and (almost) quantitatively collected — by pitfall traps. Although the question of the relative merits of this collecting method as compared to others is continuously and often hotly debated, it still remains the method in many kinds of studies involving collecting carabids in the field (Spence & Niemelä 1994, Digweed *et al*. 1995). It is remarkable to note that this debate has been going on for quite some time. Already in 1963, at a Dutch carabidologists' gathering, a progenitor of present day carabidologists' symposia, pitfall trapping was in the forefront. Piet den Boer (1971:7) writes about the discussions: 'It soon appeared that many problems are concentrated around the possibilities and difficulties of pitfall trapping'. Despite the difficulties of pitfall trapping the use of the method has contributed to making carabids popular 'model organisms' in conservation and land use evaluation (Desender *et al*. 1994). For instance, most of the studies presented at the *3rd International Symposium of Carabidology* were based on pitfall trapping, and about 75% of them dealt with questions related to the effects of human activities on carabids or to the use of carabids in conservation studies. The increase of these studies is very encouraging as in-

vertebrates have been rarely used in conservation studies, although their potential utility is immense (Wilson 1987, Franklin 1993, Kim 1993, Kremen *et al*. Miller 1993).

Before a group of organisms can be used for applied purposes, e.g. as indicator taxa, their ecology and habitat affinities must be well understood. The broad habitat requirements of the common carabid species are known, but it is still not evident which environmental variables are responsible for the observed patterns in species abundance and distribution (see also Samways 1993). Obviously, carabid occurrence is partly related to various detectable and often measured environmental variables operating on different spatial scales (Lövei & Sunderland 1996). Sometimes it is possible to pinpoint the exact factor, e.g. soil moisture, but often this fails because the variables are confounded or information about the crucial ones is not measured. Moreover, factors operating on one ecological scale may have little or no explanatory power on another level (Niemelä 1990). For instance, soil moisture may be very important in determining carabid distribution within an old-growth forest stand (e.g. Niemelä *et al*. 1987) but the overall availability of suitable forest patches may be decisive for the species' survival on a regional scale (Niemelä *et al*. 1994a, Haila *et al*. 1994). A fresh contribution to the understanding of the distribution of carabids is provided in this volume by Lyubomir Penev who examines the usefulness of the Russian 'local fauna' concept in studying questions related to spatial scale and distribution.

In addition to spatial variation, there is considerable temporal variation in insect assemblages on different scales. An important question then arises: Are our conclusions about carabid abundance and distribution affected by the time scale of sampling? As all field-oriented carabidologists know, the season of sampling affects the catches because some species occur in the early season, some later. In addition, there is variation between years, which is more difficult to study as this requires long-term monitoring. In some cases variation from one year to the next in the same assemblage may be greater than variation in the same year between neighbouring assemblages. For instance, Sanderson (1994) reports that within a farm-level experiment 47% of the variation in invertebrate assemblages was explained by between year differences and 17% by environmental variation.

An additional obstacle in understanding the temporal and spatial occurrence of carabids is that the degree of year-to-year variation appears to be at least partly habitat specific. In late successional habitats, such as mature forests, populations tend to be more stable than in early successional stages and disturbed habitats, such as cultivated areas (Loreau 1992, 1994). Furthermore, only a few carabid species tend to dominate numerically in late successional habitats, suggesting that variation in community parameters is primarily driven by these abundant species (Niemelä 1993a). An especially stable habitat for carabids appears to be the mature boreal forest, as assemblages in geographically distant areas have similar species compositions and are dominated by the same species (Niemelä *et al*. 1988, 1993, 1994b). However, these studies also indicate that wide temporal variation is common in carabid assemblages, and that this may mask and confound spatial effects. It is therefore wise to cautiously interpret results from studies involving spatial and temporal heterogeneity. Moreover, sampling covering only one field season obviously cannot provide more than a snapshot view of the dynamics of a carabid assemblage, and subsequent snapshots of the same assemblage would probably show different patterns (Niemelä *et al*. 1986).

In addition to abiotic environmental factors, species interactions may affect carabid occurrence. Traditionally, interspecific competition has been considered relatively unimportant in carabid ecology as compared to the presumably decisive role of abiotic factors (Thiele 1977). There is, however, some evidence that interspecific competition may affect the structure of carabid assemblages and even cause character displacement (Niemelä 1993b). An obvious reason for lack of firm evidence for or against interspecific competition as a significant factor in a carabid's life is that competition is notoriously difficult to study in the field. Most experiments conducted so far have deficiencies causing difficulties in interpreting the results (Niemelä 1993b). On the other hand, most of these studies have focussed on adult beetles, but competition among larvae or between larvae and adults may be more important (Currie *et al*. 1996, Lövei & Sunderland 1996).

To conclude, carabid occurrence appears to be determined by a multitude of biotic and abiotic factors acting together. Furthermore, the relative importance of these factors may vary from species to species as suggested by Loreau (1992). Numerically

dominant species may be affected by interspecific competition, whereas less abundant species may be primarily influenced by abiotic conditions. Moreover, the relative importance of these effects may vary from year to year; this year biotic effects may be more important while next year abiotic conditions may be decisive.

3rd International Symposium of Carabidology

The history of carabidological symposia is as diverse as carabids themselves. The European carabidologists' meetings started in the 1960's in the Netherlands as gatherings of enthusiastic entomologists. For instance, the meeting held in Wijster in 1969 was attended by 12 carabidologists including such well-known names as Lindroth, Thiele, den Boer and Palmén (Den Boer 1971). More recently, the *European Carabidologists' Meetings* have been held regularly every three years with a steadily increasing number of participants. The *First International Carabidologists' Symposium* was organized in connection with the *XV International Congress of Entomology* in 1976 (Erwin *et al*. 1979). The most recent symposium, held in Kauniainen, Finland, 4–7 September 1995, combined the international and the European one into the *3rd International Symposium of Carabidology*. This symposium was attended by 105 delegates representing 22 countries.

An integral part of carabid symposia is publication of the contributions presented. However, there are several options for publishing congress papers. In planning the publication of the proceedings of the 3rd ISC, the organizers decided to publish only papers representing new research or synthesis. This decision was made for three reasons. First, it would have been very difficult to find a publisher for a voluminous collection of papers made up of most of the 103 talks and posters presented at the symposium. Second, the attractiveness and consequently the distribution of such a volume would probably have been limited due to the high price and the greatly varying quality of papers included. Third, we were offered the highly appreciated opportunity to publish a peer reviewed set of the papers in *Annales Zoologici Fennici*, an international journal with a wide distribution. This offer was gratefully accepted and, accordingly, each submitted manuscript was reviewed by at least two referees. A total of 54 manuscripts were submitted, and after the review process 25 of them (46%) were accepted and appear in this special issue. As the Guest Editor, I believe that the adoption of this publishing procedure ensured that the contributions in this issue represent the forefront of carabid research today.

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