Faunal inventories of sites for cartography and nature conservation

PROCEEDINGS OF THE
8th INTERNATIONAL COLLOQUIUM OF THE
EUROPEAN INVERTEBRATE SURVEY,

BRUSSELS, 9-10 SEPTEMBER 1991

EIS

REGALE BELGICUM INSTITUTUM SCIENTIARUM NATURALIUM

BRUSSELS 1992

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Edited by

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&
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Royal Belgian Institute of Natural Sciences

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Opening address

by J.L. VAN GOETHEM

Dear President,
Director,
Ladies and Gentlemen,

On behalf of the organizing committee, especially on behalf of co-chairman Patrick GROOTAERT, I have the honour to welcome you to the 8th European Invertebrate Survey colloquium.

The E.I.S. started 22 years ago. Biannual meetings and a newsletter ensured fruitful contacts between the committee members. In the past couple of years a colloquium or symposium was held together with these meetings. May I remind you of Gembloux 1985, Paris 1987 and Strasbourg 1989. This combination provides potential participants with more opportunities to obtain funding to join E.I.S. meetings. Moreover these colloquia are in my mind the best way to promote E.I.S. projects and to arouse interest and participation in them.

A new political Europe is growing. Political borders will hardly exist anymore. this could make our work easier and more complete. Some 200,000 invertebrate species in Europe are essential components of numerous and complex ecological processes. What do we know about their distribution? Are they declining, vulnerable, or are they almost extinct? Where are the identification keys for European invertebrates?

There is still so much work to do but there are so few of us. Therefore I think the most important actions must be to focus on fund raising, especially from the European authorities. In every European country, there should be a Central E.I.S. Bureau with adequate possibilities.

I had the pleasure last week to receive a letter from our Honorary President, Professor emeritus Jean LECLERCQ.
He wrote:

" Messieurs les Présidents,
" Messieurs et Mesdames participants au Colloque,
"
" C'est avec joie et fierté que j'observe la prospérité du projet européen que j'eus
" l'audace de concevoir et de proposer, avec mon ami regretté John HEATH, en
" 1969, projet auquel j'ai consacré tout ce que j'ai pu jusqu'au terme de ma
" responsabilité de président, en 1985.
"
" Le programme du colloque actuel est impressionnant et témoigne de la maturité
" des soucis et des efforts dans ce qui est notre part dans la biogéographie appliquée
" moderne. Je vous en félicite et souhaite que le colloque soit une réussite agréable à
" tous points de vue.
"
" Amitiés à vous tous. Bon travail ! "

Before I can wish you the same, I would like to thank **Dr. Daniel CAHEN**, Director of the Royal Belgian Institute of Natural Sciences, for giving us hospitality at the Institute and for financial support. Further financial support was given by the **National Fund for Scientific Research** and by the **Ministry of Internal Affairs**. **Geocart** and the **Abbey of Affligem** are offering a get together drink this evening.

Finally I owe a debt of sincere gratitude to the co-chairman Patrick GROOTAERT, to the members of the organizing committee and to the numerous persons who will ensure technical, secretarial and logistic help during these two days.

I have the honour to declare herewith the colloquium open.

Distribution data, threat categories and site evaluation

by Martin C.D. SPEIGHT

Summary

The need for greater standardisation of the way in which distribution data are used as the basis for consigning invertebrates to threat categories, at both national and international levels, is considered. Some suggestions are made with a view to attaining an increase in standardisation. It is pointed out that the term 'threatened invertebrate' has limited value when not backed by generally agreed methods for consigning species to different threat categories. From a consideration of factors which render distribution records of unequal significance it is concluded that considerable caution must be exercised in basing threat categories simply on numbers of records and that the best distribution-data-based measure of a threatened species' status is the number of protected sites from which it is recorded. The need to secure **sufficient** resources to provide for species survival is stressed, as is the responsibility of specialists in advising what quantity and type of resources are required. A proposal on recognition of sites of international importance for protection of invertebrates is used as the basis for discussion throughout, demonstrating the need for decision on definition of terms, criteria etc. if such proposals are to result in production of useful international protocols.

Introduction

The European Invertebrate Survey (EIS) has now existed for more than 20 years, to promote study of the distribution of European invertebrates. But it is only recently that the need for reliable distribution data on European invertebrates has been more widely recognised, in particular by people other than specialists in the study of invertebrates. Recognition of this need is implicit to the act of including invertebrates among the species listed as requiring protection under the Bern Convention (see Appendix I), in the appendices of the draft Habitat Directive of the European Community and the appendices of its ECE (United Nations Economic Commission for Europe) equivalent. On a less legalistic level it is manifest in attempts to use invertebrates in environmental impact surveys and other forms of site evaluation.

The fact that there is a dawning of awareness that the European invertebrate fauna requires to be protected, along with other elements of the European flora and fauna, is clearly a positive development. It brings with it, however, a need for specialists in the study of invertebrate distribution to "get their act together" in ways not previously given much attention. We talk about "threatened species", "sites" and numbers of "distribution records", in reference to individual locations, individual species, national circumstances, the international situation, particular taxonomic groups and, even, all the invertebrates at once. Many of the contributions to this volume of colloquium Proceedings are concerned with precisely this type of topic.

A quick browse through this volume alone demonstrates both that there is still considerable variation in interpretation of much basic terminology and that this variation alone could create problems for those wishing to use the results of more than one study. We, and even more so those who are not specialists in invertebrates, require confidence that we are talking about the same thing when, for instance, we consider threatened invertebrates or internationally important sites. Unless we can agree a common approach to definitions of such basic terms, it is difficult to see how invertebrates will be taken seriously for long. As interest in protection of invertebrates develops, so must generally understood systems for their use.

Some of these problems are considered here, in the context of a proposed basis for recognition of sites as internationally important for protection of invertebrates. The text of this proposal is given in Appendix II. It is extracted from a paper by SPEIGHT *et al.* (in press) presented in June 1991 during the Bern Convention/Ramsar Convention seminar on the Conservation of Wetland Invertebrates, held in Vaduz (Liechtenstein). The question of what is a "European" invertebrate was considered then and will not be addressed here.

What is a Threatened Invertebrate?

The text of the proposal (Appendix II) on sites of international importance for invertebrates makes repeated reference to threatened European invertebrates. Indeed, it is difficult to see how such a proposal could avoid reference to threatened European invertebrates. But what is meant by the term "threatened invertebrate"? There is need both for definitions of degrees of threat to which species may be subject and for mechanisms to use for deciding to which threat category a species should be consigned.

a) The IUCN threat categories

The IUCN has performed a key role in work on faunal and floral protection everywhere, by gaining general acceptance for its "Threat Categories", by which organisms can be classified according to the degree of threat to which they are subject. These IUCN categories have given rise to the term "threatened organism", which refers to any species consigned by status to any of the IUCN threat categories. Essentially, the following categories of threatened organism are delimited by IUCN: extinct, endangered, vulnerable, rare and indeterminate. The IUCN definitions of these categories, as given by WELLS *et al.* (1983), are reproduced here in Appendix III. These categories are being as widely used for invertebrates, as for other organisms. The difficulties arise in trying to decide whether, for example, in the case of some particular invertebrate species, its "numbers have been reduced to a critical level", or whether its populations have merely been "seriously depleted" and, similarly, whether its habitats have been "drastically reduced" or just subject to "extensive destruction". Although a practical basis for application of these status categories has been worked out for birds and to a lesser extent for other vertebrates, the situation is less satisfactory for invertebrates. At the national level, various systems are in operation in Europe for applying IUCN threat categories to invertebrates: indeed it could be said that there are as many systems as there are European States which have tried to produce lists of threatened invertebrates! Even so, one feature these various systems have in common is that they are based on the use of distribution data, rather than population statistics.

b) Population size v distribution data

The approach used for vertebrates relies heavily upon knowing the number of individuals making up each population of a species. There is a corresponding tendancy for those who do not work with invertebrates to assume that it is also necessary to know the actual population size of an invertebrate species before you can determine whether it is threatened. In reality, the basis normally used for deciding the status of an invertebrate species is the number of different sites it has been recorded from, as expressed in terms of the number of different distribution squares from which it has been recorded. The same approach is used in deciding the status of plant species. The number of sites from which it has been found is argueably a more realistic measure of the status of an invertebrate species than is the size of its population at each site. However, the number of sites from which a species has been recorded is, by itself, only a very crude measure of status and considerable care is needed in interpreting distribution records before they can be used with confidence in deciding whether or no a species is threatened.

c) Interpretation of distribution data

Distribution data are normally presented as though a record for one species is the exact equivalent of a record for another, implying that to compare the status of different species all that is necessary is to compare numbers of records. But records are seldom exactly equivalent to each other and, although this fact has been recognised by many workers with distribution data, it is all too often far from clear whether it has been taken into consideration when species are being consigned to threat categories. As an example, reference may be made to the problem of flight period length, in interpretation of distribution records for Diptera. Distribution records of Diptera are almost invariably based on the adult insect, because the larvae of many species are still unknown or inadequately described. The adult flies are not on the wing throughout the year and each species has a characteristic flight period. Some species are univoltine, while others are polyvoltine and the length of the flight period varies with the species. For instance, in the case of Syrphidae in temperate parts of Europe like Belgium, flight period varies from 8 weeks to 39 weeks. Assuming recording effort is equally intensive from spring to autumn, the chance that an observer will record a syrphid whose flight period is 39 weeks is five times as great as that he will record a species whose flight period is 8 weeks, if the two species are equally widely distributed. In this instance, a record of a species with an eight week flight period is by no means the exact equivalent of a record of a species with a thirty nine week flight period! For each taxonomic group, there are features of the biology and habits of the species which require to be taken into consideration in assessing the status of species based on distribution data, since some species will otherwise be erroneously regarded as more threatened than others, and vice versa. Differences in the character of sites from which a species has been recorded also lead to inequalities in the value of distribution records. This complication to interpretation is considered later in the present account.

d) National threat categories defined on the basis of distribution data

There is no absolute measure of the degree of threat to which a species is subject and neither could there be: the number of species recognised as threatened is heavily dependent on the basis used for defining the status categories and this is as true for threat category definitions based on numbers of distribution records as it is for threat categories defined in any other way. This is illustrated by Table 1, in which, as an exercise, the same distribution data have been used in different ways to define threat categories and these definitions have then been employed to decide how many species are threatened at national level. Not surprisingly, the different definitions give rise to different totals for numbers of species threatened.

Because there is no absolute measure of the degree of threat to which species are exposed there is a danger that the term "threatened species" will come to mean very different things in different countries, because each country will develop its own basis for defining each threat category. This process is well underway, with no two European States using precisely the same basis for estimating degrees of threat. Inevitably, this reduces the credibility of national lists of threatened species and makes it more difficult to decide which species are threatened at the international level. The only practical solution to this problem would be to achieve international agreement on a standardisation of mechanisms to use at national level in defining each threat category, based on:

i) an agreed scale of distribution unit, hereafter called a "square" to be used in threat category assessment (e.g. whether to use 10km, 25km or 50km squares),

ii) an agreed index of frequency of occurrence (e.g. recorded occurrence in no more than 1 square/100 squares classifies a species as endangered, whereas occurrence in 2 squares/100 would categorise a species as vulnerable) to be used in threat category assessment.

e) Internationally threatened species defined using National Red Lists

In studies aimed at deciding which species are threatened at the international level in Europe, a generally used technique has been to put together National Red Lists (a National Red List is a list of species recognised as threatened in the State producing the list) for as many countries as possible and regard the species common to all or most of these Red Lists as threatened. This approach can only be adopted for a limited range of taxonomic groups, because it is rare to find a taxonomic group for which published Red lists are available from many countries. A further complication lies in the fact that most published Red Lists are for small States in W and central Europe, so that there is little or no information available for much the greater part of the surface area of the continent, especially its S and E regions. Finally, it has to be said that, even if Red Lists are available for an appreciable proportion of Europe's surface area, for some particular taxonomic group, there are considerable difficulties in interpreting these lists for use at the international level.

This is because each Red List has been prepared on a different basis, so that data regarded as appropriate for consigning a species to the endangered category in one State would not be regarded as appropriate for consigning it to the endangered category in another. This variation is amply illustrated by comparing the criteria used in EHNSTROM & WALDÉN (1986), GEPP (1983) and SHIRT (1987), in deciding which species to consign to different threat categories.

Using a combination of national Red Lists as a basis for deciding which species are threatened internationally makes it possible to avoid the question of how restricted in distribution a species should be, within a land mass the size of Europe, in order to be regarded as threatened. But this question requires to be addressed and, once it has been asked, it can be seen that there are even more anomalies to the use of Red Lists. For instance, using a combination of Red Lists, a species recognised as threatened in 6 small States has a greater chance of becoming recognised as internationally threatened than a species recognised as threatened in 1 large State, even if the combined surface area of the 6 small States is no greater than that of the large State. Clearly, use of combined Red Lists to decide which species are threatened internationally could lead to extremely misleading results.

f) International threat categories defined by use of the 50km UTM square

The 50km UTM square is now recognised as the unit for mapping the European distribution of organisms, so why not use it in defining threat categories? The surface of Europe comprises approximately 5000 50km UTM squares, so no single, simple definition of each category would be possible, based on numbers of squares. However, it should be possible to incorporate relevant numbers of 50km UTM squares into definitions of each threat category.

Table 1. Number of threatened species of Irish Syrphidae (Diptera), calculated in three different ways.

Basis for categorisation	Category	No.squares from which records are required	No.spp. consigned to category
Number of 50km UTM squares from which the species has been recorded since 1950	Extinct	0	4
	Endangered	1	11
	Vulnerable	2	10
	Rare	3	7
	TOTAL		**32**
Number of 10km Irish grid squares from which the species has been recorded since 1950	Extinct	0	4
	Endangered	1	8
	Vulnerable	2	8
	Rare	3	9
	TOTAL		**29**
Percentage of 10km Irish grid squares from which the species has been recorded since 1950 (total = c.1000 squares)	Extinct	0% = 0	4
	Endangered	1% = 1-10	51
	Vulnerable	1-2% = 11-20	27
	Rare	2-3% = 21-30	13
	TOTAL		**95**

As known at present, the Irish syrphid fauna comprises 180 species. The tabulated information is drawn from a database of 12000+ records.

Nonetheless, so far as I am aware, no definition of threat categories for European species employing 50km square units has yet been proposed. The following thresholds would seem worthy of establishment, with a view to gaining agreement at the international level:

i) the maximum number of 50km squares an invertebrate species can be recorded from in Europe, to be automatically considered as a threatened species at the European level,

ii) the maximum number of 50km squares an invertebrate species can be recorded from in Europe, before being automatically excluded from consideration as a threatened species,

iii) the maximum number of 50km squares an invertebrate species can be recorded from in Europe, to be automatically considered as an endangered species at the European level,

iv) the maximum number of 50km squares an invertebrate species can be recorded from in Europe, before automatically being excluded from consideration as an endangered species at the European level.

g) Internationally threatened species defined by Europe-wide study

A more comprehensive approach to deciding which species are threatened internationally can be achieved by first deciding which taxonomic group is appropriate for study and then assigning a specialist in this taxonomic group to conduct a survey of its European species, aimed specifically at investigating their status. If sponsored by an internationally recognised body, this type of study can gain co-operation from private individuals, institutions and governments, and gain access to unpublished as well as published data. This approach also has the considerable advantage that data from all sources can be assessed on the same basis. Data from Red Lists and data on numbers of 50km UTM records can be incorporated into such a survey. This approach has been used by the Council of Europe in compiling existing lists of threatened European butterflies, dragonflies and saproxylic insects. It has also been used in a WWF/Council of Europe study of terrestrial and freshwater molluscs, which is now in its final stages. The fact that the results of these studies are scrutinised by both specialist referees and all member states of the Council of Europe, before a final version is produced, ensures that when they are published, these surveys are as reliable as can reasonably be hoped for, using the available information.

Threatened species and site evaluation

The proposal (Appendix II) on recognition of sites as internationally important for invertebrates makes a strong link between site evaluation and threatened species, essentially making site categorisation heavily dependent upon the number of threatened species found there. To attempt to measure site quality in this way is not perhaps ideal, but at least it would provide an explicit role for invertebrates in the process of site evaluation at international level and provide a basis upon which sites important for conservation of invertebrates can be brought to the attention of conservation agencies. In the current state of knowledge it is also argueably the only way in which invertebrate data can easily be incorporated into site evaluation processes at the international level at present.

Further, whether we do or do not condone the practise, it is the way in which lists of threatened invertebrates are already being used in site evaluation. This is true not only at local and national levels, but also at the international level, for instance in the CORINE programme of the European Community and in the European Community's draft Habitat Directive. The lack of any agreement on what constitutes a site of international importance for protection of invertebrates, or even what constitutes a threatened invertebrate, makes present use of invertebrates in site evaluation a somewhat haphazard process, with the frequently disastrous result that sites are undervalued due to doubt about the status of the invertebrates recorded.

a) Existing lists of threatened species

In order to operate successfully any site evaluation method based largely on threatened species there is obviously a need for adequate lists of threatened species. At the national level adequate lists do exist in some instances. For example, the British lists of invertebrates threatened at national level, compiled by BRATTON (1991) and SHIRT (1987), are particularly comprehensive and are already being systematically used to identify sites of national importance. At European level the situation is far less encouraging. The lists currently available comprise butterflies derived from the study by HEATH (1981), dragonflies derived from the study by VAN TOL and VERDONK (1988), selected saproxylics derived from the study by SPEIGHT (1989) and the species listed in the Bern Convention appendices (see Appendix 1). Among these, the only list being used consistently in site evaluation processes is the Bern Convention list. Unfortunately, the Bern list was not compiled with such usage in mind and is not very useful for site categorisation procedures, particularly since it includes some species selected more because they are popular than because they are threatened.

b) Priority studies aimed at augmenting lists of internationally threatened species

The compilation of additional lists of invertebrates threatened at European level is now urgent, if they are to play a credible role in invertebrate protection, especially through site selection procedures. Considering the existing lists and their potential role, they provide some information on the state of terrestrial herbivore and detritivore faunas and some information about the state of the aquatic predator fauna. They provide no data on terrestrial predators, aquatic herbivores or aquatic detritivores. It is possible to recognise invertebrate taxonomic groups potentially appropriate for attention, using the approach suggested by SPEIGHT (1986). One taxonomic group which matches the criteria is the Mollusca, and a study of threatened European terrestrial and freshwater molluscs is now happily virtually complete. A second appropriate group is the Trichoptera, and it is possible that a European study of these aquatic detritivores will commence in the not too distant future. But coverage of additional groups is needed: in particular some group of primarily terrestrial predators, like the Carabidae (Coleoptera) or spiders (Aranaea), is a priority.

A complementary approach would be to establish lists of threatened European invertebrates associated with biotopes or habitats of critical importance to invertebrates. It was this logic which led to the study of threatened European saproxylic invertebrates carried out by SPEIGHT (1989), based on the singular significance of ancient forest in providing invertebrate habitats. A second biotope of particular significance to invertebrates is cave systems, and a study of Europe's threatened cavernicolous fauna is needed as a matter of priority.

What is a site?

There is an understandable tendency for specialists in invertebrates to consider site quality simply in terms of the interest of its invertebrate fauna, without giving due consideration to other aspects of site variability. This problem may be illustrated by reference to site area. Many sites too small to be maintained are nonetheless regarded as important and requiring protection. For instance, there are various small pieces and scraps of woodland in Europe today with an area of less than 100 hectares, which still retain elements of an interesting old-forest invertebrate fauna and which, on that basis, require protection. But protection of such small pieces of woodland in order to conserve the old-forest invertebrates found there can only be a largely self-defeating exercise, because it is so difficult to maintain all phases of the woodland regeneration cycle within such small areas: once the present generation of old trees dies, there is no longer any possibility of maintaining habitat for old forest species on site. An extreme example is provided by MARTIN (1989), who shows that the elaterid beetle *Lacon lepidoptera* was recorded repeatedly in Denmark from one particular grid square during the early part of the present century, demonstrating the presence there of a self-maintaining breeding population. However, all the records are derived from a single ancient oak (*Quercus*), still alive but now isolated among very young saplings. There is no way in which an adequate quantity of its senescent tree habitat can be maintained for *L. lepidoptera* in this, its one Danish locality. So not only has the beetle to be regarded as threatened in Denmark, but also it is unrealistic to argue that its last remaining site there is in any way secure or important to the long-term survival of the species in Denmark, however large its population may be in that old oak tree and whether or no it seems to be undergoing noticeable decline there at present. It is not sufficient to consider the importance of a site for invertebrate protection solely in terms of the threatened invertebrate species, or interesting invertebrate communities the site supports at present. It is also necessary to consider how large an area of appropriate habitat is needed to ensure the survival of that habitat, on site, for an appreciable period of time. There is then a link between site quality and site size. This, in turn, has an influence upon the interpretation of distribution records. If the sites upon which distribution records are based are not all of equal significance in determining the status of a species, the distribution records themselves are not all of equal significance in determining the status of a species.

When distribution records are used as a basis for assessing the status of an organism, one of the basic assumptions made is that the number of records available for a species is the primary determinant of its status. This is normally expressed in terms of the number of distribution "squares" from which a species has been recorded, as considered earlier in this account. But, as alluded to above, "sites" are unfortunately not standard units of reference. The Proceedings of this colloquium themselves demonstrate this, with the faunas of gardens compared with those of nature reserves, urban parks with fields and a universal use of ownership units, or administrative units, rather than ecological units, as individual "sites". Not only do these sites differ from one another in size, they differ also in ecology, manageability and the degree to which they are protected. An equivalently varied array of "sites" lies behind distribution records, making the equally sized spots on distribution maps of very unequal meaning and vastly complicating their interpretation. In essence, it has to be concluded that all apparently threatened species are to some extent more threatened than the number of their distribution records might suggest, except in cases where all the records are based on protected sites of adequate size. The heterogeneity of the other records ensures that a proportion of them are based on sites that are either themselves threatened or in some way to a significant extent inviable as habitat for the recorded species. This problem of variation in the quality of distribution records, caused by variation in site quality, clearly requires to be taken into account in efforts to standardise distribution-record based criteria to use for consigning species to threat categories, at both national and international level.

An attempt has been made to address the problem of scale in relation to site quality in Appendix II, though it has to be admitted that reference to the figure 100 ha, as the desired minimum size for sites of international importance, could well be more a recipe for universal discord than international agreement! Nonetheless, if specialists in the study of invertebrates cannot agree how large a site should be to ensure the survival there of target invertebrate species, they cannot expect conservation agencies or land managers to successfully deduce how large a piece of land should be protected, or managed in some particular way, in order to successfully ensure the survival of those species there.

When is a threatened Invertebrate no longer threatened?

To judge from events to date, it might with some justification be argued that the only time an endangered invertebrate is likely to become reclassified into a different threat category is when it becomes extinct! However, if there is any point at all to the process of trying to identify and protect sites in order to safeguard their invertebrate fauna it follows that, at some point in the future, species now threatened should, as a consequence of protection, become sufficiently widespread and numerous that they no longer require to be classified as threatened. It also follows that there is need to consider what scale of effort is required in order to stop the decline of a species, or to reverse its decline. Essentially, this is another aspect of the problem referred to in the previous paragraphs, considering the implications of variation in site quality to the question of what represents an adequate resource for ensuring the survival of a threatened species at European level.

In the Europe of today, the survival of threatened species cannot be assured outside protected sites, so that, effectively, the number of protected sites supporting populations of a threatened species provides the most accurate distribution-data based measure of its status. Distribution records of threatened species from sites of unknown status, or sites known not to be protected, are thus of lesser value in assessing the status of species. Even a record from a protected site means little, unless there is evidence that the site is of a sufficient size to support an adequate quantity of the species' habitat more or less in perpetuity. The proposal on recognition of sites of international importance for invertebrate protection (Appendix II) attempts to address this issue, by suggesting that an endangered species should continue to be regarded as endangered within a State until 500 ha of land where it occurs has been included within protected areas in that State. Whether or no the figure 500 ha is regarded as reasonable, the fact remains that for a species to survive in some part of its range an adequate supply of its habitat has to be available to it there, whatever may, or may not, be available elsewhere. In order to be successful, international effort to protect a threatened invertebrate species must result in *adequate* measures wherever protection is attempted: a State which takes steps to protect some particular invertebrate habitat, without ensuring sufficient of that habitat is protected, could fail to prevent extinction as surely as if it took no action at all. But how are conservation agencies to know what represents an adequate quantity of some particular habitat? If specialists in the study of invertebrates cannot agree some figure for the minimum amount of territory an invertebrate species requires in order that its survival may be ensured within some particular State, it is not reasonable to expect conservation agencies or managers of protected areas to successfully deduce what scale of effort is necessary to protect that species.

Tailpiece

In order to avoid considerable complication in presentation, it has been necessary to consider many of the points made in this text through the medium of discussing individual species. This has given rise to some distortions, for instance perhaps implying that separate protected areas are required for each threatened invertebrate. Not only would any such approach to protection of threatened European invertebrates be laughably impractical, it would also be unnecessary. One of the highest priorities of any programme seeking to identify sites of international importance for protection of invertebrates should be to identify those sites where maximum numbers of threatened species occur together and in company with well differentiated faunas of less threatened species. Such sites exist. Indeed, it would be highly exceptional that a threatened invertebrate species required sites to be protected for it alone.

A similar distortion has entered the text through consistent use of Appendix II as a vehicle for demonstrating the need for more generally agreed terms and criteria in the analysis and interpretation of invertebrate distribution data. The reality is that the proposal made in Appendix II happens to be the *only* one available, which attempts to address some aspect of the use of invertebrates in efforts to conserve Europe's flora and fauna at international level. The problems alluded to in the text inhibit the use of invertebrates in international and national efforts to conserve nature and consequently diminish their role, not only in respect of invertebrate conservation, but conservation in general. We need more reliable and comprehensive lists of internationally threatened invertebrates, not so much in order to get longer lists of invertebrates requiring special efforts to be made for their protection, but much more so that invertebrates can play their rightful role in processes of site evaluation. Unfortunately, legislators have yet to design legislation which will allow the latter without requiring the former. But such legislation is now desperately needed. We need long lists of threatened invertebrates validated as appropriate for use in recognising sites as of international and national importance.

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Appendix I:

Invertebrates named in the appendices of the Bern Convention

Invertebrates are included in appendices II and III of the Bern Convention. Appendix II lists "Strictly protected fauna species". These are species to be protected against all forms of killing or destruction and whose habitat is to be protected.
Appendix III lists "Protected fauna species". These are species whose exploitation is to be regulated in order to keep the population out of danger and whose protection is to be ensured.

In the following list, the species included in Bern Convention appendices II and III are listed together. The species from Bern Convention Appendix III are distinguished by the suffix (III) following their names.

ANNELIDA

Hirudinea

Hirudinidae: *Hirudo medicinalis* (III)

MOLLUSCA

Gastropoda

Arionidae: *Geomalacus maculosus*
Elonidae: *Elona quimperiana*
Helicidae: *Helix pomatia* (III)

Madeiran Gastropoda

Caseolus calculus
C. commixta
C. sphaerula
Discula leacockiana
D. tabellata
D. testudinalis
D. turricula
Discus defloratus
D. guerinianus
Geomitra moniziana
Helix subplicata
Leiostola abbreviata
L. cassida
L. corneocostata
L. gibba
L. lamellosa

Bivalvia

Margaritiferidae: *Margaritifera auricularia, M. margaritifera* (III),
Microcondylaea compressa (III)
Unionidae: *Unio elongatulus* (III)

ARTHROPODA

Crustacea

Astacidae: *Astacus astacus* (III), *Austropotamobius pallipes* (III), *A. torrentium* (III)

Arachnida

Dipluridae: *Macrothele calpeiana*

Insecta

Mantodea:

Mantidae: *Apteromantis aptera*

Orthoptera:

Tettigoniidae: *Baetica ustulata, Saga pedo*

Odonata:

Aeschnidae: *Aeschna viridis*

Calopterygidae: *Calopteryx syriaca*

Coenagrionidae: *Coenagrion freyi, C. mercuriale*

Cordulidae: *Macromia splendens, Oxygastra curtisii*

Corduligastridae: *Cordulegaster trinacriae*

Gomphidae: *Gomphus graslinii, Lindenia tetraphylla, Ophiogomphus cecilia, Stylurus (= Gomphus) flavipes*

Lestidae: *Sympecma braueri*

Libellulidae: *Brachythemis fuscopalliata, Leucorrhinia albifrons, L. caudalis, L. pectoralis*

Coleoptera:

Buprestidae: *Buprestis splendens*

Carabidae: *Carabus olympiae*

Cerambycidae: *Cerambyx cerdo, Rosalia alpina*

Cucujidae: *Cucujus cinnaberinus*

Dytiscidae: *Dytiscus latissimus, Graphoderus bilineatus*

Lucanidae: *Lucanus cervus* (III)

Cetoniidae: *Osmoderma eremita*

Lepidoptera:

Lasiocampidae: *Eriogaster catax*

Lycaenidae: *Lycaena dispar, Maculinea arion, M. nausithous, M. teleius, Plebicula golgus*

Nymphalidae: *Apatura metis, Euphydryas (Eurodryas) aurinia, Fabriciana elisa, Hypodryas maturna*

Papilionidae: *Papilio alexanor, P. hospiton, Parnassius apollo, P. mnemosyne, Zerynthia polyxena*

Satyridae: *Coenonympha hero, C. oedippus, Erebia calcaria, E. christi, E. sudetica, Lopinga achine, Melanargia arge*

Saturniidae: *Graellsia isabellae* (III)

Sphingidae: *Hyles hippophaes, Proserpinus proserpina*

Appendix II:

A proposed basis for recognition of sites as internationally important for protection of Invertebrates

Considering for purposes of this proposal a European invertebrate to be any invertebrate species whose world range is predominantly or entirely within the area of the member States of the Council of Europe and a site is an area of not usually less than 100 ha;

Considering also any European invertebrate to be threatened if it is so designated by any Europe-wide study which has been set up to identify threatened species, and whose results have been scrutinised and accepted by an international group set up for the purpose by some body recognised by the Council of Europe as competent in this field;

1. any site in a member State known to support either/or
   a) two or more invertebrate species threatened in Europe and a good representation of the nationally recorded species associated with the biotopes present,
   b) one of the five most important European populations of a threatened European species, taking into consideration the need to protect as wide a range as possible, both ecologically and geographically, of the sites supporting the species,

should be regarded as of international importance for protection of invertebrates and as a candidate site for inclusion on lists of sites recommended for protection.

Considering also any threatened European invertebrate to be regarded as endangered within a Council of Europe member State from which it is recorded until and unless a minimum of 500 ha of appropriate habitat on sites supporting the species have achieved protected status within that State and are being managed in a fashion consistent with the needs of the species;

Considering also that extinction of a threatened European invertebrate species, which is the only known species in the world representative of some particular genus or higher taxonomic grouping, would represent a more serious evolutionary loss than would extinction of a representative of a polytypic genus or higher taxonomic grouping;

2. any site in a member State known to support either/or
   a) a population of any threatened European species not known from protected sites in that State totalling more than 500 ha of appropriate habitat,
   b) a population of a threatened European species which is the only known species of its genus or of some higher taxonomic grouping,
   c) a population of a threatened European species which is known from five or less sites in Europe,

should be regarded as of international importance for protection of invertebrates and as a priority site for inclusion on lists of sites recommended for protection.

Appendix III:

IUCN status categories

The definitions of these categories given here are taken from WELLS *et al.* (1983).

Extinct
Species not definitely located in the wild during the past 50 years (criterion as used in the CITES Convention).

Endangered
Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction. Also included are taxa that are possible already extinct but have definitely been seen in the wild in the past 50 years.

Vulnerable
Taxa believed likely to move into the 'Endangered' category in the near future if the causal factors continue operating.

Included are taxa of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously depleted and whose ultimate security has not yet been secured; and taxa with populations which are still abundant but are under threat from severe adverse factors throughout their range.

Rare
Taxa with small world populations that are not at present 'Endangered' or 'Vulnerable', but are at risk.

These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

Indeterminate
Taxa known to be 'Endangered', 'Vulnerable' or 'Rare' but where there is not enough information to say which of the three categories is appropriate.

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Recent zoogeographical research in Central Europe: from mapping programs to ecological interpretations

by Jürgen H. JUNGBLUTH

The period of zoogeography prior to the beginning of modern mapping programs

Chorology (faunistics) and historical zoogeography are the oldest disciplines in zoogeographical research. Geologists and paleontologists were mainly interested in historical zoogeography for this discipline was expected to provide data concerning plate tectonics. However, because such data did not accumulate in a sufficiently rapid and reliable way, interest in historical zoogeography declined steadily.

Chorology research, on the contrary, developed from a discipline dealing with vague distributional data to a discipline in which precise locality data are processed by computer technology. Furthermore the fixation of areas was important, leading as well as from a more historical and statistical point of view to the definition of types of distribution while dynamical starts also led to the coining of centres of dispersal and types of dispersal (tendencies of dispersal). These are two important steps in the development of zoogeography.

This phase of zoogeography can essentially be characterized by the question: *Where does which animal species exist?* or in a zoogeographical-coenological way: *Where do which animal communities (coenoses) exist?*

The period of installing survey programs throughout different countries

In spite of the fact that in different sections of zoogeography several attempts had been undertaken to survey animal species or whole animal groups in a supranational way, these attempts have been restricted as a rule to selected species or geographically.

Different attempts to design, organize and carry out extensive mapping programs have been strengthened after the second World War only. These developments are found in Botany and in Zoology, at national and international levels. In some countries the attempts of international cooperation go along with the time of stagnation of faunistics to their prevailing declining development.

In numerous countries national mapping centres alongside with the European wide programs of the *European Invertebrate Survey* (E.I.S.) are being founded, they start with their work of coordination and enforcement and reach respectable mapping results in a relatively short period of time. The centres of Monks Wood (England), Gembloux (Belgium) and Leiden (the Netherlands) have to be named especially. Other such centres follow, e.g. Neuchâtel (Switzerland) or institutions fulfill similar tasks like the University of Linz (Austria). In other countries different trials to establish national mapping centres fail as in the Federal Republic of Germany (former countries, compare JUNGBLUTH, 1984; JUNGBLUTH, BÜRK & BERGER, 1982).

Work of national mapping centres can be promoted via the publication of results and by support of international societies in special fields. In this context the program of the survey on molluscs of *Unitas Malacologica* for Europe has to be cited. It is to hope that under the pression especially of heavy environmental changes up to catastrophical events (like tanker accidents or the pollution accidents of Sandoz in the river Rhine) understanding will grow. National mapping centres should be able to store and analyse biological data which could serve as a basic information for an estimation of developments of the environment of any kind and as an indispensable basis for the analysis and installation of counter concepts.

The work, so far being carried out at the national mapping centres should give reason for further and more intensive support and, at the same time, inspire the thougth to about where such centres do not exist so far. At a time of growing coordination between data banks and in respect to the fact of the establishment of the common market within the European Community, the establishment of national mapping centres within all the countries of the EC, should be initiated. Alongside with existing technical means and needs in respect to a basic change of environmental policies a coordination of national mapping centres to an European data bank of flora and fauna must be demanded. Naturally, this can only happen with the support of the European Commission.

The amount of knowledge and experience, which has been stored in the national centres for decades should be considered and efficiently utilized.

The "postfaunistical period" or the change of role of chorological mapping programs to a "Zoogeography on an ecological basis"

While in faunistics, the chorological section of zoogeography, distribution data have only been recorded in a global way at the beginning, locality data were more exact in later times. Locality records were reported not only in a more precise way, by description of the locality or its position in the geographical region or with geographical coordinates, but by report circumstances of the record, e.g. the mentioning of the accompanying plant and animal species or the societies (coenoses) etc. This means that first attempts are being made to record the habitat of an investigated species at the same time. This puts the question of such surveys from an autecological (idiographical) level to a synecological, or holographical, and therewith higher level. We herewith approach a holistical view, already demanded by THIENEMANN (1956) and others. At the same time zoogeography and geography get closer (compare JUNGBLUTH, 1978).

First attempts within zoogeography to overcome the level of idiographical view to higher levels by putting a [syn]ecological question in the foreground date from DAHL (1921-1923) and HESSE (1924). HESSE described the difference betweeen an ecological and zoogeographical proceeding as follows: "... Not every locality of a biocoenosis is at the same time a habitat in a biogeographical sense ..." and furthermore: "... biogeography cannot split as far as ecology can when considering a biocoenosis. The habitat as a biogeographical unit is a feature in the face of the earth, it covers an area of certain physiognomical value like a landscape which more or less shows us within a different environment as a characteristical singularity of the description of a piece of the surface of the earth ...". In this context it may be mentioned, that DE LATTIN (1967) has also pointed out that historical and ecological zoogeography are not contrary but rather supplementary towards a complete understanding of causalities of organisms.

Going back to concepts of an ecological zoogeography which can be summarized by the question: "*Why does a species exist at a certain locality?*" it has to be asked, why didn't ecological zoogeography proceed in addition to first concepts after the publication of the two basic works of F. DAHL and R. HESSE? Shortly afterwards the vehement development and subdivision of biology into special disciplines took place, primarily concentrated in physiological fields, and later on studies of ultrastructures etc. Classical disciplines, to which zoogeography belongs, lost influence and importance in research and education at the universities (the institutions of education in these fields). Another reason might have been a difficulty of its own. Zoogeographical work demands, as a prerequisite apart from a knowledge of geography, a comprehensive knowledge of the groups of animals concerned which implies a knowledge of a species and the ability to determinate it.

Once more within Germany, an increase of zoogeographical studies can be registered after the Second World War, which however, did not last. Within the Federal Republic of Germany a breaking off of faunistical tradition in numerous sections of special zoology as well as for numerous groups of animals can be registered, beginning by the end of the sixties at the latest. For this reason efforts for a sufficient German participation in the EIS-program, which started at Saarbrücken in the beginning of the seventies must have failed (MÜLLER, 1977).

Knowing this, one might ask the question, whether the elaboration of distribution maps can be the only goal of national and international mapping programs?

Let us first examine which kind of work is necessary to achieve maps of distribution? They demand comprehensive surveys and interpretations of data. Data come from museums and private collections, records of private excursions, oral information and letters, literature and the so called "grey literature" [unpublished studies, samplings by governmental offices, unpublished expertises, etc.].

Costs and efforts to be undertaken, for a so limited and singular utilization can't justify the expense.

Here we have to follow the direction of an ecological zoogeography already shown by F. DAHL and R. HESSE and also by G. DE LATTIN and energeticly go on. To the question, asked in the beginning "*Why does a species occur at a certain locality?*", another question arises increasingly: "*Why doesn't a species occur at a certain locality anymore today?*". Disappearance of species, with an increasing tendency, are well known, the causes are frequently unknown. This has lead to the publication of Red Lists, which get larger with every edition. In this case ecological zoogeography can produce results which can help to understand these phenomena.

This means, that ecological questions have to be followed alongside with chorology which by no means has to come to an end. Once more I would like to cite DE LATTIN (1967), who distinctly gave his opinion on the decrease of species and on the necessary consequences already at that time:

> "There is only one solution - which admittedly must be a measure of emergency. It is important to come very rapidly to inventories of species as closemeshed as possibly in all areas threatened at different localities to be able to use later on maps of distribution (possibly stored in a central archif [sic !]) for all kind of biogeographical work, going beyond mere chorology. This is a kind of work with no spectacular scientific merits to achieve, but which must be done in order not to allow that the basis of an entire discipline of natural science gets lost. It is to be hoped, that enough suitable scientists are prepared for this task." (DE LATTIN, 1967: 447-448).

DE LATTIN also has distinctly pointed out, that the necessary financial means would have to come from national and international authorities in charge, for without means such comprehensive problems couldn't be countered. This so far has happened in some countries only, an international unit - with international support - has still to come. I won't conceal to you that the success of mapping centres and programs basically depends on the scientists involved. They have to engage clearly in administration beyond to the duties in their specific scientific field and when necessary, also in politics. Otherwise they won't find support and sponsors.

Prospects: What does the forgoing exactly mean in respect to the work of national mapping centres and mapping groups?

> They have to make it clear to the public, to their employers and especially their sponsors, that their work doesn't consist in making dots on distributions maps. But they must not forget on the other hand, that this is a presupposition for further steps in the framework of ecological zoogeography.
>
> By extension of the mapping conception to a *survey- and biomonitoring conception*, using modern methods of data handling, data stocks could be build up and be kept ready. In running them regularly they could supply information about the situation of flora and fauna at any time. Up-to-date information of the situation and the quality of habitats, biocoenosis and ecosystems could finally be asked for by getting hold of species, which serve as bioindicators.

As a last point I would like to present a result of something from my own conception.

> The E.I.S.-Symposium in Saarbrücken in 1972 initiated a conception of mapping molluscs in the Federal Republic of Germany, which comes to its final phase today. Asking for necessary funds was most difficult while there is still no trend for zoogeography in this country. For this reason we have thought very early about what to do with the data and to whom they might be useful.
> We first thought about nature conservation authorities as adressee for our results. For this reason "Preliminary Atlases", "Preliminary Red Lists" and "Regional Malacozoological Bibliographies" were prepared and published.
> Similar to the British Atlases we first published maps and data sources. This started about 15 years ago. We are able today, our first "Preliminary Atlases" at hand, to publish "Preliminary Atlases" somehow more complete together with explanations and illustrations. This will further be improved when the mapping scheme comes to an end. The "Preliminary Red Lists" have been a good advertisement because they were based on a considerable amount of data due to the mapping schemes. They are not to be missed as an instrument to raise funds. The "Regional Malacozoological Bibliographies" are now funded by means of responsibles from the documentary section.

We still have thougths about whether these results are sufficient for the target of a mapping scheme and whether they justify the efforts and costs. We do believe that it isn't enough, it still has to be more.

Our considerations and experience led us again to the demands of F. DAHL, R. HESSE and G. DE LATTIN.

We look at the mapping work, being done so far as this basic step to collect, study and evaluate data. While this has to be called chorological work we have extended our conception. We see three stages at the moment:

I. To secure Chorological Proof
- to survey, study and evaluate all kind of data, including such of own field research for species distribution.

II. Examination of the Ecological Situation of Habitat
- to examine the distribution data of a species in the field - sampled by securing chorological proof - together with the investigations of populations and the situation of the habitat.

III. Projects of Species Conservation
- the results of examination of the ecological situation of the habitat deliver data for the installation of projects of species protection which then have to be accompanied by scientific studies.

By this, work also being done in national mapping centres, is transferred from the chorological level to ecological zoogeography as the next higher level and gets close to a holistic view in the sense of August THIENEMANN.

It is my opinion, that this is the future path of zoogeography - namely *ecological zoogeography* - and that it will lead to successful work of national mapping centres on the way to an international union. Following this path, it would at the same time enclosure them of a better acceptance by their employers and funders and should lead to the prompt establishment of such centres in those countries of the European Community that are still lacking them.

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Research applications using data from species surveys in Britain

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Abstract

Recent research by the Biological Records Centre has used species survey data from Britain to examine changes in the distribution of species, the effects of recorder effort, patterns of biodiversity and the occurrence of ecological assemblages of species. The development of a Biotope Preference Database, for use with data from national species surveys, is described.

Introduction

National or regional biological surveys now operate in many European countries. These surveys, such as those co-ordinated by the Biological Records Centre (BRC) in Britain, provide data for species distribution maps and information on individual sites, particularly valuable for nature conservation. Opportunities exist for other applications using data from such surveys, for example in development and resource planning, and in research. This paper describes recent developments in research uses of data from Britain compiled at the Biological Records Centre, with special reference to data for invertebrates. The applications described are relevant to data for most taxonomic groups, and to similar data from any comparable area where coverage of recording is adequate.

The Biological Records Centre database

BRC was set up in 1964 to map the distribution of the flora and fauna of Britain and Ireland. The development of the Centre during the first 25 years is described by HARDING (1990a) and HARDING and SHEAIL (in press), and the operation of species distribution surveys in the United Kingdom is summarised by HARDING (1990b).

BRC has compiled over 5 million records of the occurrence of more than 9000 species as a computerised database using the ORACLE database management system on VAX computers. The database includes terrestrial and freshwater flora and fauna, and is structured as a series of tables, each table being for a discrete taxonomic group (for example Odonata) or for a selection of species in a group. Each table contains rows (usually one row per record) made up of columns. Each column represents a separate field covering taxon, geographical and temporal information, details of recorder/determiner and in some cases details of habitat, abundance or developmental stage, as appropriate to the scope of the survey. Although much of the database consists of site-relatable information, in some of the earlier datasets (particularly for vascular plants and macro-lepidoptera) geographical information is limited to the 10-km squares of the British/Irish national grids, but more detailed information is often contained in the archive of original field record cards.

The analyses and applications described use only subsets of data from the database, where the geographical information has been summarised to the level of 10-km squares. Most of these analyses are numerical, but can be summarised in the form of national maps. Similar, spatially referenced datasets, on environmental factors such as climate, topography, geology and land use, are held by other units of the Environmental Information Centre. These datasets are being used to aid the analysis of species distribution data and the results can be summarised graphically through the use of a Laserscan Geographical Information System and other automatic cartographic processes.

Changes in the distribution of species

Changes in the geographical ranges of species have been detected for many species. Changes may be caused by, for example:

- altered land-use (leading to loss of one habitat type in favour of another),
- altered management of habitat/vegetation,
- deliberate action to favour or to control a species,
- increased pollution or the amelioration of pollution,
- changes in climatic conditions,
- changes in the ecological requirements of species,
- changes in the genetic make-up of species,
- naturalisation of non-native species.

Examples of species affected by such changes are familiar, although some of the best documented instances are of vascular plants and vertebrates.

The strong temporal component in data from Britain, which results from a long tradition of biological recording by amateur specialists, makes it possible to obtain a measure of the changes in geographical range of many species (see for example authors in HAWKESWORTH, 1974 and in HARDING, in press).

A potential cause of changes in the distribution of species is climate change resulting from a build-up of 'greenhouse gases'. Current climate change models forecast a range of increases in global temperature and the concentrations of gases such as CO_2 and NOx. The Biological Records Centre is collaborating with researchers in ITE and universities to assist the UK programme of research into the potential effects of climate change (see for example WATT, WARD & EVERSHAM, 1990). Much of this work is at an early stage, but a recent paper (HILL, 1991) dealt with aspects of the modelling techniques being developed. By modelling the 'climate space' occupied by a species under present conditions, together with selected environmental factors, it is possible to predict the geographical range of a species under different climate change scenarios (CAREY, in preparation).

Although the developmental work on climate change response modelling has been with data for vascular plants and birds, the models will be applied to data for selected invertebrates. It is widely considered that invertebrates (with generally short life-cycles) will respond rapidly to climate change and evidence from the Flandrian record (reviewed by COOPE, 1979) supports this opinion.

Trends in biodiversity

Maps of the distribution of single species have been a familiar product of data centres, such as BRC, for decades. These maps normally show distribution summarised at the level of grid cells; in the United Kingdom 10-km squares of the national grids are used. Maps of the overall coverage of records have been included in published atlases of species distribution maps, and for some groups these coverage maps have been enhanced to show the number of species recorded in each grid cell used for mapping (see for example the atlas for non-marine Mollusca (KERNEY, 1976)).

Representation of biodiversity in this form is meaningful only if there is good general coverage of recording and if any variation in coverage can be quantified. The map included by KERNEY (1976) illustrates this problem: the species richness demonstrated for Britain confirms the general expectation that southern Britain has more species than the north, but the coverage and species richness shown for Ireland is very patchy and reflects recorder effort rather than true richness.

Recorder effort

In assessing the results of national surveys, the effects of recorder effort and bias are inadequately understood. Particular aspects of variation in recorder effort are discussed by PRESTON & EVERSHAM (in preparation) and HARDING (1991b).

Recording by volunteers tends to favour accessible sites with semi-natural vegetation and sites likely to be rewarding for uncommon species. Remote sites, or those with degraded habitats, are less frequently visited. For sufficiently detailed datasets it should be possible to quantify recorder effort at a site using several criteria:

- number of different recorders who visited,
- number of dated visits,
- time of each visit,
- length of each visit,
- weather conditions at time of visit,
- habitats sampled at each visit,
- sampling technique,
- species sampling bias of recorder,
- competence of recorder.

In reality, few of these variables are recorded except in very specialised surveys. One approach being developed at the Biological Records Centre is based on the numbers of visits to a site/area, a statistic which is included in most data sets. This simple count may be refined by weighting for 'recorder competence', which may be quantified by categorising species according to ease of recording, then ranking recorders by the number of records of each grade of species that they have provided. The values may be calculated regionally, which can remove the effects of underlying patterns of species-richness.

Species richness mapping

Using datasets (from Britain only), in which coverage is known to be good, species richness mapping techniques have been developed as part of an undergraduate training project. Scales of richness, using a range of symbols to indicate the number of species recorded per 10-km square, can be varied and mapped. These maps can reveal patterns of species richness and can reveal broad trends in the biodiversity of a taxonomic group (Fig. 1) or of a suite of ecologically associated species (Fig. 2). For most taxonomic groups in Britain, the general trend is for a gradient of species richness from south-east (high diversity) to north-west (low diversity). This trend follows the gradients of the main environmental factors such as temperature, insolation, rainfall, topography, geology and soils, and also of land use.

Data smoothing

One of the programs developed during work on species richness mapping was for 'smoothing' of data by averaging the number of species recorded over blocks of 10-km squares. Each individual 10-km square takes the mean species richness of itself and the 8 or 24 adjacent 10-km squares in a block of 30 x 30 km or 50 x 50 km (Fig. 3). The technique is conceptually similar to that employed in the classification of remote-sensed imagery, for example of land use. The program can be applied to single species to provide a measure of the probability of a species occurring in any given 30-km or 50-km square. Having 'graded' the potential occurrence of a species, it is possible to select contours to represent the range-edge of a species.

Biodiversity 'hotspots'

Development of species richness mapping techniques, and of a means of smoothing data which help to suppress the effects of irregular recording effort, reveal broad trends in biodiversity and have opened up new areas for research.

There are certain sites or areas which are apparently much richer in species than the surrounding countryside. In some cases this may be due to a unique and often very stable history of land use, an unusual diversity of habitats in a small area, a long history of survey and recording,or any combination of these factors. In addition there are areas, detectable at the level of 10-km squares, which apparently are unusually rich in species for other reasons, possibly due to topographic and/or local climatic reasons. Fig. 1 illustrates a selection of 'hotspots' for butterfly species-richness. Areas 1, 2, 5 and 6 appear to be genuinely richer than their surroundings, due partly to topography (1, 2 and 5 contain many south-facing slopes), and partly to the presence of semi-natural habitats of long continuity. Area 3 has been thoroughly recorded for over a century, due to its proximity to a centre of population (the town of Doncaster), and so shows an accumulation of records over time. Area 4 was the home of a very active and competent recorder, and may represent a recorder-effort artefact. Further research on these 'hotspots' is being undertaken at the Biological Records Centre.

Biotope Preference Database (BPD)

In the course of research on the effects of climate on invertebrate distributions, species richness mapping has emphasised the coincidence of species range edges and even concurrent changes in the range of ecologically associated species (EVERSHAM, unpublished).

To investigate the possible role of climate in determining the distributions of species occupying the same habitat, a Biotope Preference Database has been compiled from existing British published sources. The information derived from the literature has been supplemented and validated by relevant taxonomic experts.

Content of the Biotope Preference Database

The database originally contained only invertebrate groups: Mollusca, Macrolepidoptera, Odonata, Orthoptera, Chilopoda, terrestrial Isopoda, Diptera (Dixidae, Sepsidae), Coleoptera (Coccinellidae, Staphylinidae (part)) and Hirudinea, drawn from readily available computer data sets.

Habitat data were later entered for the breeding birds and selected vascular plants. The use of a broad range of groups for each biotope lessens the effects of recorder effort, because of the low level of correlation of activity between botanists, entomologists, ornithologists, etc.

Habitat information is given for each species in the dataset two formats: firstly, the principle overall habitat preference, then a series of coded habitats in which the species is also known to occur, in descending order of preference. It was not possible to enter a single preferred habitat for eurytopic and/or ubiquitous species such as *Pieris rapae* (L.) or *Oniscus asellus* (L.).

Sources are cited for each species examined. For each invertebrate species its rarity is also given following BALL (1986). Maps of species-richness of nationally scarce and Red Data Book invertebrates can thus be produced.

At the outset, a habitat classification scheme had to be devised. Authors of taxonomic works use descriptive habitat terms which are tailored to the needs of their particular group; no standard classification exists. For the Biotope Preference Database, a general all-inclusive classification was used, which broadly reflected the quality of information available in the literature. This comprised 14 main habitat categories, such as woodland, grassland, wetland etc., most of which had numerous qualifiers, such as calcareous, upland, coastal, etc.

During the preliminary analyses using the BPD, two simple criteria were used to select usable habitat types. These were: that the habitats support an adequate number of species, with a high degree of specificity; and that those species represent a broad taxonomic range i.e. with no one group dominant (to minimise recorder effects). The 9 suitable habitats used in the preliminary studies are:

Wetland,	fen
	bog
	salt marsh
Woodland,	deciduous
Grassland,	calcareous
	neutral/acid
Heathland,	lowland
	upland/moorland
Sand dune.	

Biotope maps of each of the above habitats have been produced; the Lowland Heath map is shown.

However, successful as these maps may be, they are based entirely on literature searches: none of these habitat maps has yet been thoroughly ground-truthed, nor has strength of the affinity of a species for a habitat been examined in detail. No allowance has been made for regional variation in habitat occupancy (e.g. THOMAS *et al.*, 1989).

To test the appropriateness of the inclusion of certain species within a habitat category, their affinity with other members of the habitat assemblage was tested by measuring the proportion of other habitat indicators with which a species was found to co-occur.

The results for a moorland moth, *Celaena haworthii* (CURTIS), are shown in Fig. 4a. This species appears to co-occur with species from many different habitats, and is at least as well correlated with woodland as it is with moorland. This first comparison takes no account of the distribution and frequency of each habitat in the countryside. The pattern must be compared with the mean proportion of habitat indicator species found in each square (Fig. 4b), which provides a baseline against which the habitat affinities of a species can be judged. If *C. haworthii* were distributed randomly with respect to the habitats in question, it would be expected to co-occur with the national mean proportion in each habitat. If it has a real affinity for a habitat, it will occur with more than the national average proportion. Adjusted habitat affinities are shown in Fig. 4c. They show a high habitat affinity with moorland, a strong affinity for lowland heath and bog (two closely related habitats), but a negative correlation with all the other habitats.

Further methods for assessing the success of the BPD by comparing with actual site lists are discussed later under Validation.

Species frequencies in different habitats

Having defined assemblages of species typical of each broad habitat type, it is possible to assess differences in species frequencies in different habitats. For example, in a habitat such as a saltmarsh, defined by a single over-riding physicochemical characteristic, there is an all-or-nothing of species occurrence: a site either contains a large proportion of the typical salt-marsh species, or none at all. Conversely, many habitats accumulate species gradually: few sites contain the full range, and much of the wider countryside supports just one or two species.

Validation of the Biotope Preference Database

The accuracy of the literature search used in compiling BPD has been tested by reference to actual field data. Sites were selected which contained a single main habitat, and which were well recorded for a wide range of groups. The number and proportion of habitat indicators, classified by the BPD, was calculated for each site. A few examples are shown in Table 1.

Table 1. Proportion of habitat-indicator moths recorded at selected sites

	Spurn Point	Borth	Wicken Fen	Arne Heath	Castle Eden Dene
Grassland	40.7	8.6	33.3	12.3	19.8
Heathland	8.3	6.9	9.7	15.3	1.4
Coastal	39.3	0.0	5.4	12.5	3.6
Wetland	28.9	10.5	50.0	10.5	13.2
Fen	25.0	0.0	75.0	12.5	16.7
Woodland	17.3	8.3	24.4	22.4	24.0
Cultivated	47.4	5.3	39.5	26.3	26.3
Ubiquitous	96.3	29.6	96.3	59.3	81.5

Conclusions

National species distribution surveys are a valuable resource of data for research on the factors influencing the occurrence of species. Through the analysis of spatial and temporal information, changes in the distribution of species (for example over the last 100 years) have been detected. Many changes are known to have occurred as a result of changes in land-use or of management practices within the same land-use type. As a result of research on the possible effects of climatic changes on wild fauna and flora, past changes affecting ecological assemblages of species have been detected. Using the broad taxonomic coverage of datasets held by the Biological Records Centre, and a newly compiled Biotope Preference Database, it will be possible to examine these changes in more detail.

Within the matrix of species richness in Britain, determined largely by environmental factors such a climate, topography and geology and by land-use, some areas of greater biodiversity are apparent across many taxonomic groups. The causes of these 'biodiversity hotspots' are to be investigated as part of a research programme being developed at the Biological Records Centre and involving several universities. This programme is also investigating the influence of variable recorder effort and bias on apparent patterns of biodiversity.

A multidisciplinary data centre, such as the Environmental Information Centre of which the Biological Records Centre is a component, is able to provide the range of resources necessary to analyse and interpret the distribution of species using modern statistical, data management and data display techniques. Analyses of data on species, such as those described, augment the results of more intensive and specialised surveys commissioned for wildlife conservation and environmental planning.

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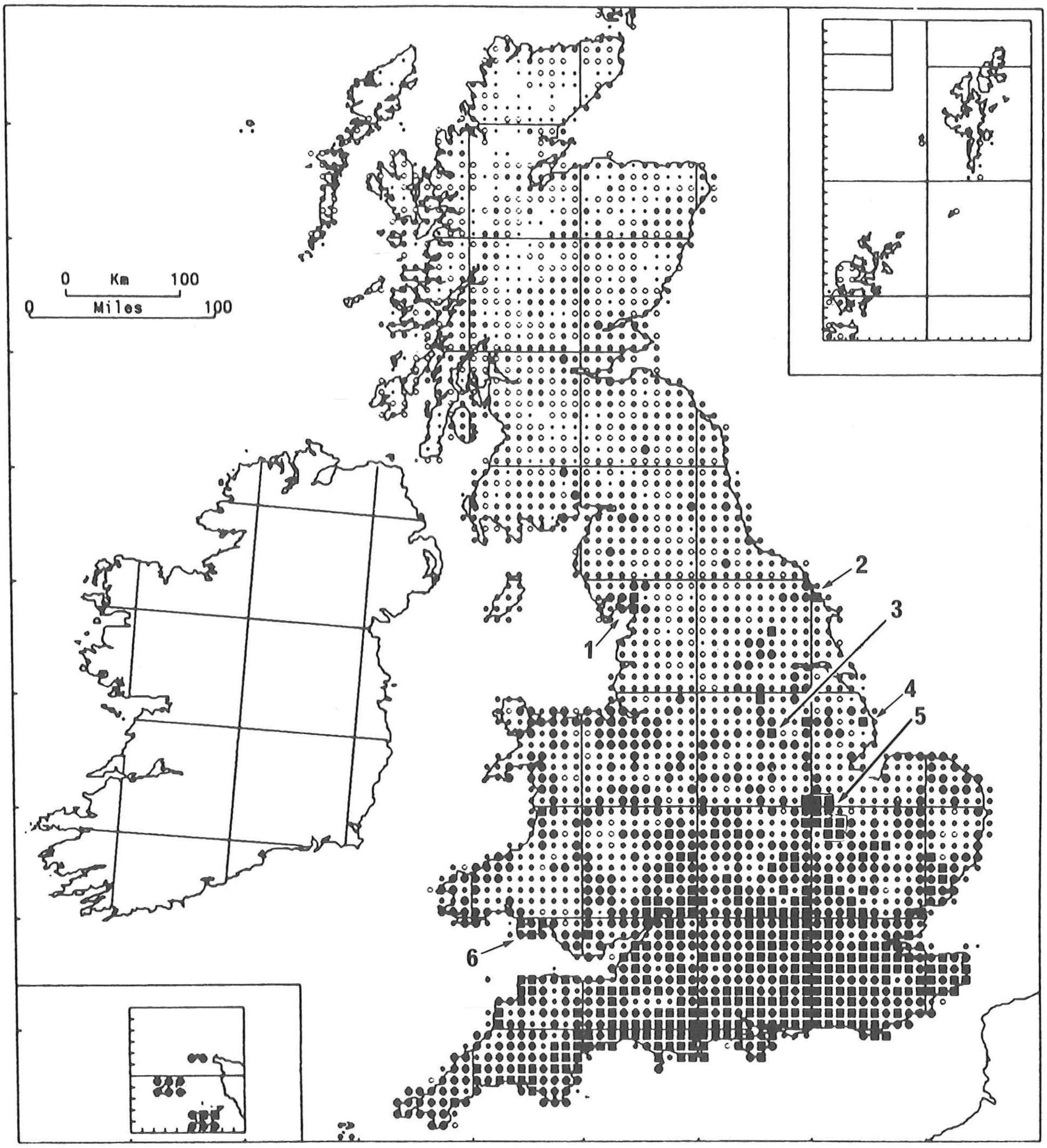
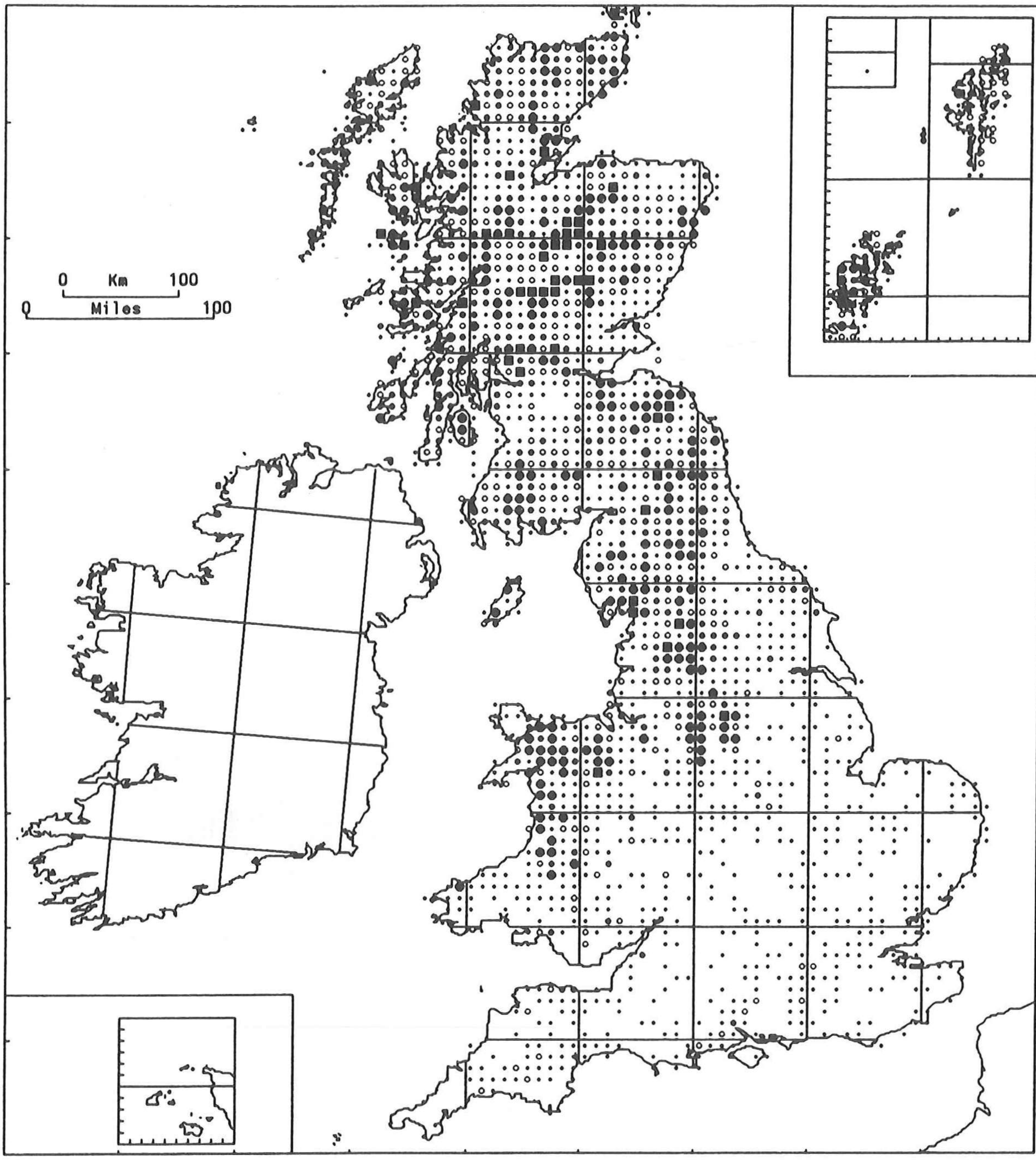
Biological Records Centre
Environmental Information Centre
NERC Institute of Terrestrial Ecology
Monks Wood Experimental Station
Abbots Ripton, Huntingdon
Cambs PE17 2LS, UK.



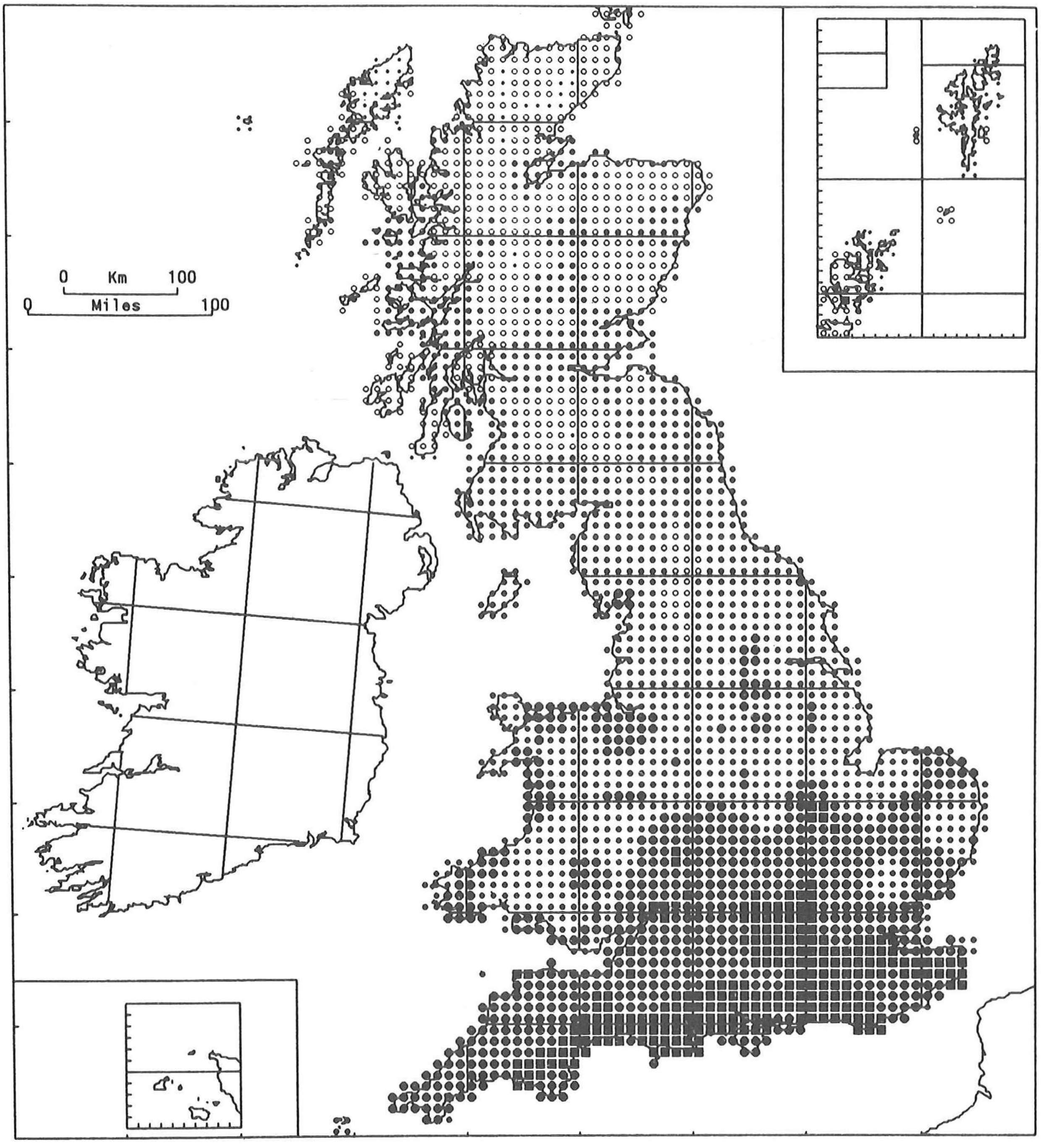
■	37+	species (>100%) 10.85%	(GB-292, Ir-0, Ch.Is-2)
●	25-36	species (89.04%)21.67%	(GB-589, Ir-0, Ch.Is-12)
•	10-24	species (67.37%)40.27%	(GB-1068, Ir-0, Ch.Is-0)
○	4-9	species (27.10%)18.23%	(GB-487, Ir-0, Ch.Is-0)
·	1-3	species (8.87%) 8.87%	(GB-234, Ir-0, Ch.Is-0)

Fig. 1. Species richness of butterflies in Britain. Scaled symbols indicate the number of species recorded in each 10-km square of the British national grid.
Areas marked 1 to 6 are recognisable biodiversity 'hotspots'.



■ 17+ species(10%) (GB-40, Ir-0, Ch.Is-0)
● 10-16 species(27%) (GB-213, Ir-0, Ch.Is-0)
• 7-9 species(20%) (GB-298, Ir-0, Ch.Is-0)
○ 5-6 species(20%) (GB-382, Ir-0, Ch.Is-0)
· 1-4 species(23%) (GB-1133, Ir-0, Ch.Is-6)

Fig. 2. Species richness of an assemblage of species which are characteristic of wet moorland in Britain. Scaled symbols indicate the number of species recorded in each 10-km square.



■ 37+ species (GB-232, Ir-0, Ch.Is-0)
● 25-36 species (GB-657, Ir-0, Ch.Is-0)
• 10-24 species (GB-1222, Ir-0, Ch.Is-0)
○ 4-9 species (GB-621, Ir-0, Ch.Is-0)
. 1-3 species (GB-109, Ir-0, Ch.Is-0)

Fig. 3. Species richness of butterflies in Britain, smoothed over groups of 9 adjacent 10-km squares, showing the average number of species in each square using scaled symbols.

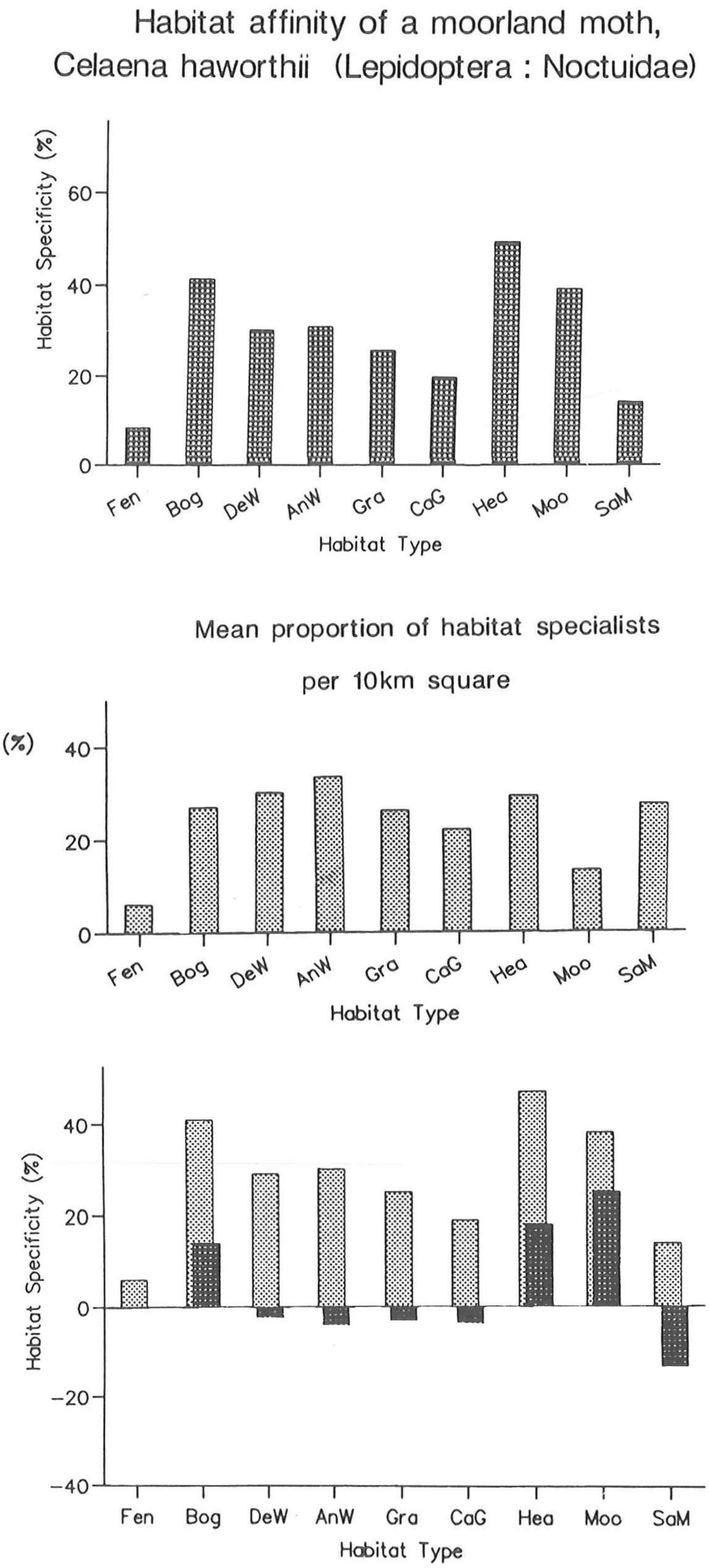


Fig. 4. Habitat affinity of a moorland moth, *Celaena haworthii* (Lepidoptera: Noctuidae). For explanation see text.

Species inventories as ecological databases in a Geographical Information System

by John R. HASLETT

Abstract

The acquisition of lists of species present in a particular area has always been an important aspect of field biology. However, the ecological usefulness of such inventories has proved to be extremely variable, and depends on a number of factors. These may be listed as follows:
a) The size of the area under consideration and the scale of the work
b) Habitat heterogeneity within the area
c) habitat heterogeneity of the surroundings
d) Spatial accuracy of the field observations
e) The availability of supplementary information (relative abundances, known biology, etc.)
f) The aims of the work and the type of analysis undertaken.
One way in which all these parameters may be taken into account is through the use of a computerised Geographical Information System.
Key-words: Geographical Information System, species inventories, distribution patterns, scaling, habitat heterogeneity, Syrphidae.

Introduction

The title of this Colloquium, "Faunal inventories of sites for cartography and nature conservation", draws attention to an inherent and certainly very important aspect of field recording of organism presence: the information is spatially referenced and can thus be directly related to some form of map. Unfortunately, whether the data are used to study the variety of sites at which any particular species occurs (distribution patterns), or to study the range of species occurring at any specified site (inventories), failure to select the appropriate forms of data storage, analysis, display and interpretation continue to severely limit the scientific value of the work. These difficulties have taken on a new and deeper significance since increased ecological and environmental awareness have provoked the use of species distributions and inventory lists as evaluation methods in various site management and conservation issues (see, for example, GOLDSMITH, 1991).

This shift in perspective, from merely descriptive to functional and applied ecology, has coincided with major advances in computer technology that can provide solutions to the problems, but that have been only partially taken up by biologists. Computerised Geographical Information Systems (GIS) interface a sophisticated graphics programme with a powerful data management system. The graphics option allows "layers" of digitised cartographic data to be viewed in any combination across a theoretically infinite range of scales, while the information database provides for the storage and manipulation of non-graphical details associated with particular map features. An introduction to GIS function and its relevance to ecology is given in the review article by HASLETT (1990) and in HASLETT (in press).

To appreciate the range of advantages offered by Geographical Information Systems for biological recording, it is necessary to examine the precise nature of the problems associated with the more

To appreciate the range of advantages offered by Geographical Information Systems for biological recording, it is necessary to examine the precise nature of the problems associated with the more conventional methods that presently limit the usefulness of inventory-type data. Much of the difficulty may, in fact, be attributed to a single phenomenon: spatial scaling.

Problems of scale

The importance of scaling to ecology is now rather well known, to the extent that the term "scale" has been referred to as a "new ecological buzzword" (WIENS, 1989). The relevance of scaling to species inventory work has not so much to do with technical cartography (although this is clearly a part), but rather with the definition of a habitat and how habitats are perceived by animals other than ourselves.

If a piece of landscape is examined at different scales (different "magnifications" if you like), different levels of heterogeneity and complexity are revealed. Thus for example, a woodland that looks rather homogeneous to us is certainly a very heterogeneous habitat mosaic to a small beetle or fly. Yet this fact is rarely taken into account during the planning or execution of distribution and inventory studies. Species distributions and habitat preferences still tend to be described under human terms of reference, even though these may be irrelevant to the ecology of the species concerned. The situation is made even more difficult when it is remembered that for practical reasons, as the size of the area under consideration increases, the accuracy with which the study is portrayed (the "grain") tends to decrease (WIENS, 1989). Quite apart from the loss of information, this ultimately promotes the continued acceptability of inexact field recording and poor input data quality.

Given these problems, How can a GIS help to improve matters? To answer this I turn to an example, the case of the European hoverfly (Diptera, Syrphidae) fauna.

Hoverfly faunas in a GIS

Syrphid flies are the subjects of a National species distribution survey in the United Kingdom, based on a standardised recording card input and a 10 km square grid map covering the country. Such a system is used to record a variety of different groups of organisms in the UK, and is clearly described by HARDING (1991).

Under this conventional system of biological recording in Britain, records of syrphids appear as a single large dot signifying presence within a grid square. From this, some large-scale trends in distribution patterns can be elucidated (for example, *Eristalis rupium* appears to be mainly confined to mountainous areas of Britain, see ENTWISTLE & STUBBS (1983)), but the maps themselves provide no information about frequencies of occurrence, habitat usage and preferences, or any of a host of other important ecological parameters. For this the worker must endeavour to extract whatever limited information is available from a separate part of the database. The result is then a summary of the present knowledge of the species as seen from the human viewpoint. This is perhaps interesting for the insect collecting fraternity, but is of little further value.
If the same recording were to be undertaken within the framework of a vector-based GIS in which selected environmental information was already available, a whole range of *new* ecological

information may be obtained; this in addition to a substantially increased data handling efficiency. Within the GIS, the species records are treated as a separate layers of cartographic data. The sites of records may be specified as points, or be given as lines or areas defined by the user, at any scale. The information may be superimposed upon maps of any other spatial variables or attributes included in the system (altitude, slope, vegetation cover, soil type, etc). Thus the GIS can be made to act as a sieve, sorting records of species according to any of the other mapped variables at a *relevant scale* within the limitations of the original data input. This has not yet been done for syrphids, but it would make it possible, for example, to identify the set of specific habitat conditions with which any particular species or group of species is most frequently associated. It would also allow extrapolations in the form of maps of potential occurrence in other areas. Alternatively, the system may be used to obtain inventory lists of species found within specified areas or combinations of habitat variables. Of course, non-cartographical information, such as relative abundances or life cycle stage may also be included in the analyses.

Such GIS-orientated distributional research has not yet been realised at the National level within Europe, but it is by no means hypothetical and is already well under way within National Parks and other protected areas in Germany, and is now also beginning in the Austrian Hohe Tauern National Park.

In Germany, in the Berchtesgaden National Park, other work on syrphid faunas provides an illustration of some further capabilities of the GIS when applied to inventory studies. In this instance, the computer system was used to provide the framework for a comparative study of the hoverfly faunas of different montane meadow habitats, the aim being to determine the overall sensitivity of the group to changes in habitat type and quality, as reported previously for ski slopes (HASLETT, 1991). The GIS was employed first to define and select standardised habitats in the field, such that each site differed from the others in only a few, predefined parameters. Syrphids were collected from these sites using Malaise traps (represented by points in the GIS) and the resulting species lists and relative abundance data were interpreted by referring to the habitat mosaic of the region, within the "catchment area" of each trap (defined, for practical purposes as a circle of radius 300 m, with the trap as the centre) and also in the surrounding landscape. The scale employed (1:10,000) was sufficient to distinguish between major plant community types and small landscape features within the meadows, so was of relevance to the behaviour of the flies under investigation.

The results of this work indicate that at constant altitude, habitat heterogeneity within and outside the collecting sites, together with vegetation type and aspect of slope, are important in determining the spectrum and relative abundances of species occurring at any site (HASLETT, in press and in preparation).

Concluding remarks

Clearly, the two examples outlined above are somewhat different in their aims and approaches, but it may be noted that the GIS principles involved apply equally to both. Certainly Geographical Information Systems exist in both raster (grid square) and vector (points, lines and areas) forms, and in some circumstances, particularly where a very large area has to be covered, or where the central aim is purely to monitor rather than to interpret species distributions, a raster system using remote sensing data may prove sufficient. However, even here, care must be taken to select a working scale relevant to the organisms being studied, and to take account of the influence of surrounding habitat types. With any GIS, the accuracy of the analyses and the correct interpretation of the results relies heavily upon high quality data input and an appreciation of scaling phenomena. The variety of factors that can lead to inaccuracies in spatial data are dealt with by GOODCHILD & GOPAL (1989).

Despite these and other shortcomings, it may be predicted that GIS will become a normal way of using maps in the near future. The present move towards the use of GIS-based recording within protected areas is an excellent starting-point from which to expand. It is the protected areas worldwide that are now acting as centres for research on natural ecosystems, and it is to these same areas that we already look for guidance in making management decisions. The Geographical Information System is an essential, if still slightly expensive, tool for all concerned!

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Politique française en matière d'inventaires faunistiques appliqués à la conservation

par Hervé MAURIN & Patrick HAFFNER

Introduction

La conservation du patrimoine naturel a été officiellement reconnue en France dans les années 70, avec la création d'un ministère "chargé de la protection de la nature et de l'environnement". En 1976, la promulgation d'une loi sur la protection de la nature a permis de mettre en place des mesures concrètes pour la conservation des espèces sauvages et de leurs habitats (listes d'espèces protégées, création d'espaces protégés ...).
Face à l'absence de connaissances récentes pour de nombreux groupes vivants, le Ministère de l'Environnement a alors mis en place une politique d'inventaires d'espèces et de milieux naturels, avec le slogan "connaître pour gérer".
Il convenait toutefois d'organiser rationnellement la collecte et le traitement des données, et de favoriser la diffusion des connaissances acquises. La création d'un service scientifique et technique spécialisé s'est de fait avérée indispensable pour répondre à cet impératif.

L'inventaire du patrimoine naturel en France

A) Le secrétariat de la faune et de la flore

Le Secrétariat de la Faune et de la Flore (S.F.F.) a été créé le 1er mai 1979 au sein du Muséum National d'Histoire Naturelle (M.N.H.N.) de Paris, par le Ministère de l'Environnement français. Les missions de ce service ont été définies dans le cadre d'une convention permanente entre le Ministère de l'Environnement et le M.N.H.N. : il coordonne des réseaux spécialisés de collecte de données sur le patrimoine naturel français; il conçoit et applique pour cela des méthodes standardisées de recueil de données factuelles et bibliographiques, et développe les nouveaux programmes d'inventaires nécessaires pour combler les lacunes dans les connaissances; il traite l'information acquise au sein de la banque de données FAUNA-FLORA, créée à cet effet; il assure le conseil scientifique et technique des administrations de l'environnement, en particulier pour la mise au point d'actions nationales ou internationales concernant la gestion et la conservation du patrimoine naturel, ainsi que l'information du public.
L'action du S.F.F. se situe donc à la croisée des préoccupations du monde scientifique (et naturaliste) et de celles des administrations gestionnaires de l'environnement.

B) La collecte des données

1. LES RÉSEAUX

La collecte des données constitue l'étape essentielle de l'inventaire du patrimoine naturel. Elle s'appuie sur différents types de réseaux de spécialistes, regroupés au sein d'un Réseau Faune Flore National, correspondant à peu près à 4.000 spécialistes et comprenant:

- des réseaux thématiques à caractère scientifique et naturaliste, composés de chercheurs des universités et de bénévoles issus d'associations d'étude et de protection de la nature, de sociétés savantes ...;
- un réseau d'équipes scientifiques pluridisciplinaires régionales, créé à l'occasion du lancement de l'inventaire des Zones Naturelles d'Intérêt Ecologique, Faunistique et Floristique (Z.N.I.E.F.F.).

Un réseau d'herpétologistes européens a été constitué dans le cadre de l'Atlas des Reptiles et Amphibiens d'Europe, animé par la "Societas Europaea Herpetologica" et piloté techniquement par le S.F.F.

Le Réseau Faune-Flore travaille en coordination étroite avec d'autres réseaux spécialisés existant au M.N.H.N. (Centre de Recherche sur la Biologie des Populations d'Oiseaux), ou dans d'autres organismes ou administrations concernés par la connaissance et la gestion du patrimoine naturel:

- réseaux thématiques à caractère plus technique, composés des fonctionnaires d'organismes utilisateurs ou gestionnaires du patrimoine naturel: services techniques et gardes de l'Office National de la Chasse, du Conseil Supérieur de la Pêche, de l'Office National des Forêts ...;
- réseaux administratifs, composés des services techniques des administrations régionales ou départementales de l'environnement et de l'agriculture.

2. LA DÉONTOLOGIE

Un règlement intérieur d'utilisation des données, ainsi qu'un code déontologique, ont été mis au point collégialement en 1982; ils garantissent la protection des données collectées et gérées par le S.F.F. (propriété scientifique, utilisation ...).

Le principe de cette déontologie est en résumé le suivant:

- l'utilisation des données brutes reste sous le contrôle des responsables mandatés des inventaires:
- les données de synthèse sont d'utilisation beaucoup plus souple que les données brutes.

3. LES COMITÉS SCIENTIFIQUES ET GROUPES THÉMATIQUES NATIONAUX

Dès son origine, le Ministère de l'Environnement a créé divers comités scientifiques et groupes thématiques nationaux pour le conseiller dans la mise en place de ses politiques de conservation de la nature.

L'action de ces comités et groupes porte à la fois sur l'évaluation et l'orientation des travaux de recherche, ainsi que sur la mise en place d'action de connaissance ou de conservation du patrimoine naturel. A titre d'exemple, ou peut citer le Groupe National pour l'Etude, la Recherche et la Conservation des Insectes et de leurs Milieux (G.N.E.R.C.I.M.), créé sur une proposition de l'Office pour l'Information Entomologique (O.P.I.E.).

4. L'OBSERVATOIRE DU PATRIMOINE NATUREL

Face à des besoins croissants au niveau national comme international, la Direction de la Protection de la Nature (D.P.N.) du Ministère de l'Environnement a posé, en 1990, les bases d'un "Observatoire du Patrimoine Naturel".

Cette structure a pour objectif de faciliter la mise en relation de toutes les connaissances disponibles, afin d'optimiser les opérations de gestion et de conservation du patrimoine naturel en cours ou en projet. L'Observatoire du Patrimoine Naturel s'appuie au niveau scientifique et technique sur les groupes thématiques nationaux et sur le S.F.F., qui assure en particulier le traitement de toutes les données collectées.

Des "fiches patrimoniales" sont réalisées progressivement à partir de l'information disponible; elles proposent, pour chaque espèce, un bilan des connaissances actuelles sur la description, la répartition, l'abondance ainsi que sur les problèmes de conservation ou de gestion posés; elle permet de mettre en évidence les lacunes éventuelles à combler en priorité.
Cette action nouvelle se situe tout à fait dans la politique actuelle de création d'un futur Institut Français de l'Environnement, lui même "point focal" national de la future Agence Européenne de l'Environnement.

Grands types de programmes d'inventaire concernant la faune

A) Inventaires chorologiques de faune

Les inventaires chorologiques reposent tous sur l'informatisation de cinq paramètres de bases:

- la référence à un programme d'inventaire,
- l'origine de l'information,
- le taxon observé,
- la date d'observation,
- le lieu d'observation en coordonnées géographiques (GRADES) les plus précises possibles, complétées par la commune concernée.

Ces données factuelles essentielles sont complétées au cas par cas, et en fonction des disponibilités et besoins, par des données complémentaires à caractère biologique, écologique ou réglementaire.
Depuis sa mise en place, le S.F.F. a ainsi constitué des états de références nationaux pour les oiseaux nicheurs, hivernants et occasionnels, les mammifères, les reptiles, les amphibiens, les poissons d'eau douce. Ces bilans nationaux sont dans certains cas complétés par des bilans régionaux ou des bilans thématiques concernant une seule espèce ou un groupe d'espèces. Au total 2,2 millions de données concernant les vertébrés ont ainsi été traitées.
La mise à jour de tels états de référence est toutefois lourde à mener; pour l'instant, seuls les oiseaux nicheurs et les oiseaux occasionnels font l'objet d'un second état des connaissances exhaustif; par contre, dans le cas de certaines espèces chassées, des mises à jour nationales peuvent être réalisées très régulièrement.
Dans le cas des invertébrés, seuls quelques groupes sont actuellement couverts. Leur nombre d'espèces très élevé, induisant de nombreux problèmes de taxonomie, constitue un premier obstacle au développement des inventaires. Il faut également signaler que ces groupes constituent rarement des axes de travail prioritaires pour les administrations gestionnaires de l'environnement. Une meilleure mobilisation des associations d'invertébristes devrait, au moins en ce qui concerne les groupes collectionnés, permettre de combler certaines lacunes criantes. La diminution dramatique des spécialistes en faunistique rend toutefois l'amélioration de la connaissance de plus en plus difficile dans le domaine des invertébrés (détermination, accès aux collections ...). Au total, 70.000 données ont été traitées.

B) Les enquêtes communales

Le territoire français comporte 36.000 communes. Cette unité administrative constitue donc une maille intéressante pour la collecte des données, en particulier par voie administrative.
Ainsi le S.F.F. réalise-t-il périodiquement des enquêtes communales pour le compte du Ministère de l'Environnement ou de l'Office National de la Chasse. Ces enquêtes portent dans la plupart des

cas soit sur des espèces menacées (vison d'Europe, loutre, lynx ...) soit sur des espèces exploitées ou limitées par l'homme (espèces chassées, carnivores).
Si elles nécessitent une validation approfondie, les données de ces enquêtes sont extrêmement précieuses car elles permettent d'établir les bilans de répartition ou quantitatif exhaustifs à l'ensemble du territoire national; la répétition périodique de ces bilans, selon des fréquences annuelles ou pluriannuelles, permet la mise en évidence d'évolutions rapides dans les répartitions.

C) L'exploitation des données historiques

L'exploitation des données historiques revêt une importance toute particulière, dans la mesure ou ces informations constituent des éléments indispensables pour une évaluation de l'évolution à long terme du patrimoine naturel. Leur valorisation constitue bien évidemment un travail de longue haleine. Les premiers résultats obtenus sur le groupe des oiseaux sont suffisamment intéressants pour qu'une extension à l'ensemble des autres groupes de faune soit envisagée à moyen terme.
Chaque référence bibliographique est indexée selon les taxons cités dans le texte, les départements concernés et une liste de mots clés descritifs. Les résultats ainsi obtenus constituent la base des statistiques chiffrées et cartographiques utilisées dans le cadre des travaux de comptabilité du patrimoine naturel français.
Dans certains cas, l'exploitation des données anciennes concerne la saisie de fichiers non publiés ou l'informatisation directe, sur table à numériser, de cartes publiées dans le passé; des logiciels de conversion automatique permettent d'assurer la compatibilité de toutes les données ainsi valorisées.

D) Les inventaires de zones naturelles d'intérêt biologique

1. LES Z.N.I.E.F.F.

L'inventaire des Zones Naturelles d'Intérêt Ecologique, Faunistique et Floristique (Z.N.I.E.F.F.) recense les zones biologiquement les plus riches, devant faire l'objet d'une attention toute particulière lors des opérations d'aménagement; chaque zone est caractérisée par sa richesse spécifique ou biocoénotique. Les listes d'espèces de faune et de flore associées à chaque zone peuvent être réutilisées dans le cadre d'études chorologiques menées par ailleurs (atlas par exemple ...). Le fichier comporte actuellement plus de 14.000 zones décrites et informatisées selon ce principe.
Structuré régionalement, cet inventaire sert actuellement de référence pour les grands projets d'aménagement et études d'impact sur l'environnement. Il constitue également, en complément du réseau d'espaces protégés, une des bases de la politique nationale pour la conservation des espaces naturels, menée par le Ministère de l'Environnement français.

2. L'INVENTAIRE DES ESPACES PROTÉGÉS

Le S.F.F. tient à jour un fichier des espaces protégés français et coordonne l'inventaire de leurs richesses biologiques.
Un effort particulier a porté récemment sur le littoral, avec constitution d'un fichier de tous les espaces naturels soumis à protection foncière et réglementaire, venant compléter le fichier des zones d'intérêt biologique.

3. LES INVENTAIRES D'UNITÉS DE POPULATION

Pour certaines espèces (espèces rares ou chassées) il est procédé à des inventaires d'unités de population. La répétition annuelle ou pluriannuelle de ces inventaires permet un suivi fin de l'évolution de la répartition et pour les effectifs des espèces concernées.

Utilisation des données faunistiques appliquées à la conservation

L'emploi de méthodologies nationales et standardisées, complété par un traitement de toutes les données dans une banque informatique unique - FAUNA-FLORA - constituent deux atouts essentiels pour une bonne valorisation des connaissances acquises. Les applications et utilisations, développées en réponse aux besoins scientifiques ou administratifs du moment, s'en trouvent de fait grandement facilitées; les traitements multifichiers sont en particulier rendus possibles grâce à l'intercompatibilité générale des données disponibles.

A) Applications pour la recherche

Après une dizaine d'années d'efforts, concentrés essentiellement sur la conception méthodologique et la collecte des données, le S.F.F., s'efforce maintenant de développer des applications pour la recherche.

Elles concernent d'abord l'exploitation directe des données de base disponibles, sous forme de traitements de type chorologique ou multifichiers, par superposition et combinaison de données.

Elles peuvent porter également sur des exploitations de type finalisé; les données de base étant alors intégrées à des travaux de recherche sur la dynamique des populations et des écosystèmes.

B) Utilisations pour la conservation des espèces et de leurs habitats

Les atlas de répartition constituent une première synthèse de connaissances, directement utilisable pour la conservation et la gestion des espèces.

Les fichiers de zones naturelles d'intérêt biologique sont quant à eux plus adaptés à une utilisation dans le cadre de la conservation des habitats de ces espèces, ainsi que des écosystèmes les plus remarquables. Les informations disponibles sont ainsi de plus en plus fréquemment consultées dans le cadre des politiques nationales et régionales d'aménagement, du renforcement du réseau national d'espaces protégés et des opérations de restauration de milieux.

Le fichier Z.N.I.E.F.F., complété par celui des espaces protégés et autres zone naturelles d'intérêt biologique, constitue un outil simple, permettant d'orienter de façon très significative certaines prises de décision.

Conclusion

Le contexte et la problématique de la conservation de la faune ont considérablement évolué depuis une dizaine d'années.

Il est évident que les atteintes portées aux espèces sauvages et aux habitats posent des problèmes de plus en plus aigus. On assiste toutefois, en réaction à ces agressions, à une multiplication des réglementations internationales et nationales.

La mise en place de réglementations nouvelles, si elle est nécessaire, ne peut toutefois suffire à régler les problèmes posés. Il est impératif qu'en amont des actions de conservation menées, en particulier à l'échelle de l'Europe, chaque état dispose des connaissances suffisantes sur son patrimoine naturel. La coordination des inventaires de faune et de leurs habitats constitue donc, à tous les niveaux, une nécessité de première priorité.
L'évolution actuelle des techniques de traitement de l'information permet quant à elle une valorisation rapide des connaissances acquises; il est en particulier indispensable de mettre rapidement à la disposition des "décideurs" l'information synthétique qui leur manque. Le risque de destruction du patrimoine naturel par négligence ou manque d'information, qui constitue de fait un danger redoutable, s'en trouve dans ce cas considérablement amoindri.

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LUXNAT: banque de données biogéographiques

par Marc MEYER

Introduction

Le développement de projets de cartographie biogéographique en Europe (p. ex. Atlas Florae Europaea, Cartographie des Invertébrés Européens) montrait clairement que des banques de données fiables et performantes doivent être à la base de toute représentation cartographique.

Depuis quelques années le Musée national d'histoire naturelle de Luxembourg a ainsi initié la création d'une banque de données biogéographiques sur ordinateur central avec le soutien du "Centre Informatique de l'Etat". La première version fût une variante rigide ne permettant pratiquement aucune utilisation de fichiers dictionnaires. Aujourd'hui la version centrale de LUXNAT se trouve dans l'environnement VM/CMS et correspond intégralement à une banque de données relationnelle gérée par le standard SQL (IBM SQL/DS, REXX-SQL, ISPF, etc). A côté de cette version centrale, qui contient toujours la dernière mise à jour des tables, nous avons installé un réseau local avec plusieurs stations de travail sur lesquelles on peut transférer des parties de LUXNAT identiques à la structure centrale. Ceci permet une utilisation simultanée des informations par différents utilisateurs sans perte de temps.

La structure relationnelle de LUXNAT

Dès le début des développements informatiques, le concept de LUXNAT correspondait à une banque de données biogéographiques universelle sans limitation ni dans l'espace, ni dans les groupes taxonomiques. Toutes les informations concernant les observations d'organismes vivants à n'importe quelle partie du globe terrestre peuvent être saisies. Ceci est une condition essentielle si l'on veut intégrer des collections scientifiques dans un tel programme. Il est évident que les données saisies dans LUXNAT sont validées par des spécialistes et que les fichiers actuels ne contiennent donc que des informations provenant des domaines et des régions traités par les collaborateurs scientifiques du Musée.

Une banque de données centralisant des observations biogéographiques de tout genre doit obligatoirement suivre une certaine standardisation des informations. Ceci implique l'identification préalable des taxons en cause (selon la nomenclature utilisée par LUXNAT!) et des lieux d'observation (coordonnées Gauss-Krueger, resp. UTM; localisation administrative de la localité la plus proche). Avant de pouvoir faire une saisie dans LUXNAT, ces informations doivent donc être validées par l'auteur lui-même. Actuellement des aides synonymiques ne sont pas prévues, mais elles peuvent être intégrées facilement en cas de besoin.

La flexibilité indispensable dans le cas d'une banque de données universelle est garantie par la structure relationnelle qui permet une gestion facile des fichiers et une recherche performante de toutes les variables contenues dans les tables.

Exemple:
Système traditionnel (1 ligne dans un fichier)

esp. loc. coord. écosyst. date auteur origine indiv.
Papilio machaon L. / Luxembourg / 32UKV9987 / mesobrometum / 03081991 / MEYER Marc / obs. de terrain / 2 femelles

Système relationnel (la même ligne dans 4 tables; codes numériques remplaçant des variables en texte clair en *italiques*):

loc. coord. écosyst.
Table 1 (= OBSLOC): *113* / 32U KV 99 87 / *E110* -> lien vers table 2
date aut. orig.
Table 2 (= OBSERV): 03 08 1991 / *81* / *1* -> lien vers table 3
esp.
Table 3 (= OBSESP): *1256* -> lien vers table 4
indiv.
Table 4 (= INDIVIDU): 2.

Les redondances dans les données sont évitées par la séparation de chaque information unitaire (l'observation minimale se composant du taxon, du lieu, de la date et de la personne) aux niveaux suivants:

1. le lieu d'observation (OBSLOC)
2. l'observation (OBSERV)
3. le taxon observé (OBSESP)

[4. les individus/abondances observés (INDIVIDU, PHYTOSOC 1)].

Cette séparation des tables offre la possibilité à des spécialistes de certains groupes taxonomiques d'ajouter des variables spécifiques à leur groupe selon leurs besoins.
La structure générale de la banque de données LUXNAT est montrée dans le schéma relationnel de la figure 1. Les 3[4] tables mentionnées ci-dessus constituent la partie centrale de la structure arborescente. Les variables décrivant les observations standardisées sont indiquées dans le tabl. 1.

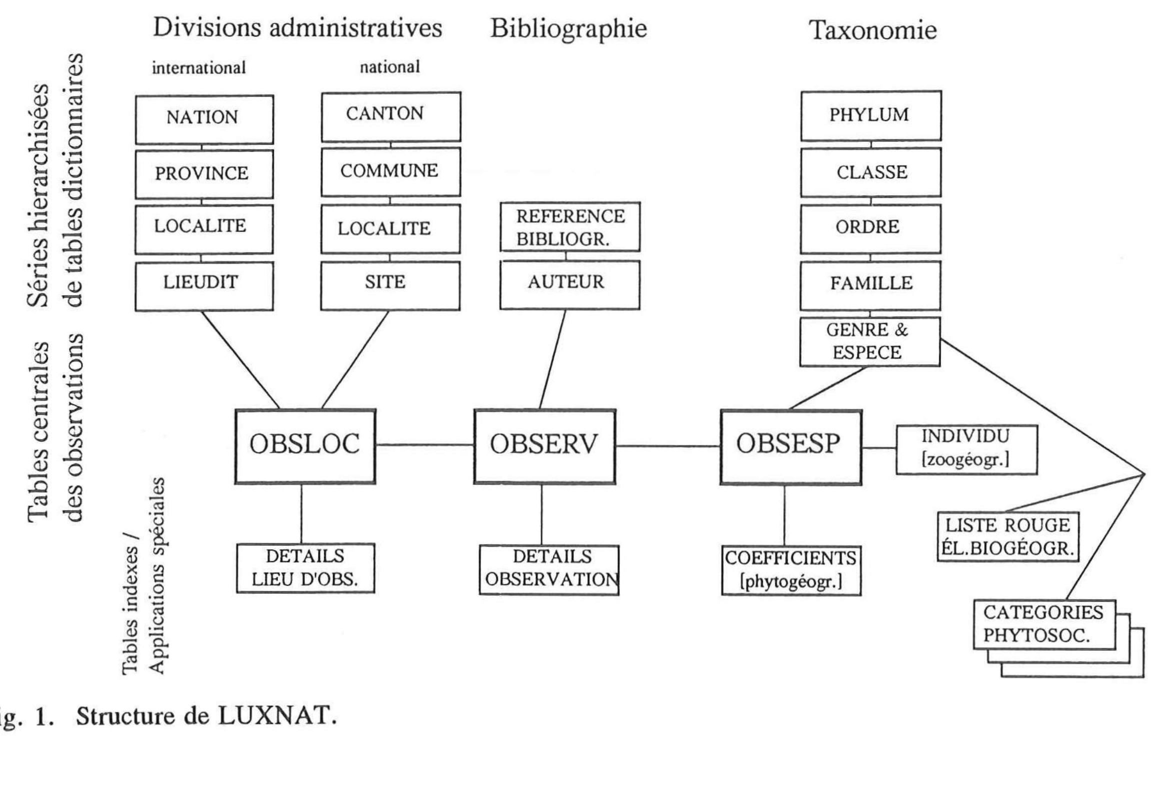

Fig. 1. Structure de LUXNAT.

Tableau 1. Tables centrales (fichiers d'observations) de LUXNAT. (Les tables et données obligatoires sont mentionnées en caractères gras)

Table	*Variables*	*Remarques*
OBSLOC	**nation**	
	coordonnées UTM	(données étrangères)
	coord. Gauss-Krüger	(données nationales)
	altitude	
	spécifications conc. l'écosystème	
	auteur	
	réf. bibliographique	
	date	
	variables relationnelles	vers tables FLOUER, OBSERV.
OBSERV	**confidentialité de l'observ.**	(accessible au public ou non!)
	date	(ou période)
	details conc. le lieu d'observation	
	origine des données	
	auteur	
	réf. bibliographique	
	variables relationnelles	vers tables OBSLOC, OBSESP [et PHYTOSOC 1]
OBSESP	code de **l'espèce**	
	variables relationnelles	vers tables OBSERV et INDIVIDU / PHYTOSOC 2.
INDIVIDU		(réservée aux animaux!)
	statut et nombre d'individus	
	variable relationnelle	vers table OBSESP.
PHYTOSOC 1		(réservée aux plantes!)
	surface de la parcelle inventoriée	
	% des niveaux de stratification végétale	
	variable relationnelle	vers table OBSERV.
PHYTOSOC 2		(réservée aux plantes!)
	coefficient d'abondance	
	coefficient de dominance	
	variable relationnelle	vers table OBSESP.

Deux séries de tables hiérarchisées ("dictionnaires") sont utilisées pour permettre la production de résultats plus compréhensifs:

* *Tables taxonomiques*
Classification et nomenclature basées sur l'ouvrage de PARKER (1982), mais seulement les catégories "phylum", "classe", "ordre" et "famille" ont été retenues, la nomenclature des espèces comme unités taxonomiques fondamentales reposant cas par cas sur les propositions des spécialistes en cause:
(PHYL -> CLAS -> ORD -> FAM -> ANIMAL / PLANTE)

* *Tables des provinces/localités*
(données étrangères: NATION -> PROVINCE -> LOCALITÉ -> LIEUDESCR; données nationales: CANTON -> COMMUNE -> LOCALITÉ -> LIEUDIT).

La redondance dans ces tables "dictionnaires" est évitée par l'utilisation de codes numériques dans les tables centrales (décrivant l'observation) qui relient celles-ci aux dictionnaires dans lesquels se trouvent les définitions exactes des données en texte clair, p. ex. l'auteur (AUTEUR), la référence bibliographique (REFERENCE), le type d'écosystème (ECOSYST), le type d'habitat (HABITAT) et les espèces (ANIMAL/PLANTE).

Utilisation de standards

Le manque de standards internationaux en matière de biogéographie a provoqué des incompatibilités importantes entre les banques de données existantes.

En premier lieu il faut regretter l'absence de classification des organismes vivants généralement acceptée par les biologistes, mais une banque de données universelle ne pourra pas prendre en considération tous les différents points de vue des spécialistes. La classification universelle proposée par PARKER (1982) a donc été adoptée pour les besoins de LUXNAT, puisqu'elle présente l'avantage d'être valable pour tous les groupes taxonomiques du monde. Si une révision générale a été publiée ultérieurement pour un certain groupe d'organismes, les codes sont facilement adaptables. Pour la production de listes de sortie, seulement les catégories "phylum", "classe", "ordre" et "famille" ont été retenues.

Des changement de nomenclature ou de systématique causent un problème majeur aux gérants de banques de données, aussi certains ont prévu des places réservées à des extensions de codes numériques. Dans LUXNAT l'utilisation d'un code double évite ces problèmes.

1. Le premier code est un nombre courant interne généré par l'ordinateur et représentant la variable relationnelle assurant le lien du taxon vers les autres tables. Ce **code est inchangeable** et lié de façon permanente au taxon en question.

2. Le second code est un code taxonomique "classique" définissant numériquement la position systématique du taxon. Ce **code pourra être adapté** à tous les changements taxonomiques éventuels.

Exemple d'un code d'espèce:

code famille	*nom de l'espèce*	*code systém.*	*numéro crt. esp.*
4358	*Papilio machaon* LINNAEUS, 1758	10010	1660

Le Conseil de l'Europe a publié une liste des écosystèmes européens et cette liste a été adoptée par le projet des Communautés Européennes "CORINE-Biotopes" (CORINE, 1986). La même liste est utilisée par LUXNAT après quelques adaptations compatibles, notamment en ce qui concerne les écosystèmes anthropogènes. Le tableau 2 montre un extrait de cette liste.

Tableau 2. Extrait de la liste standard des écosystèmes européens
(version française modifiée du standard CORINE)

A400			Forêts des sites humides
	A410		Forêts galeries alluviales (Salicetalia purpureae)
		A411	Salicion triandro-viminalis
		A412	Salicion albae
	A420		Forêts alluviales (Fraxino-Alnion glutinosae)
		A421	En zone de source (Carici-remotae-Fraxinetum)
		A422	En zone de ruisseaux (Stellario-Alnetum glutinosae)
		A423	En zone de rivières (Pruno-Fraxinetum)
	A430		Forêts de marais et tourbières
		A431	Aulnaies (Alnetalia glutinosae)
		A432	Sauricaies (Salicetalia auritae)
		A433	Boulaies (Betula sp.)

CORINE-Biotopes utilise une classification standardisée des districts adminitratifs des membres de la CE (code "NUTS"). Ce code a été adopté pour les besoins de LUXNAT, après avoir été élargi aux nations européennes non membres de la CE.

Extrait du code NUTS:

France 2000	
Est	2400
Lorraine	2410
Meurthe-et-Moselle	2411
Meuse	2412
Moselle	2413
Vosges	2414
Alsace	2420
Bas-Rhin	2421
Haut-Rhin	2412

Projets en cours d'élaboration

Le développement récent des micro-ordinateurs a permis de réaliser récemment un réseau local permettant l'installation d'extraits conformes de LUXNAT sur PC avec la possibilité de gestion on-line (stations de travail), resp. off-line (laptops utilisés sur le terrain ou ordinateurs privés des collaborateurs scientifiques du Musée).

Un lien direct entre LUXNAT et un système d'information géographique (GIS) sera développé dans les mois prochains.

Les tables dictionnaires de LUXNAT serviront à installer un système de documentation général pour l'ensemble des sections du Musée national d'histoire naturelle (Fig. 2). Ceci englobe le catalogage des collections scientifiques, mais aussi de la bibliothèque, des collections de tirés à part, de la diathèque, etc.

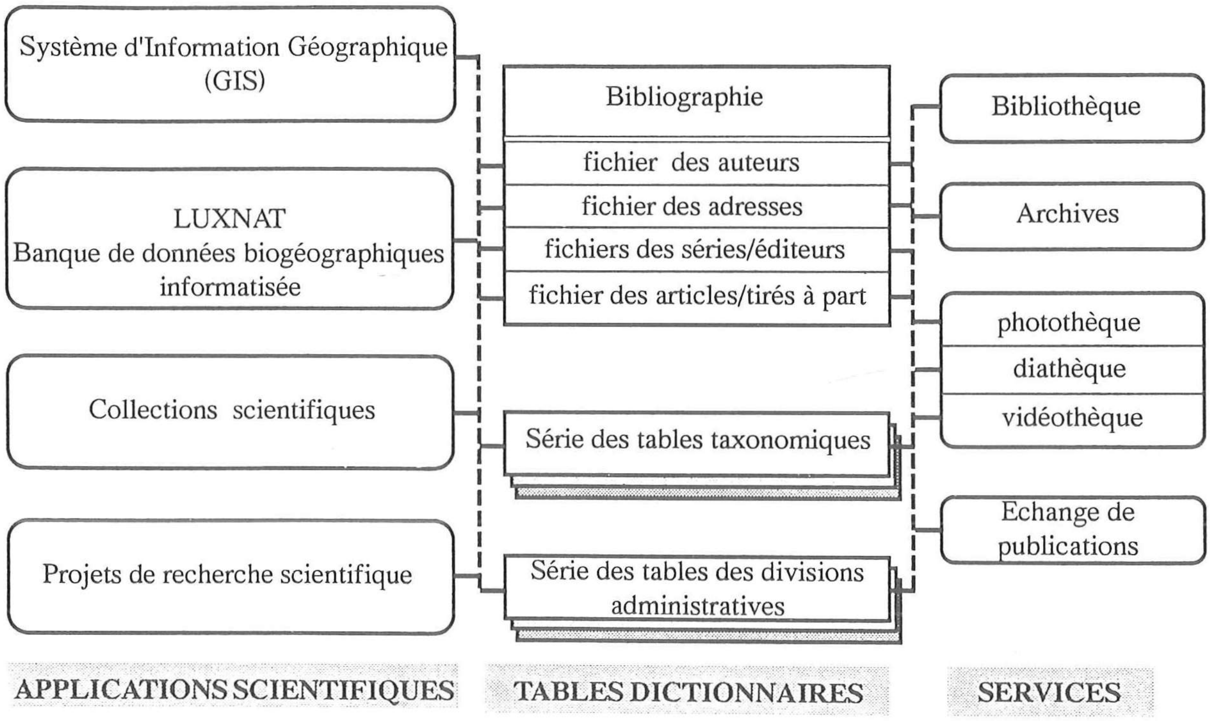

Fig. 2. Système de documentation relationnel pour le Musée National d'Histoire Naturelle de Luxembourg

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A proposal for the establishment of a red list of the Lycosid spiders in Flanders (Araneae, Lycosidae)

by Mark ALDERWEIRELDT & Jean-Pierre MAELFAIT

Summary

An analysis of the distribution data of the 37 lycosid species known to occur in Flanders, showed that a considerable part is clearly threatened and needs thorough protection. Therefore, we try to establish a red list of the threatened and endangered lycosid spiders in Flanders. These species occur in the following habitat types: coastal and inland dunes, heathland, chalk grassland, marshy areas and river banks with high water quality, saltmarshes and *Sphagnum* bogs. It is clear that priority should be given to efficient and long-term protection of these rare habitat types. Because we have shown in the past that wolf spiders are good ecological indicators which can be used efficiently in biomonitoring and site assessment studies, we believe that making up this type of red lists can be of great use in this context.
Key-words: distribution, wolf spiders, Flanders, red list, nature conservation.

Samenvatting

Uit de analyse van de verspreidingsgegevens van de 37 wolfspinsoorten die in Vlaanderen voorkomen, blijkt dat een aanzienlijk deel duidelijk bedreigd is en nood heeft aan beschermingsmaatregelen. Daarom proberen we in deze bijdrage een rode lijst op te stellen van de bedreigde Lycosidae van Vlaanderen. Deze soorten worden in de volgende habitattypes gevonden: duinen aan de kust en in het binnenland, heide, kalkgrasland, moerasgebieden en rivieroevers met hoge waterkwaliteit, zoutmoerassen en laagveen. Het is duidelijk dat de bescherming van dit soort habitaten prioriteit moet krijgen. In het verleden hebben we reeds aangetoond dat wolfspinnen goede ecologische indicatoren zijn, en daarom menen we dat het opstellen van dergelijke rode lijsten in dit verband van groot nut is.
Sleutelwoorden: verspreiding, wolfspinnen, Vlaanderen, rode lijst, natuurbehoud.

Introduction

In Flanders, wolf spiders are medium to large spiders which do not build a web to catch their prey (one exception: *Aulonia albimana* JOB, 1974). Instead they actively hunt for it. A striking characteristic of this spider family is that the egg sac is attached to the spinnerets and thus carried along by the female until the young emerge. These juveniles climb on the abdomen of the female and stay there for another week or two.

The life cycle of most species of Lycosidae occurring in Flanders can be summarized as follows (cf. ALDERWEIRELDT & MAELFAIT, 1988; SEGERS, 1989). They reach adulthood by the end of spring-beginning of summer. During that period adult males exhibit an extremely high ground surface activity in their search for females. After copulation two or three egg cocoons may be produced. The young grow, overwinter in the juvenile or subadult stage and get adult the next spring or the spring of the following year (second and third broods).

This kind of life cycle and behaviour make it very easy to trace these spiders on places where they are present. Their nice, often striking coloration, the often spectacular courtship behaviour of the males and the maternal care for eggs and offspring offer possibilities for making these animals attractive to the general public.

We recently elaborated a catalogue dealing with the Lycosidae of our country (ALDERWEIRELDT & MAELFAIT, 1990a), in which we summarize all distribution data known by using the UTM grid. In Belgium 44 species were encountered; 37 of these are known to occur in Flanders. A considerable part of these 37 are clearly endangered or threatened and need thorough protection.

In this contribution, we therefore try to make up a red list of the threatened lycosid spiders in Flanders. Because we have shown in the past that wolf spiders are good ecological indicators (ALDERWEIRELDT & MAELFAIT, 1990b) which can be used efficiently in biomonitoring and site assessment studies, we believe that making up this type of red lists can be of great use and importance in this context.

Lycosids of importance for nature conservation

The species which are of importance for nature conservation in Flanders are the following (distribution maps, Fig. 1-18):

Alopecosa barbipes (SUNDEVALL, 1832) - (Fig. 1)
This species has been recorded from several localities along the coastline where it occurs in dry dune habitats. In the north and east of Flanders, it has several well established populations in dry heathland.

Alopecosa fabrilis (CLERCK, 1758) - (Fig. 2)
This large species is confined to open, sandy places where a burrow can be excavated. It is known from only a few localities in the coastal dunes. In addition it occurs on inland dunes and in heathland with patches of bare soil (e.g. after burning) in the north and east of Flanders.

Arctosa leopardus (SUNDEVALL, 1832) - (Fig. 3)
Well established populations of this species are known from wet dune slacks, wet heathland and some wet grasslands.

Arctosa perita (LATREILLE, 1799) - (Fig. 4)
Records of this species are known along the whole coastline as well as in the north and east of Flanders. It is found in dry dunes, open heathland and in low productive grassland on dry sandy soil.

Hygrolycosa rubrofasciata (OHLERT, 1865) - (Fig. 5)
Except for one locality in West Flanders, this species is restricted to the north-east of Flanders where it occurs especially in bog and alder carr.

Pardosa monticola (CLERCK, 1758) - (Fig. 6)
In the north and east of Flanders, this species occurs in open heathland areas. Along the coast it is often numerous in rabbit-grazed dune grassland.

Pardosa purbeckensis F.O.P. CAMBRIDGE, 1895 - (Fig. 7)
Well established populations of this species are known from the few remaining, small saltmarsh areas along the coast and along the Scheldt. It rarely occurs more inland (some individual catches, mainly on arable land).

Pardosa sphagnicola (F. DAHL, 1908) - (Fig. 8)
A species exclusively known to occur in *Sphagnum*-bogs in the north and east of Flanders.

Pirata piscatorius (CLERCK, 1758) - (Fig. 9)
Known almost exclusively from the north and east of Flanders. It occurs in very wet habitats, mainly along open, oligotrophic water bodies with a good water quality.

Pirata uliginosus (THORELL, 1856) - (Fig. 10)
Except for one locality in West Flanders, this species is confined to the north and east of Flanders where it occurs in some heathland habitats.

Pirata tenuitarsis SIMON, 1876 - (Fig. 11)
This species is restricted to the Campine region where it is mainly found in wet heathland.

Trochosa spinipalpis (F.O.P. CAMBRIDGE, 1895) - (Fig. 12)
Records of this species are scattered over Flanders. The species prefers wet grasslands and marshes.

Xerolycosa miniata (C.L. KOCH, 1834) - (Fig. 13)
Well established populations are found along the coast. It is mainly a species of dry, open dunes. The species is only rarely encountered in sandy inland habitats. In open heathland, this species is replaced by *X. nemoralis* (WESTRING, 1861).

Aulonia albimana (WALCKENAER, 1805) - (Fig. 14)
In Flanders, there is only one older record (1936) from the coast where it now seems to have disappeared. It was however caught in large numbers in Dutch coastal dunes (WIEBES & DEN HOLLANDER, 1974). Well established populations can still be found in the south of Belgium. Its status in Flanders needs further investigation.

Arctosa figurata (SIMON, 1876) - (Fig. 15)
No well established populations of this species are known at present. Its status in Flanders needs further investigation.

Pardosa agricola (THORELL, 1856) - (Fig. 16)
Only known from two individual catches in Flanders. Its status first needs further investigation.

Pardosa proxima (C.L. KOCH, 1848) - (Fig. 17)
This species has been observed in low numbers in a few localities (wetlands and arable land). Flanders is clearly at the northern edge of its distribution area (ALDERWEIRELDT & DESENDER, 1989).

Trochosa robusta (SIMON, 1876) - (Fig. 18)
Only one recent capture in Flanders and no well established populations known. More information on its status is needed.

A red list of the Lycosidae occurring in Flanders

Based on these data, a red list of the Lycosidae of Flanders could be elaborated (Tab. 1). The endangered and threatened wolf spider species occur in coastal and inland dunes, marshy areas, *Sphagnum* bogs, wet grasslands, dry and wet heathland, chalk grassland and saltmarshes. Legal protection of lycosid spiders would offer a powerful tool for the protection of these habitat types and the whole of their associated fauna and flora (MAELFAIT *et al.*, 1992).

Table 1. Red list of the Lycosidae occurring in Flanders.

ENDANGERED	THREATENED	TO BE INVESTIGATED
Alopecosa fabrilis *Hygrolycosa rubrofasciata* *Pardosa purbeckensis* *Pardosa sphagnicola*	*Alopecosa barbipes* *Arctosa leopardus* *Arctosa perita* *Pardosa monticola* *Pirata piscatorius* *Pirata tenuitarsis* *Pirata uliginosus* *Trochosa spinipalpis* *Xerolycosa miniata*	*Aulonia albimana* *Arctosa figurata* *Pardosa agricola* *Pardosa proxima* *Trochosa robusta*

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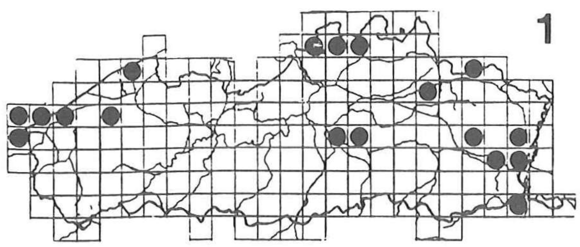
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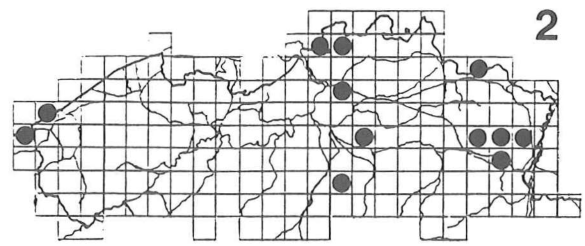
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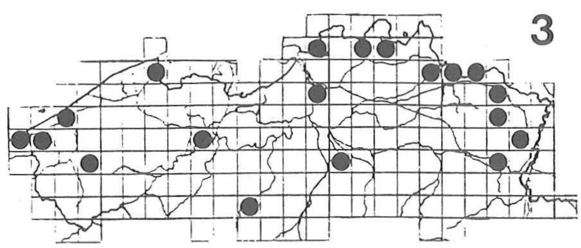
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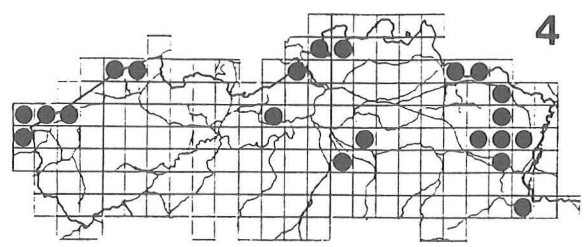
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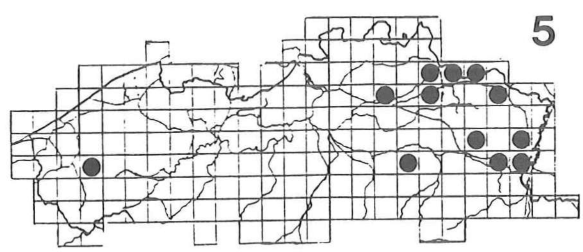
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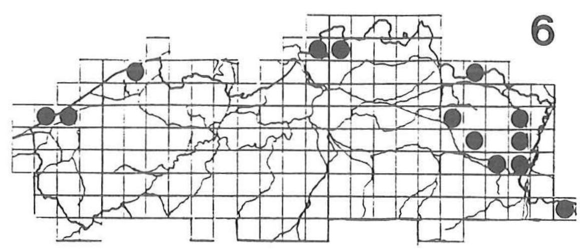
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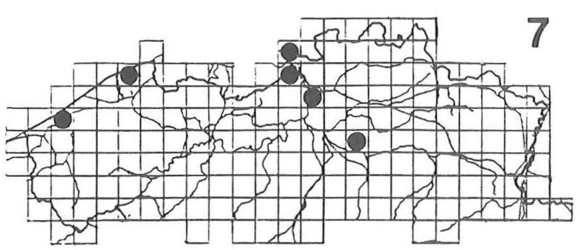
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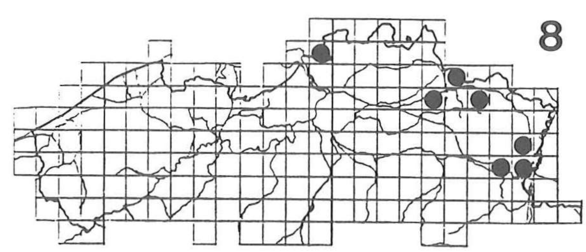
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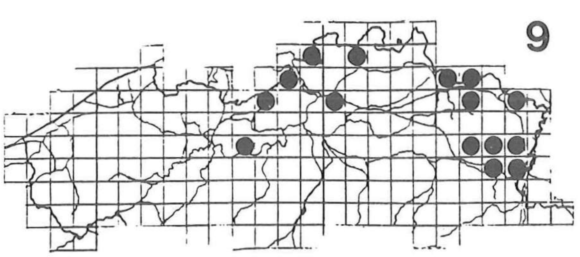
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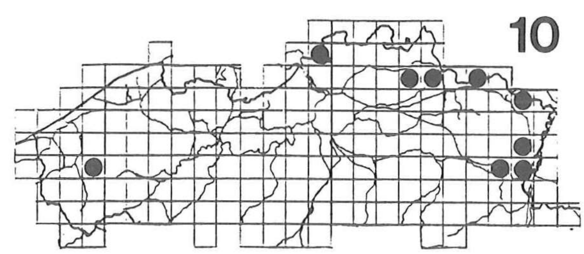
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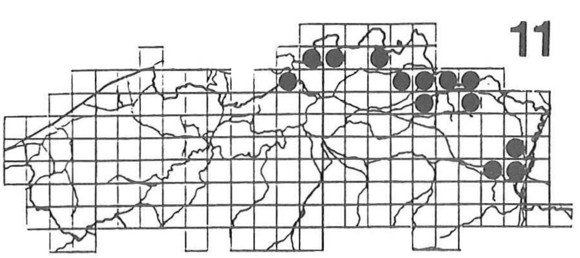
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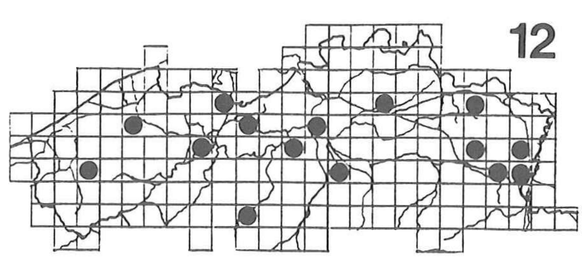
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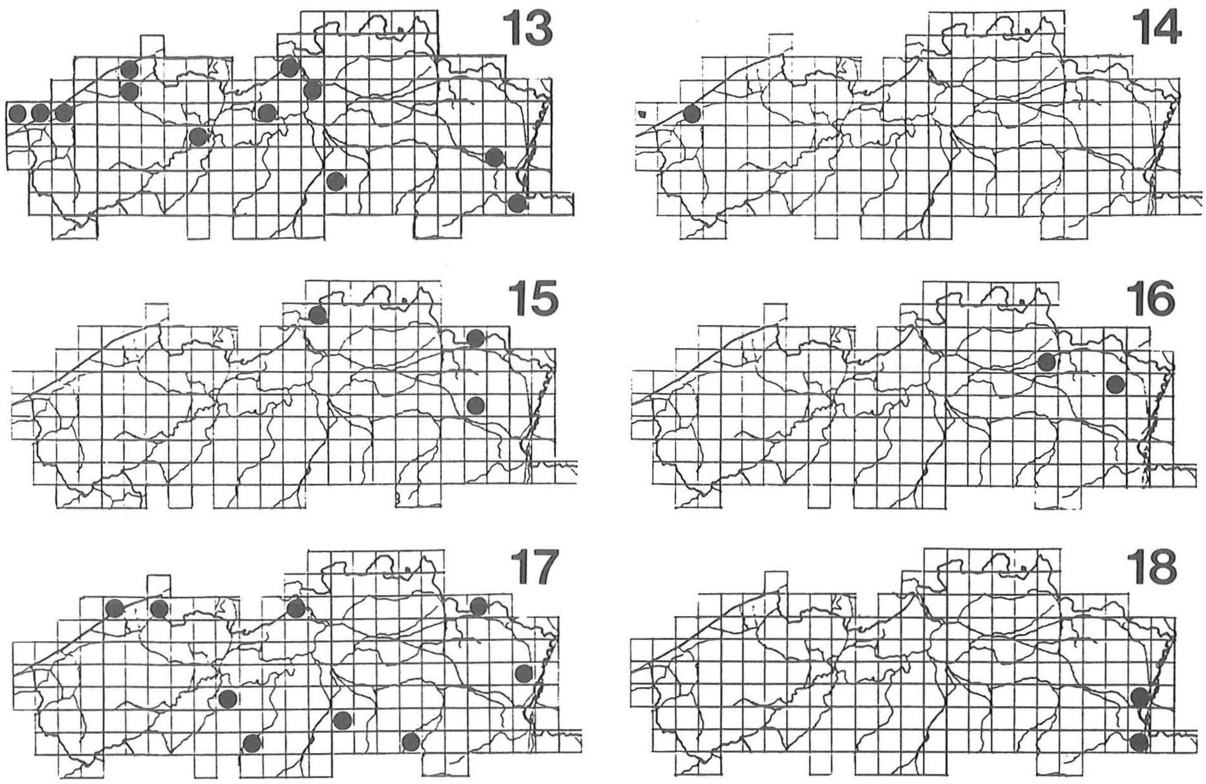

Fig. 1-18. Distribution in Flanders (UTM 10 x 10 km squares) of (1) *Alopecosa barbipes* (SUNDEVALL, 1832), (2) *Alopecosa fabrilis* (CLERCK, 1758), (3) *Arctosa leopardus* (SUNDEVALL, 1832), (4) *Arctosa perita* (LATREILLE, 1799), (5) *Hygrolycosa rubrofasciata* (OHLERT, 1865), (6) *Pardosa monticola* (CLERCK, 1758), (7) *Pardosa purbeckensis* F.O.P. CAMBRIDGE, 1895, (8) *Pardosa sphagnicola* (F. DAHL, 1908), (9) *Pirata piscatorius* (CLERCK, 1758), (10) *Pirata uliginosus* (THORELL, 1856), (11) *Pirata tenuitarsis* SIMON, 1876, (12) *Trochosa spinipalpis* (F.O.P. CAMBRIDGE, 1895), (13) *Xerolycosa miniata* (C.L. KOCH, 1834), (14) *Aulonia albimana* (WALCKENAER, 1805), (15) *Arctosa figurata* (SIMON, 1876), (16) *Pardosa agricola* (THORELL, 1856), (17) *Pardosa proxima* (C.L. KOCH, 1848), (18) *Trochosa robusta* (SIMON, 1876).

The use of invertebrate surveys as guidelines for management of wetlands in southern Belgium

by Michel BAGUETTE, Philippe GOFFART, Marc DUFRÊNE & Philippe LEBRUN

Introduction

Management of the remaining semi-natural sites like wetlands is needed, to safeguard adequate habitats for many threatened animal and vegetal species. Management guidelines are usually derived from ecological requirements of culturally well-known and attractive organisms, like birds. The time and space scales of such management plans is often too large for other organisms like invertebrates.

In this study, we have tried to design a methodology to assess priorities of guidelines management for invertebrates in five nature reserves in the Belgian Ardennes. The five reserves are wetlands : one is a lake and the other are mosaïcs of peat bogs, wet grasslands, moors and birchwoods. Some of them are crucial for the conservation of certain animal and plant species in Belgium.

Invertebrates selection

As it is impossible to deal with all invertebrates, three groups have been selected, because (1) they are complementary in habitat selection and space requirements, (2) their ecology is fairly well known, and (3) they are culturally attractive. These three groups are butterflies, dragonflies and carabid beetles.

Methodology

Several vulnerability indices have been used to compare the interest of the five reserves. These indices are either unidimensional indices, like for instance the number of UTM squares occupied by each species on a reference grid, either multidimensional indices, like a combination of species scarcity, species evenness of distribution, species abundance and species trends in population dynamics.

Two procedures of sites evaluation have been tested : (1) a synthetic approach based on the sum of the indices of the species recorded in the site and (2) a more specific approach based on the vulnerability of the different species in each site.

The conclusion is that the evaluation of the interest of a site computed by summing up the indices of the species recorded in the site must be rejected. Such indices strongly depend on the reliability of the surveys of each groups in each site. The use of such procedure in the present case would be irrelevant : careful censuses of each site were prohibited by budgetary constraints, only existing data with different sampling efforts can be used. Therefore, the basic data were very different between groups and between sites. This situation leads to an unsatisfactory ranking of the sites.

The method we develop is founded on another approach : we attach more importance to the vulnerability of the species present in each site. The indices listed above are good species vulnerability index, as well as those based on national or regional redlists. With the help of such indices, it is possible to identify vulnerable or endangered species, and to propose guidelines of management especially adapted to such species.

Priorities of management are easily detected by such a specific approach, as opposed to a global, synthetic one : the urgency of interventions required for maintaining viable populations of vulnerable or endangered species become the ultimate criterion. Moreover, with this method, biogeographical parameters like connectivity between sites or size of the sites are taken into account, because they are related to the viability of the populations of the target species.

Management guidelines derived from this method are different from one group to another, and to a lesser extent from one site to another. Nevertheless, the comparison of the measures proposed for the different groups in each of the sites show complementarities and convergences, allowing the realization of coherent global management procedures.

Evaluation of the management effects

As stressed by the Ecological Society of America in the Sustainable Biosphere Initiative (Ecology, 72: 371-412), "every management intervention is a learning opportunity if adequate baseline and follow-up are collected".

Using guidelines based on ecological requirements of vulnerable and endangered species, it is easily possible to assess the effect of management. This control is provided by monitoring the abundance of only a few target species.

Conclusions

We have to design at lower cost management guidelines of nature reserves for invertebrates. The method used is found on two main options : (1) the selection of groups of indicator species complementary in habitat selection and space requirements and (2) the proposition of concrete measures of management based on the ecological requirements of threatened species.

This method, which is certainly not the best one, is a trade-off taking into account financial constraints and the need of management guidelines adapted to both a time- and a space-scale specific to invertebrates, that is different from guidelines based on birds or vegetal species.

We hope the use of this conservation process will be useful to maintain the biodiversity of the wetlands and other semi-natural habitats.

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A state of knowledge on the distribution of Carabids in Belgium and northern France

by Konjev DESENDER, Michel BAGUETTE, Marc DUFRÊNE & Jean-Pierre MAELFAIT

Summary

A short historical overview illustrates the continuous increase in knowledge concerning the distribution of carabid beetles in Belgium. Although the cumulative number of species known from this region has not augmented much during recent decades, a lot of additional distributional as well as ecological data have been gathered recently.
Especially due to intensive pitfall trapping campaigns (year cycles), performed by our respective study groups all over our country, we have been able to add data on more than 200,000 specimens belonging to about 250 species. These data, also used in bio-monitoring studies within the framework of nature conservation, are now being incorporated into the distributional database in the context of a national project between different institutions. Within this project, financed by the National Fund for Scientific Research (Belgium), there is also a collaboration with entomologists of northern France in order to complete distributional data for that badly investigated region too. In recent years, we have also made special efforts to sample a lot of only poorly known Belgian UTM squares.
Key words : distribution, faunistics, ecology, Carabidae

Introduction

Carabid beetles, also known as ground and tiger beetles, belong to the most popular, diversified and studied insect groups, certainly in Europe, and at least in Belgium. The most recent estimates on world scale mention up to 50,000 different species which would rank carabids amongst the most diversified insect families. In Belgium, the study of these beetles started in about the middle of the 19th century and has, ever since, been continued intensively.

In this communication we will briefly : (1°) overview the history of knowledge on the distribution of carabids in Belgium, (2°) elaborate on the more recent use of these beetles in ecological research and how such data are now also incorporated in a distributional database and (3°) summarize the actual state of knowledge on the distribution of carabids in Belgium.

Results and discussion

1. Historical overview (Fig. 1)

Already in 1857, MATHIEU published the first checklist on these beetles for our country. Although it contains a lot of nomenclatorical problems, this catalogue already mentioned no less than about 80 % of the carabid fauna presently known from Belgium. Since that first catalogue, updated checklists have appeared on several occasions.

After a list had been published in 1880 by KERREMANS - a list which contained a lot of synonyms and a lot of very doubtful species names - PREUDHOMME DE BORRE published a corrected version in 1886. This list was slightly more detailed in that it also mentioned the different Belgian provinces in which every species had been found.

Due to subsequent efforts by many other well-known amateur as well as professional Belgian entomologists (like DERENNE, DE RUETTE, GUILLEAUME and FAGEL to name only a few) the next updated catalogue was published by the late DERENNE in 1957. He mentioned 399 species, corresponding to about 370 of the actually accepted species.

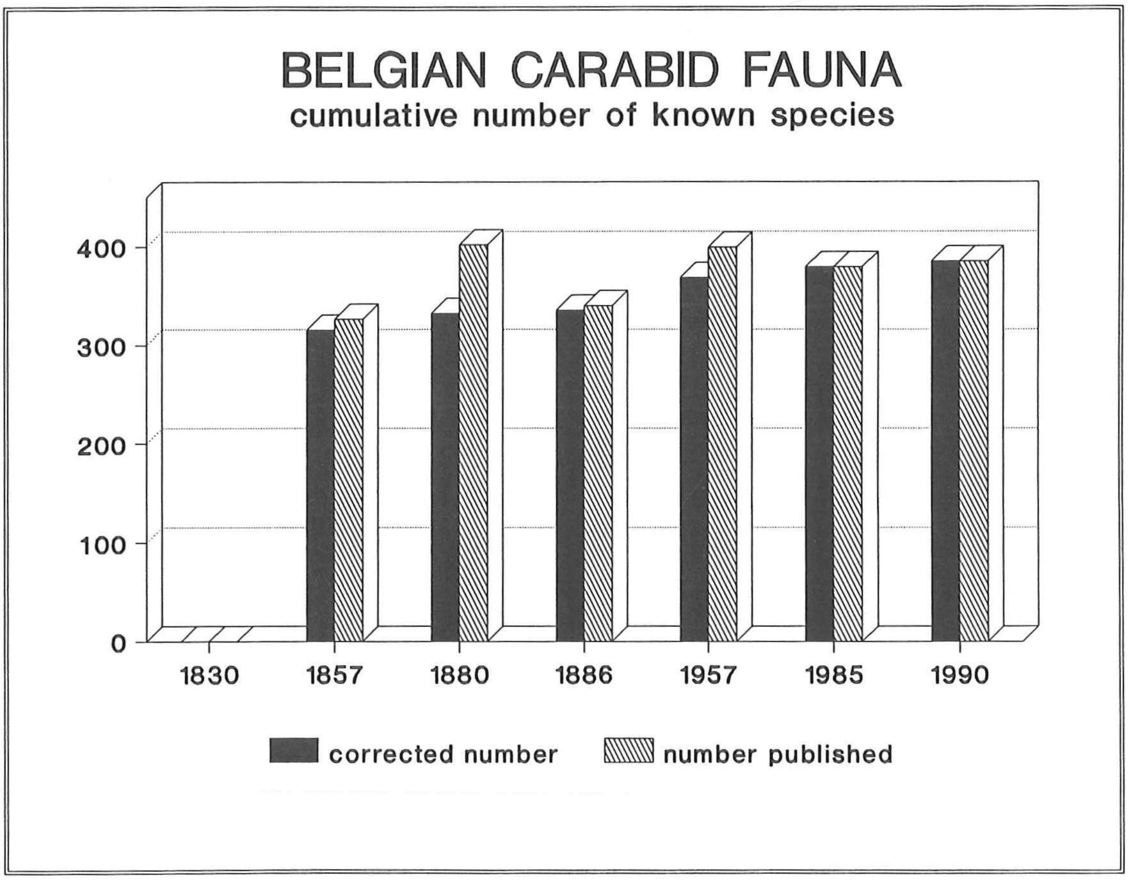

Fig. 1. Historical overview of the knowledge on the Belgian carabid fauna (number published and our correction) summarized from different checklists (see text for further explanation).

More recently, several changes have been made to the preferred nomenclature and especially to the currently used systematic classification of carabid beetles. In the seventies, some excellent identification handbooks and revisions were also published, f.e. by FREUDE *et al.* (1976) and by the late LINDROTH (1974).

In 1979, the first author started to study the Belgian carabid fauna. The approach of our studies was first ecological but gradually also included systematics and faunistics. While using these beetles in fundamental and more applied ecological and site-assessment studies, we also started a revision of all available specimens from museum as well as private collections and gathered data from nearly half a million specimens. Soon it became clear that several modifications were necessary to the 1957 catalogue of DERENNE : some species were not in his list (genuine new species for Belgium) or only recently accepted as such (f.e. some sibling species), other species had been recently synonimized or redefined in a systematic revision, while still other species of DERENNE's list were not accepted as belonging to our fauna due to the lack of reference specimens.

Our first contribution was an updated checklist, which appeared in 1985 (DESENDER, 1985). It was a revised list mentioning 379 species, with comments on those doubtfully established in Belgium and on species raising identification problems.

This checklist in turn formed the basis of a series of contributions on the detailed distribution and ecology of the Belgian carabid beetles, publications which appeared in 1986 (DESENDER, 1986a-d). For every species raw distribution data were first grouped per locality and per year, reducing the number of records, known to us at that time, to about 60,000. These records were grouped once again per UTM-10 km square and in two periods (before and/or since 1950) and these data were finally mapped. So, at the end, we obtained atlases in which all known distribution data of the entire Belgian carabid fauna were summarized on a UTM-10 km grid scale. In these, we also presented a compilation of our knowledge on the different species : for each carabid species we tabulated data and analysis results concerning many aspects of biology, ecology an distribution, f.e. number of UTM squares, number of records, temporal analysis results whether the species is recently statistically significantly decreasing or not, total distribution area, beetle size, wing developmental type, reproductive period, habitat preference codes, as well as statistical results of distribution analyses (f.e. reaction to altitude, soil type, woodland cover and type, annual precipitation, relative aridity, temperature ranges and so on).

Since 1985 we have added 6 more carabid species to the checklist of the Belgian fauna : 3 species confirmed older doubtful data, 3 others concerned sibling species only recently recognized as such (DESENDER, 1987, 1990).

This short historical overview illustrates the continuous increase in knowledge concerning the distribution of carabid beetles in Belgium. The cumulative number of species known has not augmented much during the last decades, and it is unlikely that many species will have to be added in the future. As already mentioned above, the accent has shifted more recently to the use of these beetles in quantitative ecological studies.

2. The use of carabids in ecological studies and the incorporation of such data in a distributional database

The Carabidae are an extremely speciose beetle family. They are nevertheless mostly characterized by a relatively simple body shape, while macromorphological adaptations would have occurred to a relatively small degree during their evolutionary history. Despite this seeming constraint they have radiated into nearly every terrestrial biotope. The high degree of habitat or even microhabitat preference, as exhibited by a lot of species, would mainly have evolved through ecophysiological adaptations. Microclimatological and edaphic factors would function as the main cues in their habitat preference. It is this high degree of habitat preference, the high species-diversity of ground beetles as well as their occurrence in nearly every terrestrial biotope, which make carabids so useful in ecological and bio-monitoring studies.

We started such studies in Belgium during the 70's, within the pedobiological section of the Laboratory of Animal Ecology at the State University of Ghent. Later, similar studies and sampling campaigns were started in other institutions too. These intensive pitfall trapping campaigns (year cycles), performed all over the country (as illustrated on a map, Fig. 2) yielded data on more than 200,000 carabids belonging to about 250 species and have been already analyzed and used in many different ways. The most important of these topics are summarized as follows : our studies range from *ecology and biology* (with population and reproductive biology, activity cycles, dynamics, f.e. in some long-term studies, dispersal power, habitat preference, community structure and so on), to the use of carabids in *nature conservation* (species diversity studies, bio-indicators in monitoring, site assessment and management studies) and to *biogeography* (faunistics, distribution patterns and other cartographic analyses, temporal evolution analyses). These pitfall trapping data are indeed now also being incorporated into the distributional database within the context of a national project between different institutions. Within this project, financed by the National Fund for Scientific Research (Belgium), there is also a collaboration with entomologists of northern France in order to complete distributional data for this badly investigated region as well. In recent years, we have also made special efforts to sample a lot of poorly known Belgian UTM squares.

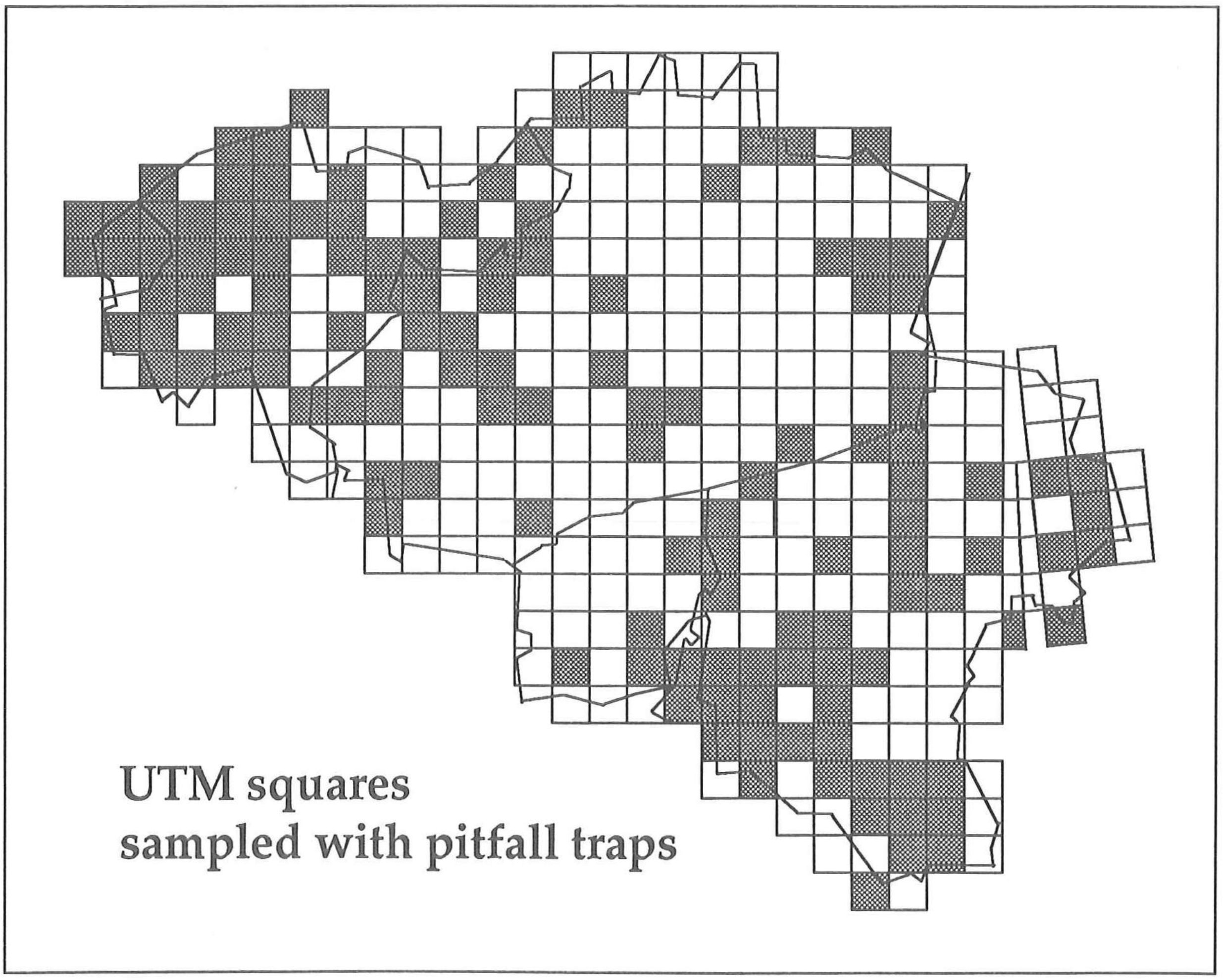

Fig. 2. UTM squares sampled by means of pitfall trap year cycles in Belgium (I.N., Hasselt; K.B.I.N., Brussel; R.U.G., Gent; U.C.L., Louvain-la-Neuve).

These efforts already yielded a lot of new distributional data, as can be deduced from Fig. 3, which presents the number of carabid species that were added per UTM square since the publications in 1986 (DESENDER, 1986a-d) and within the context of our interinstitutional project.

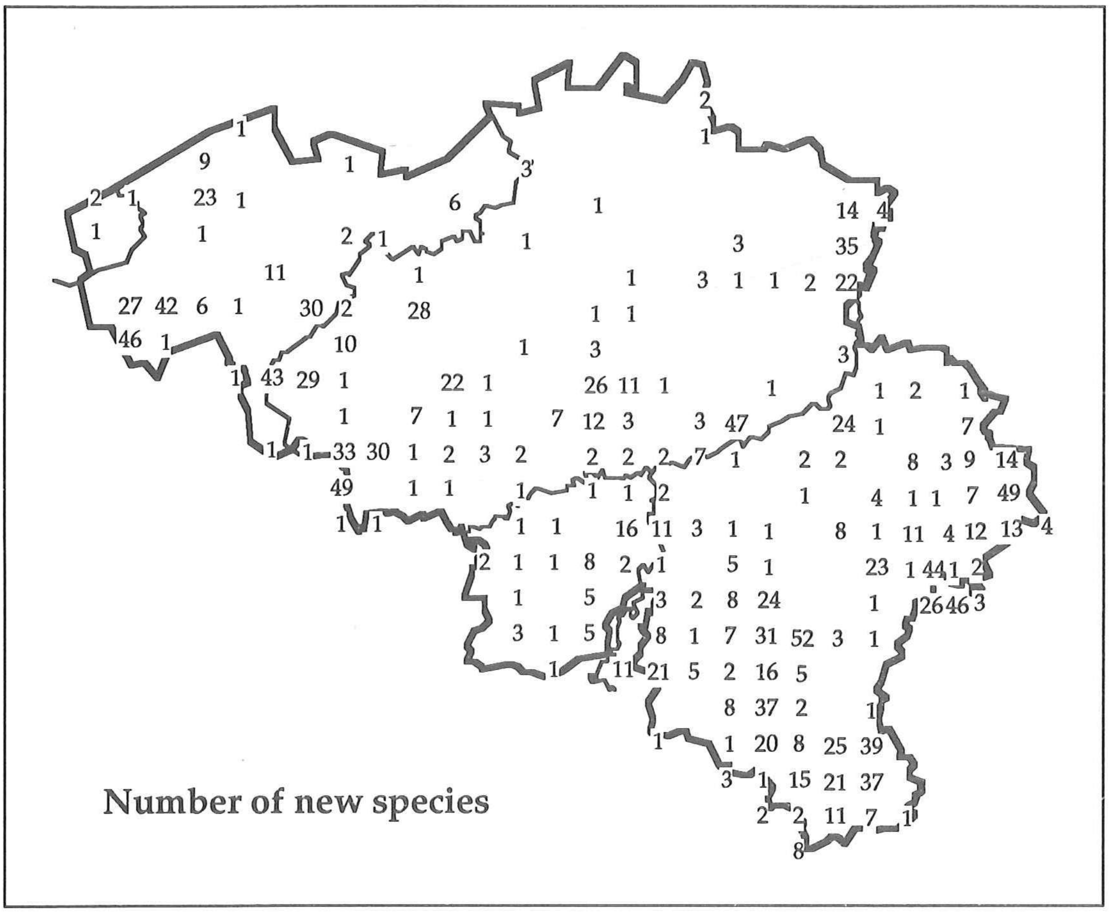

Fig. 3. Number of carabid species added per UTM square since DESENDER (1986a-d) within the context of an interinstitutional project.

3. Conclusion : actual state of knowledge on the distribution of the Belgian carabid fauna

To conclude we present a summary of the number of carabid species per UTM square actually known to us (Fig. 4). On average nearly 70 species are reported per UTM square. Note the regions which are still probably not well sampled, especially in the western and southern part of Limburg. These regions are presently being sampled by means of pitfall traps.

Although we are convinced that new studies, especially on monitoring, will always be necessary, we think it is not exaggerated to say that the study of carabids in Belgium has reached an advanced stage, thanks also to our predecessors and to the work of so many interested people. It is our hope to complete this continuously growing database within a couple of years, in order to provide us with a firm basis for future studies on biogeography, ecology and biology of carabid beetles as well as for bio-indicator or site-assessment studies within the framework of nature conservation. Our main goal at the moment is to compile all the available information and to computerize all distribution data.

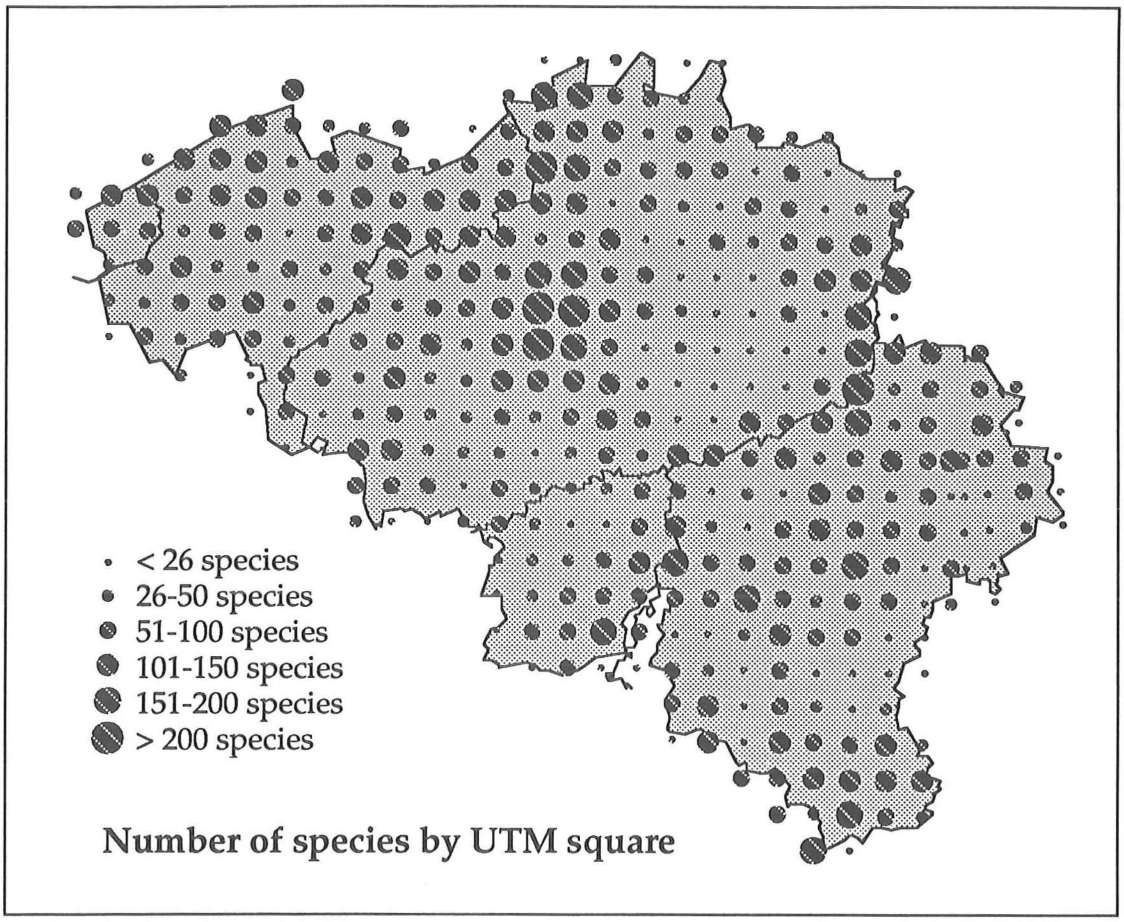

Fig. 4. Number of carabid species actually known from each UTM square in Belgium.

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Inventaire des Coléoptères Elatérides de la "Petite Suisse Luxembourgeoise" (Grand-Duché de Luxembourg) et particularités biogéographiques et écologiques de ce site

par Charles JEUNIAUX

Résumé

La faune des Coléoptères Elatérides de la "Petite Suisse Luxembourgeoise", partie orientale du Gutland luxembourgeois comprise dans la boucle de la Sûre en amont d'Echternach, comprend 38 espèces.
A côté d'espèces typiquement sylvicoles, cette faune se caractérise par la présence de nombreuses espèces psammophiles, dont certaines à distribution atlantique en Europe occidentale, ce qui contraste avec la faune du reste du pays, notamment de l'Oestling, et des massifs de l'Ardenne et de l'Eifel.
Mots clés: Coléoptères, Elateridae, Grand-Duché de Luxembourg, biogéographie.

Summary

Thirty-eight click-beetle species (Coleoptera Elateridae) have been observed in the "Petite Suisse Luxembourgeoise", oriental area of the Gutland enclosed in the main loop of the Sûre River above Echternach.
Besides typically sylvicolous species, this fauna is original by the presence of several psammophilous species, some of which showing however atlantic distribution in Western Europe. These faunistic characteristics stand in contrast with those of neighbouring areas, namely Oestling in Luxemburg, Ardenne in Belgium, and Eifel in Germany.
Key-words: Coleoptera, Elateridae, Grand-Duchy of Luxemburg, biogeography.

Introduction

La partie orientale du Gutland luxembourgeois, comprise dans la boucle de la Sûre en amont et à l'ouest de la ville d'Echternach, est connue sous le nom de "Moellerdall" (ou "Müllerthal") ou de "Petite Suisse Luxembourgeoise". Elle est localisée entre l'Eifel allemand et l'Ardenne belge, et fait partie du Parc Naturel Régional germano-luxembourgeois. Cette région jouit d'une grande réputation touristique, due à son relief tourmenté très particulier : la Sûre et ses affluents ont en effet creusé profondément le sous-bassement rocheux, fait de "grès de Luxembourg" (SCHMIT & WIESE, 1981), et ont découpé les escarpements rocheux en formes pittoresques. Si les plateaux au sol argileux sont généralement cultivés ou livrés à la pature, les vallées sont occupées par d'épaisses forêts, dont la plupart ont gardé le caractère primitif de hêtraie ("hêtraie du Grès de Luxembourg", MASSARD & GEIMER, 1983). Le sol de ces vallées boisées est formé d'un sable alluvionnaire, résultat de l'érosion des grès de Luxembourg.

Au point de vue biogéographique, la "Petite Suisse Luxembourgeoise" s'étend approximativement sur les carrés n° LA01, LA02, LA11 et LA12 du quadrillage UTM. J'ai analysé la faune des Coléoptères Elatérides de cette région sur base de récoltes et d'observations personnelles réalisées de 1957 à 1990, complétant les données publiées antérieurement (JEUNIAUX, 1957) et celles compilées et cartographiées par MOUSSET (1979). La plupart de ces données ont également été intégrées dans l'atlas des Insectes de Belgique et des régions limitrophes, partie "Elateridae" (JEUNIAUX & de BELLEFROID, 1989; JEUNIAUX, 1990, 1991).

L'objet de cette note est de proposer une synthèse de nos connaissances sur la faune des Elatérides de cette région et d'en dégager certaines particularités biogéographiques et écologiques.

Espèces de milieux cultivés ou sububiquistes en Europe occidentale

Dans la "Petite Suisse Luxembourgeoise", ces espèces sont fréquentes dans tous les milieux de culture et de prairies, milieux ouverts relativement exposés que l'on trouve surtout sur les plateaux à sol argileux.

- *Adelocera murina* (LINNAEUS), dans les jardins et les champs cultivés
- *Cidnopus pilosus* (LESKE), dans les champs cultivés, mais aussi occasionnellement en sous-bois
- *Cidnopus minutus* (LINNAEUS), même observation que pour *C. pilosus*
- *Athous niger* (LINNAEUS), fréquent en bordure de champs cultivés, sur les chaumes de graminées
- *Selatosomus latus* (FABRICIUS)
- *Agriotes lineatus* (LINNAEUS), relativement peu fréquent
- *Agriotes obscurus* (LINNAEUS), en bordure des champs cultivés, mais aussi en sous-bois de feuillus, hêtraies ou chênaies. Fréquent.
- *Agriotes pilosellus* (SCHÖNHERR)
- *Agriotes sputator* (LINNAEUS), en bordure de champs et à la lisière des bosquets.

Espèces à tendances sylvicoles, ubiquistes ou sububiquistes en Europe occidentale

Dans la "Petite Suisse Luxembourgeoise", ces espèces fréquentent les forêts de haute fûtaie, principalement des hêtraies, occupant tous les flancs et les fonds des vallons.

- *Ampedus pomorum* (HERBST), se trouve surtout dans les vergers
- *Melanotus castanipes* (PAYKULL), une seule capture, à Berdorf, 20 mai 1966
- *Melanotus rufipes* (HERBST), une seule capture, à Berdorf, 4 avril 1967
- *Athous haemorrhoòdalis* (FABRICIUS), très commun dans tous les biotopes boisés
- *Athous vittatus* (FABRICIUS), très commun dans les sous-bois
- *Athous subfuscus* (MÜLLER), très commun dans tous les biotopes boisés, en sous-bois comme en lisière ou en clairière
- *Dalopius marginatus* (LINNAEUS), très abondant dans les sous-bois humides
- *Agriotes (Ectinus) aterrimus* (LINNAEUS), espèce à tendance psammophile, fréquente dans les milieux boisés sur sols sablonneux
- *Agriotes acuminatus* (STEPHENS), capturé à plusieurs reprises dans les sous-bois humides, sur sols sablonneux
- *Agriotes pallidulus* (ILLIGER), espèce très abondante sur les plantes basses des sous-bois humides, notamment au bord des ruisseaux
- *Denticollis linearis* (LINNAEUS), fréquent dans tous les milieux boisés.

Espèces sylvicoles strictes

Ampedus cinnabarinus (ESCHSCHOLTZ) est une espèce sylvicole, inféodée au terreau des vieux arbres morts ou malades, relativement rare en Belgique, sauf au sud de l'Ardenne et en Gaume (JEUNIAUX, 1990). Elle a été trouvée à deux reprises à Berdorf, le 19 mai 1966 et le 14 juin 1987.

Ampedus sanguineus (LINNAEUS) est une espèce inféodée aux conifères. Je l'ai trouvée à Berdorf dans des souches de pin sylvestre.

Selatosomus (Calambus) bipustulatus (LINNAEUS), cité par MOUSSET (1979) de la région de Beaufort, est une espèce typique des forêts de feuillus.

Espèces tyrphophiles et psammophiles

Deux espèces, assez largement répandues en Europe occidentale, mais principalement dans des biotopes sablonneux humides, peuvent être trouvées occasionnellement dans les milieux sablonneux des fonds de vallées de la Müllerthal :

- *Selatosomus nigricornis* (PANZER)
- *Sericus brunneus* (LINNAEUS).

Espèces à distribution à tendance atlantique en Europe occidentale

Cinq espèces sont particulièrement intéressantes, car elles présentent une distribution à tendance atlantique. Sur le territoire de la Belgique, elles sont surtout répandues au nord du Sillon Sambre-Meuse. Leur présence au sud de ce sillon est beaucoup plus exceptionnelle, et liée à l'existence de milieux humides à forte charge en silice, notamment dans certains sites isolés des Hautes Fagnes. Le maintien de petites populations isolées de ces espèces dans la "Petite Suisse Luxembourgeoise" s'explique par la présence de milieux sablonneux humides dans les fonds de vallées. Il s'agit des espèces suivantes :

- *Negastrius pulchellus* (LINNAEUS). Trouvé à Beaufort, le 2 juin 1957; c'est une espèce typiquement psammophile, dont la présence au sud du Sillon Sambre-Meuse est exceptionnelle (JEUNIAUX, 1990)
- *Cardiophorus asellus* ERICHSON. Espèce pasmmophile, capturée à Rodenhof, près d'Echternach (Collection VAN VOLXEM, à l'Institut royal des Sciences naturelles de Belgique), et que j'ai retrouvée à Consdorf, le 7 mai 1967. En Belgique, on ne la trouve, au sud du Sillon Sambre-Meuse, que dans les Hautes Fagnes et en Gaume (JEUNIAUX, 1990).
- *Dicronychus cinereus* (HERBST) est signalé de la "Petite Suisse Luxembourgeoise" par MOUSSET (1979); l'espèce habite surtout les forêts de conifères sur sols sablonneux.
- *Dicronychus equiseti* (HERBST), également signalé de la région de Berdorf par MOUSSET (1979). C'est une espèce psammophile.
- *Cidnopus aeruginosus* (OLIVIER). C'est une espèce de dunes et de landes sur sols sablonneux, abondante en Belgique au nord du Sillon Sambre-Meuse, mais qu'on ne trouve, au sud de ce sillon, qu'en Hautes Fagnes et en Gaume (JEUNIAUX, 1990). Elle

n'est pas rare dans le Grand-Duché de Luxembourg, sur terrains jurassiques, notamment dans les fonds de vallées à sol sablonneux humide de la région de Consdorf.

Espèces à tendances montagnardes d'Europe centrale

Quatre espèces sylvicoles sont vraisemblablement originaires d'Europe centrale, car leur distribution en Belgique ne s'étend pas (ou peu) au nord du Sillon Sambre-Meuse. Il s'agit des espèces suivantes :

- *Limonius aeneoniger* (DE GEER), qui n'est pas rare dans les sous-bois humides.
- *Ctenicera pectinicornis* (LINNAEUS), très peu fréquent dans la "Petite Suisse Luxembourgeoise", malgré son caractère sylvicole bien accusé.
- *Anostirus purpureus* (PODA), espèce sylvicole à tendances psammophiles, se trouve de manière très localisée dans deux vallées boisées sur sol sablonneux à Consdorf.
- *Denticollis rubens* PILLER et MITTERPACHER. Cette dernière espèce mérite un intérêt particulier. C'est une espèce sylvicole et montagnarde d'origine orientale, dont la "Petite Suisse Luxembourgeoise" semble constituer, avec la Lorraine belge, la limite occidentale de son expansion biogéographique vers l'ouest et le nord-ouest. Cette espèce, d'habitude rare dans nos contrées, semble former des populations stables et relativement denses dans les hêtraies de plusieurs vallées encaissées et humides de la "Petite Suisse", où je l'ai capturée à plusieurs reprises depuis 1966, à Berdorf, Consdorf et Scheidgen.

Autres espèces

- *Agriotes gallicus* BOISDUVAL et LACORDAIRE, a été signalé par MOUSSET (1979) dans la région d'Echternach. C'est une espèce méridionale, à tendance xérophile, que je n'ai jamais observé moi-même.
- *Actenicerus sjaelandicus* (MÜLLER) : c'est une espèce fréquente dans les marais, fagnes et sous-bois humides d'Europe occidentale, qui a été observée occasionnellement dans la "Petite Suisse Luxembourgeoise" d'après MOUSSET (1979).
- *Adrastus pallens* (FABRICIUS), signalé par MOUSSET (1979).
- *Adrastus rachifer* FOURCROY, signalé par MOUSSET (1979).

Conclusion

La faune des Elatérides de la "Petite Suisse Luxembourgeoise" comprend 38 espèces, dont une vingtaine sont sububiquistes en Europe occidentale et dont la plupart sont inféodées aux biotopes forestiers et forment des populations denses dans les hêtraies des vallées humides. Quelques autres espèces, comme *Limonius aeneoniger*, sont typiques des régions boisées à climat continental situées au sud du Sillon Sambre-Meuse en Belgique.

Cette faune comprend également des éléments plus originaux, dont la distribution géographique est du type atlantique, et qu'on ne trouve habituellement pas au sud du Sillon Sambre-Meuse, sauf parfois de manière discontinue. Il s'agit notamment de *Negastrius pulchellus, Cardiophorus asellus, Dicronychus cinereus, Dicronychus equiseti, Cidnopus aeruginosus*. La présence de ces

espèces dans cette région peut s'expliquer par l'existence de biotopes sablonneux humides dans les vallées encaissées des affluents de la Sûre, favorables à l'installation d'espèces à caractère psammophile et hygrophile. L'abondance de biotopes forestiers sur sols sablonneux explique également la présence d'espèces comme *Agriotes (Ectinus) aterrimus* et *Anostirus purpureus*. Enfin, l'espèce centre-européenne *Denticollis rubens* trouve ici et dans la Gaume belge la limite nord-ouest de son expansion.
Par la présence de ces éléments psammophiles, dont certains sont d'origine atlantique, la faune des Elatérides de la "Petite Suisse Luxembourgeoise" contraste avec celle du reste du pays, notamment de l'Oestling et des massifs de l'Ardenne et de l'Eifel qui l'entourent.

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The Flemish legislation on the protection of Coleoptera in the European perspective

by Jean-Pierre MAELFAIT, Georges COULON & Konjev DESENDER

Abstract

The Flemish legislation on the protection of invertebrates is out of date and should be adapted. This can be shown by considering the beetles that are protected by law. An alternative approach (i.e. the protection of ecological indicator species) is proposed.
Key-words: nature conservation, species protection, Flemish legislation, Coleoptera.

Introduction

In our opinion a well constructed and good functioning legislation giving protection to insects can be a powerful tool for nature conservation. A comparison of the existing Flemish legislation on insect protection with recent European developments within that context (for instance the inclusion of 51 species of insects in appendix 2 of the Convention on the Conservation of European Wildlife and Natural Habitats, known as the Bern Convention) shows that the Flemish legislation will have to be adapted.

This is why we discuss the current Flemish legislation, show its shortcomings and propose an alternative approach. The goal would be a law on insect protection that is not merely defensive (habitat protection and acquisition) but also provides possibilities for funding of:

- habitat management in order to maintain or obtain the proper habitat requirements,
- conservation agreements between landowners and conservation agencies,
- research on the ecology of endangered and threatened species.

The Decree of 22.09.1980 and beetle protection

The shortcomings of the Decree of 22.09.1980 and its being out of date can easily be illustrated by considering the beetles protected according to that law. These are:

- all *Calosoma* and *Carabus* species as ground beetles (Carabidae),
- all tiger beetles (Cicindelidae),
- *Cerambyx scopolii* and *Prionus coriarius* as longhorns (Cerambycidae),
- *Cetonia aurata, Cetonia (Potosia) cuprea, Osmoderma eremita* and *Oxythyrea funesta* (Cetoniinae),
- *Odontaeus armiger* and *Typhaeus typhoeus* (Geotrupinae),
- the Stag Beetle (*Lucanus cervus*, Lucanidae),
- *Polyphylla fullo* (Melolonthinae),
- all *Donacia* and *Plateumaris* species (Chrysomelidae),
- all ladybirds (Coccinellidae),
- all *Cybister* and *Dytiscus* species (Dytiscidae) and the Great Silver Beetle (*Hydrous* or *Hydrophilus piceus*, Hydrophilidae) as water beetles.

It is immediately clear that this list is very heterogeneous and does not fulfil the requirements of a modern legislation on species protection; especially because the list contains higher taxa and consequently a lot of species which are not threatened at all. There are also several species for which the status is badly known. Mostly, large and spectacular species are represented.

Carabus species of Flanders

The limited applicability of the law can be further illustrated by considering the Flemish species of the genus *Carabus*.

There are fourteen species of *Carabus* which have been found in Flanders. These are: *Carabus arvensis, C. auratus, C. auronitens, C. cancellatus, C. clathratus, C. convexus, C. coriaceus, C. granulatus, C. intricatus, C. monilis, C. nemoralis, C. nitens, C. problematicus* and *C. violaceus*. Based on the maps of DESENDER (1986a) the status of these insects in Flanders can be characterized as follows.

Carabus arvensis (Fig. 1) is a species living in dry habitats which are not too shady like dry heathland and dry open forests. It is declining in its occurrence and has become really rare with very few localized populations. It is endangered.

Carabus auratus (Fig. 2) is a species of open ground that can also occur on agricultural land. It decreased during recent decades. It is threatened or vulnerable.

Carabus auronitens (Fig. 3) is a woodland species with a Mideuropean distribution pattern. In Flanders it is known to occur only in a few well established populations like the ones of the Zoniën forest near Brussels. It is a rare and endangered species.

Carabus cancellatus (Fig. 4) is a carabid beetle which was not rare on arable land before 1950. During recent decades however it has been only rarely encountered. It is threatened.

Carabus clathratus (Fig. 5) is a hygrophilous species bound to oligotrophic riparian habitats. This species decreased drastically and by now, is only known to occur in a few remaining populations. It is very rare and therefore endangered.

Carabus convexus (Fig. 6) is a species mainly found on chalk grassland. It has not been recorded after 1950.

Carabus coriaceus (Fig. 7) was - before 1950 - often found in open woodland and on agricultural land. During recent decades it has become quite rare. It does not seem to be really endangered but is vulnerable.

Carabus granulatus (Fig. 8) is a eurotopic species of wet habitats which may vary from meadows with some hedgerows to wet open forests. It is still widely distributed and not really threatened.

Carabus intricatus (Fig. 9) can occur in moist woodlands with a well developed litter layer. It was - before 1950 - found in a few forests. No more recent records of that species in Flanders are known to us.

Carabus monilis (Fig. 10) and *Carabus nemoralis* (Fig. 11) are both quite eurotopic species which have not declined during recent decades. No special protection seems to be needed.

Carabus nitens (Fig. 12) is a species of particular heathland habitats, both wet and dry. It is an endangered species because of the drastic decrease of its habitat.

Carabus problematicus (Fig. 13) and *Carabus violaceus* (Fig. 14) are widely distributed and neither they nor their habitats are generally threatened.

Considering those fourteen species we can conclude (Tab. 1) that two are probably extinct, four are endangered, three are vulnerable and five are not threatened or not yet threatened.

Table 1. Red list of the *Carabus* species in Flanders.

	Extinct	Endangered	Threatened	Not threatened
C. arvensis		+		
C. auratus			+	
C. auronitens		+		
C. cancellatus			+	
C. clathratus		+		
C. convexus	+			
C. coriaceus			+	
C. granulatus				+
C. intricatus	+			
C. monilis				+
C. nemoralis				+
C. problematicus				+
C. violaceus				+
C. nitens		+		

An alternative approach

Instead of protecting all of the *Carabus* species in an unspecified way, we think it would be much better that:

- a site supporting a population of one or several of these threatened species should be regarded as a site to be included on a list of sites recommended for protection,
- a site supporting a population of at least one endangered species should be recognized as a priority site for protection.

A lot of other beetle and other invertebrate species (other carabid beetles) should be added to such a list in order to cover all the threatened habitat types within the region. Hereafter, we give some examples, based on DESENDER (1986b) :

- *Bembidion lunatum* (Fig. 15) can only be found, in our region, on not too brackish mud flats along the banks of tidal rivers;
- *Bembidion nigricorne* (Fig. 16) only occurs on the open dry sandy soil between young *Calluna* heathland;
- *Bembidion normannum* (Fig. 17) can only be found in saltmarshes.

We deliberately give these examples of small carabid species because we think that not only spectacular or especially beautiful species should be protected. Other species which are good indicators for threatened particular environmental conditions should also be considered as candidates for listing. There is indeed a serious danger linked to the inclusion of large and attractive invertebrates to lists of species to be protected. By including them, their commercial value often increases and they may even become more endangered. This is not the case for less spectacular species. The last strategy will however require qualified specialists to identify these animals. At first sight this may seem to be a drawback, because for an effective species and habitat protection it is not sufficient to have persons being able to recognize or to identify a protected species. Specialists are needed who can recommend measures to be taken to again obtain well thriving populations of threatened or endangered species. So specialists are needed anyhow. A corollary of this is that groups of indicator species to be protected in any given region will depend on the specialists available. It also implies that agencies responsible for nature conservation not only have to make sure that endangered and threatened species are preserved but also will have to support the specialists knowing and studying the ecology of these species.

Acknowledgements

The authors are much indebted to D. PAELINCKX (Instituut voor Natuurbehoud) for his help in preparing the map of Flanders and M. BRUYNEEL for the photographs. We acknowledge the Belgian National Fund for Scientific Research (NFWO) for financial support of our recent studies (FJBR-projects 2.9008.89 and 2.9014.91).

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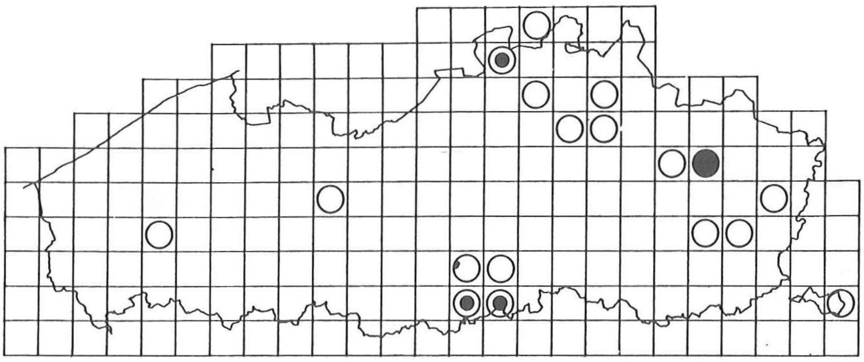


Fig. 1. *Carabus arvensis*.

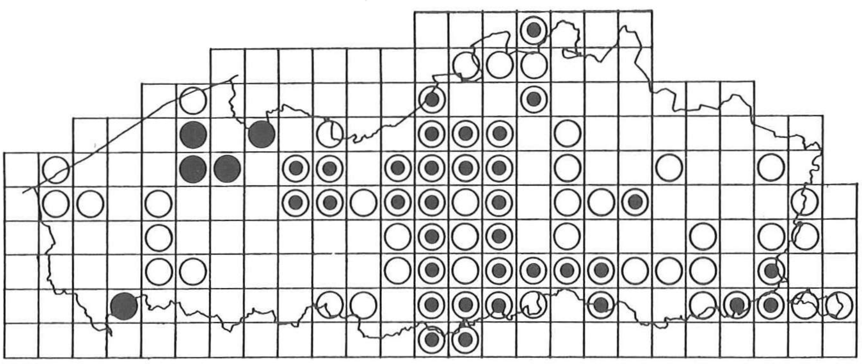
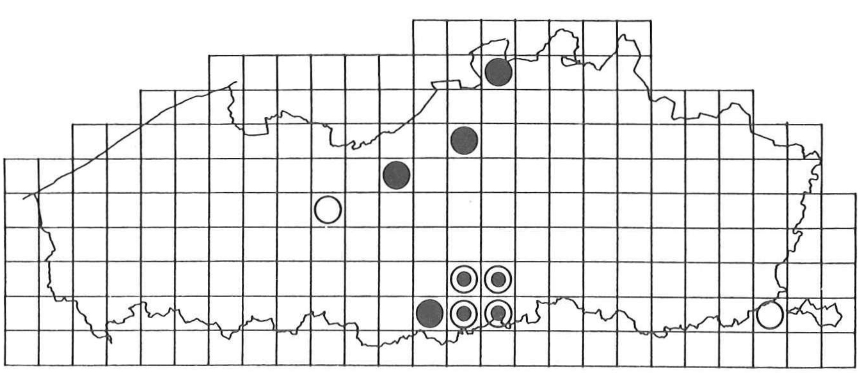


Fig. 2. *Carabus auratus*.



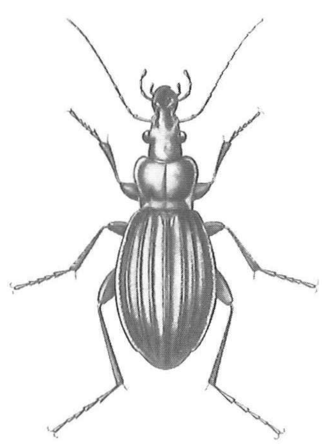


Fig. 3. *Carabus auronitens*.

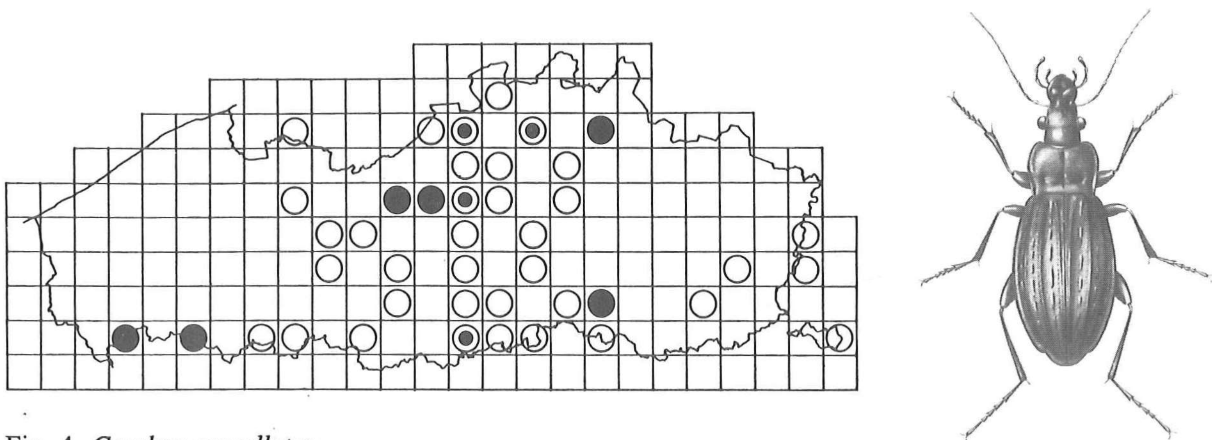


Fig. 4. *Carabus cancellatus.*

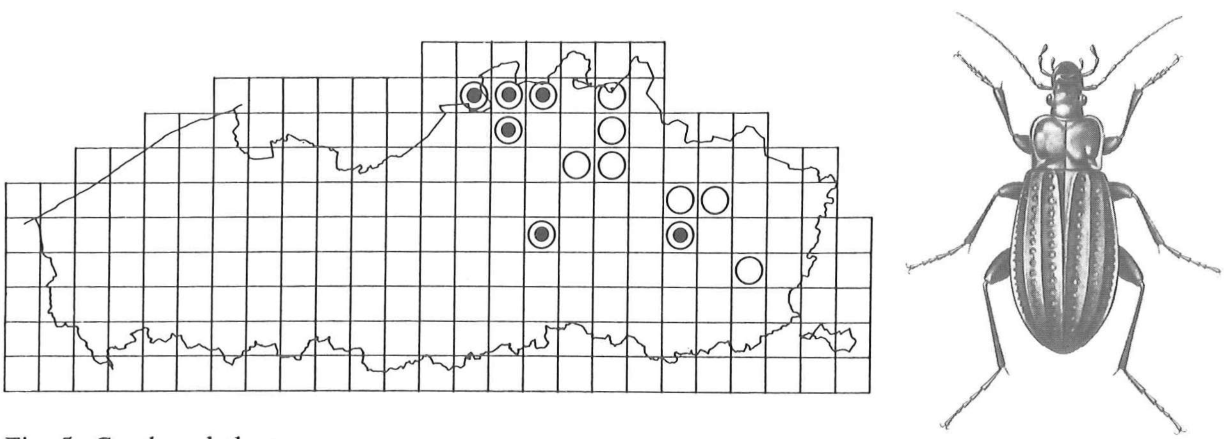


Fig. 5. *Carabus clathratus.*

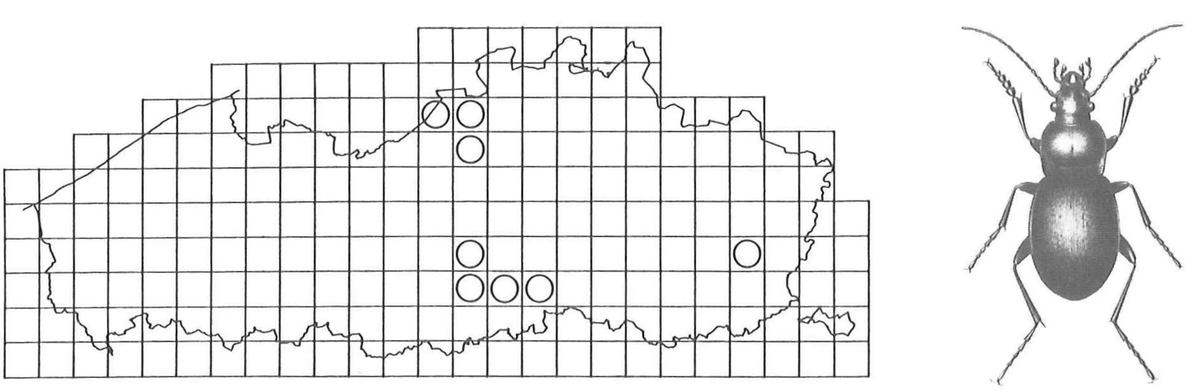


Fig. 6. *Carabus convexus.*

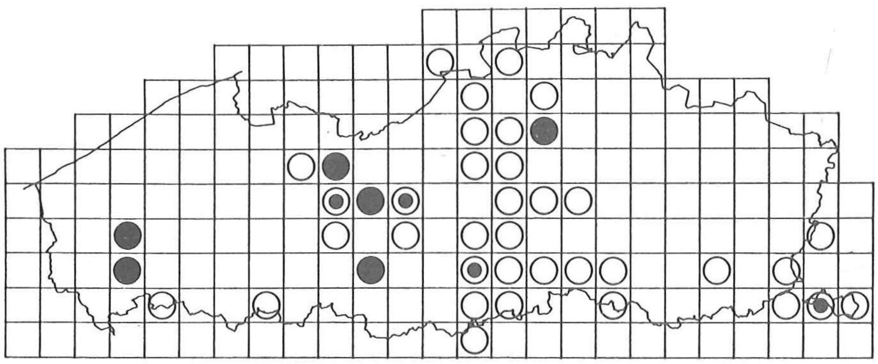
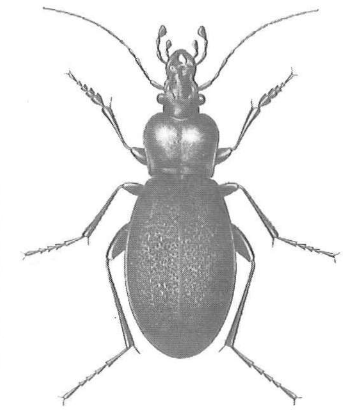



Fig. 7. *Carabus coriaceus.*

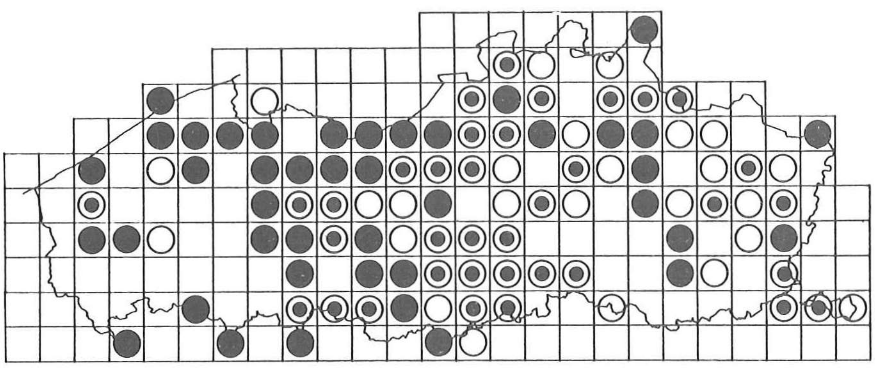


Fig. 8. *Carabus granulatus.*

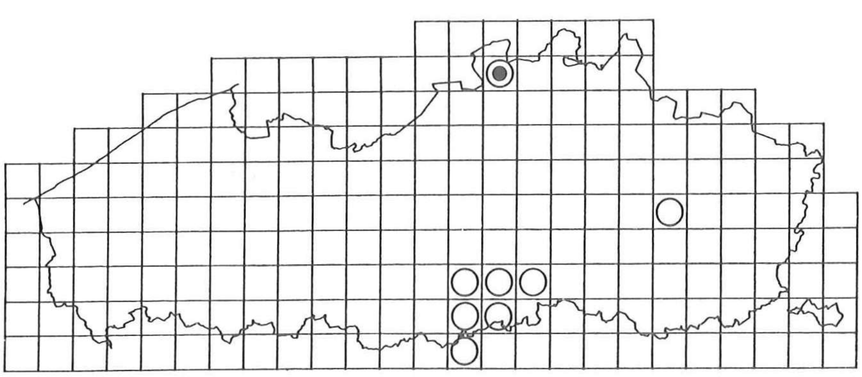
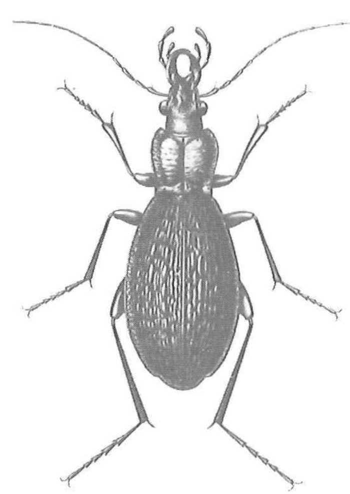



Fig. 9. *Carabus intricatus.*

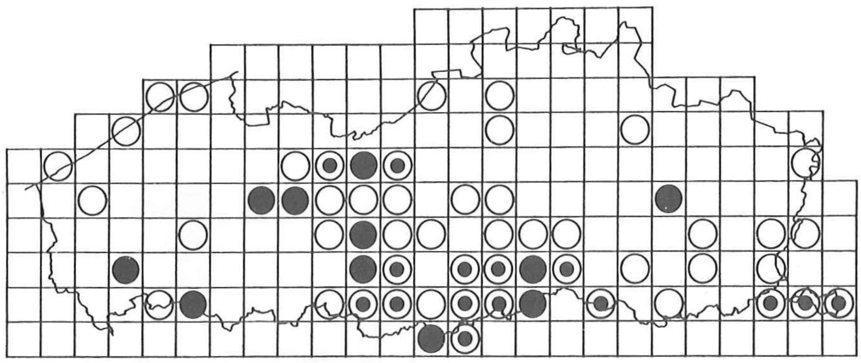


Fig. 10. *Carabus monilis.*

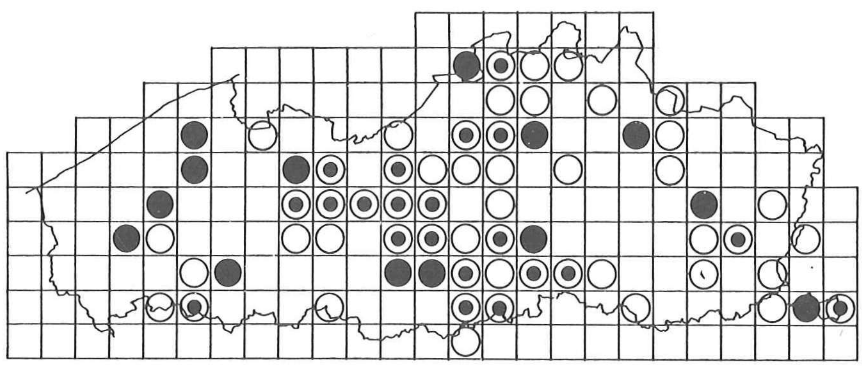


Fig. 11. *Carabus nemoralis.*

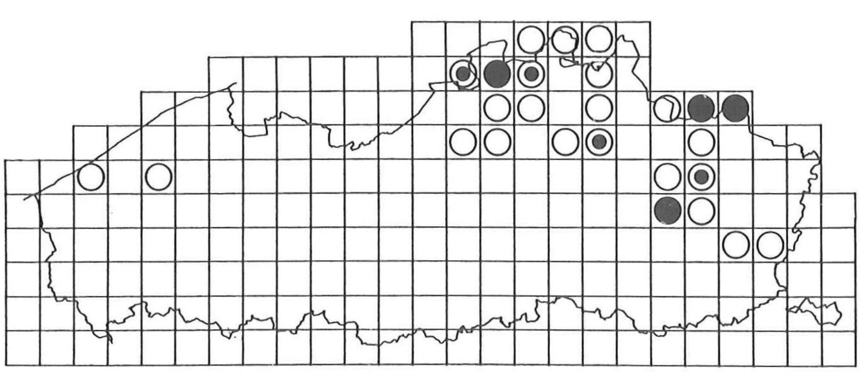


Fig. 12. *Carabus nitens.*

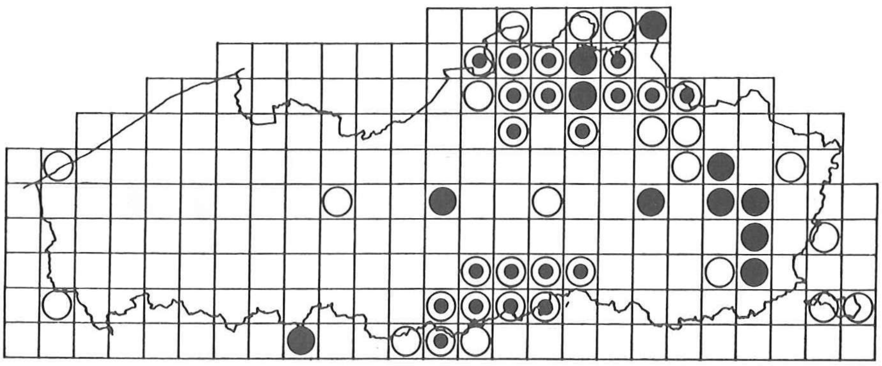
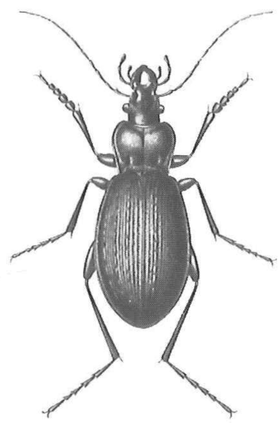



Fig. 13. *Carabus problematicus*.

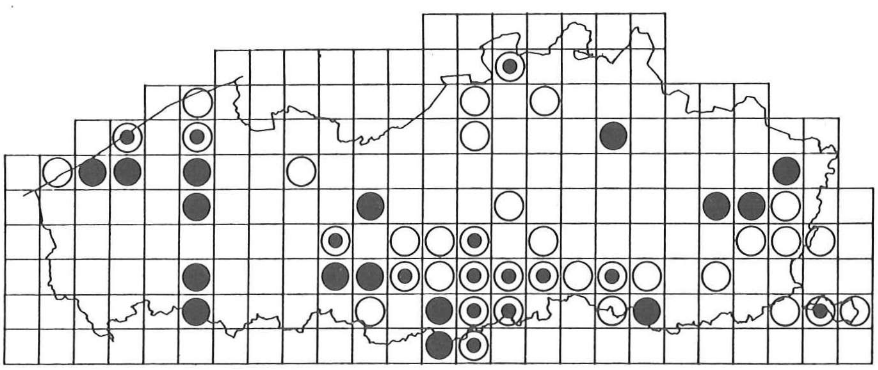
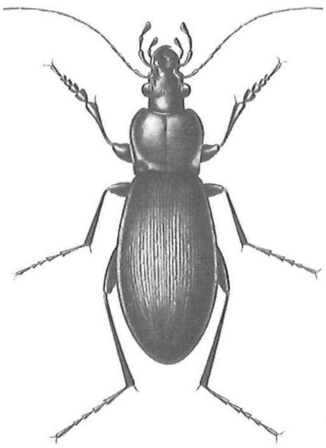



Fig. 14. *Carabus violaceus*.

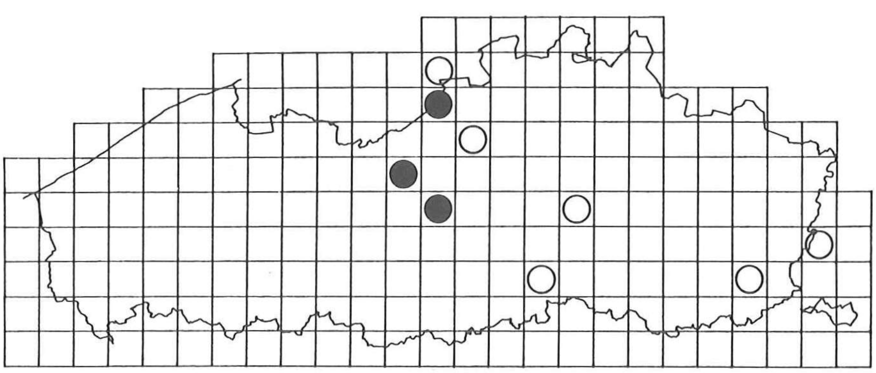
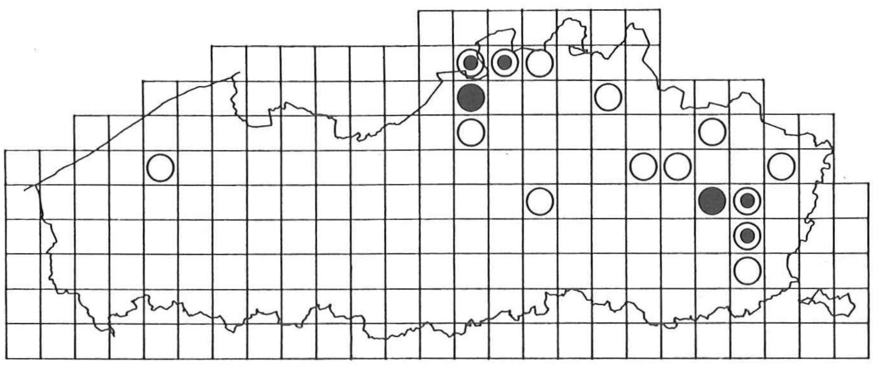


Fig. 15. *Bembidion lunatum*.



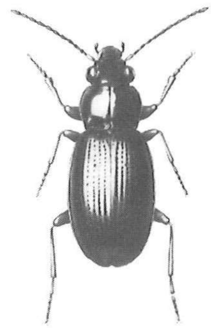


Fig. 16. *Bembidion nigricorne.*

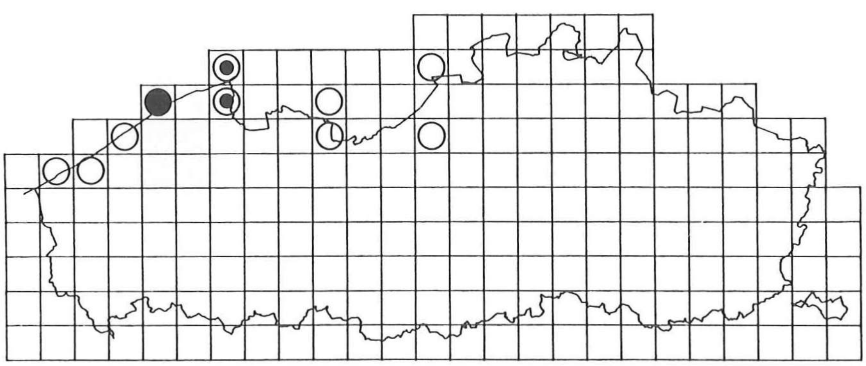


Fig. 17. *Bembidion normannum.*

Figs. 1-17. Distribution in Flanders of the observations of the species discussed in the text following a 10x10 km UTM-grid (hollow circle: observations before 1950; filled circle: after 1950; half-filled circle: before and after 1950).

Preliminary database on the distribution of Pipunculidae (Diptera) in Europe

by Marc DE MEYER

Abstract

Based on literature references and unpublished data, a preliminary database was compiled for the distribution of Pipunculidae (except the genus *Chalarus*) in Europe. The database shows that the pipunculid fauna is well known for only a limited number of European countries. Especially for southern Europe the data are incomplete. Specific distribution patterns among the Pipunculidae could be distinguished regarding the northernmost limit of their distribution, as well as boreal and boreomontane patterns. The database shows that certain pipunculid genera need a thorough revision, especially the genera *Eudorylas* and *Tomosvaryella*. Also the need is felt for a reliable and updated identification key for European Pipunculidae.
Key-words: Pipunculidae, distribution, Europe.

Samenvatting

Op basis van literatuurgegevens en niet gepubliceerde data, werd een voorlopige database opgesteld voor de verspreiding van Pipunculidae in Europa (met uitzondering van het genus *Chalarus*). Er werd aangetoond dat de pipunculidenfauna slechts voor een beperkt aantal Europese landen goed gekend is. Gegevens voor zuidelijk Europa zijn echter zeer beperkt. Specifieke verspreidingspatronen konden aangetoond worden met betrekking tot de noordelijke verspreidingslimiet, alsook voor boreale of boreomontane soorten. Uit deze studie bleek dat een aantal genera (vooral *Eudorylas* en *Tomosvaryella*) dringend gereviseerd dienen te worden. Ook werd het gemis van een bijgewerkte determinatiesleutel voor de Europese Pipunculidae aangevoeld.
Trefwoorden: Pipunculidae, verspreiding, Europa.

Introduction

Pipunculidae (Diptera) are small inconspicuous flies, closely related to hoverflies (Syrphidae). During their larval stage they are known as parasitoids of Auchenorrhyncha (Homoptera). Faunistic and taxonomic research on this family in Europe has been extensive during the last decade (DE MEYER, 1989b). Within the scope of a larger Diptera sampling program by the Royal Belgian Institute of Natural Sciences (K.B.I.N./I.R.Sc.N.B.) (see GROOTAERT, 1989) a number of faunal inventories of interesting ecological sites in Belgium have been performed. These surveys have shown the Belgian pipunculid fauna to be much more diverse than initially thought, and also stressed the importance for conservation of certain biotopes in our country (DE MEYER, 1984, 1985; GROOTAERT *et al.*, 1988). Similar studies have been performed in other European countries (DELY-DRASKOVITS, 1983; TESCHNER, in press).

These inventory studies, have however shown that the general distribution of most species throughout Europe is not well known, hence causing problems for general faunal surveys or cartography. TANASIJTSHUK (1988) gives a list of faunal records for all Palaearctic species but this one has proven to be greatly incomplete. Therefore, the need was felt to produce a database on the distribution of the European Pipunculidae which could serve as a preliminary basis for further surveys, and which would also point out the present problems regarding faunistic work on the group.

Faunal surveys in European countries

The author tried to compile all possible records of occurrence for the European species, based on literature references (listed at the end) and unpublished data kindly provided by colleagues in response to a circular sent in November, 1990.

In total, 134 Pipunculidae species are reported from European countries. Not included in the survey was the U.S.S.R. The results are summarized in Table 1. The genus *Chalarus* was omitted in this table. M. JERVIS (Cardiff, U.K.) has pointed out that several of the European *Chalarus* species recognized at the moment are in fact species complexes (JERVIS, pers. comm.) hence making the records for this genus unreliable. Therefore Table 1 presents the results for the remaining 126 pipunculid species. The records for the genus *Dorylomorpha* were taken from ALBRECHT's recent revision of this genus (ALBRECHT, 1990) with addition of data provided after the revision was published.

Table 1 shows that the pipunculid fauna is known very well for a limited number of countries only, like Belgium, Czechoslovakia, Great Britain and Sweden. This mainly because of recent surveys performed in these countries regarding the pipunculid fauna. All these countries show a total of between 70 and 80 different species. For a number of countries, the pipunculid fauna is partly known, based on revisions of the fauna for certain genera (like *Dorylomorpha* in Finland) or revisions of the fauna of particular areas (TESCHNER pers. comm. for Germany, DE MEYER & STARK, in press) or specified collections (DE MEYER *et al.*, 1990).

For the majority of the countries, the pipunculid fauna is poorly known. Many of the records are based on old literature references and not always reliable, except for genera for which a recent revision was published like *Dorylomorpha* (ALBRECHT, 1990) and *Cephalops* and adjacent genera (DE MEYER, 1989a). Especially for southern Europe the data are incomplete.

Distribution of species

Table 1 shows that a number of pipunculid species are fairly common and generally distributed over most of Europe. 35 species are reported from more than half the countries surveyed and 7 species are known from more than 4/5 of all countries (like *Verrallia aucta, Cephalops aeneus, Cephalosphaera furcatus, Pipunculus campestris, Dorylomorpha confusa, Tomosvaryella geniculata* and *T. sylvatica*). Most likely these species will occur all over Europe, although because of the lack of records of mediterranean countries they can not be confirmed yet.
On the other hand, 32 species are reported from only 1 or 2 localities. Very often it concerns here obscure species of which the validity is not ascertained, like *Eudorylas dudai, E. obtusicornis, E. roseri, E. straelenis, E. straminipes, E. trigonus, E. triplex, Tomosvaryella lyneborgi, T. miniscula, T. olympicola* and *T. rondanii*. Several of these species are described from South European countries and again because of the lack of recent surveys in these areas their validity is not confirmed. Also the major part of them belong to the genera *Eudorylas* and *Tomosvaryella*, which are in need of a taxonomic revision. For other species, their limited distribution seem to be a true reflection of their uncommon occurrence. This is especially the case for species belonging to genera that were revised recently. For example the few data for species like *Dorylomorpha onegensis, D. clavata, D. spinosa* and *D. semiclavata* is possible because these species seem indeed to have a limited distribution. The same applies for example for *Cephalops conjunctivus*. This species was originally described from one specimen from Yugoslavia. A collection recently received from Spain has provided a high number of additional material. On the other hand

Table 1. Occurrence of Pipunculidae in Europe, based on literature references and unpublished data (see text): No: Norway, Sw: Sweden, Fi: Finland, Dk: Denmark, Gb: Great Britain, Ir: Ireland, Be: Belgium, Nt: the Netherlands, Ge: Germany (unified), Po: Poland, Fr: France, Zw: Zwitserland, Au: Austria, Cz: Czechoslovakia, Hu: Hungary, Ru: Rumania, Bu: Bulgaria, Yu: Yugoslavia, It: Italy, Sp: Spain, Gr: Greece.

	No	Sw	Fi	Dk	Gb	Ir	Be	Nt	Ge	Po	Fr	Zw	Au	Cz	Hu	Ru	Bu	Yu	It	Sp	Gr
VERRALLIA																					
aucta (Fallén)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡		‡		
JASSIDOPHAGA																					
beatricis Coe				‡	‡		‡						‡	‡							
pilosa (Zett.)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡	‡						
setosa Verrall	‡	‡	‡	‡	‡	‡	‡	‡	‡					‡	‡						
villosa (von Roser)	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡		‡	‡	‡	‡			‡		
NEPHROCERUS																					
flavicornis Zett.		‡	‡	‡	‡		‡	‡	‡	‡	‡		‡	‡							
lapponicus Zett.		‡	‡				‡	‡	‡				‡	‡							
scutellatus (Macq.)	‡	‡	?		‡		‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡	‡		‡
CEPHALOPS																					
aeneus Fallén	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡	‡	‡			‡	‡		
carinatus (Verrall)		‡	‡	‡	‡		‡	‡			‡		‡	‡					‡		
chlorionae (Frey)	‡	‡	‡		‡																
conjunctivus Collin																		‡		‡	
grandimembranus De Meyer									‡												
obtusinervis (Zett.)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡					‡		
perspicuus (de Meijere)		‡		‡	‡		‡	‡	‡		‡		‡	‡							
semifumosus (Kowarz)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡	‡						
signatus (Becker)					‡		‡	‡			‡		‡	‡	‡			‡			
subultimus Collin	‡	‡	‡	‡	‡	‡	‡	‡	‡					‡					‡		
ultimus (Becker)	‡				‡		‡	‡	‡		‡		‡	‡			‡		‡		‡
vittipes (Zett.)	‡	‡	‡		‡		‡	‡	‡	‡	‡		‡	‡			‡				
CEPHALOSPHAERA																					
furcata (Egger)	‡	‡	‡		‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡				
germanica Aczél		?	‡	‡	‡		‡	‡	‡				‡	‡							
MICROCEPHALOPS																					
vestitus (Becker)					‡		‡	‡	‡	‡			‡	‡							
BECKERIAS																					
pannonicus Aczél					‡		‡		‡		‡			‡	‡						
PIPUNCULUS																					
calceatus von Roser		‡		‡			‡		‡	‡	‡		‡	‡							
campestris Latreille	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡		‡		
fonsecai Coe	‡	‡			‡		‡	‡						‡							
lichtwardti Kozanek														‡							
oldenbergi Collin		‡					‡		‡					‡							
omissinervis Becker									‡			‡		‡							
phaeton Coe					‡		‡														
spinipes Meigen	‡	‡	‡	‡	‡		‡	‡	‡	‡		‡	‡	‡			‡		‡		
tenuirostris Kozanek		‡		‡	‡		‡							‡							
thomsoni Becker	‡	‡	?	‡	‡	‡	‡	‡	‡	‡			‡	‡					‡		
varipes Meigen	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡	‡				‡		
zugmayeriae Kowarz					‡		‡	‡	‡	‡				‡							
DORYLOMORPHA																					
aczeli Hardy			‡					‡		‡	‡		‡	‡	‡				‡		
albitarsis (Zett.)	‡	‡	‡		‡		‡	‡		‡		‡		‡	‡						
anderssoni Albrecht	‡	‡	‡	‡	‡			‡	‡												
beckeri (Aczél)	‡	‡	‡		‡			‡	‡				‡	‡	‡						
borealis (Wahlgren)	‡	‡	‡									‡	‡	‡							
canadensis Hardy	‡	‡	‡																		
clavata Albrecht			‡																		
clavifemora Coe	‡	‡	‡		‡									‡	‡						
confusa (Verrall)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡		‡		
extricata (Collin)	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡	‡	‡	‡	‡						
fennica Albrecht		‡	‡					‡						‡	‡						
hackmani Albrecht	‡	‡	‡																		
haemorrhoidalis (Zett.)	‡	‡	‡	‡	‡			?	?				?								
hungarica (Aczél)		‡		‡	‡		‡	‡	‡	‡			‡	‡	‡		?				
imparata (Collin)	‡	‡	‡		‡		‡	‡	‡		‡	‡	‡	‡	‡						
incognita (Verrall)		?					?	‡	‡	‡	‡		‡	‡			‡	‡			
infirmata (Collin)	‡	‡	‡	‡	‡	‡	‡	‡						‡							
lautereri Albrecht			‡											‡							
maculata (Walker)	‡	‡	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡	‡		‡			‡		
occidens (Hardy)	‡	‡	‡					‡													
onegensis Albrecht			‡																		
platystylis Albrecht		‡	‡						‡				‡	‡							
praetermissa Albrecht		‡	‡						‡					‡	‡						
rufipes (Meigen)	‡		‡		‡		‡	‡	‡	‡	‡	‡	‡	‡	‡			‡			
semiclavata Albrecht																				‡	
spinosa Albrecht			‡																		
xanthocera (Kowarz)		?	‡	‡			‡	?	‡	‡		‡	‡	‡	‡	‡		‡	‡		
xanthopus (Thomson)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡	‡				‡		
TOMOSVARYELLA																					
cilifemorata (Becker)													‡		‡		‡			‡	
cilitarsis (Strobl)		‡	‡		‡		‡	‡					‡	‡					‡		
coquilletti (Kertész)									‡					‡	‡	‡	‡	‡			
frontata (Becker)											‡					‡			‡		
geniculata (Meigen)		‡	?	‡	‡		‡	‡	‡	‡	‡		‡	‡	‡	‡	‡	‡	‡	‡	
hirticollis (Becker)											‡								‡		
kuthyi (Aczél)					‡		‡	‡					‡	‡	‡	‡	‡	‡		‡	‡
littoralis (Becker)		‡		‡	‡	‡	‡	?	‡	?	‡										
lyneborgi (Coe)																				‡	
minima (Becker)		‡			‡		‡	‡	‡	‡				‡	‡	‡				?	
miniscula (Collin)		‡																			
mutata (Becker)															‡	‡				‡	
nigronitida (Collin)																		‡		‡	
olympicola (Janssens)																					‡
palliditarsis (Collin)		‡			‡		‡		‡					‡						‡	
rondanii (Collin)																			‡		
sylvatica (Meigen)	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡	‡	‡	‡	
EUDORYLAS																					
arcanus Coe					‡																
coloratus (Becker)		‡		‡					‡	‡			‡			‡					
dissimilis Coe					‡																
dudai (Hardy)									‡												
electus (Hardy)														‡							
elephas (Becker)		‡	‡						‡	‡			‡	‡							
fascipes (Zett.)		‡	‡		‡	‡	‡	‡	‡	‡			‡	‡							
fluviatilis (Becker)																				‡	
furvulus Collin		‡	‡											‡							
fuscipes (Zett.)		‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡	‡				‡	‡	
fusculus (Zett.)	‡	‡	‡		?		‡	‡		‡			‡	‡	‡		‡	‡			
halteratus (Meigen)			?		‡		‡		‡				‡	‡							
horridus (Becker)					‡		‡	‡	‡					‡	‡		‡	‡	‡		
imperfectus (Becker)														‡					‡		
inferus Collin		‡		‡	‡		‡	‡		‡									‡		
jenkinsoni Coe		‡			‡		‡	‡						‡			‡				
kowarzi (Becker)					‡		‡	‡		‡				‡	‡			‡			
longifrons Coe					‡		‡							‡							
melanostolus (Becker)		‡		‡	‡		‡	‡	‡				‡	‡					‡		
modestus (Haliday)					‡																
montium (Becker)	‡			‡	‡		‡	‡	‡	‡		‡	‡	‡					‡	‡	
obliquus Coe					‡	‡	‡	‡	‡					‡					‡		
obtusicornis (Duda)										‡											
obscurus Coe	‡	‡			‡		‡	‡	‡					‡	‡				‡		
opacus (Fallén)		‡	‡											‡							
pannonicus (Becker)			?								‡				‡	‡		‡			
restrictus Coe					‡									‡							
roseri (Becker)			?						‡												
ruralis (Meigen)					‡		‡	‡	‡	‡		‡	‡	‡	‡		‡		‡		
sericeus (Becker)				‡						‡						‡			‡		
setosus (Becker)																				‡	
straeleni (Janssens)																					‡
straminipes (Becker)																			‡		
subfascipes Collin	‡	‡			‡		‡	‡	‡	‡		‡		‡							
subterminalis Collin		‡			‡		‡	‡	‡		‡	‡	‡	‡	‡	‡	‡	‡	‡		
sulcatus (Becker)		‡		‡			‡		‡									‡			
terminalis (Thomson)		‡	‡	‡	‡		‡	‡	‡	‡	‡		‡	‡	‡		‡	‡	‡		
trapezoides (Becker)															‡	‡					
trigonus (Becker)																					‡
triplex (Becker)																			‡		
trochanteratus (Becker)			?																		
unicolor (Zett.)		‡	?		‡				‡	‡			‡		‡		‡				
zermattensis (Becker)		‡		‡	‡		‡	‡	‡		‡	‡	‡	‡	‡			‡			
zonatus (Zett.)		‡	‡	‡	‡	‡	‡	‡	‡	‡			‡	‡			‡		‡	‡	
zonellus Collin		‡			‡		‡	‡	‡	‡			‡	‡			‡	‡	‡		

extensive collections from Central and North European countries has not given any specimens. This species has most likely a mediterranean distribution, and a preliminary study of genital structures, has revealed that it is closely related to some Afrotropical species like *Cephalops obtusus* (see DE MEYER, in press).

Distribution patterns

Again, because of the lack of southern European records, it is not possible yet to give complete distribution patterns for pipunculid species. However, because of the fair amount of data from Central and northern Europe, some interesting conclusions can be drawn regarding northernmost distribution limits for several species. ALBRECHT (1990) divides northern Europe into three parts (northern and southern Fennoscandia and Central Europe) for its flight period diagrams and distribution of *Dorylomorpha* species. The borders between the three regions roughly equals the 1000 degree and 1400 degree centigrade effective temperature sum isopleth respectively. These isopleths seem to equal approximately the northernmost distribution limits of several pipunculid species.

- species occurring all over Central and northern Europe and well into the northern Fennoscandia region (region A of ALBRECHT, 1990), for example *Tomosvaryella sylvatica, Pipunculus campestris, Cephalops aeneus, C. vittipes, Dorylomorpha maculata* and *D. xanthopus* (Fig. 1).
- species with a northernmost limit equaling the southern Fennoscandia region (region B of ALBRECHT, 1990), for example *Cephalops obtusinervis, C. subultimus, Cephalosphaera furcata, Verrallia aucta, Dorylomorpha imparata* and *D. confusa* (Fig. 2).
- species with a northernmost limit equaling Central Europe (region C of ALBRECHT, 1990), for example *Dorylomorpha hungarica, Eudorylas zermattensis, E. subterminalis,* and *Pipunculus zugmayeriae* (Fig. 3).

A few special cases show that these isopleths can form the border of northernmost and southernmost limit for closely related species. ALBRECHT mentioned the case of *D. hungarica* and *D. haemorrhoidalis* (ALBRECHT, 1990, pers. comm). A similar distribution may be the case for *Nephrocerus flavicornis* and *N. scutellatus* (see GROOTAERT & DE MEYER, 1986) although the records for a number of the countries have to be revised in this respect.

A fourth limit of northernmost distribution can be differentiated, running approximately from Czechoslovakia, the southern part of former West Germany, Belgium (possibly with the southern part of the Netherlands) and the southern part of England (Fig. 4), as can be seen in species like *Microcephalops vestitus, Tomosvaryella kuthyi, Eudorylas obliquus* and *E. horridus.*

In addition a number of other distribution patterns could be detected. Number of species appear to have a purely boreal distribution, like *Dorylomorpha clavata.* Others typical boreomontane distribution like *D. borealis,* and maybe also *D. beckeri.* A well illustrated case is *Tomosvaryella cilitarsis* which also has a boreomontane distribution with reported distribution from the Scottish Highlands, the Boreal region of Fennoscandia, Czechoslovakia, Austria and Belgium. In Belgium, the distribution of this species is restricted to the 'Hautes Fagnes' a mountainous area in the East of the country which is famous for its boreomontane fauna (GROOTAERT, 1989).

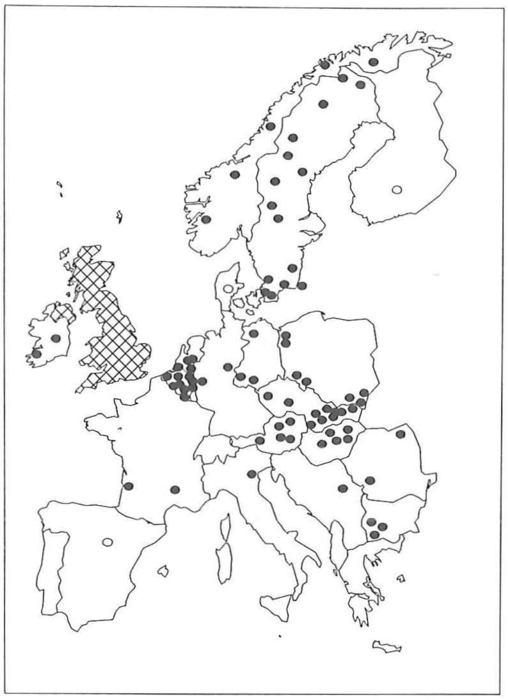


Fig. 1. Distribution of *Tomosvaryella sylvatica* in Europe (solid dots indicate localities; open circles indicate presence in a certain country without knowing the exact localities; barred area represents widespread species throughout the country).

Fig. 2. Distribution of *Cephalops obtusinervis* in Europe (symbols as in Fig. 1).

Fig. 3. Distribution of *Eudorylas subterminalis* in Europe (symbols as in Fig. 1).

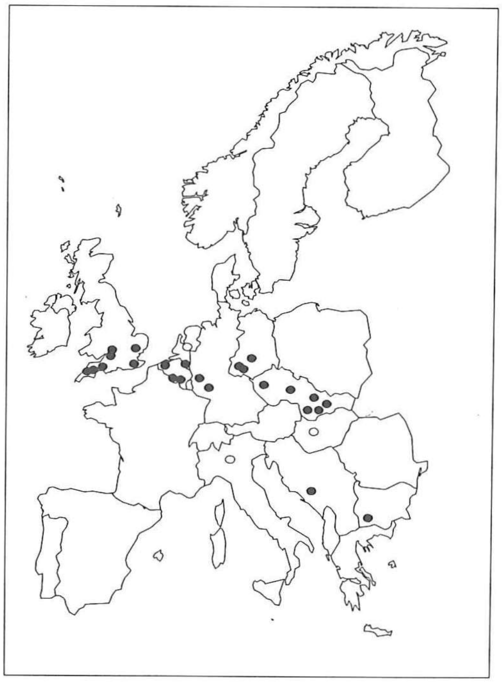


Fig. 4. Distribution of *Eudorylas horridus* in Europe (symbols as in Fig. 1).

Pipunculid fauna and specific biotopes

With respect to the importance of conservation of certain biotopes, it is necessary to know the relationship of the organisms present and their environment. Pipunculidae can have a specific relationship with their environment, indirectly through their hosts (Homoptera) and their relationship to the vegetation. Only limited studies have been done in this respect (for example WALOFF (1975) for acidic grasslands).

Our study of certain specific biotopes in Belgium and a preliminary cartography (DE MEYER, 1983; DE MEYER & DE BRUYN, 1985), has given some indications that the occurrence of certain Pipunculidae seem to be related to specific environments. The restricted occurrence of *T. cilitarsis* in the "Hautes Fagnes", as mentioned above, is one of them. *D. albitarsis* seems to be restricted to meadows and peatbogs, which is confirmed by findings in other countries like Czechoslovakia and Finland (ALBRECHT, 1990; LAUTERER, 1981). *Eudorylas horridus* mainly occurs in calcareous regions in our country, with the exception of one finding at the coastal area. LAUTERER (1983) describes this as a thermoxerophilous species. *Tomosvaryella littoralis* seems to be indeed a littoral species, occurring in the Atlantic region (the finding of Poland has to be confirmed). In general however, the data are too limited to make any definite conclusions for most pipunculid species.

Conclusion

This is a first attempt to bring together all available data on distribution of Pipunculidae in Europe. Because of the small size of the family this is still quite feasible.

From this preliminary study it is felt that a number of general problems have to be solved first, before reliable faunal surveys and cartography can be undertaken. A number of genera are in need of systematic revisions, especially *Eudorylas* and *Tomosvaryella*. In this respect there is also a necessity for extensive sampling in areas which are not well known at the moment, especially in southern Europe. The taxonomic problems for the genus *Chalarus* have been mentioned in the introduction. For other genera, revisions exist or the groups are fairly small (ALBRECHT, 1990; DE MEYER, 1989a; GROOTAERT & DE MEYER, 1986; LAUTERER, 1981). Also an updated identification key is a necessity if reliable surveys would be undertaken.

Only when these problems are solved, a more in depth study can be undertaken in order to look for specificity of species for certain habitats, and the possible link with their environment.

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Geographical distribution and habitat selection of species of *Hercostomus* subgenus *Gymnopternus* in the Benelux (Diptera: Dolichopodidae)

by Marc POLLET, Henk MEUFFELS & Patrick GROOTAERT

Abstract

All 9 species of the subgenus *Hercostomus* (*Gymnopternus*) which are known from western Europe occur in Belgium and The Netherlands and limited collecting has revealed *H. celer* and *H. brevicornis* in Luxembourg. In Belgium habitat selection was studied using three data sets. Data set I comprises yields from standardized sampling campaigns, data set II contains yields obtained by continuous sampling during complete or almost complete year cycles, whereas data set III consists of all capture records of the separate species.

H. aerosus, H. cupreus and *H. celer* are widespread in Belgium and The Netherlands, whereas *H. metallicus* and *H. brevicornis* in particular are considerably scarcer in The Netherlands as compared to Belgium. The remaining species can be termed rare. In Belgium, *H. assimilis* and *H. blankaartensis* are entirely confined to the north-western part of the country. All species are more or less restricted to one or few habitat types. *H. assimilis* and *H. blankaartensis* prefer marshlands and reedmarshes in particular. All other species occur in woodland habitats, where they demonstrate specific preferences for certain woodland types e.g. *H. silvestris* is entirely confined to humid deciduous woodland types. Besides woodlands, *H. aerosus* and *H. angustifrons* are also found very frequently in wooded heathland, whereas *H. celer* is often encountered on riverbanks.

The geographical distribution patterns of the species can be considered as a reflection of the availability of favourable habitats.

Key-words: zoogeography, habitat selection, Diptera, *Gymnopternus*, Benelux.

Samenvatting

De 9 Westeuropese soorten van het subgenus *Hercostomus* (*Gymnopternus*) werden alle in België en Nederland aangetroffen en beperkte vangsten in het Groothertogdom Luxemburg wezen uit dat *H. brevicornis* en *H. celer* er voorkomen. De habitatvoorkeur in België werd onderzocht aan de hand van drie gegevensets.

Dataset I omvat de opbrengsten van gestandaardiseerde bemonsteringscampagnes, dataset II bestaat uit opbrengsten van jaarcyclussen, terwijl dataset III is samengesteld uit alle vangsten voor de verschillende soorten.

H. aerosus, H. cupreus en *H. celer* vertonen een grote verspreiding in België en Nederland, terwijl *H. metallicus* en *H. brevicornis* in het bijzonder veel zeldzamer zijn in Nederland dan in België. De overige soorten kunnen als zeldzaam bestempeld worden. De verspreiding van *H. assimilis* en *H. blankaartensis* is in België overigens beperkt tot het noordwesten. Alle soorten zijn min of meer gebonden aan één of enkele habitattypes. *H. assimilis* en *H. blankaartensis* zijn de enige soorten met een voorkeur voor moerassen en rietlanden in het bijzonder. Alle andere soorten komen voor in bossen, alhoewel bij de verschillende soorten een specifieke preferentie voor welbepaalde bostypes werd aangetroffen. Naast bossen, komen *H. aerosus* en *H. angustifrons* zeer frekwent voor in beboste heide-landschappen, terwijl *H. celer* vaak werd verzameld op rivieroevers. De geografische verspreiding van de soorten kan beschouwd worden als een weerspiegeling van de aan- of afwezigheid van geschikte biotopen voor de soorten.

Trefwoorden: zoögeografie, habitat-selectie, Diptera, *Gymnopternus*, Benelux.

Introduction

Dolichopodidae or long-legged flies are very small to medium-sized flies with usually metallic shining colours, long legs and protruding mouthparts. Males of many species show specific ornaments on the legs or antennae and a genital apparatus, folded underneath the abdomen. These sometimes extraordinary features are believed to be of great importance for the courtship behaviour. The adult flies as well as the larvae are predatory, although exceptions occur such as the leaf-mining larvae of *Thrypticus* and the flower-visiting adults of *Hercostomus nigripennis*.

Hercostomus is a cosmopolitan genus with its main distribution in the Palaearctic Region (STACKELBERG, 1933). It is situated within the subfamily *Dolichopodinae* which also includes genera such as *Dolichopus, Poecilobothrus* and *Hypophyllus*. Generally, *Hercostomus* males do not show conspicuous ornaments and females are very alike and thus sometimes hard to distinguish. *Gymnopternus* is treated as a distinct genus among American dipterists, whereas until recently it was generally not recognized as a taxonomic entity in Europe. POLLET (1990a) reerected this taxon as a subgenus of *Hercostomus*. Its European representatives can be separated from species of the subgenus *Hercostomus* by the possession of all four of the following features in combination: (i) all postoccipital bristles black; (ii) a cluster of hairs in front of the posterior spiracle present; (iii) third and fourth vein almost parallel along whole wing length; (iv) antennae entirely black.

The composition of the Nearctic *Hercostomus* s.l. fauna differs considerably from the Palaearctic: *Hercostomus* s.s. includes only few, whereas *Gymnopternus* proved to be very rich in species in the eastern half of the United States of America (67 species, ROBINSON, 1964). In the western part of the Palaearctic Region, on the contrary, the opposite situation is encountered (PARENT, 1938). Only 9 *Gymnopternus* species have thus far been found in Europe (on the basis of species identified by the first author): *H. aerosus* (FALLÉN), *H. angustifrons* (STAEGER), *H. assimilis* (STAEGER), *H. blankaartensis* POLLET, *H. brevicornis* (STAEGER), *H. celer* (MEIGEN), *H. cupreus* (FALLÉN), *H. metallicus* (STANNIUS) and *H. silvestris* POLLET.

In a recent revision, POLLET (1990a) described 2 new species and examined the phylogenetic and general ecological relationships between the western European species of this subgenus. Somewhat later, additional data were published and information on the habitat selection of the newly recognized species were given (POLLET, 1990b). In the present contribution, the geographical distribution is presented and the habitat selection of all species is more elaborately examined.

Material and methods

Data on the geographical distribution of the species were gathered for The Netherlands, Belgium and Luxembourg, together known as the Benelux. The number of data from Luxembourg was, however, very restricted. Nearly all data are based on specimens identified or examined by the first two authors.

Data on the habitat selection of the species are based on Belgian records collected until 1990. They could be separated into three sets, the records of which are characterized by a unique combination of locality, habitat and sampling year. In this way, sampling yields from two successive years are treated as two separate records. Sampling yields without any indication of habitat type were not used in our analyses.

Data set I: the records of this dataset were derived from samples collected with a standardized collecting method. The trap unit is a small white water trap (diameter: 9 cm, depth: 4.5-6.5 cm), which was filled with a 2.5 % formalin solution. Sufficient detergent was added in order to decline the surface tension. These traps were emptied at weekly to two-monthly intervals, dependent upon the sampling campaign, but one-monthly collections were the rule. In each site, 2 to 10 trap units were in operation during the entire or the main activity period of most dolichopodid species (April-October). The following restrictions were introduced: (i) sites with zero yields for *Gymnopternus* species were excluded (n = 5); (ii) only species with a total of 50 or more specimens collected over all sites were considered. In this way, quantitative data on the occurrence of 5 *Gymnopternus* species from 30 sites could be analyzed (Tab. 2).

Data set II: contains the yields of all sampling campaigns carried out on a continuous basis during a complete or most of a year cycle by means of Malaise, pitfall and/or water traps. Accordingly, this set incorporates dataset I. Again, restrictions were applied in order to get more reliable information: (i) records with zero yields for *Gymnopternus* species were excluded; (ii) only records with yields of 10 or more specimens for at least one *Gymnopternus* species were withdrawn for analysis. On this basis, 65 out of the 107 sites were selected for a further analysis (Tab. 3a-b).

Data set III: this set merely consists of all existing sampling data on *Gymnopternus* species. Dataset III includes all records of dataset II, supplemented by one-day sweeping collections. This implies that both full year samples and samples taken at random are concerned. Again, as a rule only samples with 10 or more specimens per species were considered for analysis. In the case of *H. angustifrons, H. blankaartensis* and *H. silvestris*, however, all records were considered due to the very few data available (Tab. 4).

Data of data sets I and II were analyzed by means of the Chi-square test for goodness of fit (SOKAL & ROHLF, 1981). It must, however, be emphasized that the analysis of dataset I is based on the number of specimens/site, whereas in the case of dataset II, only the number of sites where the species were found, were used in the analysis.

Results

Geographical distribution

Table 1 presents the number of UTM-squares in which the different species have been collected. The distribution of *Gymnopternus* species in Luxembourg is not discussed due to a lack of sufficient records.

H. cupreus and *H. aerosus* are the most commonly found species of this subgenus in Belgium and The Netherlands. *H. brevicornis* is equally widespread in Belgium, although it is much rarer in The Netherlands. Except for the moderately common *H. metallicus* and *H. celer*, the remaining species (*H. angustifrons, H. assimilis, H. blankaartensis* and *H. silvestris*) can be termed rare in the former countries. All species have thus far been encountered in Belgium and The Netherlands, though some of them very recently in the latter country (*H. blankaartensis*: 1988; *H. silvestris*: 1990).

Figure 1 shows the distribution of all species in the Benelux.

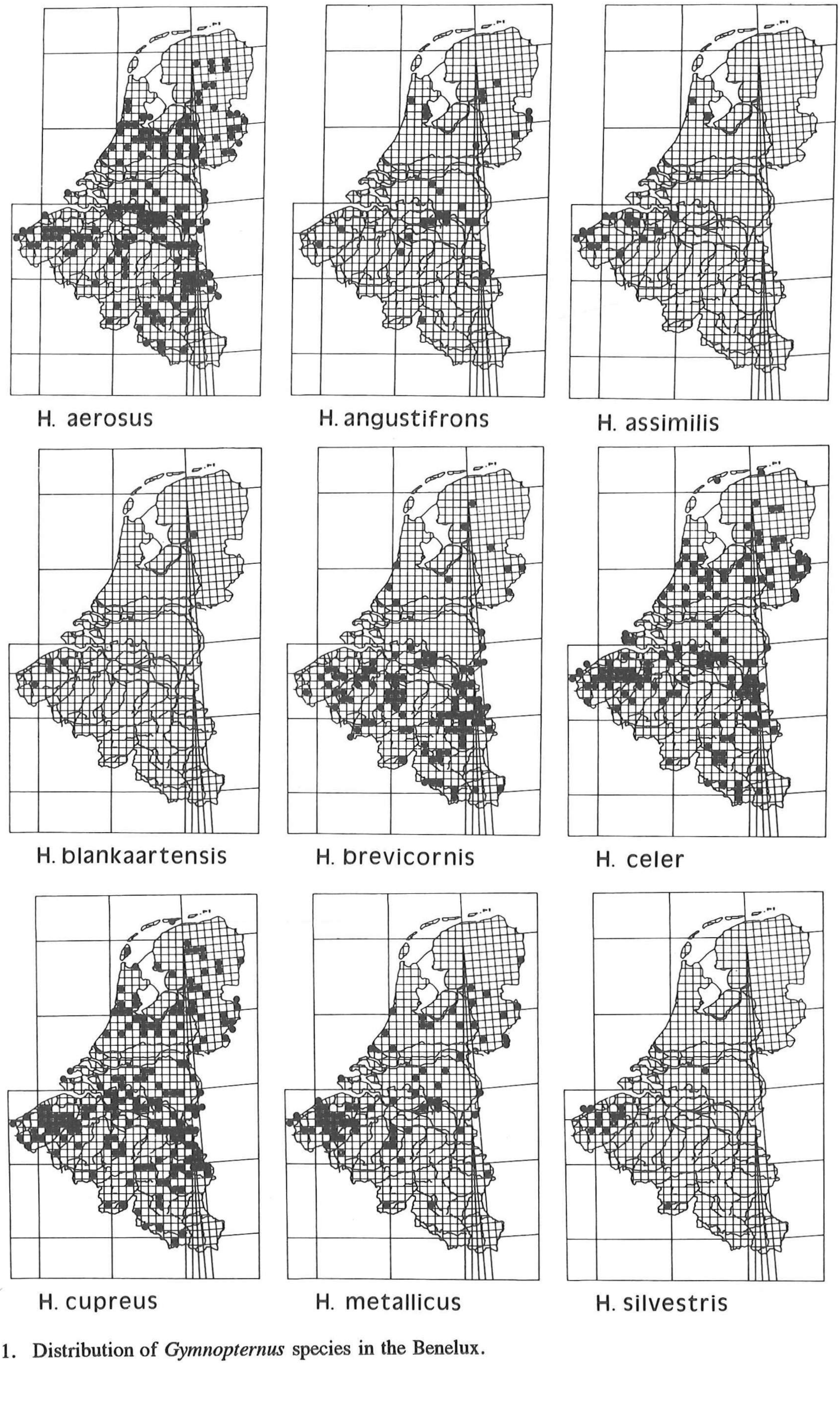

Fig. 1. Distribution of *Gymnopternus* species in the Benelux.

Table 1. Distribution of *Gymnopternus* species in countries of the Benelux. Number of 10 km UTM-squares in which the species was found, based on records gathered until 1990.

Countries	*Belgium*	*The Netherlands*	*Luxembourg*
Number of squares with at least one species	165	148	3
H. aerosus	98	77	-
H. angustifrons	14	14	-
H. assimilis	15	4	-
H. blankaartensis	4	1	-
H. brevicornis	85	20	2
H. celer	69	65	2
H. cupreus	92	84	-
H. metallicus	41	28	-
H. silvestris	11	1	-

H. aerosus and *H. angustrifrons* (one third of the records) are both mainly found in the Belgian-Dutch border region and the "Hautes Fagnes" area. These are predominantly sandy or peatbog areas. Exactly the same result has been obtained for The Netherlands. However, *H. angustifrons* is considerably rarer than its congener. Moreover, in contrast with *H. angustifrons, H. aerosus* does also occur in the coastal dunes.

H. assimilis and *H. blankaartensis* are both clearly restricted to the coastal areas. The latter species is distinctly rarer than *H. assimilis*, which can be found often in very large numbers in the coastal dunes.

In The Netherlands, *H. brevicornis* is more or less restricted to the extreme south: 50 % of all Dutch records are known from the province of Limburg. In Belgium, this species is apparently more widespread. Nevertheless, it is found in high numbers only at inland sites. Indeed, the most northwestern records are all based on very few or single specimens and it has thus far not been collected at the coast. It is most abundantly found in the central (Zoniënwoud) and the eastern parts of Belgium.

H. celer is very closely related to *H. brevicornis* as both have a thickening of the costal vein. However, in contrast to the latter, *H. celer* is much more common in The Netherlands, where it is mainly found in the central and southern region. In Belgium, distribution patterns of both species show distinct discrepances: records of *H. celer* are concentrated in the northern part of the country and in particular in the littoral zone. Moreover, a sampling campaign in a humid coastal woodland site yielded over 700 specimens of this species. *H. cupreus* is undoubtedly the most common species of this subgenus both in Belgium and The Netherlands and is more or less equally distributed in both countries.

H. metallicus is somewhat rarer in The Netherlands as compared to Belgium but does not show a clear distribution pattern in the former country. In Belgium, however, it is almost completely confined to the northern part. Only 3 records originate from the region south of the line formed by the Sambre and Meuse rivers. It has also been found in suitable habitats at the coast.

In Belgium, nearly all records of *H. silvestris* are located in the extreme north-west. The only exception is the Lake of Virelles Nature Reserve at Chimay in the south, where the species has been found in rather high numbers. The only Dutch record is also known from an inland locality.

Habitat selection

Tables 2-4 summarize the results of the analyses on data sets I-III. The analyses are based either on the numbers of specimens per site (Tab. 2) or the number of capture sites per species (Tab. 3b).

All five species show distinct preferences for certain habitat types (Tab. 2) which is confirmed by the analysis of data set II (Tab. 3b). However, the habitat preference of *H. aerosus* and *H. metallicus* proved not to be significant. On the basis on Tables 2-4 and direct observations in the field, the habitat selection in *Gymnopternus* species can be described as follows:

H. aerosus is the most eurytopic species of the subgenus as it occurs in almost every habitat type sampled. Its capture sites range from humid woodland to dry coastal dune grassland. Nevertheless, it demonstrates a clear preference for heathlands and to a lesser extend woodlands. Although it occurs in different kinds of woodland, carrs are highly preferred to other woodland types. *H. aerosus* is very characteristic for the muddy and well-lit flat banks of oligotrophic ponds in sandy areas and at these sites, it is often found as the far most abundant dipteran species. In The Netherlands too, it seems to occur in large numbers in heathlands. There, it clearly prefers humid heathland to dry sites.

Table 2. Habitat preferences in *Gymnopternus* species, based on species abundances per habitat type (data set I, see text). Abundance expressed as the total number of specimens collected per habitat type during a complete year cycle. df: degrees of freedom; ***: $p < 0.001$.

Dataset I	*deciduous woodland*	*heathland grassland*	*marshland reedmarsh*	*total*	*Chi-square*	*df*	*signif. level*
H. aerosus	16	56	0	72	262.87	2	***
H. assimilis	0	0	96	92	125.54	2	***
H. brevicornis	81	0	0	81	105.92	2	***
H. cupreus	865	26	1	892	1049.42	2	***
H. metallicus	136	3	0	139	168.56	2	***
Number of sites	13	4	13	30			

Even more than the previous species, *H. angustifrons* seems to be entirely confined to woodland, heathland and peatmoor habitats. At these sites, it is most often encountered near open water. Nearly all woodland sites where this species has been collected, are located within heathland areas. Exclusively sandy and peaty soils are preferred, which holds true for both Belgian and Dutch records.

H. assimilis demonstrates a distinct preference for marshlands and reedmarshes in particular. It also occurs in meadows and in the coastal dunes. In the latter sites, it is confined to rather humid grasslands and shows distinct aggregations within *Carex*-vegetations surrounding small pools. Nevertheless, *H. assimilis* appears to be characteristic for littoral reedmarshes where it is sometimes one of the dominant dolichopodid species. It is mainly observed sitting or running on broad-leaved herbs within the reed vegetations.

H. blankaartensis is more stenotopic than the previous species as it is entirely confined to reedmarshes. Moreover, within these habitats the presence of trees such as willows or poplars seems to be essential for its occurrence. These highly specific ecological demands were confirmed by observations in Great Britain (B.D. LAURENCE, in litt.). This species has very recently been described from De Blankaart Nature Reserve, a marshland site in Belgium in which a large population was discovered in 1984 (POLLET, 1990a).

Table 3a. Habitat preference of *Gymnopternus* species, based on data from continuous sampling by means of Malaise, water or pitfall traps (data set II, see Text). Numbers indicate the number of sites in which 10 or more specimens of the species were collected. Hae: *H. aerosus*, Hass: *H. assimilis*, Hbla: *H. blankaartensis*, Hbre: *H. brevicornis*, Hcel: *H. celer*, Hcup: *H. cupreus*, Hmet: *H. metallicus*, Hsil: *H. silvestris*.

Species	*No. sites*	*Hae*	*Hass*	*Hbla*	*Hbre*	*Hcel*	*Hcup*	*Hmet*	*Hsil*
Habitat type totals									
TOTAL WOODLAND	38	12	-	-	11	5	26	19	4
Deciduous woodlands	36	11	-	-	11	4	24	18	4
- Beech	11	1	-	-	11	-	2	1	-
- Oak/mixed oak	10	2	-	-	-	1	10	5	-
- Birch	5	1	-	-	-	-	5	3	-
- Carrs	9	7	-	-	-	3	6	9	4
- Miscellaneous	1	-	-	-	-	-	1	-	-
Coniferous woodlands	2	1	-	-	-	1	2	1	-
TOTAL HEATHLAND	4	4	-	-	-	-	4	1	-
TOTAL GRASSLAND	2	-	1	-	-	-	-	-	-
TOTAL MARSHLAND	22	2	19	7	-	-	-	5	-
- Reedmarshes	20	2	17	7	-	-	-	5	-
- Miscellaneous	2	-	2	-	-	-	-	-	-
No. of sites with one or more species	66	18	20	7	11	5	30	25	4

Table 3b. Habitat preference of *Gymnopternus* species, based on data set II (see Text). Numbers indicate the number of sites in which 10 or more specimens of the species were collected. df: degrees of freedom; n.s.: not significant; ***: p < 0.001; -: no sufficient data available to enable Chi-square test.

Dataset II	*deciduous/ coniferous woodland*	*heathland grassland*	*marshland reedmarshes*	*total*	*Chi-square*	*df*	*signif. level*
H. aerosus	12	4	2	18	0.70	1	n.s.
H. assimilis	0	2	18	20	35.94	1	***
H. brevicornis	11	0	0	11	8.32	1	***
H. cupreus	26	4	0	30	10.82	1	***
H. metallicus	18	2	5	25	2.32	1	n.s.
H. blankaartensis	0	0	7	7	-		
H. celer	5	0	0	5	-		
H. silvestris	3	1	0	4	-		
Total no. of sites	37	7	21	65			

Table 4. Habitat preferences of *Gymnopternus* species, based on all collecting data available (data set III, see text). Numbers indicate the number of sites where 10 or more specimens of the corresponding species were collected. For *H. angustifrons*, *H. blankaartensis* en *H. silvestris*, all data were included. Disturbed sites comprise ruderal sites, parks, orchards and gardens.

Habitat types	*deciduous/ coniferous woodland*	*heathland*	*grassland*	*marshland reedmarshes*	*disturbed sites*	*river banks*
Species						
H. aerosus	26	18	3	5	-	1
H. angustifrons	11	6	-	-	-	-
H. assimilis	-	-	1	26	-	-
H. blankaartensis	-	-	-	21	-	-
H. brevicornis	24	5	-	-	1	3
H. celer	12	-	1	1	-	7
H. cupreus	44	12	2	1	2	-
H. metallicus	29	2	-	19	-	1
H. silvestris	21	-	-	8	1	-

H. brevicornis is a true woodland-inhabiting species, where it reaches significant higher abundances as compared to grasslands, heathlands and marshlands. Beech woodlands are clearly favoured, although this species has also been encountered in fair numbers in other mature humid woodlands. All non-woodland capture sites were adjacent to woodland areas, although these samples mostly contained very few specimens of this species.

In accordance with the previous species, *H. celer* is mainly found in woodland habitats too. However, not a single specimen was collected in the beech woodlands investigated, whereas mainly carrs (especially alder carrs) seem to be preferred. Unlike other species of this subgenus, *H. celer* also occurs in fair numbers on riverbanks, especially when a well developed vegetation is available.

Despite its commonness, *H. cupreus* can be termed a eurytopic woodland species. It has not only been encountered in significantly highest numbers in woodlands, but proved to occur in fair numbers both in deciduous and coniferous stands. Nevertheless, within woodland habitats it seems to prefer oak, mixed oak, birch woodlands and carrs to beech forests. In any case, it is exclusively found in relatively old and stable woodland habitats and does not seem to occur in young poplar plantations without old woodland in the direct vicinity. It is also frequently found in wooded heathland and more occasionally in other habitat types.

H. metallicus is more exigent than the previous species concerning its habitat. Similar to *H. cupreus*, it is a true woodland-inhabiting species but with a clear preference for carrs and humid birch, oak and mixed oak stands. It seems to wander occasionally into neighbouring heathland but its frequent and abundant occurrence in marshlands could always be related to the presence of neighbouring willow carrs.

H. silvestris is obviously a stenotopic species with a preference for rather old willow or poplar carrs on a loamy soil. Although highest abundances are reported from inland sites, this species has been collected in small numbers in humid dune woodlands too and even in wooded marshlands. At the latter sites, it can sometimes be found together with *H. blankaartensis*. POLLET (1990a) described *H. silvestris* from De Mandelhoek Nature Reserve at Ingelmunster (Belgium).

Discussion

Literature data on the distribution of *Gymnopternus* species are mostly rather inaccurate and therefore not very useful. Nevertheless, the distribution in the surrounding countries is very similar to that in the Benelux. *H. aerosus, H. cupreus* and *H. celer* seem to be common in Denmark, Great Britain and Schleswig-Holstein too. *H. metallicus* is somewhat rarer everywhere, whereas *H. angustifrons* and *H. assimilis* are considered rare in most neighbouring countries (LUNDBECK, 1912; EMEIS, 1968; ASSIS FONSECA, 1978). The distinct difference observed between the distribution patterns of *H. brevicornis* and *H. celer* in The Benelux are also found in Great Britain: *H. celer* is not uncommon in the north but becomes scarcer southwards while *H. brevicornis* is locally very common in the south (ASSIS FONSECA, 1978).

Most information on the habitat selection of *Gymnopternus* species in the literature corresponds strikingly well with our own observations. *H. aerosus* has been recorded mainly from woodland and moorland (LUNDBECK, 1912; GOETGHEBUER, 1943; SOMMER, 1978; OLEJNICEK, 1985; POLLET & GROOTAERT, 1987; POLLET *et al.*, 1988; POLLET *et al.*, 1989; MEYER & HEYDEMANN, 1990; POLLET, 1991; POLLET & GROOTAERT, 1991). The most accurate information is given by EMEIS (1964). In Schleswig-Holstein, this author found *H. aerosus* mainly in woodland, both deciduous and coniferous stands. It seemed to prefer alder carrs, whereas it could also be collected in wooded heathland and moorland. These results are almost identical to those gathered in the present study.

Despite its rarity in our adjacent countries too, *H. angustifrons* has been mainly recorded from moorland and peatmoors (EMEIS, 1964; SOMMER, 1978; DRAKE, 1991; POLLET, 1991). LUNDBECK (1912) only gives "in humid places, especially at the border of water on water plants", whereas, on the contrary, DRAKE (1991) gives very precise descriptions of the capture sites: in Cumbria and Shropshire (U.K.), this species was collected in raised mires with mainly peat vegetations. Open as well as covered sites seemed to be favoured.

Very few literature data are available on the ecological demands of *H. assimilis*. In contrast to our findings (see also POLLET & DECLEER, 1989), both GOETGHEBUER (1943) and EMEIS (1964) record it from woodland sites. Most probably, these records might be based upon captures of *H. silvestris*, which was first recognized as a true species as late as 1990.

H. brevicornis is mainly known from woodland and to a lesser extent wooded moorland (LUNDBECK, 1912; GOETGHEBUER, 1931; SOMMER, 1978). Only MEYER & HEYDEMANN (1990) report beech and oak woodlands as capture sites of this species. Investigations on the emergence of aquatic and semi-aquatic insects also revealed the presence of this species along streams and brooks (CASPERS & WAGNER, 1982; BELLSTEDT, 1989).

The findings of EMEIS (1964) correspond exactly with our results for *H. celer*. This author too recorded this species mainly from woodlands and from borders of waterbodies. LUNDBECK (1912) claimed that the species occurs in meadows, on humid places and at borders of woodland pools. Other authors mentioned it only from woodland sites (GOETGHEBUER, 1943; POLLET *et al.*, 1986; POLLET & GROOTAERT, 1987; TAYOUB *et al.*, 1990).

Most authors reported collections of *H. cupreus* from woodland and moorland (LUNDBECK, 1912; GOETGHEBUER, 1943; EMEIS, 1964; SOMMER, 1978; POLLET *et al.*, 1986; POLLET & GROOTAERT, 1987; POLLET *et al.*, 1989; MEYER & HEYDEMANN, 1990; TAYOUB *et al.*, 1990; POLLET & GROOTAERT, 1991). However, not all data are equally valuable. Highly interesting observations were made by EMEIS (1964): "It likes insolation and the vicinity of open water. It occurs in very different woodland types, from beech woodland in the east of Schleswig-Holstein over oak-hornbeam to oak-birch woodland. It is often encountered at woodland edges too. Ocassionally, it wanders into meadows and moorland." Again, that is in full agreement with our own results. In the frame of a large scale sampling campaign in the littoral zones in northern Germany, not a single specimens of *H. cupreus* was collected in saltmarsh and other marshland habitats. In sharp contrast, it was abundantly found in some of the adjacent more inland moorlands, oak and coniferous woodlands (SOMMER, 1978; MEYER & HEYDEMANN, 1990).

Very few ecological data could be found in the literature concerning *H. metallicus*. It is mostly considered a true woodland species (LUNDBECK, 1912; GOETGHEBUER, 1943; EMEIS, 1964; POLLET & GROOTAERT, 1987), though it has been collected on the banks of waterbodies too (LUNDBECK, 1912).

From both our own findings and literature data, it can be concluded that *H. brevicornis* and *H. celer* clearly differ in their distribution and ecology. Although both species have been reported to occur together on the banks of brooks and rivers (CASPERS & WAGNER, 1982; BELLSTEDT, 1989; POLLET, unpubl. data) and woodland (TAYOUB *et al.*, 1990), they are never found together in equal abundances.

Besides the geographical distribution and the macrohabitat selection, more detailed information has been gathered on the ecology of the *H. (Gymnopternus)* species discussed here.

In the first place, the attractiveness of Dolichopodidae to differently coloured water traps was investigated by POLLET & GROOTAERT (1987). In the humid poplar stand studied, *H. celer, H.*

cupreus, H. metallicus and *H. silvestris* were collected in significantly higher numbers in the white water traps as compared to blue and red ones. *H. aerosus* was attracted to the white and red water traps to the same extent. Later sampling campaigns by the first author, however, revealed that this colour attraction is not constant and at other sites, *H. metallicus, H. celer* and *H. silvestris* were collected most numerously in red devices.

Data on microhabitat selection of some *Gymnopternus* species was studied by POLLET & GROOTAERT (1987) and TAYOUB *et al.* (1990). The first authors examined the distribution of dolichopodid species on a light/humidity gradient within a woodland habitat. The most wet and well-lit sites were favoured by the *Gymnopternus* species mentioned above. Moreover, the same results were retrieved from the successive sampling campaign at the same site during 1987 (POLLET & GROOTAERT, 1991). TAYOUB *et al.* (1990) sampled several sites, ranging from regularly flooded pond banks to rather dry oak-birch woodlands. Their study showed that *H. aerosus, H. angustifrons, H. brevicornis, H. celer* and *H. cupreus* occurred in each of the sampled sites. Nevertheless, *H. celer* clearly preferred the oak birch woodland sites, whereas *H. brevicornis* did not demonstrate a distinct habitat preference.

Finally, investigations on the vertical distribution of some species from the soil surface to 80 cm height in a woodland habitat proved that a clear interspecific variation is evident (POLLET & GROOTAERT, 1991). *H. aerosus* was mainly found near the soil surface, *H. celer* and *H. silvestris* were collected in highest numbers in the highest levels whereas *H. metallicus* and *H. cupreus* were more equally, though not significantly, distributed over the different levels.

Summarizing, all representatives of the subgenus *Gymnopternus* show a more or less distinct habitat affinity. Although *H. aerosus* and *H. cupreus* are the most eurytopic, both have considerably stronger ecological requirements as compared to species such as *Dolichopus ungulatus* and *D. plumipes*. In this regard, the geographical distribution of species of *Gymnopternus* can be considered as a reflection of the presence or absence of suitable sites for the different species e.g. *H. angustifrons* is almost exclusively recorded from sandy and peatbog areas in Belgium and The Netherlands. In Belgium, the reedmarsh-inhabiting *H. assimilis* and *H. blankaartensis* seem to be confined to the north-western part. In this way, the distribution of, at least, *H. assimilis* is very similar to that of the chloropid *Lipara lucens* MEIGEN, which is known as a monospecific parasite of common reed (DE BRUYN, 1989). However, for the stenotopic *H. silvestris*, its restricted occurrence in the extreme north-western part of Belgium is not fully explained by its pronounced preference for willow and poplar carrs. The only southern record from Belgium and the single Dutch inland record already suggested that it might actually be distributed far beyond its currently known distribution area. This hypothesis was confirmed by a very recent collection campaign (June 1991) in the extreme east of Belgium, where this species was encountered in fair numbers in a flooded alder carr.

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A standard method for site evaluation and indication of "Red Data Book"-species, using distribution data of invertebrates. An example based on the Hoverfly fauna (Diptera, Syrphidae) of Belgium

by Kris DECLEER & Luc VERLINDEN

Summary

A standard method is presented for analysing distribution data of invertebrates. Species are divided into ten status categories according to their rarity. Interval limits of the different categories are defined on the basis of an Arcsin-scale. This method allows for a better subdivision of both the rare and the common species than methods based on a logarithmic or arithmetical scale. Sampling efforts are taken into account as well. The total number of records of a species gives the most reliable picture of its rarity.
The proposed method may be particularly useful to recognize 'Red Data Book'-species in different countries or regions on a more standardised basis. Furthermore, this method may also be used in evaluation studies of sites, habitats or traps. The method is illustrated by the example of the Hoverfly fauna of Belgium. A check list is presented of the Belgian Hoverflies with their valuation index for the different regions of the country.

Résumé

Une methode standardisée pour analyser les données de distribution d'Invertébrés est présentée. Selon leur rareté, les espèces sont divisées en dix catégories, les intervalles étant définis par l'échelle d'ARCSIN. Cette méthode, subdivisant les espèces rares ainsi que les espèces communes, permet une meilleure analyse que les méthodes utilisant des échelles logarithmiques ou arithmétiques. L'effort d'échantillonnage est également considéré. Le nombre total de captures reflète le mieux la rareté d'une espèce.
Cette nouvelle méthode peut être extrêmement utile pour reconnaître les espèces en régression (Red Data Book species) d'un certain pays ou d'une région. Aussi, elle pourrait être utile pour évaluer la valeur écologique de certains sites, habitats ou pièges. La méthode est illustrée, en utilisant les données des Syrphides belges. Ainsi, nous présentons une liste de toutes les espèces, donnant, selon la région, leur indice biotique calculé.

Introduction

The growing attention given to invertebrates in the management of nature reserves and in national and international conservation programs during the past decade is a positive development. In this the rarity of certain species and/or the degree of threat to their survival in a deteriorating environment play an important part. Mapping schemes currently performed in the different European countries, dealing with various invertebrate groups, provide a suitable basis for the singling out of threatened or rare species. However, different countries and different entomologists apply different standards to distinguish status categories within a species group. Consequently the comparison of the status of one and the same species in different countries becomes rather difficult. In other words, the nomination of "Red Data Book"-species is based on dissimilar criteria, varying greatly according to the author or the country.

To overcome this problem, this paper proposes a more standardised approach based on the analysis of distribution data. The national status categories established by this method may also be used in site or habitat evaluation studies. In this paper the Belgian Hoverfly fauna is used as an example.

Why Hoverflies were chosen as an example

Hoverflies are eminently suitable for the purpose of an ecological evaluation of sites or habitats. They are a popular and attractive group of insects. Their ecology and taxonomy is well studied and good identification keys are available (e.g. STUBBS & FALK, 1986; VAN DER GOOT, 1981; VERLINDEN, 1991). There are many species (317 have been recorded in Belgium) and a lot of them are more or less stenotopic. The habitat requirements of the early stages vary greatly from species to species (e.g. associations with sap runs, specific plant species, fungi, dung, decaying wood and other vegetable matter, different aquatic habitats, nests of bees, wasps and ants, (specific) aphid species or small caterpillars). Hoverflies can easily been sampled, using a simple insect net, malaise traps or water traps. Up-to-date distribution maps of Hoverflies in Belgium are available (VERLINDEN, 1991), based on more than 70,000 records. The analysis of these distribution maps permits us to recognize species groups of different rarit y which, in their turn, can be used in ecological evaluation studies of traps, habitats, sites or even different regions in Belgium.

The proposed arcsin-scale method

The method we propose here is based on the number of UTM-squares (10 x 10 km) where a Hoverfly species has been recorded since 1950 (maps published in VERLINDEN, 1991). The number of UTM-squares can be considered as a measure of both the distribution pattern of a species (widespread versus local species) and its frequency (very common versus very rare species). It should be noted, however, that there may be a tendency of overestimating the large or conspicuous species, compared to the more elusive ones, especially when the great majority of data were obtained by traditional means, i.e. eye-catches. Another possibility would be the use of the total number of records [1] of a species instead of the number of UTM-squares: this would certainly give a more reliable picture of the rarity of a species. However, for the Hoverfly fauna of Belgium, this information is not (yet) computerised.

Belgium is characterised by large zoogeographical differences and is de facto divided into two (politically) separate regions: Flanders and Wallonia. For our purpose, Belgium has been subdivided into 4 zones [2] (Fig. 1). This allows for site evaluation on local, regional and national scales.

For site evaluation each species must be given a set of valuation indices according to its status (based on the number of UTM-squares or records). Altogether, 10 status categories are adopted here, ranging from the very common species (category 1) to the extremely threatened species (category 10). If necessary, the species with no recent records (in our case no records after 1950) can be given an additional value 11.

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[1] One 'record' may be defined as the observation of a species in a particular site during one particular year.

[2] These zones have been adopted as they approximately coincide with distribution patterns roughly shared by a very considerable number of species. The northern lowlands have been divided into a western and an eastern section on this ground. As for the Walloon part of the country the Sambre-Meuse valley constitutes the northern limit of the area of many hoverfly species : it therefore seemed a practical solution to divide this region into two parts as well.

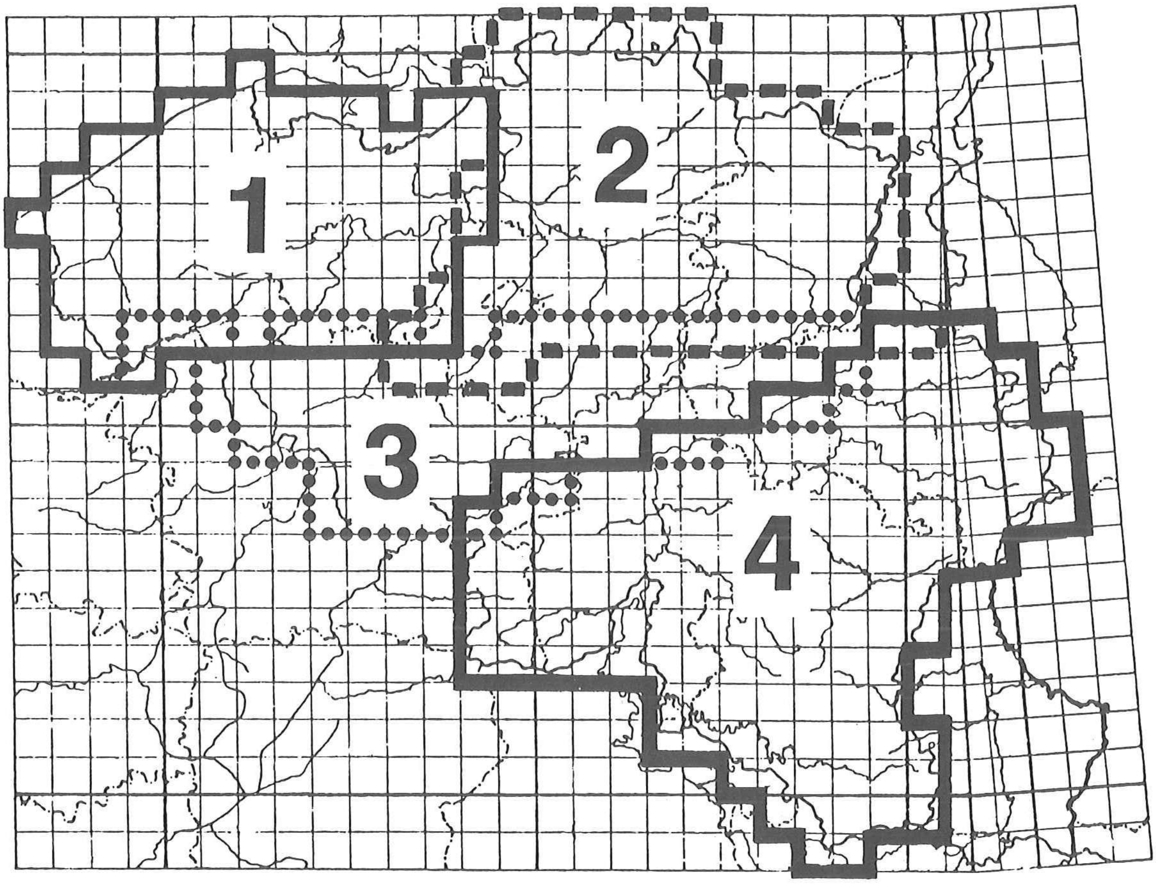

Fig. 1. For six parts of Belgium valuation categories were calculated.

1. FLANDERS: WESTERN PART
   Total of UTM-squares: 80
   Commonest hoverfly: *Episyrphus balteatus* and *Eristalis arbustorum* (59 squares)
2. FLANDERS: EASTERN PART
   Total of UTM-squares: 100
   Commonest hoverfly: *Helophilus pendulus* (74 squares)
3. WALLONIA: NORTHERN PART
   Total of UTM-squares: 78
   Commonest hoverfly: *Eristalis arbustorum* (77 squares)
4. WALLONIA: SOUTHERN PART
   Total of UTM-squares: 144
   Commonest hoverfly: *Rhingia campestris* and *Eristalis tenax* (127 squares)

1 + 2. FLANDERS
   Total of UTM-squares: 175
   Commonest hoverfly: *Helophilus pendulus* (128 squares)

3 + 4. WALLONIA
   Total of UTM-squares: 214
   Commonest hoverfly: *Rhingia campestris* and *Eristalis tenax* (193 squares)

1 + 2 + 3 + 4. BELGIUM
   Total of UTM-squares: 365
   Commonest hoverfly: *Eristalis pertinax* (297 squares).

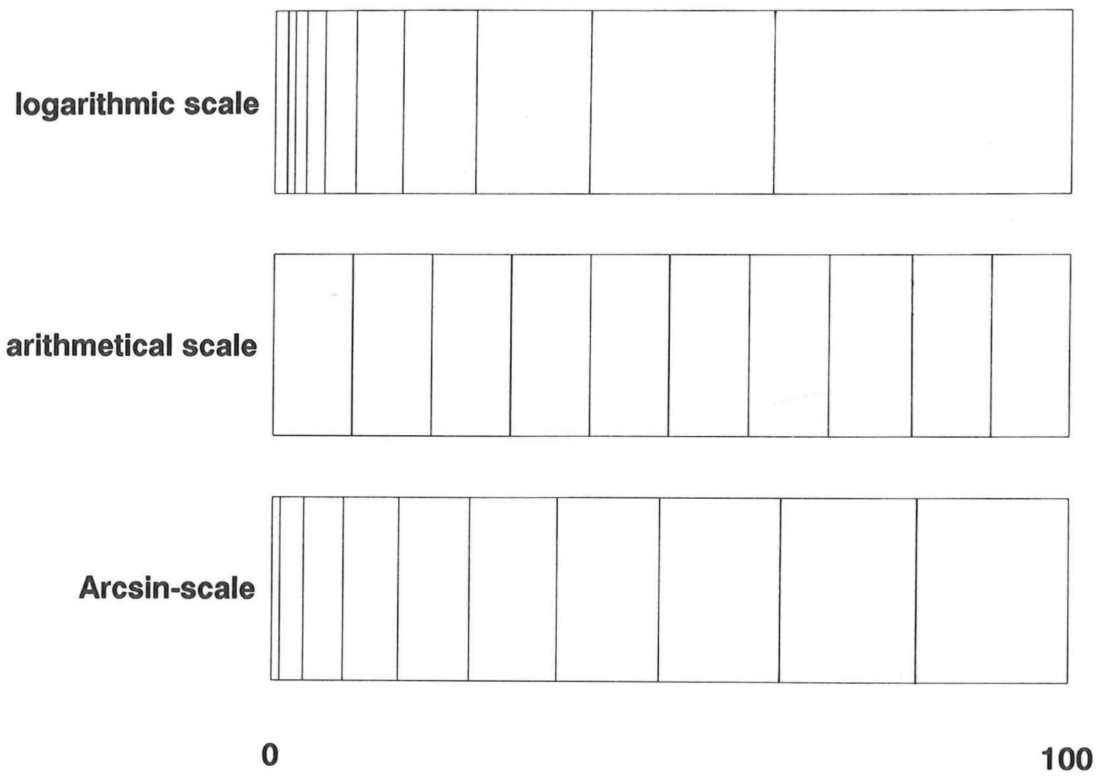

Fig. 2. Subdivision of 100 in 10 frequency classes on the basis of a logarithmic, arithmetical and Arcsin-scale.

The 10 categories are defined on the basis of an Arcsin-scale. Compared with a logarithmic or arithmetical scale, this method gives the most convenient subdivisions (see Fig. 2). Since an Arcsin-transformation stretches out both tails of a distribution of proportions and compresses the middle (SOKAL & ROHLF, 1981), this method allows a more precise evaluation of both 'rare' and 'common' species.

There is no evidence that sampling has been evenly spread over the territory. Therefore calculation of the interval limits of the number of UTM-squares for each category is based on the score of the most common species in each zone (e.g. cat. 1 for Flanders is defined as 105 to 128 UTM-squares, since *Helophilus pendulus* is the most common species, known from 128 UTM-squares). Intervals for the different zones and categories are shown in Table 1.

A check list of the Belgian Hoverfly species with indication of their valuation index for the different parts of Belgium is presented in Appendix 1. A frequency distribution of the number of species per category is given in Table 2. Thirteen species have not been recorded since 1950: *Chamaesyrphus lusitanicus, Chrysogaster macquarti, Eristalis cryptarum, Eumerus tarsalis, Mallota cimbiciformis, Orthonevra intermedia, Parhelophilus consimilis, Psarus abdominalis, Paragus bicolor, Paragus flammeus, Rhingia rostrata, Tropidia fasciata* and *Xylota curvipes*.

Practical use of the arcsin-scale method

Evaluation of sites (or habitats or traps) is possible by comparing:

* the number of 'rare' species (e.g. belonging to cat.7-10)
* their mean valuation index with 95%-confidence intervals
* the total sum of all valuation indices in relation to the minimal total sum which can be expected for the recorded number of species
* the number of species for each of the 10 categories in relation to habitat requirements of the immature and adult stages.

This method may also be used to compare the status of a species in different parts of a country or between countries and allows the indication of 'Red Data Book'-species on a more standardised basis (e.g. species belonging to categories 9-10). This method can be helpful when trying to find out which species are declining all over Europe. Of course the degree of threat can be subdivided into several categories, according to habitat requirements or decrease in the number of records.

A slight disadvantage of the proposed method is that the interval limits of the different valuation categories may need modification each time updated distribution data become available. With a view to the extreme population variations from year to year shown by a considerable number of species such updatings should not be undertaken at too short intervals.

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Table 1. Interval limits of the number of UTM-squares for 10 valuation categories for different parts of Belgium. The limits are defined on the basis of an Arcsin-scale. The maximum limit of category 1 is based on the number of UTM-squares of the most abundant species in that particular part of Belgium.

Valuation Index	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
10	1	1	1	1	1	1-2	1-3
9	2	2-3	2-5	2-3	2-5	3-8	4-12
8	3-5	4-7	6-12	4-7	6-11	9-17	13-27
7	6-9	8-12	13-21	8-12	12-20	18-31	28-48
6	10-15	13-19	22-32	13-19	21-32	32-48	49-75
5	16-21	20-27	33-46	20-28	33-46	49-70	76-108
4	22-29	28-36	47-63	28-38	47-62	71-95	109-146
3	30-38	37-47	64-82	39-49	63-81	96-124	147-191
2	39-48	48-60	83-104	50-62	82-103	125-157	192-241
1	49-59	61-74	105-128	63-77	104-127	158-193	242-297

Table 2. Frequency distribution of the number of hoverflies for the 10 valuation categories in the different parts of Belgium. Additionally listed are the total number of 1) species not (yet) recorded in this part of Belgium; 2) species only recorded before 1950; 3) species recorded since 1950; 4) species recorded before and/or after 1950.

Valuation Index	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
No records	114	54	48	82	20	12	-
only < 1950	19	24	23	23	16	17	13
10	37	33	34	31	33	48	53
9	22	24	37	38	60	60	60
8	36	43	57	49	52	56	64
7	24	46	38	20	31	34	38
6	18	25	22	22	35	30	25
5	11	21	18	12	24	18	23
4	9	14	12	11	12	8	9
3	10	10	6	9	12	11	12
2	10	12	12	13	12	17	12
1	7	11	10	7	10	6	8
only > 1950	184	239	246	212	281	288	304
< + > 1950	203	263	269	235	297	305	317

Appendix 1

Check list of the Belgian Hoverfly species with indication of their valuation index for the different regions of Belgium. The nomenclature follows VERLINDEN (1991).

1	= extremely common,
10	= extremely rare,
*	= not recorded since 1950,
-	= never recorded in this part of Belgium.

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
Anasimyia contracta	9	8	8	*	-	*	9
A. interpuncta	6	6	6	8	9	9	7
A. lineata	5	4	4	8	8	8	6
A. lunulata	10	10	10	-	-	-	10
A. transfuga	6	7	6	8	9	9	7
Arctophila bombiformis	-	*	*	10	6	7	8
A. fulva	*	9	9	*	7	8	8
Baccha elongata	4	4	4	5	5	5	4
Blera fallax	-	*	*	*	8	9	9
Brachyopa bicolor	9	9	9	*	9	9	9
B. insensilis	-	*	*	*	10	10	10
B. panzeri	-	-	-	-	9	9	9
B. pilosa	9	7	7	9	8	9	8
B. scutellaris	7	7	7	8	9	8	8
B. testacea	-	9	9	9	8	8	9
B. vittata	-	-	-	-	9	9	10
Brachypalpus eunotus	-	-	-	-	10	10	10
B. laphriformis	10	10	9	8	8	8	9
B. meigeni	-	-	-	-	10	10	10
B. valgus	10	-	10	-	10	10	10
Caliprobola speciosa	-	8	8	7	7	7	7
Callicera aenea	-	-	-	-	10	10	10
C. bertolonii	-	-	-	10	10	10	10
C. rufa	-	-	-	-	10	10	10
Ceriana conopsoides	*	10	10	9	9	9	9
Chamaesyrphus lusitanicus	-	*	*	-	-	-	*
C. scaevoides	-	-	-	-	10	10	10
Cheilosia albipila	7	5	6	6	7	7	6
C. albitarsis	3	2	3	2	2	2	2
C. antiqua	10	8	8	8	8	8	8
C. barbata	-	10	10	9	4	6	6
C. bergenstammi	8	8	8	8	7	7	8

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
C. caerulescens	-	10	10	9	9	9	9
C. canicularis	10	6	7	6	6	6	6
C. carbonaria	9	7	7	8	7	7	7
C. chlorus	9	6	7	6	7	6	7
C. chrysocoma	*	7	8	8	7	6	7
C. cynocephala	9	7	8	8	9	8	8
C. fasciata	-	10	10	-	10	10	10
C. flavipes	-	10	10	-	7	8	8
C. fraterna	8	6	7	7	6	7	7
C. frontalis	-	-	-	-	9	10	10
C. grossa	7	7	7	7	8	8	8
C. honesta	-	10	10	-	8	8	9
C. illustrata	9	5	6	5	2	3	4
C. impressa	7	5	6	7	6	7	6
C. intonsa	8	7	8	9	7	8	8
C. lenis	-	8	9	6	6	6	7
C. longula	10	7	8	-	9	9	8
C. maculata	10	8	8	9	8	8	8
C. mutabilis	8	7	7	*	7	8	7
C. nasutula	-	9	9	9	7	8	8
C. nebulosa	-	-	-	-	10	10	10
C. nigripes	10	9	9	8	8	8	9
C. pagana	4	3	3	4	3	3	3
C. praecox	8	8	8	8	8	8	8
C. proxima	10	7	8	8	7	6	7
C. pubera	-	10	10	-	9	9	9
C. rotundiventris	10	8	8	9	9	9	8
C. ruficollis	-	10	10	-	9	10	10
C. rufimana	10	8	8	8	8	8	8
C. scutellata	9	6	7	7	6	6	6
C. semifasciata	*	9	9	-	9	9	9
C. soror	-	-	-	10	9	9	9

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
C. uviformis	*	10	10	-	9	9	9
C. variabilis	7	5	6	4	3	3	4
C. velutina	10	7	8	7	8	8	8
C. vernalis	6	5	5	7	5	6	5
C. vulpina	-	10	10	9	9	9	9
Chrysogaster chalybeata	9	7	8	8	8	8	8
C. hirtella	4	4	4	6	6	6	5
C. macquarti	-	*	*	-	-	-	*
C. solstitialis	6	5	5	6	4	5	5
C. viduata	7	5	6	6	5	5	5
C. virescens	10	10	9	-	8	8	8
Chrysotoxum arcuatum	-	9	9	9	5	6	7
C. bicinctum	7	4	5	5	4	5	5
C. cautum	8	3	5	2	3	3	3
C. elegans	-	10	10	*	*	*	10
C. festivum	*	6	7	8	7	7	7
C. intermedium	-	*	*	10	*	10	10
C. latilimbatum	-	-	-	-	10	10	10
C. octomaculatum	-	9	9	*	9	10	9
C. vernale	-	7	8	-	8	8	8
C. verralli	-	-	-	*	9	9	9
Criorhina asilica	8	8	8	8	7	7	8
C. berberina	6	5	5	5	5	5	5
C. floccosa	8	7	8	8	9	8	8
C. pachymera	-	8	9	9	-	9	9
C. ranunculi	10	9	9	9	8	8	8
Dasysyrphus albostriatus	5	4	5	5	5	5	5
D. friuliensis	-	-	-	9	7	8	8
D. hilaris	8	6	6	7	6	6	6
D. lunulatus	9	7	7	8	6	7	7
D. nigricornis	-	-	-	-	10	10	10
D. tricinctus	8	4	6	6	5	5	5

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
D. venustus	6	3	4	5	3	4	4
Didea alneti	-	9	9	10	8	9	9
D. fasciata	7	7	7	8	6	7	7
D. intermedia	8	8	8	9	8	8	8
Doros conopseus	-	9	9	*	9	9	9
Epistrophe diaphana	-	-	-	-	8	8	9
E. eligans	5	4	4	4	4	4	4
E. euchroma	-	8	8	8	8	8	8
E. grossulariae	8	7	7	7	5	6	6
E. melanostoma	-	8	9	8	8	8	8
E. melanostomoides	*	-	*	8	7	8	8
E. nitidicollis	7	6	6	5	6	6	6
E. ochrostoma	-	9	9	8	8	8	9
Episyrphus auricollis	5	7	6	7	6	6	6
E. balteatus	1	1	1	1	1	1	1
E. cinctellus	7	5	6	6	3	4	5
Eriozona syrphoides	*	-	*	9	7	8	9
Eristalis abusivus	3	5	4	6	5	5	5
E. aeneus	6	7	7	6	9	7	7
E. alpinus	-	*	*	-	10	10	10
E. arbustorum	1	1	1	1	1	1	1
E. cryptarum	-	*	*	-	*	*	*
E. horticola	6	3	5	5	1	2	3
E. intricarius	2	2	2	4	4	2	3
E. jugorum	-	-	-	-	6	7	7
E. nemorum	5	2	4	3	1	2	2
E. pertinax	1	1	1	1	1	1	1
E. piceus	-	7	8	8	7	7	7
E. pratorum	6	6	6	5	6	5	5
E. rupium	-	10	10	8	5	6	6
E. sepulchralis	2	2	2	3	5	4	3
E. tenax	1	1	1	1	1	1	1

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
Eumerus flavitarsis	-	-	-	-	9	9	9
E. ornatus	-	*	*	*	8	9	9
E. sabulonum	10	10	9	*	*	*	10
E. sogdianus	8	10	9	10	*	10	9
E. strigatus	5	7	6	7	8	7	7
E. tarsalis	-	-	-	*	*	*	*
E. tricolor	-	10	10	10	9	9	9
E. tuberculatus	8	7	7	9	8	9	8
Ferdinandea cuprea	7	6	6	6	5	6	6
F. ruficornis	*	-	*	10	9	9	9
Helophilus hybridus	5	5	5	9	9	9	7
H. pendulus	1	1	1	2	2	2	1
H. trivittatus	3	2	2	3	3	3	3
Heringia heringi	8	8	8	9	9	9	8
H. senilis	-	10	10	10	9	10	10
Ischyrosyrphus glaucius	9	7	7	6	3	4	5
I. laternarius	8	6	7	9	6	6	5
Lejogaster metallina	4	5	5	6	7	6	5
L. splendida	7	8	8	-	-	9	8
Lejops vittata	10	*	10	-	-	-	10
Leucozona lucorum	8	4	6	4	3	5	5
Mallota cimbiciformis	-	*	*	-	-	-	*
M. fuciformis	10	*	10	10	10	10	10
Megasyrphus annulipes	-	7	8	9	6	7	7
Melangyna barbifrons	-	*	*	-	10	10	10
M. cincta	6	6	6	7	7	7	6
M. compositarum	-	-	-	-	9	9	9
M. guttata	8	7	7	10	10	10	8
M. labiatarum	-	-	-	-	7	8	8
M. lasiophthalma	9	8	8	9	8	8	8
M. quadrimaculata	10	8	9	*	*	*	9
M. triangulifera	8	7	7	8	8	8	8

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
M. umbellatarum	7	7	7	8	7	7	7
Melanostoma mellinum	2	1	1	2	2	2	2
M. scalare	3	2	2	3	2	3	2
Merodon aeneus	-	-	-	-	10	10	10
M. avidus	10	*	10	*	10	10	10
M. equestris	5	5	5	3	4	3	4
M. ruficornis	-	10	10	-	10	10	10
M. rufus	-	-	-	-	10	10	10
Metasyrphus corollae	2	3	2	3	2	2	2
M. lapponicus	8	8	8	8	6	7	7
M. latifasciatus	6	6	6	6	5	6	6
M. latilunulatus	8	8	8	8	8	8	8
M. luniger	5	5	5	4	5	5	5
M. nielseni	10	-	10	-	9	9	9
M. nitens	-	-	-	10	7	8	8
Microdon devius	*	10	10	10	8	9	9
M. eggeri	-	8	9	10	6	7	8
M. mutabilis	-	9	9	-	9	10	9
Myathropa florea	2	1	2	1	1	1	1
Myolepta luteola	-	10	10	10	-	10	10
M. vara	*	10	10	-	*	*	10
Neoascia aenea	7	7	7	8	7	8	7
N. dispar	4	4	4	7	6	7	5
N. floralis	-	-	-	-	10	10	10
N. geniculata	7	8	8	-	10	10	8
N. interrupta	8	9	8	-	10	10	9
N. obliqua	-	8	9	9	9	9	9
N. podagrica	2	2	2	3	3	3	3
N. unifasciata	-	-	-	-	10	10	10
Neocnemodon brevidens	7	8	8	10	-	10	9
N. latitarsus	10	9	9	-	-	-	10
N. pubescens	8	8	8	9	8	8	8

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
N. vitripennis	6	6	6	8	8	8	7
Olbiosyrphus laetus	-	-	-	-	10	10	10
Orthonevra brevicornis	10	8	8	8	8	8	8
O. elegans	-	*	*	*	9	9	10
O. geniculata	9	7	8	10	8	9	8
O. intermedia	*	*	*	-	-	-	*
O. nobilis	-	8	8	9	6	7	7
O. splendens	10	7	8	7	9	8	8
Paragus albifrons	-	-	-	-	9	10	10
P. bicolor	-	*	*	-	*	*	*
P. finitimus	*	10	10	-	9	9	9
P. flammeus	-	-	-	-	*	*	*
P. haemorrhous	8	7	7	8	7	8	7
P. majoranae	-	9	9	-	9	9	9
P. tibialis	8	*	9	-	10	10	9
Parasyrphus annulatus	10	8	8	-	7	8	8
P. lineola	-	7	8	8	4	5	6
P. macularis	-	-	-	-	8	8	9
P. malinellus	10	9	9	9	6	7	8
P. nigritarsis	-	9	9	10	10	10	9
P. punctulatus	7	7	7	8	6	7	7
P. vittiger	-	8	9	10	6	7	7
Parhelophilus consimilis	*	*	*	-	-	-	*
P. frutetorum	10	6	7	8	8	8	8
P. versicolor	8	7	7	9	9	9	8
Pelecocera tricincta	*	10	10	-	10	10	10
Pipiza austriaca	10	6	7	8	6	7	7
P. bimaculata	7	7	7	8	6	7	7
P. fenestrata	*	9	9	8	9	9	9
P. festiva	8	8	8	8	9	9	9
P. lugubris	8	7	7	9	8	8	8
P. luteitarsis	9	9	9	8	9	9	9

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
P. noctiluca	7	6	6	7	6	6	6
P. notata	*	10	10	-	9	9	9
P. quadrimaculata	9	8	8	8	5	6	7
P. signata	10	9	9	-	9	10	9
Pipizella annulata	-	-	-	9	8	9	9
P. divicoi	-	-	-	10	9	9	10
P. maculipennis	-	10	10	-	-	-	10
P. pennina	-	-	-	-	10	10	10
P. varipes	6	5	5	7	5	5	5
P. virens	*	7	8	9	8	8	8
P. zeneggenensis	-	*	*	*	9	10	10
P. spec.	-	10	10	-	-	-	10
Platycheirus albimanus	3	2	2	2	2	2	2
P. ambiguus	9	8	8	10	9	9	9
P. amplus	-	-	-	-	9	10	10
P. angustatus	3	3	3	5	5	5	4
P. clypeatus	2	1	1	2	1	2	2
P. discimanus	10	*	10	*	10	10	10
P. europaeus	-	-	-	-	10	10	10
P. fulviventris	4	5	5	9	8	8	6
P. immarginatus	7	10	8	-	-	-	9
P. manicatus	6	5	5	5	5	5	5
P. occultus	-	-	-	-	9	9	9
P. ovalis	10	7	8	6	6	6	7
P. peltatus	2	1	1	2	3	2	2
P. perpallidus	10	9	9	-	*	*	10
P. scambus	4	5	4	8	6	7	5
P. scutatus	2	3	2	3	4	3	3
P. sticticus	-	10	10	-	*	*	10
P. tarsalis	10	8	8	8	8	8	8
Pocota personata	*	-	*	10	-	10	10
Psarus abdominalis	-	*	*	*	*	*	*

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
Pyrophaena granditarsa	4	3	3	5	4	4	4
P. rosarum	8	4	6	6	5	6	6
Rhingia campestris	1	1	1	1	1	1	1
R. rostrata	-	-	-	*	*	*	*
Scaeva pyrastri	3	4	3	2	5	3	3
S. selenetica	6	4	5	4	4	4	4
Sericomyia lappona	-	7	8	9	6	6	7
S. silentis	8	6	7	7	4	5	5
Sphaerophoria batava	9	6	7	10	9	9	8
S. chongjini	-	-	-	-	9	10	10
S. fatarum	-	7	8	9	9	9	8
S. loewi	-	10	10	*	-	*	10
S. menthastri	10	9	9	10	6	6	7
S. philantus	-	8	9	*	8	9	9
S. rueppelli	8	7	8	8	9	9	8
S. scripta	3	2	2	2	2	2	2
S. taeniata	8	6	7	9	6	7	6
S. virgata	10	8	8	10	8	8	8
Sphegina clunipes	8	6	7	7	5	6	6
S. kimakowiczi	10	7	8	8	7	7	7
S. nigra	-	8	9	9	8	8	8
S. sibirica	-	-	-	-	9	9	9
S. verecunda	-	9	9	10	10	10	10
Spiximorpha subsessilis	-	*	*	9	9	9	9
Spilomyia saltuum	-	10	10	*	-	*	10
Syritta pipiens	1	1	1	2	2	2	1
Syrphus nitidifrons	-	-	-	-	9	10	10
S. ribesii	2	2	2	2	2	2	2
S. torvus	5	3	4	4	3	3	3
S. vitripennis	3	2	3	2	3	2	2
Temnostoma apiforme	-	-	-	-	8	9	9
T. bombylans	9	6	7	6	6	6	7

	Flanders West	Flanders East	Flanders	Wallonia North	Wallonia South	Wallonia	Belgium
T. vespiforme	9	6	7	6	5	6	6
Trichopsomyia carbonaria	-	-	-	-	9	9	9
T. flavitarse	8	7	8	-	8	9	8
T. lucida	10	8	8	-	9	10	9
Triglyphus primus	9	8	8	9	9	9	9
Tropidia fasciata	-	-	-	-	*	*	*
T. scita	3	4	4	8	10	8	6
Volucella bombylans	5	3	4	3	2	2	3
V. inanis	-	10	10	8	7	7	8
V. inflata	-	*	*	10	7	8	8
V. pellucens	6	4	5	4	1	2	3
V. zonaria	7	7	7	6	7	7	7
Xanthandrus comtus	7	8	7	10	8	9	8
Xanthogramma citrofasciatum	10	7	8	6	5	5	6
X. pedissequum	6	5	5	4	5	5	5
Xylota abiens	8	8	8	10	7	8	8
X. coeruliventris	-	-	-	-	6	7	8
X. curvipes	-	-	-	-	*	*	*
X. femorata	-	-	-	*	8	8	9
X. florum	8	6	7	7	6	6	6
X. ignava	-	-	-	-	8	9	9
X. lenta	7	6	7	6	6	6	6
X. meigeniana	-	8	8	10	8	9	8
X. nemorum	7	5	6	7	8	7	7
X. pigra	-	-	-	-	9	9	9
X. segnis	4	2	2	2	2	2	2
X. sylvarum	6	5	5	4	4	4	5
X. tarda	9	8	8	10	8	8	8
X. xanthocnema	9	8	8	9	9	9	8

Gardens: An important refuge for insects, or a green desert ?

by Luc DE BRUYN, Luc VERLINDEN & Jens VERWAERDE

Abstract

In recent years, the conservation of insects has received increasing attention. It has been stated several times in the past that gardens are becoming increasingly important as a refuge for wildlife, particularly for smaller organisms like insects and other small Arthropods.
To test this hypothesis, a sampling campaign was started in three gardens with a different environmental background, but each typical for the local situation. The order of Diptera was chosen as a target group because it is a large insect group which encompasses a wide range of feeding styles (e.g. herbivores, predators, parasitoids, detrivores, coprophages, ...). In addition, flies were collected in a number of natural habitats (including several nature reserves). To capture the flies a Malaise trap was used at each sample site.
A preliminary analysis of the data revealed that in general the Diptera fauna of the gardens studied is poor compared to the Diptera fauna of natural habitats.
Key-words: insect conservation, gardens, Diptera.

Samenvatting

De laatste jaren wordt meer en meer aandacht geschonken aan de bescherming van insekten. In het verleden werd verscheidene malen geopperd dat tuinen een steeds belangrijkere rol spelen als een refugium voor bedreigde dieren en meer bepaald voor kleinere organismen zoals insekten en andere Arthropoda. Om deze hypothese te testen werd gestart met de inventarisatie van drie tuinen, elk gelegen in een andere ecologische omgeving. Als doelgroep werd de orde Diptera uitgekozen daar dit een grote insektengroep is waarvan de vertegenwoordigers een groot aantal verschillende voedingswijzen vertonen (o.a. herbivoren, predatoren, parasitoïden, detritivoren, coprofagen, ...). Naast de tuinen werden tevens Diptera verzameld in een aantal natuurlijke habitaten (inclusief een aantal natuurreservaten). Om de vliegen te vangen werden Malaise vallen gebruikt.
De analyse van de gegevens toonde aan dat, algemeen genomen, de Diptera fauna van de tuinen veel armer was dan deze van de natuurlijke habitaten.
Trefwoorden: bescherming van insekten, tuinen, Diptera.

Introduction

One of the most important aspects of human impact on nature is fragmentation of natural habitats. The resulting distribution and subdivision of the total habitat not only holds important demographical and evolutionary implications, but also largely affects the extinction probability of a resident animal or plant population (SOULÉ, 1986; SAUNDERS *et al.*, 1991). Therefore the preservation of suitable habitats is of vital importance in nature conservation (PYLE *et al.*, 1981; NOSS, 1987; SAMWAYS, 1989a).

In the past, biological conservation efforts were mainly focused on plants, birds and/or mammals (USHER, 1986). The last decade, however, the conservation of insects has received increasing attention. (PYLE *et al.*, 1981; SAMWAYS, 1989b; COLLIN *et al.*, 1991), This is not only because many of them are endangered, but also because insects are particularly good ecological indicators which makes them suitable for site assessment for nature conservation (DISNEY, 1986; SIEPEL, 1989; USHER, 1990).

It has been stated repeatedly that gardens are becoming increasingly important as a refuge for wildlife, particularly for smaller organisms like insects (OWEN, 1980, 1991). OWEN & OWEN (1975) and OWEN (1991) even stated that suburban gardens could constitute the most important nature reserve for small Arthropods. However, a faunal survey of a garden in Schoten in 1983 revealed that the entomofauna, and more particular the Diptera fauna, was quite poor (POLLET & DE BRUYN, 1987). Other studies carried out in agricultural and residential areas gave analogous results (BANKS, 1959; BANKOWSKA, 1980). To test whether or not the assumption of OWEN & OWEN (1975) and OWEN (1991) can be applied to insects, and more in particular to Diptera, we started a sampling campaign in two additional gardens in the vicinity of Antwerp (Belgium). The results were compared with the faunal composition of some natural habitats in the same geographical area.

Material and Methods

Sample localities

During the present study the entomofauna of three garden habitats (Schoten - FS.08; Wijnegem - FS.07 and Oelegem - FS.17) and six natural habitats (the nature reserve "De Kuifeend": Antwerpen - ES.98, two sites; the nature reserve "De Oude Landen": Ekeren - ES.98, two sites; and the nature reserve "Het Groot Schietveld": Wuustwezel - FS.09 and Brasschaat - FS.08) were compared.

The garden in Schoten, which covers a total surface of approximately 500 m^2, consists mainly of two habitat types; a more or less conventional garden and an unkempt woodland. The first consists of a central lawn (mown weekly) bordered by flowerbeds and shrubberies. Many plants are introduced aliens, other are natives which could penetrate the garden, or were introduced intentionally, and established afterwards. A small pond ($\pm$ 20 m^2) bordered by a swampy vegetation is situated in one of the corners of the garden. The other side of the garden serves as a small orchard of *Malus* sp., *Prunus persica* and *Pyrus* sp. The woodland consists mainly of native trees like *Alnus glutinosa*, *Quercus rubra*, *Q. robur*, *Betula pendula* and *Sorbus aucuparia*. Furthermore, we have to mention the sampling plot was situated in a humid environment due to the presence of a (strongly polluted) brooklet which has its course through the garden, and the canal Schoten-Turnhout at the back of the garden. The adjacent gardens are similar in general appearance although the vegetational diversity is usually lower due to a strong dominance of shortly cut lawns.

The main part of the garden in Wijnegem ($\pm$ 250 m^2) is also occupied by a central lawn (mown twice a week), surrounded by coniferous and ornamental shrubs (*Viburnum* sp., *Forsytia* sp., *Syringa* sp.). A number of fruit trees (*Malus* sp., *Pyrus* sp., *Prunus* sp.) are scattered in the garden. The garden is situated in a residential area with approximately the same type of gardens in the neighbourhood. At the other side of the house there is an agricultural pasture of $\pm$ 3 ha.

The third garden, "Vrieselhof" at Oelegem ($\pm$ 900 m^2) is situated at the edge of a deciduous forest (mainly *Fagus*). Here again, there is a large central lawn (mown at longer, irregular intervals) with a *Crataegus* hedge. A few coniferous shrubs and trees are scattered in the garden. At one side, the garden is bordered by a house, on the other side by the stables of a riding school.

In the nature reserve "De Kuifeend" two different habitat types were selected. The first (Kuifeend 1), was a narrow strip (± 20 m) of moist reedland, bordered by a lake at the one side and a moist *Salix* forest at the other side. The vegetation consisted mainly of *Phragmites australis* with patches of *Carex* sp. and *Typha latifolia*. The second habitat (Kuifeend 2) was a ruderal area on a sandy soil. Dominant plants were Poaceae, *Oenothera parviflora, Reseda lutea, Urtica dioica* and *Symphytum officinale*.

The first sample plot in the nature reserve "De Oude landen" (Oude Landen 1) was situated in a large marshy reedland, dominated by *Phragmites australis*. Other abundant species were *Carex* spp. Some 20 m to the North was a deciduous forest edge. The second plot (Oude Landen 2) consisted of an overgrown, moist grassland, surrounded by an *Alnus-Salix* brushwood. Abundant plant species in the grassland were *Symphytum officinale, Mentha aquatica* and some *Carex* spp.

Both sample plots in the nature reserve "Groot Schietveld" were heathland habitats, dominated by *Molinia caerulea*. In the first (Groot Schietveld 1), which was very humid, also *Phragmites australis, Narthecium ossifragum* and *Juncus* spp. were abundant. Some *Betula pendula* trees were scattered in the vegetation. In the second, dry heathland (Groot Schietveld 2), *Molinia caerulea* was less abundant and replaced by *Calluna vulgaris* and *Erica tetralix*. Several forest patches of *Betula pendula* and *Myrica gale* were scattered in the sample station.

Collection techniques

To collect the flies, one Malaise trap (Townes, 1972; Muirhead-Thomson, 1991) was used at each sample station. The trap has a black, vertical panel which forms a barrier across the flight paths of flying insects. The insects striking this barrier crawl upwards into a peaked roof where they enter a collecting jar attached at the highest point of the trap. The collecting jar was filled with a 70% alcohol solution. The traps in the three gardens were operative from 28.04.1991 to 25.08.1991 and emptied at weekly intervals. The other trap were active during complete year cycles, but only the same time period was used in the faunal analyses. For each locality we determined the species number and abundance, and calculated the diversity index (Shannon-Wiener index and Simpson index) and evenness index (Hurlbert index) (Pielou, 1966; Krebs, 1989).

Results

Identification of the captured flies revealed that representatives of several Diptera families were present (e.g. Pollet & De Bruyn, 1987). In the present work, we confined our analyses to the family Syrphidae. This family was selected because it is a well studied and well known, rather large group of insects that encompass a wide range of feeding styles like herbivores, predators, coprophages, ... (e.g. Owen, 1981; Verlinden & Decleer, 1987; Röder, 1990). Besides this, an extensive survey of the Belgian Diptera fauna has been carried out during the last decade (Grootaert, 1989) which gives us a fair idea of the actual distribution and abundance of the different Syrphidae species (Verlinden & Decleer, 1987).

All three gardens harbour conspicuously less Syrphidae species than the natural habitats (Tab. 1). In addition, these species are all caught in very low numbers; most species are only represented by a single individual. This is also reflected in the diversity indices which are lowest for the gardens. Furthermore, the Hurlbert evenness index shows the hoverfly communities in Wijnegem and Oelegem are not homogeneously spread. Two species, *Episyrphus balteatus* (DE GEER) (Wijnegem: 190; Oelegem: 95) and *Metasyrphus corollae* (FABRICIUS) (Wijnegem: 89; Oelegem: 15), together account for 79% and 63.6% of the total number hoverflies collected in the respective localities. Both species are known to migrate in large numbers over long distances (AUBERT *et al.*, 1976; GATTER & SCHMID, 1990). Almost all specimens of both fly species were caught during one single week between 2.08.1991 and 9.08.1991. During this period the flies were also recorded in high numbers throughout the country. This indicates that the high numbers caught at both localities were presumably produced by migrating flies, and not by local breeding flies.

Table 1. Species composition, diversity (Shannon-Wiener & Simpson) index and evenness index of the different sample sites.

Locality	# species	# specimens	Shannon-Wiener	Simpson	Hurlbert	N_1
Schoten	14	36	2.062	0.853	0.781	0.724
Wijnegem	19	376	1.588	0.678	0.539	0.462
Oelegem	29	176	1.914	0.682	0.568	0.649
Oude Landen 1	37	1025	2.814	0.917	0.779	1.035
Oude Landen 2	55	1148	2.427	0.826	0.606	0.887
Groot Schietveld 1	48	519	2.678	0.886	0.692	0.985
Groot Schietveld 2	55	693	3.095	0.928	0.772	1.130
Kuifeend 1	47	2023	2.769	0.946	0.719	1.018
Kuifeend 2	64	2238	2.789	0.926	0.671	1.026

When comparing sites for conservation purposes, the classical way of measuring species richness or species diversity indices, where all species (of the same taxonomic group) carry the same weight, are considered inadequate (VANE-WRIGHT *et al.*, 1991; COUSINS, 1991). In addition, other properties of the species in question have to be taken into account. Therefore we analysed the Syrphidae communities according to the adult habitat preference and migrating abilities, and the larval feeding type (Tab. 2).

The adults flies of most species caught in the gardens are eurytopic, while their larvae are opportunist feeders, mainly predacious on aphids and other Homoptera. Other species have aquatic larvae which are common in waters, strongly polluted with organic matter (e.g. *Eristalis arbustorum* (LINNAEUS), *Helophilus pendulus* (LINNAEUS)) or burrow in decaying organic matter (e.g. *Syritta pipiens* (LINNAEUS)). The phytophagous species *Merodon equestris* (FABRICIUS) and *Eumerus strigatus* (FALLÉN) are commonly encountered in gardens and other cultured areas. The larvae of both species live as internal parasites in bulbs (RÖDER, 1990). At Oelegem, also a considerable number of woodland species were caught as might have been expected with a view to the proximity of the deciduous forest.

It was quite surprising, however, to find that at Wijnegem a couple of the rare *Platycheirus ambiguous* (FALLÉN) was caught, so far the only capture in 50 Malaise trap samplings. Both at

Wijnegem and Oelegem there were single individuals of *Epistrophe melanostoma* (ZETTERSTEDT) and *Metasyrphus latilunulatus* (COLLIN), known from 22 and 28 UTM-squares respectively, but not known from this country until recent times. Especially these last years, *E. melanostoma* has turned up regularly and the species may well be a recent immigrant, expanding its area and now established and prospering. *M. latilunulatus* is probably a very widespread species; it was only defined accurately in 1976 by DUSEK & LASKA and is in the field indistinguishable from more common *Metasyrphus*; it has turned up (1 or 2 specimens) regularly in Malaise traps and may be less rare than we thought so far.

Table 2. **Species composition based on adult habitat preference, larval feeding type and adult migrating ability for the different sample localities (species with unknown or doubtful lifestyle are omitted).**

		Schoten	Wijnegem	Oelegem	Kuifeend 1	Kuifeend 2	Oude Landen 1	Oude Landen 2	Groot Schietveld 1	Groot Schietveld 2
adult habitat	ubiquist	8	11	15	21	27	19	23	22	25
	woodlands (s.l.)	2	4	10	2	11	6	16	14	11
	wetlands (s.l.)	1			13	13	8	7	5	11
	grasslands (s.l.)	2	3	2	7	6	4	5	3	4
	cultures / gardens	1	1		1	2		1		1
	xerophilous				3	2		1		2
larval type	carnivorous	9	18	21	23	30	21	32	25	26
	aquatic	2		3	17	20	11	9	8	15
	phytophagous	2	1	1	4	6	1	4		4
	nests					3		3	6	5
	rotting wood			3		1	2	3	4	4
	coprophagous	1		1	2	3	2	3	3	3
	sap feeding							1	1	
Migrants/	long distance migrants	6	7	6	11	13	10	10	10	13
	short distance migrants	4	6	12	7	10	8	11	9	9
	local species	6	8	11	31	44	19	19	28	38

In the nature reserves most species turned out to be eurytopic. In addition there were a fair number of flies with more specialised environmental requirements (e.g. xerophilous: *Paragus haemorrhous* MEIGEN, *Sphaerophoria rueppelli* (WIEDEMANN); swamps: *Neoascia* spp.; heathlands: *Chrysotoxum vernale* LOEW, *Didea intermedia* LOEW) or specialised larval feeding type, which were completely absent in the gardens. The latter group comprises species as *Chrysotoxum* spp. and *Microdon egerri* MIK which are scavengers in the nests of wasps and bumblebees, *Ferdinandea cuprea* (SCOPOLI) and *Brachyopa pilosa* COLLIN which feed on sap running from tree wounds and *Xylota* spp. with larvae living in decaying wood.

Interesting to notice is the small proportion of local species in the three garden habitats in comparison to the natural habitats (Tab. 2). Local species are species with low mobility which do not migrate during their life cycle and are assumed to breed in the garden or surrounding area. The other two groups of long distance and short distance migrators pass through a migrating phase to some extent (GATTER & SCHMID, 1990). The species of the last two categories may occasionally visit the garden when dispersing or migrating. However, as many migrants are known to breed in our country, it cannot be excluded that some of them actually are residents.

Another way to analyse the data is to look at the frequency of occurrence (Tab. 3). The different frequency classes are based on the number of UTM-squares (maximum = 401 squares; LECLERCQ *et al.*, 1980) in which a species has been recorded (VERLINDEN & DECLEER, 1987). Although this is obviously a rather rough way to catalogise the syrphid fauna, it gives us a fair idea of the relative commonness or rareness of the different species. The four classes used are common and widespread (more than 121 squares), frequent species (49-120 squares), infrequent species (25-48 squares) and rare or local species (fewer than 24 squares). In general, local species are those species which display a narrow ecological tolerance. As a result, these species can only survive in those localities where their specific ecological demands are fulfilled and are therefore usually only found at a limited number of sites. In these localities however, they can reach high population densities.

Table 3. Species composition based on the frequency of occurrence for the different sample localities (species with unknown or doubtful frequency of occurrence are omitted).

		Schoten	Wijnegem	Oelegem	Kuifeend 1	Kuifeend 2	Oude Landen 1	Oude Landen 2	Groot Schietveld 1	Groot Schietveld 2
Frequency	common and widespread	10	12	19	18	23	21	25	22	21
	frequent	4	9	9	16	20	10	15	15	21
	infrequent				6	11	5	7	4	7
	rare or local				6	8	1	8	5	6

In the three gardens, all captured species are common and widespread, or at least frequent (Tab. 3). In the nature reserves the hoverfly fauna is also largely dominated by common and widespread, or frequent species; in addition however, there are also a considerable number of infrequent and rare or local species. Among the locally abundant species we mainly find habitat specialists such as *Neoascia interrupta* (MEIGEN), *N. geniculata* (MEIGEN), *Lejogaster splendida* (MEIGEN), *Parhelophilus versicolor* (FABRICIUS), which are all bound to wetland situations (mainly marshes, vegetation at the margin of ponds and rivers but also humid woodlands), *Didea intermedia* LOEW, a species with affinities to xerotherm woodlands or heathlands and *Xylota meigeniana* STACKELBERG, an inhabitant of humid deciduous forests.

Three species were rarely recorded in the past and can be regarded as rare or threatened (VERLINDEN & DECLEER, 1987). *Cheilosia ruficollis* BECKER was formerly only recorded from 4 (5 specimens) localities. *Pipiza notata* MEIGEN was only reported from 6 localities (9 specimens), mostly in Malaise traps. Practically all records of *Doros conopseus* (FABRICIUS) date from before 1950. Only one additional specimen was found in 1960. Because no other specimen was found during the recent sample campaigns, it was thought that *D. conopseus* had virtually disappeared (VERLINDEN & DECLEER, 1987). The new discovery during the present study shows *D. conopseus* is not extinct, although it probably still is a highly endangered species.

Discussion

The results from our study revealed that, at least for the family Syrphidae, the gardens are a poor habitat for Diptera. The few species inhabiting the gardens are characterised by a high ecological tolerance and mostly possess a high ability to reproduce. These are especially species with aphidophagous larvae (*Episyrphus balteatus* (DE GEER), *Metasyrphus corollae* (FABRICIUS), *Sphaerophoria scripta* (LINNAEUS)) or generalist flies with aquatic larvae which can survive in small, temporary ponds, even when polluted, and/or saprophagous larvae (*Eristalis* spp., *Helophilus pendulus* (LINNAEUS)). More specialised species are completely absent, due to the intense management performed in the gardens. Most suburban gardens are indeed dominated by a large, short cut lawn, surrounded by flowerbeds with usually a strong dominance of introduced plants. The more specialised microhabitats needed for the larval development, such as old and rotting wood, tree wounds or nests of Hymenoptera, are lacking or removed soon after they appear.

Table 4. Species number and abundance for different habitat types.

Locality	UTM	year	# species	# specimen	habitat type
St-Martens Latem	ES.45	1985	14	187	Garden
Schoten	FS.07	1983	16	41	Garden
St-Truiden	FS.53	1985	15	76	Orchard
Bleret	FS.51	1984	17	181	Orchard
Woumen	DS.94	1986	18	120	lakeside grassland (*Phragmites*)
Zandvoorde	DS.97	1988	21	268	lakeside grassland (*Phragmites*)
Wemmel	ES.94	1987	23	215	Garden
Oostende	ES.97	1987	27	198	city park
Raverszijde 1	DS.87	1986	27	117	public park in sea dunes
Raverszijde 2	DS.87	1987	27	117	public park in sea dunes
Wanze	FS.50	1982	33	343	Garden
Oude Landen 1	ES.98	1988	37	1110	swamp (*Phragmites*)
Logne	FR.88	1986	38	546	deciduous wood
Erpent	FR.39	1984	39	831	Orchard
Antheit	FS.50	1986	40	314	wood edge
Koksijde	DS.76	1983	41	474	Garden
Torhout	ES.05	1986	42	658	moist *populus* wood
Turnhout 2	FS.38	1985	43	599	overgrown meadow
Virton	FQ.89	1987	45	341	abandoned orchard
Mont-Rigi 2	KA.99	1984	45	594	grassland/wood edge
De Kuifeend 1	ES.98	1988	49	2201	swamp
Gembloux	FS.10	1984	49	3745	woodland relict
Groot Schietveld 1	FS.09	1988	51	692	heathland (*Molinia*)
Oude Landen	ES.98	1989	55	1231	grassland/wood edge
Wingene	ES.25	1986	59	577	unkempt moorland
Groot Schietveld 2	FS.08	1989	60	708	heathland/wood edge
Targnon	FR.88	1986	66	427	deciduous woodland
Logne 2	FR.88	1989	67	1058	deciduous woodland (edge)
De Kuifeend 2	ES.98	1989	67	2266	overgrown meadow
Mont Rigi 1	KA.99	1983	69	1235	grassland/wood edge
Turnhout 1	FS.38	1982	76	1313	overgrown meadow
Treignes	FR.25	1984	79	1947	chalk grassland/wood edge
Werbamont	FR.88	1986	83	1747	wood edge
Virelles	ER.94	1986	103	3857	grassland/border of lake

The large sampling campaign, carried out at several localities spread over the different geographical regions in Belgium during the last decade (GROOTAERT, 1989) gave us the opportunity to extend our study to a much larger scale. As a result we were able to analyse the syrphid communities of 34 localities where a Malaise trap was active during a complete year cycle (Tab. 4). Among those localities were 5 gardens, 4 orchards (one abandoned) and three city parks. The other localities consisted of more natural habitats situated in nature reserves or other areas with less human interference. The results of these analyses confirm the conclusions obtained during the present study. Although the data were collected in geographical areas with different ecological backgrounds (DUFRÊNE & LEGENDRE, 1991), during different years, the man-made habitats on the average harbour fewer species at a lower population level than natural habitats.

The other dipteran groups which are thus far identified produce the same results. Only in some cases, where specific habitat requirements are fulfilled, species of special faunistic interest can occur. The Dolichopodidae community of the garden in Schoten consisted mainly of common, eurytopic species. Besides these, some less common species, characteristic for humid woodlands and fenlands were present (POLLET & DE BRUYN, 1987). Also at Schoten a compost heap, with mainly kitchen refuse, produced more sphaerocerid species, at higher population densities than a nature reserve in the same area (VEN & DE BRUYN, *in litt.*).

As a conclusion we can state that conventional gardens seem to be of low significance for the conservation of Diptera. Although appropriate garden management, creating and maintaining high plant and habitat diversity, can contribute to a high insect diversity, the conservation of rare and specialised species may only be possible by preservation of specific habitats in adequately managed nature reserves.

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Biogéographie, écologie et gestion d'habitats d'espèces de Lépidoptères Rhopalocères protégés (Lycaenidae, Satyridae)

par J. LHONORÉ

Résumé

Dans le cadre d'un contrat avec le Ministère de l'Environnement français, une nouvelle répartition géographique de quatre espèces de Lépidoptères est proposée (*Thersamolycaena dispar, Maculinea alcon, Maculinea teleius, Coenonympha oedippus*), ainsi que les premiers résultats de gestion écologique expérimentale pour deux taxons.

Mots-clés: biogéographie, Rhopalocères, aménagement de biotopes.

Summary

Within a French Ministery of Environment grant, a new geographic distribution of four butterflies is proposed (*Thersamolycaena dispar, Maculinea alcon, Maculinea teleius, Coenonympha oedippus*) as well as the first results on an experimental ecological gestion for two taxa.

Keywords: biogeography, Rhopalocera, biotope conservation.

Introduction

Parmi les Lépidoptères français protégés, quatre espèces présentent simultanément deux caractéristiques intéressantes:

- une répartition géographique mal connue à l'heure actuelle,
- une biologie originale; ainsi les espèces du genre *Maculinea* dépendent de la présence conjointe d'une plante-hôte particulière et d'une fourmi.

Il s'agit de: *Thersamolycaena dispar*, *Maculinea alcon*, *M. teleius* et *Coenonympha oedippus*.

Dans le cadre d'un contrat du S.R.E.T.I.E. avec le Ministère de l'Environnement notre Laboratoire a entrepris l'étude de ces taxons sur dix-sept départements de l'ouest de la France. Ce contrat fait suite à un "Projet de faisabilité" accordé pour 1990 par ce même Ministère. Il comporte quatre objectifs principaux:

1 - l'étude de la répartition géographique de ces taxons; ceci en collaboration avec le Secrétariat Faune-Flore au Muséum National d'Histoire naturelle de Paris avec qui une convention a été signée,
2 - la biologie de ces insectes: * biologie du développement,
    * relations de myrmécophilie pour les Lycènes,
3 - l'étude du polymorphisme des populations (génétique et phénétique),
4 - la mise au point de méthodes de gestion visant à une protection pour *M. alcon* et *C. oedippus*.

Les caractéristiques des différentes populations sont appréciées sur des critères morphologiques (biométrie), génétiques (polymorphisme enzymatique) et écologiques (éco-démographie). L'étude des populations de *M. alcon* et *C. oedippus* est complétée par une expérience de gestion de l'habitat.

Observations et discussion

Dans cette étude il sera dressé un premier bilan de la biogéographie, de la biologie des taxons concernés, ainsi que des premières mesures de gestion expérimentale mises en oeuvre.

1 - **Biogéographie**

Nous avons été conduits à préciser la cartographie la plus exacte possible connue jusqu'ici en fonction de:

- la littérature,
- des collections privées ou publiques accessibles,
- de nos propres prospections.

Ces quatre espèces, qui appartiennent à des lignées monophylétiques, occupent des aires continues mais souvent disjointes avec des pressions de sélection souvent importantes.

Depuis leur installation dans nos régions au tardiglaciaire, ces taxons ont subi d'abord un isolement paléogéographique et ensuite consécutif aux activités humaines. Ils constituent des populations fermées, à la limite de l'insularisme dans le cas des Azurés. Trois des taxons fréquentent des prés humides fauchés comme litière (en remplacement de la paille) et leurs conditions de développement sont très strictes.

Depuis quelques années, chacun constate que les populations de ces insectes sont en régression constante; on peut considérer que la moitié des stations a disparu depuis vingt ans et qu'une dizaine seulement verra l'an 2000 en l'absence de toute nouvelle intervention néfaste!

A - *Thersamolycaena dispar* HAW. (Fig. 1)

D'origine eurasiatique, sa répartition est morcellée depuis la France jusqu'à la Chine en petites populations souvent bivoltines. Quelques sous-espèces sont hélas éteintes (Grande-Bretagne, France, Tchécoslovaquie) ou très menacées (Italie).

La littérature donne pour la région concernée deux sous-espèces principales: *T. d. carueli* LE MOULT, répandue depuis le centre jusqu'à l'est du pays et *T. d. burdigalensis* LUCAS autour de la région bordelaise. Or l'étude en cours semble montrer que les populations de la vallée de la Loire et même de l'Indre appartiennent à la sous-espèce *burdigalensis*. Il est également possible que cette dernière ne soit pas différente de *carueli*; ce que nous essaierons de démontrer par des voies biochimiques et morphologiques.

Les stations de la banlieue bordelaise régressent suite à une urbanisation intensive. Ainsi *T. dispar* persiste dans une friche de deux hectares, coincée entre des usines, dans la zone industrielle de Bègles; à Blanquefort l'extension du pâturage et des cultures maraîchères réduit les surfaces disponibles.

B - *Maculinea alcon* D. & S. (Fig. 2)

Il s'agit du taxon *M. alcon alcon* et non de son vicariant de terrain sec (*M. a. rebeli* HIRSCHKE) également présent dans l'ouest mais non retenu pour ce travail.

Cette espèce eurasiatique monovoltine est particulièrement menacée car sa survie dépend de la présence simultanée de la Gentiane pneumonanthe et d'espèces de fourmis qui hébergent les chenilles à partir du quatrième stade (*Myrmica ruginodis* et *M. scabrinodis*).

L'Azuré des Mouillères est disparu depuis une vingtaine d'années des stations classiques des Deux-Sèvres (Le Bourdet, Prin-Deyrançon, Amuré, Epannes); des environs d'Angoulême (Mouthier-sur-Boëme, vallée des Eaux-Claires); du Morbihan (Vannes, Questembert); de Loire-Atlantique (Bois de Touffou, vallée de l'Erdre) et de l'Ile-et-Vilaine (Bois de Cicé).

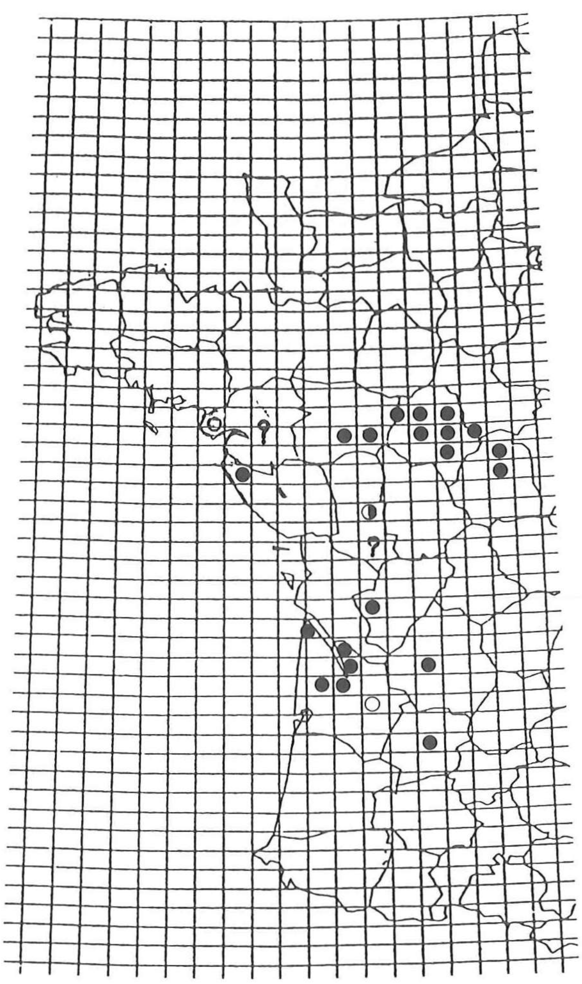

Fig. 1. *Thersamolycaena dispar*

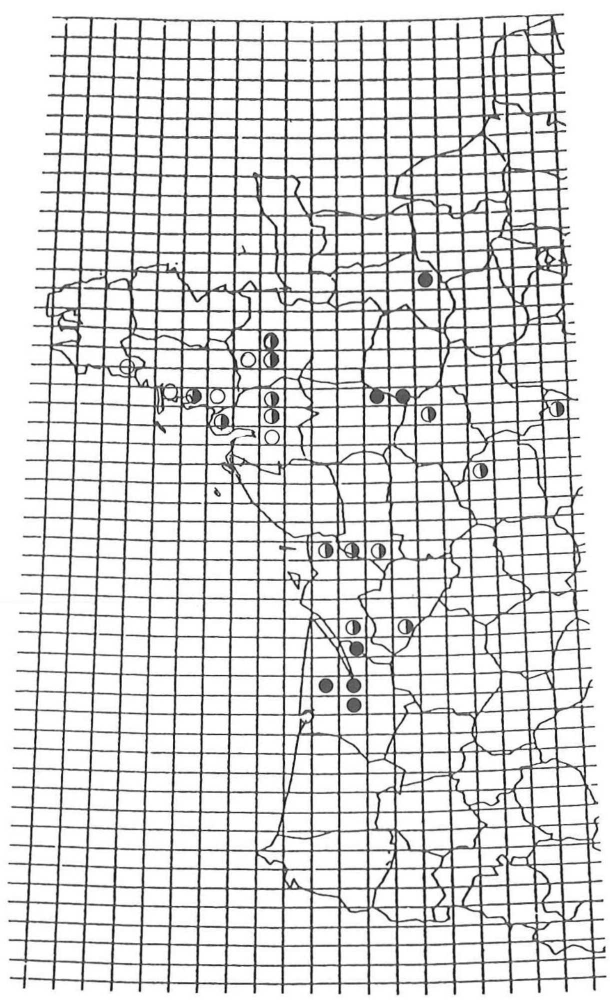

Fig. 2. *Maculinea alcon*

Figs 1-2. Cartes de répartition des taxons étudiés, maillage des cartes I.G.N. au 1/50 000 (S.F.F., 1984)
○ connu avant 1960; ◑ disparu entre 1960 et 1980;
● connu depuis 1980; ? à vérifier.

C - *Maculinea teleius* BGSTR. (Fig. 3)

Très voisine de l'espèce précédente, elle est également tributaire de la plante-hôte (*Sanguisorba officinalis*) et de Myrmicidés du groupe *Myrmica rubra-laevinodis*.

Plusieurs sous-espèces françaises ont été décrites mais deux semblent présentes dans l'aire étudiée: *M. t. teleius* BGSTR. (= *euphemus* HB.) et *M. t. burdigalensis* STEMPFF., de la Gironde et des Charentes. La découverte par notre collègue le Dr CAMA, de deux populations très isolées en Indre-et-Loire remonte de 220 km vers le nord sa limite de répartition. En attendant que l'étude du polymorphisme génétique confirme ou infirme l'hypothèse d'une nouvelle sous-espèce, nous admettrons qu'il s'agit de *M. t. burdigalensis*.

L'Azuré de la Sanguisorbe est particulièrement menacé à St Médard-d'Eyrans où ses habitats évoluent en Mégaphorbiaie ou bien sont recouverts d'arbres ou arbustes.

D - *Coenonympha oedippus* F. (Fig. 4)

D'origine eurasiatique, ce taxon qui est probablement le plus menacé d'Europe, fréquente des habitats peu modifiés à l'état de climax ou paraclimax (BISCHOF, 1968). Sa répartition s'étend entre le 43ème et le 48ème parallèle en populations très isolées les unes des autres et monovoltines en juin-juillet. Relativement commune dans le sud-ouest de la France (Gironde, Landes) cette espèce se scinde en petites populations de plus en plus éloignées les unes des autres en remontant vers le nord; au nord elle dépasse rarement la vallée de la Loire. VARIN (1952) avait séparé la sous-espèce *C. o. sebrica* des Deux-Sèvres, de *C. o. aquitanica* répandue depuis Angoulême jusqu'aux Pyrénées. La validité de cette distinction est discutable (VERITY, 1957).

Le Fadet des Laîches, probablement le Lépidoptère le plus menacé d'Europe (KUDRNA, 1986), est déjà disparu de nombreuses stations: au nord de la Loire (Turbilly, Maine-et-Loire; Bois de Touffou, Loire-Atlantique), des stations charentaises et poitevines, du nord de la Gironde (St Mariens) depuis vingt cinq ans. La ssp. *C. o. sebrica* semble éteinte depuis 1963-1965. Certaines stations ont été détruites récemment: Turbilly (Maine-et-Loire), Saint-Mariens (Gironde). Même dans les Landes certains habitats sont particulièrement menacés (Parentis-en-Born).

D'anciennes citations et l'existence de zones tourbeuses aux associations végétales favorables nous avaient conduits à rechercher cette espèce en Sologne. Les prospections de cette année ne nous permettent pas de confirmer cette hypothèse qui autoriserait de faire un lien entre les populations angevines et celles de l'est de la France.

2 - **Biologie**

A - *Thersamolycaena dispar* HAW.

Cette espèce bivoltine peut présenter un net décalage entre les générations; ainsi dans le bordelais il y a même parfois une troisième génération au début octobre (Fig. 5).

Les adultes fréquentent des associations à *Polygono-bidentetum* mais peuvent se maintenir dans des prairies fraîches (mésohygrophiles) voire pacagées (à *Ranunculus repens*). Il semble qu'en plus de la plante-hôte (*Rumex*), la présence de pieds de Menthe et de Pulicaire soit presque constante pour l'alimentation des imagos. Plusieurs auteurs (BERNARDI *et al.*, 1981; BLAB *et al.*, 1988) considèrent que ce taxon est en voie d'extension; nous sommes en désaccord avec cette hypothèse car d'une part les imagos sont peu vagabonds et de plus la répartition géographique est mal connue. Il nous semble plus logique d'admettre que ces insectes se déplacent au fur et à mesure que leurs biotopes se dégradent, de quelques kilomètres seulement sur une dizaine d'années, ce qui n'empêche pas la colonisation d'habitats plus xériques.

Les adultes de la première génération pondent indifféremment sur *Rumex aquaticus, R. obtusifolius, R. crispus, R. conglomeratus*, espèces souvent desséchées et en fruits fin juillet. La seconde se développe sur de petits *Rumex* dont la croissance n'est pas terminée en été comme: *R. acetosa, R. pulcher*. Cette différence dans la qualité de l'alimentation pourrait expliquer la petite taille des spécimens estivaux. Une expérience en cours sur cette génération devrait permettre de répondre à cette question.

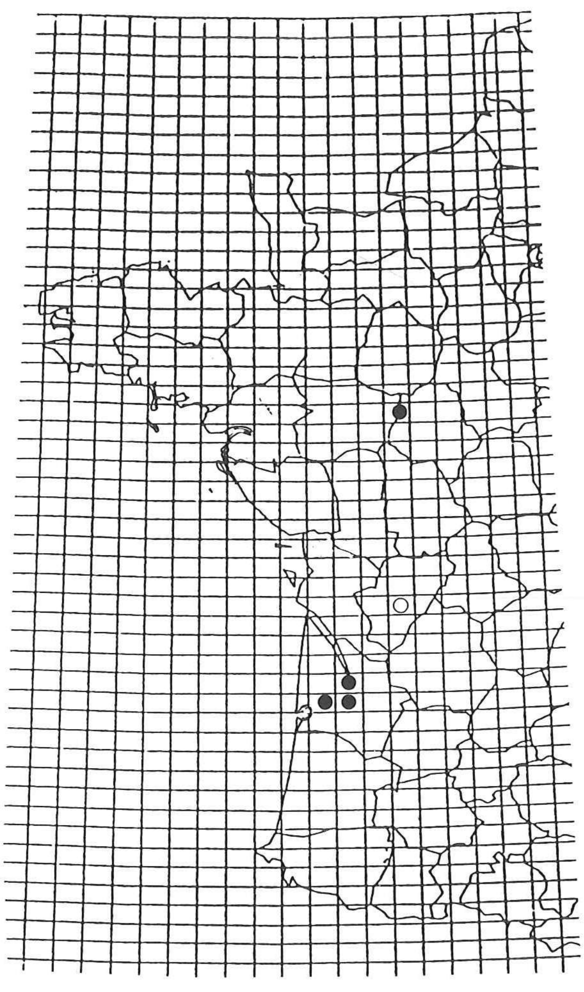

Fig. 3. *Maculinea teleius*

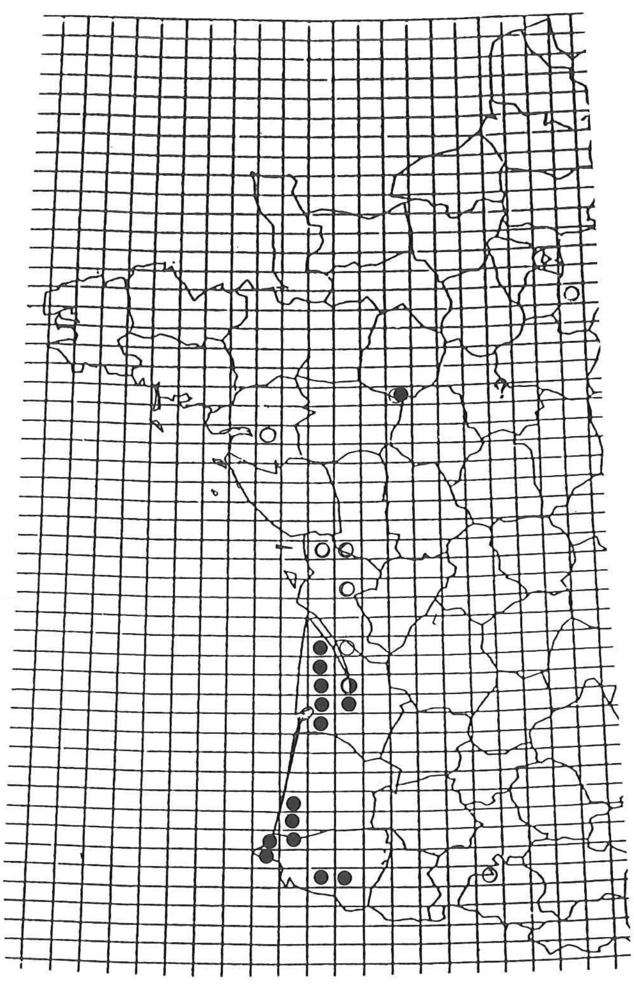

Fig. 4. *Coenonympha oedippus*

Figs 3-4. Cartes de répartition des taxons étudiés, maillage des cartes I.G.N. au 1/50 000 (S.F.F., 1984)
○ connu avant 1960; ◑ disparu entre 1960 et 1980;
● connu depuis 1980; ? à vérifier.

B - *Maculinea alcon* D. & S.

Cette espèce monovoltine fréquente des zones marécageuses souvent exploitées comme litière à bétail; ce sont essentiellement des Molinaies (Classe des *Molinio-juncetae*), tourbières neutro-alcalines (*Caricion-fuscae*) ou des Cladiaies-Phragmitaies (*Caricion-lasiocarpae*). Elle présente un léger décalage géographique entre les périodes de vol (Fig. 5). Les femelles pondent sur les corolles de *Gentiana pneumonanthe*, ce qui permet de reconnaître facilement la présence de l'espèce et de faire une estimation des populations.

Les premières chenilles sortent des corolles de Gentianes, en perforant le calice, dès la troisième semaine de juillet; elles sont alors au quatrième stade. Soixante à soixante-dix pour cent d'entre elles sont détruites, soit par des prédateurs comme le Coléoptère *Rhagonycha fulva* qui vient prélever directement dans les corolles, soit meurent de déshydratation quand elles ne rencontrent pas de fourmis.

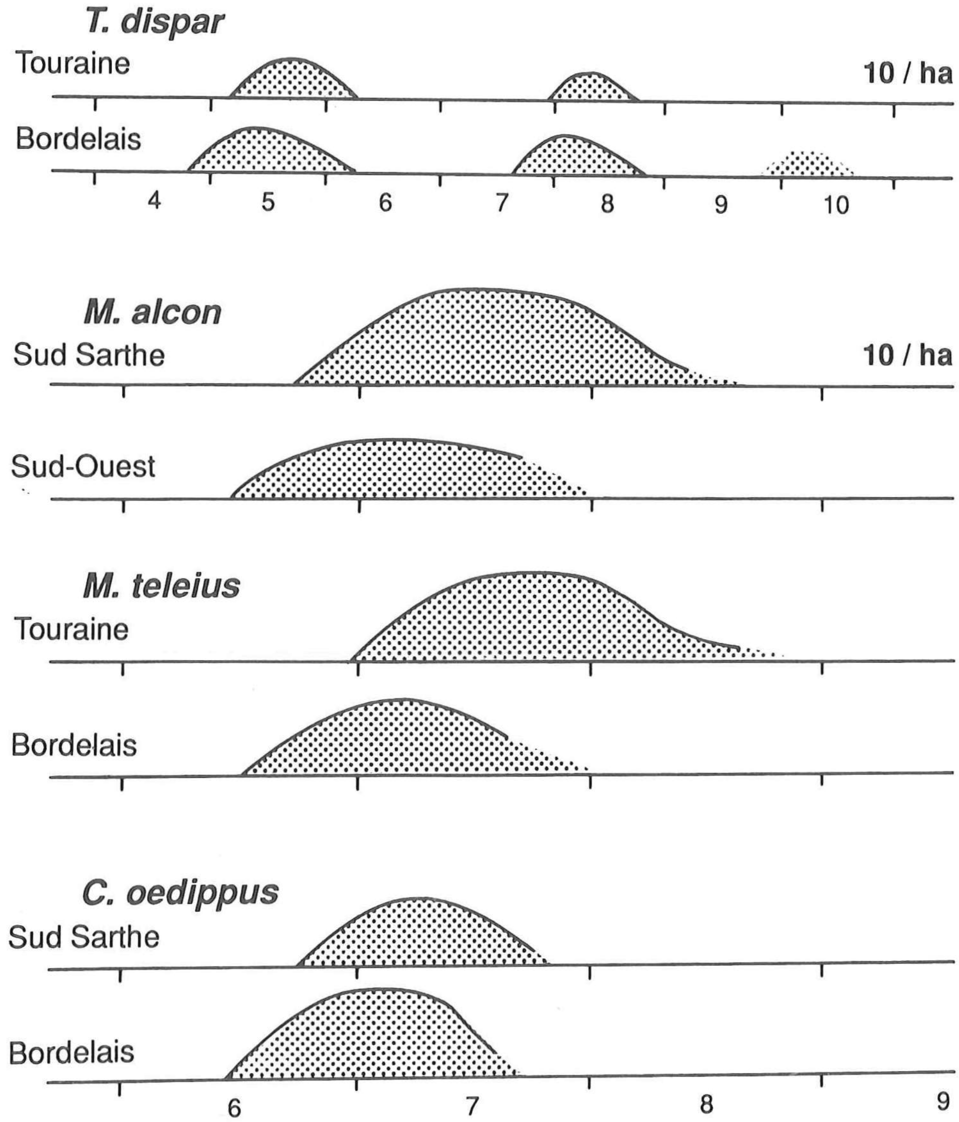

Fig. 5. Diagrammes illustrant le voltinisme régional pour les quatre espèces étudiées. La hauteur des zones grisées traduit en valeurs relatives l'importance des populations.

C - *Maculinea teleius* BGSTR.

Egalement monovoltine, cette espèce fréquente des associations voisines de l'espèce précédente; les femelles pondent à l'intérieur des fleurs de *Sanguisorba officinalis*. Il n'y a, dans ce cas, aucun moyen simple d'estimer la population d'une station.

Les chenilles sortent des inflorescences au quatrième stade, à partir du début août, se laissent tomber à terre et sont emportées par les *Myrmica*.

D - *Coenonympha oedippus* F.

Cette espèce monovoltine se rencontre dans les mêmes stations que *M. alcon*, entre la mi-juin et la mi-juillet malgré quelques différences géographiques (Fig. 5).

Les femelles pondent leurs oeufs isolément ou par groupes de deux ou trois sur les feuilles de *Molinia coerulea*, les petites chenilles éclosent entre quinze et vingt jours plus tard. Le second stade est atteint après une dizaine de jours et c'est à ce moment ou au troisième stade qu'elles se réfugient à la base des feuilles de Molinie, dans un petit abris soyeux, pour passer l'hiver. Elles reprennent leur activité en avril de l'année suivante.

3 - **Gestion et Protection**

D'une façon générale les différentes stations prospectées sont menacées par trois groupes de facteurs:
- l'assèchement par drainage ou plantation de peupliers,
- l'abandon puis le recouvrement par des arbres et arbustes,
- l'implantation de cultures maraîchères ou céréalières.

A - *Thersamolycaena dispar* HAW.

Le principal obstacle au maintien de ses populations de *T. dispar* est la plantation de peupliers qui, très rapidement en sept à dix ans, modifient la couverture végétale. L'extension de zones ombragées liées à un assèchement et une modification du pH de la couche superficielle du sol, entraînent la disparition progressive des *Rumex* et des plantes nectarifères butinées par les adultes (Menthes, Pulicaires). Le mauvais entretien de la strate herbacée dans les trois première années qui suivent la plantation entraîne un développement excessif des liserons en étouffant la flore suivit de la disparition de ce Lycène (Fig. 6).

B - *Maculinea alcon* D. & S.

Cette espèce fait l'objet d'une étude expérimentale dans deux parcelles du sud de la Sarthe, distantes d'un kilomètre, séparées par des cultures et qui reposent sur une couche de tourbe épaisse de trois à huit mètres.

La première (A, 1,5 ha), abandonnée depuis une dizaine d'années a subi un assèchement consécutif à l'abaissement de la nappe phréatique par suite du creusement du lit de la rivière proche. Elle évolue dans ses parties sud et ouest en Mégaphorbiaie où prédominent l'Eupatoire chanvrine, l'Angélique et le *Cirsium helenoides*. La partie "est" est constituée par une Molinaie qui commence à être envahie par des Phragmites. Dans la parcelle A l'expérience porte sur une régénération du milieu afin de revenir à une Molinaie. L'inventaire botanique et entomologique a été commencé cette année, les travaux de nettoyage débuteront à l'automne.

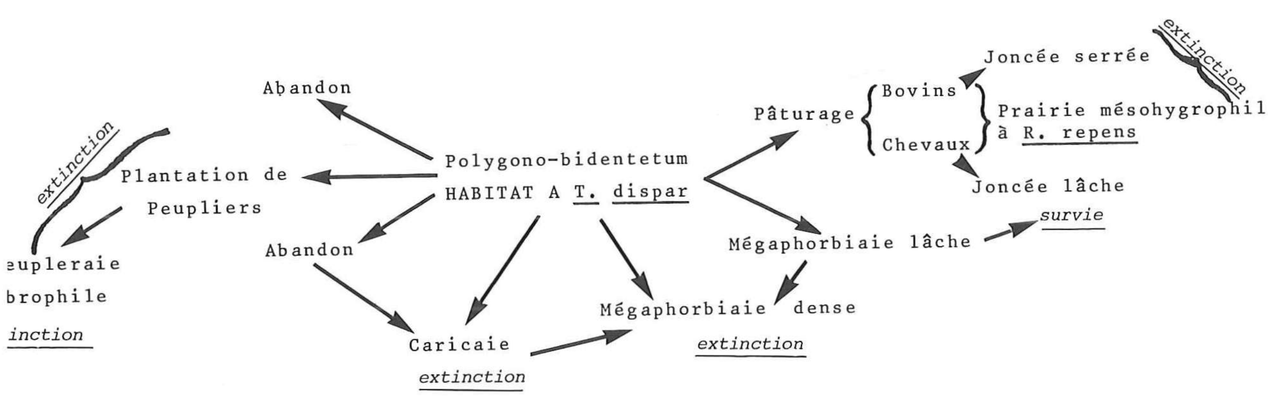

Fig. 6. Schéma d'interprétation de l'évolution d'un habitat à *T. dispar* dans la région étudiée.

La seconde (B, de 6 ha), est entretenue comme pré à litière depuis plus d'une centaine d'années et composée de plusieurs lots cadastraux appartenant à des propriétaires différents, fauchés en alternance par un seul exploitant. Il en résulte un aspect homogène de l'ensemble qui correspond à un stade climacique dont la flore est particulièrement riche (17 espèces d'Orchidées, *Parnassia palustris, Eriophorum*, etc.). *M. alcon* et *C. oedippus* y volent simultanément.

Dans ces parcelles des comptages des pieds de Gentianes ont été effectués ainsi que des marquages-recaptures de papillons toutes les 48 heures entre le 22 juin et le 10 août.

Il apparaît que les premiers Azurés des Mouillères qui éclosent ont un comportement vagabond; une femelle a été recapturée cinq kilomètres au sud du point de marquage. Hélas l'absence de sites favorables à proximité immédiate ne permet pas son implantation.

Ces dernières années, particulièrement sèches, ont incité l'exploitant à faucher plus tôt (7-8 août en 1990 et 23-24 juillet en 1991). Chaque fois plus de 700 pieds de Gentianes ont été coupés, chacun portant en moyenne sept oeufs. Paradoxalement ce traitement drastique ne semble pas avoir perturbé la population car un tiers des imagos restait à éclore à ces dates. De plus de nombreux pieds de Gentianes ont repoussé et refleuri à partir du 15 août permettant de nouvelles pontes. Il n'en reste pas moins que la destruction de ces oeufs induit une pression de sélection intense et artificielle qui s'exerce conjointement sur le papillon et sur sa plante-hôte. Il nous est apparu que, même sans fauchage, il n'y avait pas assez de pieds de Gentianes par rapport à la population d'Azurés aussi, en collaboration avec des botanistes de notre Université nous allons multiplier *in vitro* des pieds de Gentianes afin de les implanter sur le terrain.

Enfin, en collaboration avec M. L. FAILLIE, nous venons d'introduire simultanément six femelles fécondées et une dizaine de corolles portant des oeufs, dans une station favorable distante de trois kilomètres de B mais séparée par un massif de Pins, et où curieusement, *M. alcon* était absent.

Les prés à litière sont en voie de disparition, l'usage de la paille se généralisant. En conséquence ces prés sont maintenant destinés soit au pâturage des bovins, soit à la plantation de peupliers. Afin d'accélérer le processus les agriculteurs creusent des drains ou bien abaissent le niveau de la nappe phréatique en recreusant le lit des ruisseaux ou rivières.

En conclusion les prairies à Gentianes sont sensibles à trois facteurs:
- l'assèchement du sol,
- la modification du pH,
- le pâturage.

La modification du pH est consécutive à ces actions mécaniques et l'enrichissement en azote par les défécations animales ne fait que s'additionner! Ainsi pour le troisième facteur une population Bretonne semble avoir été détruite en juin dernier, le propriétaire ayant placé une vingtaine de moutons sur ce terrain.

D - *Coenonympha oedippus* F.

Cette espèce très abondante voici une trentaine d'années (FAILLIE, comm. pers.) semble en lente régression, elle est d'ailleurs disparue d'une station d'Indre-et-Loire seulement distante de sept kilomètres!

Les problèmes de gestion sont identiques à ceux de *M. alcon*, les deux insectes fréquentant le plus souvent les mêmes stations. Dans la parcelle expérimentale A, incendiée en janvier 1989, ce Satyre semblait avoir disparu; or cette année une petite population est revenue (une cinquantaine d'exemplaires), probablement issue d'individus ayant vagabondé sur un ou deux kilomètres.

Conclusions

Les décisions de gestion et de protection d'espèces ou d'habitats ne peuvent être prises que sur la base d'une solide connaissance de la biologie et de l'écologie des espèces ou de leurs populations.

Les quatre taxons étudiés et leurs habitats sont en voie d'extinction rapide; leur inscription sur une liste nationale d'invertébrés protégés est insuffisante. C'est au niveau régional, voire départemental, que des mesures concrètes doivent être prises. Parmi celles-ci la réintroduction de colonies ou le renforcement de populations dans certaines stations est à envisager. Ces quatre papillons sont particulièrement précieux car ils constituent des modèles expérimentaux pour:
- la gestion des habitats,
- la biologie de populations le plus souvent réduites ou isolées dont nous ignorons la dynamique,
- la paléogéographie et l'histoire des peuplements.

Remerciements

Nous tenons à remercier toutes les personnes qui nous apportent leurs compétences et leur temps: M. L. FAILLIE, M. C. MILLE pour la participation aux marquages - recaptures; MM. HERINS et CHARBONNEAU qui mettent à notre disposition leurs terrains; les responsables des Musées qui m'ont permis d'accéder aux collections: Mme A. PESSEY-LUX (Alençon), Melle F. SUPPLISSON (Nantes), ceux des parcs et réserves: Melle A. BOULET, M. Y. LETELLIER, M. CONAN et tous les entomologistes pour leurs renseignements et suggestions: M. Y. GRELIER, M. R. LEVESQUE, les Dr A. CAMA et M. CHINERY . . . et tous les autres.

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How to achieve more with butterfly inventory data

by K. VELING & C.A.M. VAN SWAAY

Introduction

In 1981 the Dutch Butterfly Mapping Scheme started at the Agricultural University of Wageningen. It's main aim was to make distribution maps of all butterfly-species in The Netherlands. In 1989 this resulted in the Dutch Butterfly Atlas (TAX, 1989). In this atlas the distribution of all dutch butterfly species before 1981 was compared to the distribution in the period 1981-1986. In VAN SWAAY (1990) the changes in the abundance of the dutch butterflies are discussed.

These investigations showed that the distribution and abundance of many dutch species of butterflies has strongly decreased. Of 71 native species fifteen have become extinct. A large proportion of the remainder is assumed to have declined. The main reasons are loss of habitat, mostly caused by the intensification of agriculture, and bad management of the remaining populations (mostly in nature reserves).

Today areas which are rich in butterfly-species are restricted to small nature reserves, scattered all over the country. The rest of the land is unfit for butterflies. Isolation and bad management of the nature reserves have subsequently affected many of these isolated populations. Although isolated butterfly populations can survive very well for a long time, a change in the management regime can lead to the lowering of the carrying capacity to a point where local extinction is very likely as a result of natural fluctuations caused by environmental changes. After this local extinction isolation will reduce the chance of natural recolonisation.

To maintain these remaining species in The Netherlands biotope management will also have to be adapted to the special demands of butterflies.

The Dutch Butterfly Foundation (De Vlinderstichting)

The Dutch Butterfly Foundation was founded in 1983. It's main aim is to maintain and restore the dutch butterfly fauna. Starting with a small group of enthousiastic volunteers is soon grew out to become the central point for butterfly research in The Netherlands (together with the Agricultural University of Wageningen). In 1991 the foundation employed 12 persons. The activities can be devided in two main categories:

- Research and Advise
- Extension and Education.

Research

At this moment two general research projects are being carried out by the Dutch Butterfly Foundation:

- "Butterflies in the dutch landscape" (VNL).

Objectives: Getting more detailed information on the distribution of butterflies in The Netherlands (even at a scale of 100 x 100 m) and gathering ecological information of rare and characteristic species by making exact descriptions of their populations.

- Dutch Butterfly Monitoring Scheme (Monitoring-project).
  Objectives: Monitoring changes in the abundance of dutch butterflies. This project can be compared with the British Butterfly Monitoring Scheme (Fig. 1).

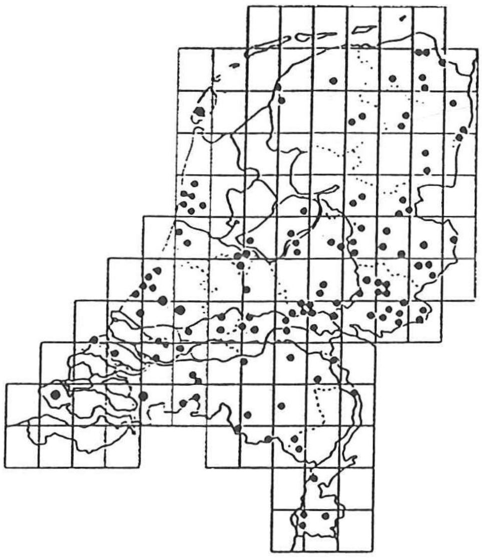

Fig. 1. Dutch butterfly monitoring sites in 1990.

Advise

The data collected in these research projects are immediately used in nature management and urban and rural planning to achieve maintenance and restoration of the butterfly fauna.

- The Butterfly Protection-plan of the Ministry of Agriculture and Fisheries (Ministerie van Landbouw en Visserij, 1989), written with help from The Dutch Butterfly Foundation, gives detailed information about this. The plan describes the characteristic butterfly species per biotope and mentions the principal threats and causes of decline.
  It also indicates which landscaping and management measures should be taken for characteristic butterflies in groves and scrubland, grasslands and verges, heathland, marshes, fields and urban areas. For extinct species which are not able to colonise former sites where the management has been improved, reintroduction is proposed.

- Courses "Butterfly-friendly management" are given to the planners and managers of nature reserves, public spaces in towns and road-verges in the countryside. In these courses the following aspects are being discussed:
  - Biology and ecology of butterflies
  - The decline of the butterfly fauna
  - Which measures can be taken in various types of habitat to stop this decline.

The participants receive written information in which this management is explained and summarised (Fig. 2).

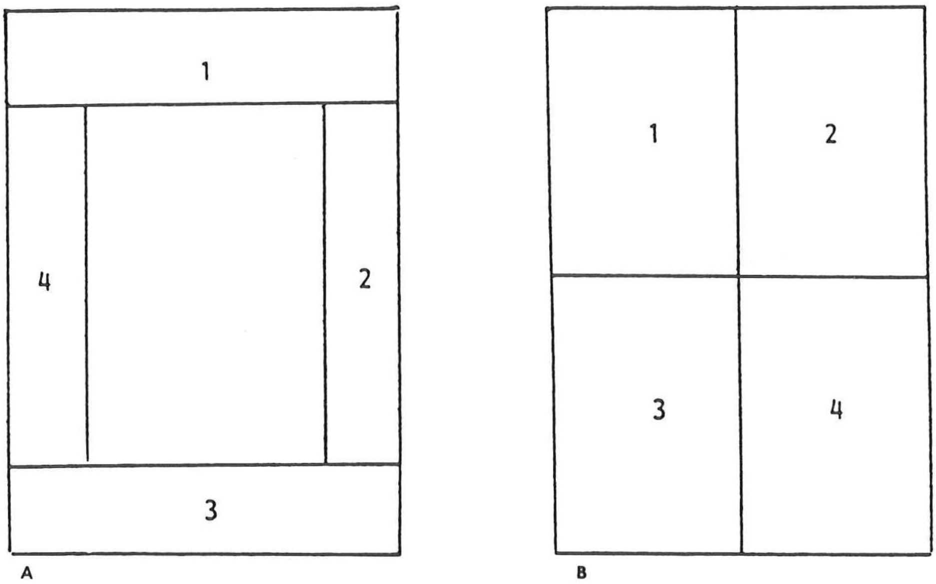

Fig. 2. Two examples of phased mowing schemes from the course "Butterfly-friendly management"; A. in nutrient rich fields; B. in nutrient poor fields (Vlinderstichting, 1990).

- Because in the new inventory project VNL very detailed information is collected on distribution and ecology, The Butterfly Foundation can make precise management plans, even for small reserves. These plans use the butterfly fauna as example-species, to achieve a better management for all flora and fauna.

- The butterfly data are used in "environmental impact studies". These studies summarise what impact a certain new development has on the environment. These developments can for example be (rail)road construction, land development plans or the creation of military areas. When there is lack of recent information, fieldwork is done to actualise the data. This study is paid for by the bodies responsible for the new development.

- The monitoring scheme is being used for evaluation of management in reserves and other areas. Managers of nature reserves participate in the monitoring scheme, as do many volunteers.

Extension

To achieve a change in planning and management a lot of information must be given to politicians, planners, landowners and general public.

- The Butterfly Foundation produces field guides, leaflets, posters, traveling exhibitions, slide-series and brochures on butterflies in different dutch landscapes.

- Lectures are given for many different groups: from Rotary groups to aged people, from Christian women groups to young farmers.

- General public is informed on how they can recreate their garden into a butterfly garden, by putting in adult and larval foodplants and create sheltered and sunny places.

- The Butterfly Foundation has intensive contacts with the press. Not only daily and weekly papers, but also radio and sometimes even television have features on butterflies.

Education

By getting schoolchildren to be interested in butterflies many people, including their parents can be reached.

- Lessons are produced about ecology and biology of butterflies with emphasis on the behaviour and how man can take concrete measures which will benefit butterflies.

- Live material (eggs, larvae and pupae) are sent to schools to be bred in class situations. The material is from common and widespread species (*Aglais urticae*, *Inachis io* and *Pieris brassicae*) and can be released by the children after they succesfully bred them.

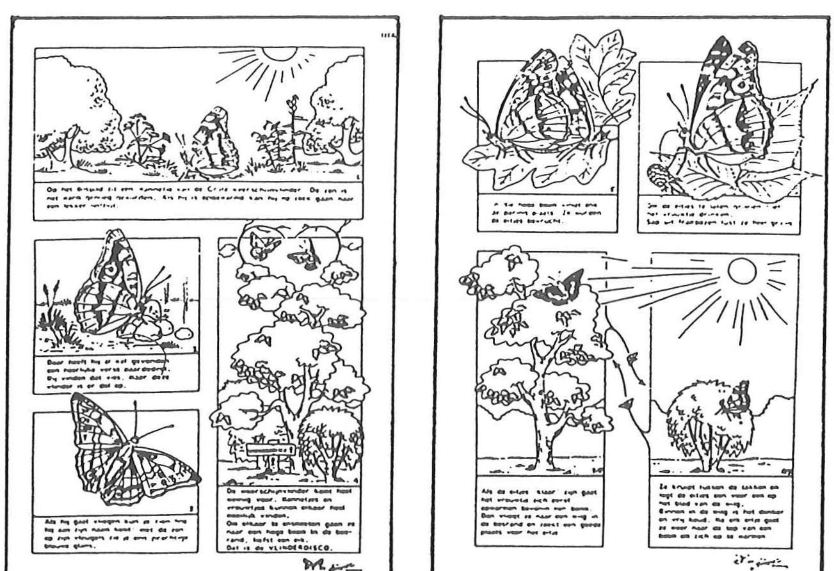

Fig. 3. Part of lessons produced on ecology and behaviour of butterflies. The tree-topping behaviour of *Apatura iris* (Vlinderstichting, 1989).

Conclusion

The inventory data collected by the Dutch Butterfly Foundation and the Agricultural University Wageningen are immediately used in nature management and urban and rural planning and management. By drawing the attention of as much people as possible these measures are supported by the public.

If we want to achieve more with our inventory data, we need an offensive attitude. Only then we can assure that invertebrates are taken into account by policy-makers, politicians and managers.

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The use of monitoring systems in nature reserves, an example : "De Vallei van de Zwarte Beek" at Koersel-Beringen (Limburg, Belgium)

by Dirk MAES

Summary

Although several surveys on invertebrates have been performed during the last couple of years in most of the Belgian nature reserves, the results of such surveys rarely seem to be used when reserve management schemes are discussed.
In order to have a tool to evaluate different management practices, a monitoring system has been started in "De Vallei van de Zwarte Beek" (Koersel-Beringen). On four monitor routes with different management practices butterflies are counted weekly to detect if changes in abundance are due to management or not.
Finally, the incorporation of different invertebrate groups in management schemes is highly recommended together with their use in evaluating nature management.
Key-words : monitoring scheme, butterflies, invertebrates, nature management.

Samenvatting

Ondanks het feit dat er recent vele inventarisaties van invertebraten gebeurd zijn in verscheidene Belgische natuurreservaten worden de resultaten ervan slechts zelden gebruikt bij het opmaken van een beheersplan voor het reservaat.
Om de verschillende beheersmaatregelen te kunnen evalueren is er in "De Vallei van de Zwarte Beek" (Koersel-Beringen) gestart met een monitoring-project : op vier monitor-routes, elk met een verschillend beheer, worden de dagvlinders wekelijks geteld om na te gaan of veranderingen in abundantie te wijten zijn aan het gevoerde beheer of niet.
Ten slotte wordt er aangeraden om rekening te houden met ongewervelden bij het opstellen van beheersplannen en wordt er op gewezen dat ongewervelden uitermate bruikbaar zijn bij het evalueren van natuurbeheer.
Trefwoorden : monitor-project, dagvlinders, ongewervelden, natuurbeheer.

Introduction

In several nature reserves in Belgium invertebrate surveys were done over the years but very exceptionally the results of these surveys are used when a management scheme is discussed for the reserve. Invertebrates though are good ecological indicators (MAELFAIT & BAERT, 1987; MAELFAIT *et al.*, 1989; RUSHTON, 1987; SIEPEL, 1989; SPEIGHT, 1986) and should therefore play a role in managing nature reserves. In most nature reserves flora and avifauna are used to evaluate management and the reason for doing so is obvious : their ecology is well known and they are easy to detect and to identify. Invertebrates, however, react remarkably faster to changes in the local environment. The most important obstacle for not using invertebrate animals in a management scheme is probably the lack of ecological knowledge of many invertebrate groups; therefore it is difficult to estimate the impact of management practices on the invertebrate group in question. Of some invertebrate groups (spiders, carabid beetles, butterflies) however enough knowledge is present to use them in management schemes. A second reason for not taking invertebrates into account is the lack of

research on the impacts of management practices on invertebrates, although recently some studies were done on this subject (BLAB & KUDRNA, 1982; MAES, 1989; VELTHUIS, 1986).
This paper tries to give an example of how some invertebrate groups can fit into a global management scheme for the nature reserve "De Vallei van de Zwarte Beek" at Koersel-Beringen (Limburg, Belgium).

Study area

"De Vallei van de Zwarte Beek" (Fig. 1) is one of the biggest nature reserves in Belgium (about 800 ha) and consists of a wide variety of habitats (heathland, deciduous forest, meadows, sand dunes, ...). It is one of the best preserved lowland brooks in Western Europe, because of the very low human impact on the ecosystem. "De Vallei van de Zwarte Beek" is owned by "Natuurreservaten v.z.w." (former B.N.V.R.) and is managed by BERO, a local nature organization. Over the years several invertebrate surveys (spiders, butterflies, grasshoppers, dragon flies, carabid beetles, hoverflies, ...) were done in "De Vallei van de Zwarte Beek" and today more than 1,100 invertebrate species are known for the reserve. The long list of invertebrates has been collected mostly by (amateur) entomologists on occasional visits to the reserve and by a couple of members of the local management group; up until now there has been no professional or well organized invertebrate survey by any research institute. In 1991 a first attempt is made to incorporate an invertebrate group into the management scheme by monitoring butterflies in different habitats.

The monitoring of butterflies started in april 1991 with four routes and if the results are satisfying they will be used in future management schemes. The reason for taking butterflies as ecological indicators is fivefold :

- their ecology is very well known (TAX, 1989),
- they are easy to identify (WYNHOFF *et al.*, 1990),
- they can be counted with a standardized technique (POLLARD, 1977; VAN SWAAY & VELING, 1991),
- they react quickly to changes in the ecosystems (SIEPEL, 1989; VAN SWAAY & VELING, 1991),
- if a site is rich in butterflies it is thought to be beneficial for other invertebrates as well.

Method

The technique used for counting butterflies is the transect method (POLLARD, 1977), adapted by VAN SWAAY & VELING (1991). A given route is walked weekly from april to september and all butterflies within 5 meters are counted (Fig. 2). The route is divided into sections of 50 meters each and may only be walked under certain climatic circumstances :

- counting must take place between 11.30 a.m. and 4.30 p.m.,
- when temperatures are between 13 and 17°C the route may only be walked when cloud coverage is less than 40%,
- counting is not allowed when wind speed exceeds 6 beaufort, when it is raining or when mist is present.

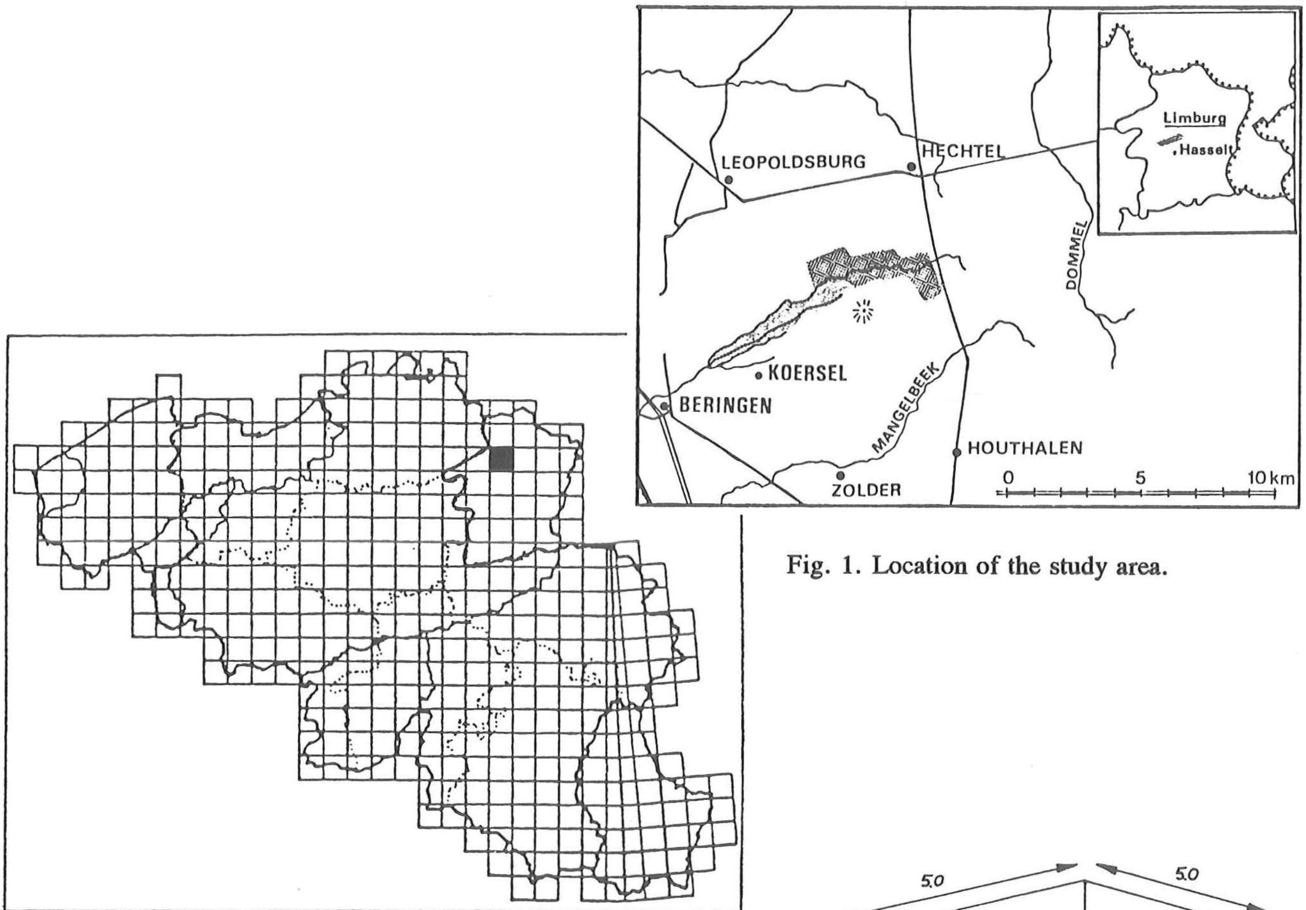


Fig. 1. Location of the study area.

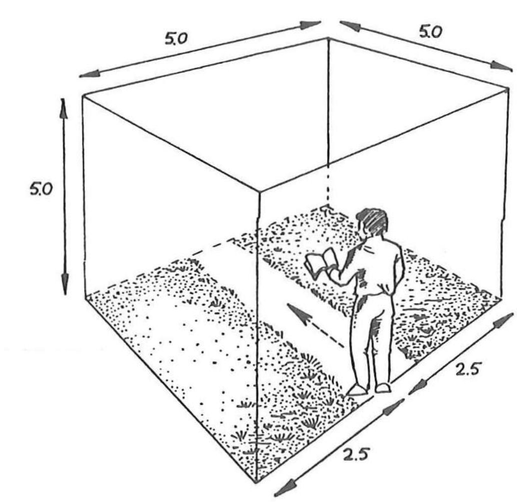
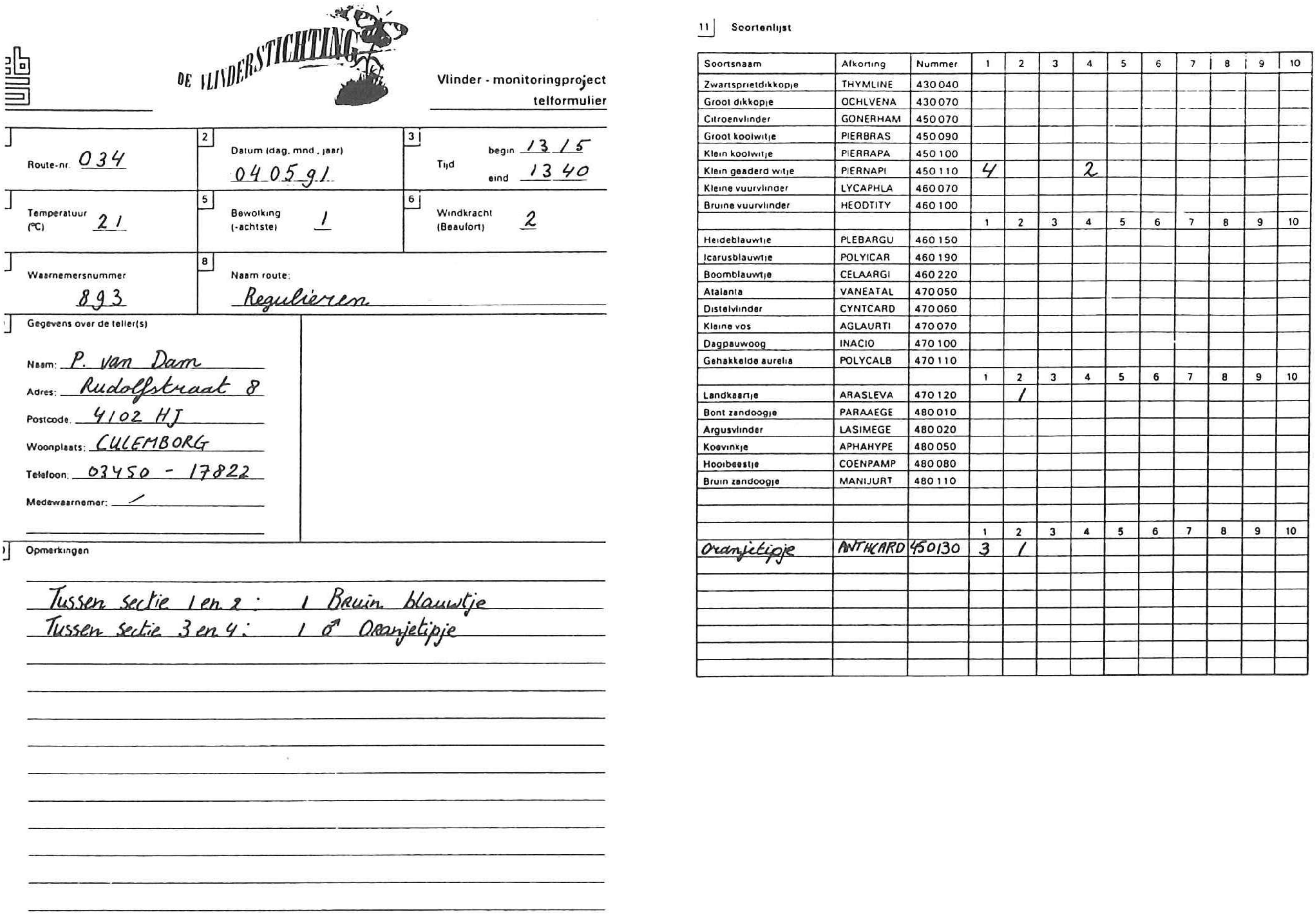


Fig. 2. Imaginary cage in which butterflies are counted during monitoring (from VAN SWAAY & VELING, 1991).

Special forms (Fig. 3) are designed by the "Vlinderstichting" to facilitate the counting. The first form describes the route and deals with all kinds of biotic factors (flowering plants, management, habitat, etc.); the second form has to be used to fill in the weekly counting of the butterflies on the route. Drastic changes (mowing or any other form of management practice) can be noted on the second form as well, but should only be noted once (although the influences of the change can be long lasting).



Vlinder - monitoringproject telformulier

Route-nr. 034	2 Datum (dag, mnd., jaar) 04 05 91	3 Tijd begin 13 15 eind 13 40
Temperatuur (°C) 21	5 Bewolking (-achtste) 1	6 Windkracht (Beaufort) 2
Waarnemersnummer 893	8 Naam route: Regulieren	

Gegevens over de teller(s)

Naam: P. van Dam
Adres: Rudolfstraat 8
Postcode: 4102 HJ
Woonplaats: CULEMBORG
Telefoon: 03450 - 17822
Medewaarnemer: /

Opmerkingen

Tussen sectie 1 en 2: 1 Bruin blauwtje
Tussen sectie 3 en 4: 1 ♂ Oranjetipje

11 Soortenlijst

Soortsnaam	Afkorting	Nummer	1	2	3	4	5	6	7	8	9	10
Zwartsprietdikkopje	THYMLINE	430 040										
Groot dikkopje	OCHLVENA	430 070										
Citroenvlinder	GONERHAM	450 070										
Groot koolwitje	PIERBRAS	450 090										
Klein koolwitje	PIERRAPA	450 100										
Klein geaderd witje	PIERNAPI	450 110	4			2						
Kleine vuurvlinder	LYCAPHLA	460 070										
Bruine vuurvlinder	HEODTITY	460 100										
			1	2	3	4	5	6	7	8	9	10
Heideblauwtje	PLEBARGU	460 150										
Icarusblauwtje	POLYICAR	460 190										
Boomblauwtje	CELAARGI	460 220										
Atalanta	VANEATAL	470 050										
Distelvlinder	CYNTCARD	470 060										
Kleine vos	AGLAURTI	470 070										
Dagpauwoog	INACIO	470 100										
Gehakkelde aurelia	POLYCALB	470 110										
			1	2	3	4	5	6	7	8	9	10
Landkaartje	ARASLEVA	470 120		1								
Bont zandoogje	PARAAEGE	480 010										
Argusvlinder	LASIMEGE	480 020										
Koevinkje	APHAHYPE	480 050										
Hooibeestje	COENPAMP	480 080										
Bruin zandoogje	MANIJURT	480 110										
			1	2	3	4	5	6	7	8	9	10
Oranjetipje	ANTHCARD	450130	3	1								

Fig. 3. Counting form (Vlinderstichting/CBS).

This technique has already proved to be useful in the Netherlands and in Great-Britain where a lot of routes are walked all over the country. A widespread monitoring net is necessary for distinguishing local (due to nature management) from national changes (due to climatic factors); together with the extensiveness of the monitoring net, it is very important that the monitoring is maintained for 10 years or more to detect changes in abundances of butterflies.

Using the monitoring scheme in nature management

How can the results of this monitoring be used in nature management? For each butterfly species, an index of abundance is calculated (POLLARD, 1977) and if, after a couple of years of monitoring, a change in the index of abundance is noticed (for examples, Fig. 4), an explanation for the change has to be found: is the change only local or is it national? If the change is a local phenomenon, is it possible that it is caused by management or is it due to changes in other factors (changes in waterlevel, the eutrofication of the site,...)? If the change is caused by the management practice an adaptation of the management scheme should be considered, especially on sites where rare and endangered species show a decreasing index of abundance. The monitoring system that is presented here has its limitations (only butterflies are counted) and should be extended. Therefore a monitoring system, using monitor species from different invertebrate groups for the different habitats is worked on and will eventually replace the butterfly monitoring project in the future.

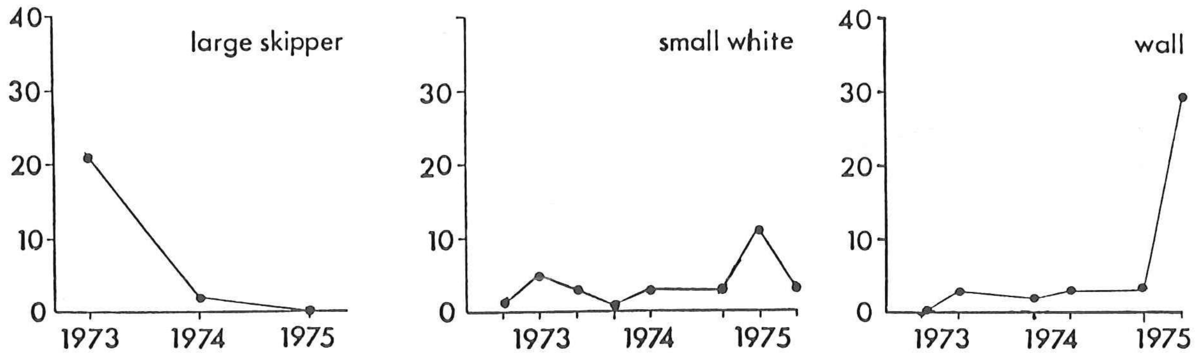


Fig. 4. Examples of changes in the index of abundance; left, decrease: Large skipper (*Ochlodes venatus*; middle, status quo: Small white (*Pieris rapae*); right, increase: Wall (*Lasiommata megera*) (from POLLARD, 1977).

Conclusion

Because of the ecological importance of invertebrates they should play a role in management schemes, but up until now very few nature organizations take them into account. Several groups of invertebrates can be used as ecological indicators (carabid beetles, spiders, butterflies, ...) because their ecology is well known. A monitoring scheme for butterflies, as proposed in this poster, is easy to do (even by laymen !) and gives a lot of information about the possible effects of management practices on the abundance of butterflies. It surely is not right to manage only butterflies, management schemes for nature reserves are supposed to approach the reserve as a global entity with difficult and unknown relationships. Management practices should have beneficial effects on plants as well as on animals (including invertebrate animals) that are becoming rare outside nature reserves. The installation of a management commission is therefore recommended for all bigger nature reserves inable to discuss the proper management scheme. Hopefully henceforth invertebrates are going to be taken into account when management schemes for nature reserves are to be discussed. Professional entomologists should therefore provide adequate and handy monitoring schemes that can be used by amateur entomologists as well.

Acknowledgements

I wish to thank Willy VAN LOOK, warden of "De Vallei van de Zwarte Beek" for allowing me to do this monitoring, Chris VAN SWAAY (Vlinderstichting) for providing me with a manual and counting forms for this project and Bart HOREMANS for correcting my English.

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Projet de mise à jour de l'atlas cartographique des Lépidoptères Rhopalocères de la Région Wallonne (Belgique)

par B. DE BAST, Ch. VERSTRAETEN, M. BAGUETTE & Ph. GOFFART

Summary

Since more than twenty years, the department of Zoology of the "Faculté des Sciences agronomiques de Gembloux" collects biogeographical data regarding different groups of insects among which *Lepidoptera Rhopalocera*.

Three years ago, a new working group composed by biologists and naturalists have been formed to carry on studies about butterfly populations in our country.

The aims of the butterfly working group are to supplement the knowledge about butterfly biogeography and ecology in our country and by that way, to contribute safeguard of threatened populations and their habitats.

Actual projects are (1) to achieve an updated mapping of Belgian butterflies and, (2), to monitor yearly butterfly populations on a site network.

About 6,500 data have been collected during the period 1989 - 1990, and more than 8,000 data in 1991, giving a total of about 14,500 butterfly records during the first three years. They deal with 92 species of butterflies, corresponding to about 77 % of the known species in Belgium. The other species being, for the greatest part, vagrants irregularly seen in Belgium or butterflies which are or could be extinct in our country.

Introduction

Depuis plus de vingt ans, le service de Zoologie de la Faculté des Sciences agronomiques de Gembloux recueille des données biogéographiques relatives à divers groupes d'insectes, dont les Lépidoptères Rhopalocères.

Il y a bientôt trois ans, s'est constituée une cellule de biologistes et naturalistes désireux de mieux connaître l'état actuel des populations de Rhopalocères de nos régions et d'en évaluer leur vulnérabilité.

Objectifs du "Groupe de Travail Lépidoptères"

Les objectifs du "Groupe de Travail Lépidoptères" visent non seulement à compléter les connaissances relatives à la biogéographie et à l'écologie de ce groupe d'insectes, mais aussi à contribuer à la sauvegarde des populations menacées et de leurs biotopes. Les projets actuels sont d'une part la réalisation d'un atlas cartographique mis à jour des Rhopalocères et d'autre part le suivi, d'année en année, des populations de Rhopalocères dans une série de sites choisis.

Réalisations du "Groupe de Travail Lépidoptères"

Environ 6,500 données (observations) ont été récoltées en 1989 et 1990 (Fig. 1); à celles-ci viendront s'ajouter environ 8,000 données recueillies en 1991, ce qui portera l'ensemble des données de ces trois dernières années à environ 14,500. De la sorte, il a été possible de retrouver 92 espèces de

papillons dans nos régions, soit 77 % de la faune des Rhopalocères enregistrés jusqu'ici en Belgique (voir Annexe 1). Les autres espèces n'étant pour la plupart qu'occasionelles dans notre région.
La bonne réalisation des objectifs que se sont déterminés les membres du GTL nécessitait la mise en oeuvre de conventions et de méthodes de travail. Ainsi, certaines règles ont-elles été établies : partant du fait que les populations de bon nombre d'espèces de Rhopalocères sont devenues vulnérables, les membres du groupe de travail ont décidé de minimiser les récoltes. En effet, dans la plupart des cas, l'identification des spécimens peut être menée à bien aisément sur place; celle-ci necessitant tout au plus la capture au filet. Si, le cas échéant, la détermination n'est pas possible sur place, alors le papillon est conservé.
D'ordinaire, les sites visités sont localisés, en coordonnées UTM, au kilomètre près.
Un échange de vues est organisé environ tous les deux mois. Lors de ces réunions, les membres rapportent et commentent leurs visites sur le terrain. L'information est ensuite encodée de façon standardisée, soit à Gembloux, soit à Louvain-La-Neuve, et déposée ensuite à Gembloux. Le Groupe de Travail Lépidoptères est membre de la Fédération des Banques de Données Biogéographiques de Belgique. Ces deux laboratoires se font forts de réaliser des bilans qu'ils présentent lors des réunions du Groupe de Travail ou de répondre à une demande d'analyse émanant d'un des membres du groupe.
La réalisation de travaux de grande envergure requiert l'accord des membres et, le cas échéant, la publication en commun.

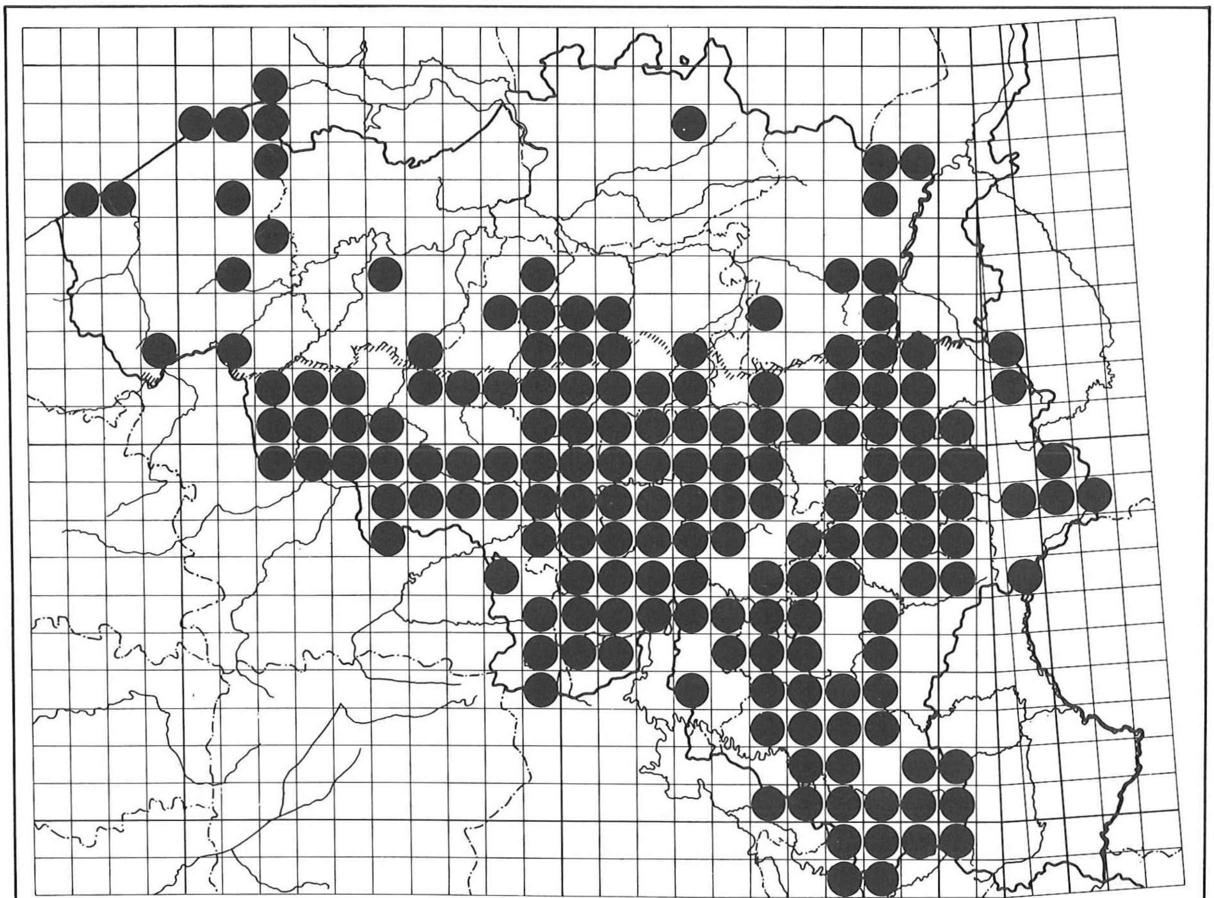

Fig. 1. Couverture globale pour l'ensemble des observations récoltées en 1989 et 1990; toutes espèces confondues.

En outre, il a été convenu de garder certaines informations confidentielles. Cette restriction vise à sauvegarder les populations les plus fragiles de la destruction par des récolteurs peu scrupuleux. La liste des espèces dont les observations doivent rester confidentielles a été établie. Pour ces espèces, les membres s'engagent à de ne pas diffuser d'informations stationnelles. Pour les autres espèces, seules les données résumées (c'est à dire avec une précision d'observation correspondant à un carré UTM de 10 km) peuvent être diffusées.

Depuis deux ans, le Groupe de Travail Lépidoptères participe au programme de surveillance de l'environnement wallon organisé par la Région Wallonne. 20 sites ont été visités en 1990, 35 en 1991.

Des inventaires des Rhopalocères ont été réalisés sur demande et des rapports d'expertise ont été rédigés.

Des essais d'analyse de la santé de nos espèces de papillons sont entrepris dans différentes directions: les quelques 72.000 données de la Banque de Données fauniques de Gembloux ont été analysées d'un point de vue spatio-temporel. Pour ce faire, trois paramètres ont été étudiés:
- le nombre de carrés UTM;
- le nombre de données géographiques enregistrées;
- le nombre de localités-années.

Pour chaque espèce, la méthode consiste à comparer, par un test de proportions, la valeur de chacun de ces trois paramètres à la valeur correspondante pour l'ensemble des Rhopalocères, à l'exception de l'espèce considérée, avant et après une date pivot (1950 et 1970). Cette approche permet de cerner des tendances à l'augmentation ou à la diminution relatives de l'espèce sur base de chacun des paramètres étudiés. Les résultats des tests font apparaître un phénomène généralisé de contraction d'aires de répartition. Entre 1950 et 1970, le nombre d'espèces pour lesquelles existait une diminution significative du nombre de carrés occupés a quadruplé.
Une autre préoccupation du "Groupe de Travail Lépidoptères" est la révision des connaissances biogéographiques de certains groupes : la révision des connaissances acquises dans la littérature au sujet du genre *Pyrgus* HÜBNER, 1819 (Lep., Hesperidae) a permis de cerner leur distribution ancienne et actuelle.
Huit espèces de *Pyrgus* ont été signalées pour notre pays dans les catalogues faunistiques. Parmi celles-ci, cinq seulement ont effectivement été observées dans nos contrées. Les mentions des trois autres espèces résultent d'erreurs de déterminations. Ces erreurs ont été occasionnées par la difficulté d'identifier avec certitude certains spécimens sans recourir à la préparation et à l'observation des pièces génitales.
Sur les cinq espèces de *Pyrgus* observées jadis dans notre pays, deux seulement peuvent encore y être retrouvées. Si l'une (*Pyrgus malvae*) présente encore une distribution assez large, l'autre est essentiellement confinée dans la province de Namur

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Annexe 1.

Liste des Rhopalocères observés en région wallonne ces trois dernières années

NEMEOBIIDAE

Hamearis lucina

PAPILIONIDAE

Iphiclides podalirius
Papilio machaon

PIERIDAE

Anthocharis cardamines
Aporia crataegi
Colias australis
Colias crocea
Colias hyale
Gonepteryx rhamni
Leptidea sinapis
Pieris brassicae
Pieris napi
Pieris rapae
Pontia daplidice

NYMPHALIDAE

Aglais urticae
Apatura ilia
Apatura iris
Araschnia levana
Argynnis paphia
Boloria aquilonaris
Brenthis ino
Clossiana dia
Clossiana euphrosyne
Clossiana selene
Eurodryas aurinia
Fabriciana adippe
Fabriciana niobe
Inachis io
Issoria lathonia
Limenitis camilla
Limenitis populi
Melitaea cinxia
Melitaea diamina
Mellicta athalia
Mellicta aurelia
Mesoacidalia aglaja
Nymphalis antiopa
Nymphalis polychloros
Polygonia c-album
Proclossiana eunomia
Vanessa atalanta
Vanessa cardui

SATYRIDAE

Aphantopus hyperantus
Coenonympha arcania
Coenonympha glycerion
Coenonympha pamphilus
Coenonympha tullia
Erebua aetguios
Erebua ligea
Erebia medusa
Hipparchia semele
Lasiommata maera
Lasiommata megera
Maniola jurtina
Melanargia galathea
Pararge aegeria
Pyronia tithonus

LYCAENIDAE

Aricia agestis
Callophrys rubi
Celastrina argiolus
Cupido minimus
Cyaniris semiargus
Fixsenia pruni
Glaucopsyche alexis
Heodes tityrus
Heodes virgaureae
Lycaena dispar
Lycaena helle
Lycaena phlaeas
Lycaena hippothoe
Lysandra bellargus
Lysandra caridon
Maculinea alcon
Nordmannia ilicis
Plebejus argus
Polyommatus icarus
Quercusia quercus
Satyrium w-album
Strymonidia pruni
Thecla betulae

HESPERIDAE

Carcharodus alceae
Carterocephalus palaemon
Erynnis tages
Hesperia comma
Heteropterus morpheus
Ochlodes venatus
Pyrgus malvae
Pyrgus serratulae
Spialia sertorius
Thymelicus acteon
Thymelicus lineolus
Thymelicus sylvestris

Le suivi des Lépidoptères Rhopalocères en Région Wallonne (Belgique) dans le cadre du programme de surveillance de l'environnement par bio-indicateurs

par Michel BAGUETTE, Philippe GOFFART, Benoît DE BAST & Charles VERSTRAETEN

Résumé

Dans le cadre du programme de surveillance de l'environnement wallon à l'aide de bio-indicateurs mis en place par M. D. DUCARME et financé par M. G. LUTGEN, Ministres de la Région Wallonne, le Groupe de Travail Lépidoptères a pris en charge le suivi des Rhopalocères. La méthode utilisée consiste à échantillonner d'année en année de manière standardisée un réseau de sites de référence, de manière à pouvoir enregistrer les fluctuations du nombre d'espèces présentes sur chacun d'eux. En fonction de la vulnérabilité et des caractéristiques écologiques des espèces en augmentation ou en diminution, un diagnostic peut être porté sur la potentialité du milieu, et le cas échéant, des mesures correctives proposées.
Le suivi des Rhopalocères a débuté en 1990. Durant cette année de lancement et de mise au point du projet, 20 sites ont été surveillés. Ce suivi a permis de recenser un total de 78 espèces, soit 75% de la faune des Rhopalocères existant en Wallonie si l'on excepte les espèces considérées comme accidentelles ou disparues. Ce chiffre très élevé reflète la grande richesse des sites inventoriés. Il faut souligner que ces sites ont été sélectionnés sur base de leur grand intérêt biologique, qui surpasse de loin la qualité moyenne de l'environnement en Wallonie.

Introduction

Une mission que s'est fixée la Région Wallonne est d'assurer d'année en année le suivi de l'état de l'environnement. Les résultats de ce suivi sont publiés annuellement sous la forme d'un rapport intitulé "Etat de l'Environnement Wallon", qui détaille l'état des différents compartiments de l'environnement, les pressions qu'ils subissent et les différentes mesures de gestion correctives.
Pour assurer une bonne fiabilité du suivi de l'évolution des compartiments "faune", "flore" et "écosystème" de l'environnement wallon, une méthode originale basée sur la surveillance d'indicateurs biologiques de groupes animaux et végétaux de type "sentinelle" a été mise au point conjointement par l'Institut royal des Sciences naturelles de Belgique (Section: Evaluation biologique, Dr P. DEVILLERS), l'Université Catholique de Louvain (Unité d'Ecologie et de Biogéographie, Prof. Ph. LEBRUN) et l'Université de Liège (Service de Botanique Systématique et de Phytogéographie, Dr E. SÉRUSIAUX). Les groupes actuellement pris en compte sont les Oiseaux, les Odonates, les Lépidoptères Rhopalocères, les Orchidées et les Lichens.
Le système de surveillance proposé est basé sur la complémentarité de ces différents groupes en matière de sélection de l'habitat et d'exigence spatiale. Le principe fondamental de fonctionnement du système est de détecter toute modification de distribution et d'abondance des organismes "sentinelles", et si possible d'en identifier la cause. Il y a donc deux phases distinctes : tout d'abord, recensement des groupes cibles dans un réseau de sites échantillons constant d'année en année; ensuite traitement et analyse des résultats par comparaison avec les recensements des années antérieures.
En ce qui concerne les Lépidoptères Rhopalocères, le recensement est réalisé par des naturalistes de terrain et supervisée par le Groupe de Travail Lépidoptères. Les résultats obtenus sont ensuite transmis aux promoteurs du projet.

La communication présentée ici a pour objet de décrire la méthodologie et les résultats de la première année du suivi des Rhopalocères en région wallonne.

Méthodologie de surveillance

A) Recensement

La méthode de recensement consiste à établir la liste de toutes les espèces présentes en un site donné une année donnée. Par site, on entend une entité topographique cohérente. Le système de surveillance prévoit que les Lépidoptères Rhopalocères soient suivis sur une cinquantaine de sites environ; cependant, l'année 1990 étant considérée comme une année de lancement du système, 20 sites ont été surveillés; leur localisation est présentée à la Fig. 1.
Dans chacun des sites, l'observateur est invité à établir un itinéraire type, constant d'une visite à l'autre, qu'il parcourt en notant toutes les espèces rencontrées. Le nombre de visites à effectuer est variable suivant les périodes de vol des espèces présentes dans les différents milieux: ainsi, si les pelouses calcaires doivent être parcourues une fois par quinzaine de mai à septembre, il n'en va pas de même des prairies semi-naturelles humides, qui peuvent être visitées à intervalles moins rapprochés, une fois toutes les trois semaines, à partir du mois de juillet.

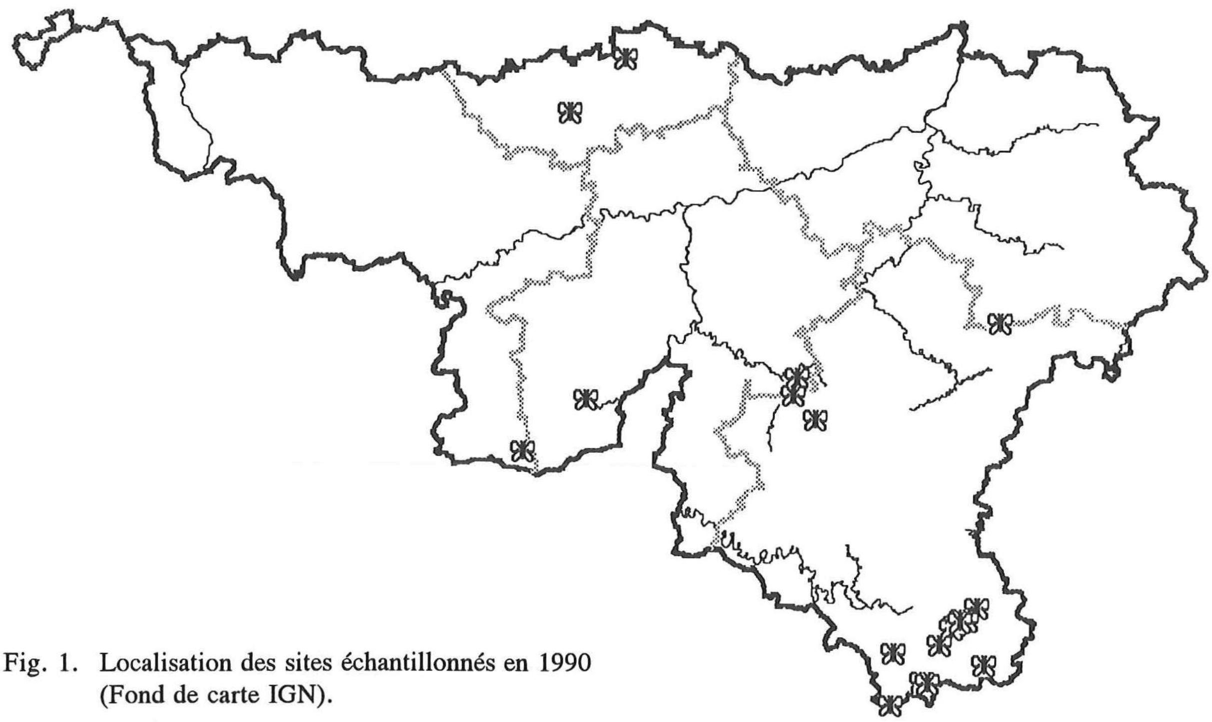

Fig. 1. Localisation des sites échantillonnés en 1990 (Fond de carte IGN).

B) Analyse et traitement des résultats

Les listes d'espèces obtenues pour chacun des sites sont comparées à celles des années antérieures. L'importance de la disparition ou de l'apparition d'une espèce en un site donné est jugée en fonction d'un indice de rareté de l'espèce calculé au niveau européen et peut être pondérée par des conditions climatiques ou locales particulières.

Résultats et perspectives

Les 20 sites sélectionnés par les 11 membres du Groupe de Travail Lépidoptères qui ont contribué à la première campagne de surveillance des Rhopalocères ont fait l'objet de 164 visites au total, soit un peu plus de 8 visites par site.
Ce suivi a permis de recenser un total de 78 espèces (Tab. 1), soit 75% de la faune des Rhopalocères existant en Wallonie si l'on retire les espèces considérées comme accidentelles ou éteintes. Ce chiffre très élevé reflète la grande richesse des sites inventoriés. Il faut souligner que ces sites ont été sélectionnés sur base de leur grande qualité biologique, qui surpasse de loin la qualité moyenne de l'environnement en Wallonie.
Ce résultat très encourageant incite le Groupe de Travail Lépidoptères à étendre le suivi à 15 nouveaux sites en 1991, portant ainsi le nombre de sites surveillés à 35. Les membres du Groupe de Travail Lépidoptères espèrent qu'un nombre croissant d'observateurs se joindront à l'enquête, de manière à compléter le réseau de sites échantillonnés. Tous renseignements à ce sujet peut être obtenu auprès des auteurs.

Remerciements

Le programme de surveillance a été préparé en collaboration avec K. KERWIJN, M.N. VAN DER ELST, J.P. JACOB, R.M. LAFONTAINE et J.P. LEDANT, sous la supervision de P. DEVILLERS, Ph. LEBRUN et E. SÉRUSIAUX. Le suivi des sites a été réalisé par les membres du Groupe de Travail Lépidoptères, B. DE BAST, Ph. GOFFART, J. HECQ, K. HOFFMAN, A. KEYMEULEN, Ch. TAYMANS, M. TAYMANS, P. TAYMANS et Ch. VERSTRAETEN, ainsi qu'avec l'aide de J.P. JACOB et de J. IDE. La synthèse informatisée des résultats a été effectuée par M. DUFRÊNE et D. MARCHAL. Le projet n'a été rendu possible que grâce à la clairvoyance et à l'intérêt du Ministre D. DUCARME qui a accepté d'en entreprendre l'étude, et du Ministre G. LUTGEN, qui lui a permis de se concrétiser.

Tableau 1. Espèces de Rhopalocères recensées en 1990.

Papilionidae
Iphiclides podalirius (SCOPOLI, 1763)
Papilio machaon (LINNAEUS, 1758)

Pieridae
Anthocharis cardamines (LINNAEUS, 1758)
Aporia crataegi (LINNAEUS, 1758)
Colias australis (VERITY, 1911)
Colias croceus (FOURCROY, 1758)
Colias hyale (LINNAEUS, 1758)
Gonepteryx rhamni (LINNAEUS, 1758)
Leptidea sinapis (LINNAEUS, 1758)
Pieris brassicae (LINNAEUS, 1758)
Pieris napi (LINNAEUS, 1758)
Pieris rapae (LINNAEUS, 1758)

Nymphalidae
Aglais urticae (LINNAEUS, 1758)
Apatura ilia (DENIS & SCHIFFERMÜLLER, 1775)
Apatura iris (LINNAEUS, 1758)
Araschnia levana (LINNAEUS, 1758)
Argynnis paphia (LINNAEUS, 1758)
Boloria aquilonaris (STICHEL, 1908)
Brenthis ino (ROTTEMBURG, 1775)
Clossiana dia (LINNAEUS, 1767)
Clossiana selene (DENIS & SCHIFFERMÜLLER, 1775)
Cynthia cardui (LINNAEUS, 1758)
Euphydryas aurinia (ROTTEMBURG, 1775)
Fabriciana adippe (DENIS & SCHIFFERMÜLLER, 1775)

Inachis io (LINNAEUS, 1758)
Issoria lathonia (LINNAEUS, 1758)
Ladoga camilla (LINNAEUS, 1764)
Melitaea cinxia (LINNAEUS, 1758)
Melitaea diamina (LANG, 1789)
Mellicta athalia (ROTTEMBURG, 1775)
Mesoacidalia aglaja (LINNAEUS, 1758)
Nymphalis antiopa (LINNAEUS, 1758)
Nymphalis polychloros (LINNAEUS, 1758)
Polygonia c-album (LINNAEUS, 1758)
Proclossiana eunomia ESPER, 1799
Vanessa atalanta (LINNAEUS, 1758)

Satyridae
Aphantopus hyperantus (LINNAEUS, 1758)
Coenonympha arcania (LINNAEUS, 1758)
Coenonympha glycerion BORKHAUSEN, 1788
Coenonympha pamphilus (LINNAEUS, 1758)
Coenonympha tullia (MÜLLER, O.F., 1764)
Erebia aethiops (ESPER, 1777)
Erebia medusa (DENIS & SCHIFFERMÜLLER, 1775)
Lasiommata maera (LINNAEUS, 1758)
Lasiommata megera (LINNAEUS, 1767)
Maniola jurtina (LINNAEUS, 1758)
Melanargia galathea (LINNAEUS, 1758)
Pararge aegeria (LINNAEUS, 1758)
Pyronia tithonus (LINNAEUS, 1771)

Riodinidae
Hamearis lucina LINNAEUS, 1758

Lycaenidae
Aricia agestis (DENIS & SCHIFFERMÜLLER, 1775)
Callophrys rubi (LINNAEUS, 1758)
Celastrina argiolus (LINNAEUS, 1758)
Cupido minimus (FOESSLY, 1775)
Cyaniris semiargus (ROTTEMBURG, 1775)
Glaucopsyche alexis PODA, 1761
Heodes tityrus (PODA, 1763)
Heodes virgaureae (LINNAEUS, 1758)
Lycaena dispar (HAWORTH, 1803)
Lycaena helle (DENIS & SCHIFFERMÜLLER, 1775)
Lycaena phlaeas (LINNAEUS, 1758)
Lysandra coridon (PODA, 1761)
Nordmannia ilicis (ESPER, 1779)
Palaeochrysophanus hippothoe (LINNAEUS, 1761)
Plebejus argus (LINNAEUS, 1758)
Polyommatus icarus (ROTTEMBURG, 1775)
Quercusia quercus (LINNAEUS, 1758)
Thecla betulae (LINNAEUS, 1758)

Hesperidae
Carcharodus alceae (ESPER, 1780)
Carterocephalus palaemon (PALLAS, 1771)
Erynnis tages (LINNAEUS, 1758)
Hesperia comma (LINNAEUS, 1758)
Ochlodes venata (BREMER & GREY, 1852)
Pyrgus malvae (LINNAEUS, 1758)
Spialia sertorius (HOFFMANNSEGG, 1804)
Thymelicus acteon (ROTTEMBURG, 1775)
Thymelicus lineola (OCHSENHEIMER, 1804)
Thymelicus sylvestris (PODA, 1761)

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Mise à jour de la cartographie des Rhopalocères de la Belgique: genre *Pyrgus* HÜBNER, 1819 (Lepidoptera, Hesperidae)

par Ch. TAYMANS, B. DE BAST, Ch. VERSTRAETEN, M. BAGUETTE & Ph. GOFFART

Summary

The Lepidoptera Working Group intends to increase the knowledge about butterfly biogeography and ecology in Belgium. It plans to supply a scientific basis for conservation of species and their habitats.
The two main projects are (1) to achieve an updated mapping of Belgian butterflies, and (2) to monitor yearly butterfly populations on a network of sites.
In connection with the project (1), one of us (Ch. TAYMANS) revised the Belgian distribution of the genus *Pyrgus* HÜBNER, 1819. Species of this group are quite difficult to identify and genitalia preparation is sometimes required.
Using the faunistic data bank (Gembloux), it has been possible to turn back to museum specimens and to check old identifications. Eight species of *Pyrgus* have been quoted from Belgium in previous catalogues. Only five have been really recorded, the others resulting of misidentifications.
Moreover, field work between 1985 and 1991 update the distributions of the five Belgian species. Three species have disappeared, one is quite widely distributed and another is restricted to chalk grasslands in the Province of Namur.

Introduction

Dans le cadre des activités du Groupe de Travail Lépidoptères, l'un de nous (Ch. TAYMANS) s'est attaché à la révision des informations chorologiques relatives au genre *Pyrgus* HÜBNER, 1819 (Lep., Hesperidae). Au départ des données récoltées par la Banque de Données fauniques de Gembloux, il a été possible de retourner aux spécimens eux-mêmes afin d'en valider l'identification. Les espèces de ce groupe sont difficiles à séparer et nécessitent parfois la dissection et l'examen des pièces génitales. En outre, les prospections sur le terrain ont permis de cerner la distribution des populations existant encore aujourd'hui.

Huit espèces de *Pyrgus* ont été signalées pour notre pays dans les catalogues faunistiques. Parmi celles-ci, cinq seulement ont effectivement été observées dans nos contrées. Les mentions des trois autres espèces résultent en fait d'erreurs de détermination. Ces erreurs ont été occasionnées par la difficulté d'identifier avec certitude certains spécimens sans recourir à la préparation et à l'observation des pièces génitales.

Espèces signalées par erreur de la faune belge

- *Pyrgus onopordi* (RAMBUR, 1839): cité de Bure (FR65) le 13-VIII-1893 par DERENNE (1926). L'examen des 2 exemplaires conservés à l'IRSNB (Institut royal des Sciences naturelles de Belgique) révèle qu'il s'agit de spécimens de *Pyrgus armoricanus*.

- *Pyrgus cirsii* (RAMBUR, 1839): cité par BALL (1913) de Sosoye (FR27), un individu mâle capturé le 29-VIII-1900. L'examen de ce spécimen ainsi que d'un autre exemplaire (étiqueté

Maharenne-Denée, FR27, 28-VIII-1900) conservés tous deux à l'IRSNB appartiennent en fait à *P. armoricanus*.

- *Pyrgus bellieri* (OBERTHÜR, 1910): cité par BALL (1913) d'Arlon (GR00) le 02-VI-1871 et de Virton (FQ89) le 11-VI-1905. Ces deux insectes, conservés à l'IRSNB, sont en fait des *P. alveus*.

Espèces disparues de Belgique

- *Pyrgus alveus* (HÜBNER, 1803). Espèce accidentelle, elle n'a été capturée que très rarement en Belgique où elle ne se reproduisait sans doute pas. Elle y a été rencontrée surtout en Lorraine, à Arlon (GR00), Virton (FQ89) et Torgny (FQ78), Fig. 1. Sa dernière capture en Belgique daterait de 1938.

- *Pyrgus carthami* (HÜBNER, 1813). L'aire où cette espèce volait se limitait à quelques communes de la Lorraine où elle semblait commune au début du siècle (SAUSSUS, 1980): Arlon (GR00), Virton (FQ89), Châtillon (FR90), Orval (FQ69), Torgny (FQ78), Ethe (FQ89), St-Léger (FQ99) et Chantemelle (FR90), Fig. 2. On l'y trouvait en juin et juillet. L'espèce a été signalée pour la dernière fois en 1921.

- *Pyrgus armoricanus* (OBERTHÜR, 1910) volait jadis surtout sur la Calestienne et aussi dans les dunes du littoral belge en deux générations, du début juin à fin septembre. La dernière observation date de 1956, à Tellin (FR55), Fig. 3.

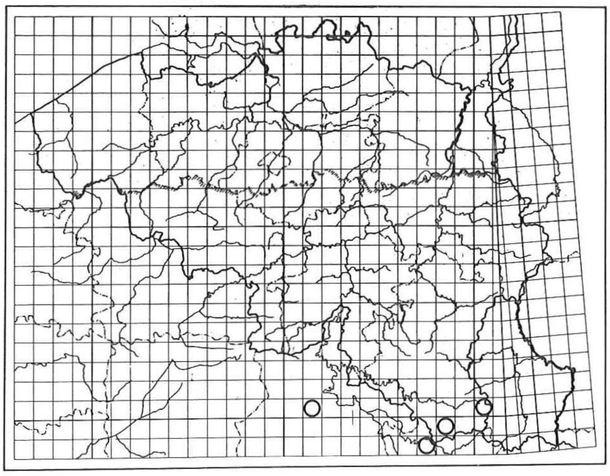

Fig. 1. Distribution de *Pyrgus alveus* (HÜBNER, 1803) - Dernière observation en 1938.

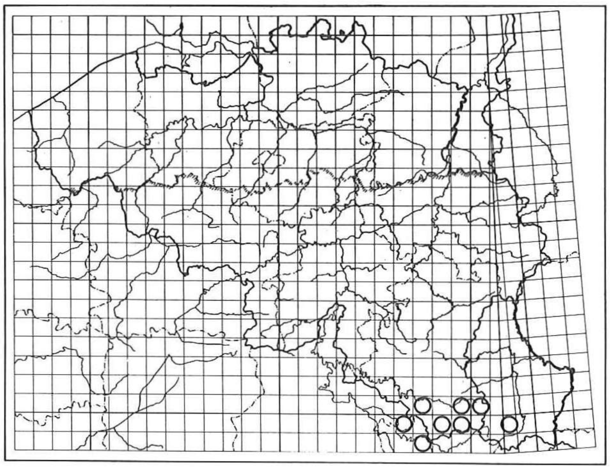

Fig. 2. Distribution de *Pyrgus carthami* (HÜBNER, 1813) - Dernière observation en 1921.

Espèces actuelles en Belgique

- *Pyrgus serratulae* (RAMBUR, 1839): avant 1960, l'espèce se rencontrait un peu partout en Wallonie. Depuis lors, elle est en nette régression et n'a plus été observée que dans les provinces de Namur (surtout sur la Calestienne) et de Luxembourg (Torgny (FQ78) et Neupont (FR54)). Sa période de vol s'étale de mai à septembre (Fig. 4).

- *Pyrgus malvae* (LINNÉ, 1758): sans conteste l'espèce la plus commune, sa dispersion est large puisqu'on la retrouve dans toutes les régions du pays. Toutefois, elle est actuellement répandue au sud du sillon Sambre et Meuse, surtout dans les régions calcaires. On peut la rencontrer depuis mars jusqu'en fin août (Fig. 5).

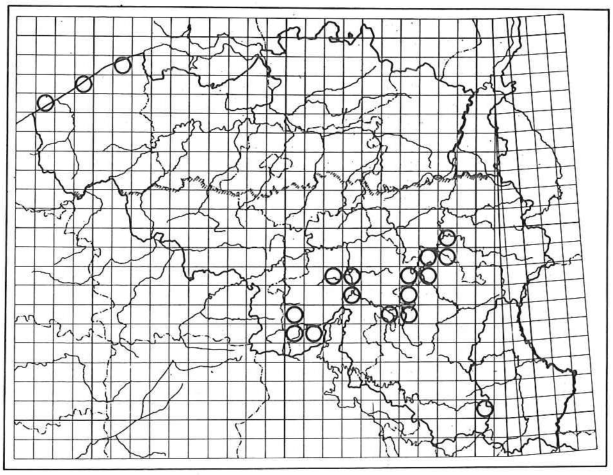

Fig. 3. Distribution de *Pyrgus armoricanus* (OBERTHÜR, 1910) - Dernière observation en 1956.

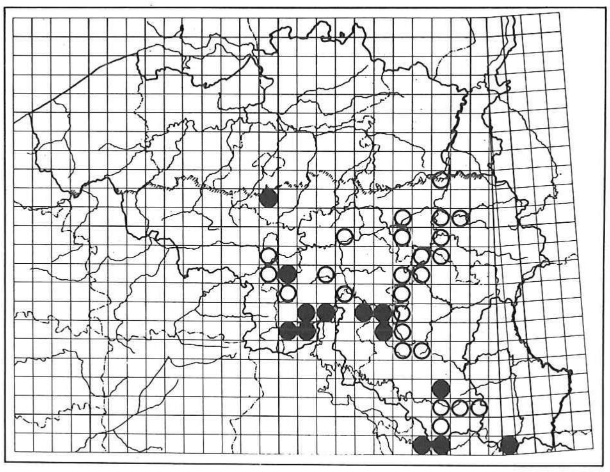

Fig. 4. Distribution de *Pyrgus serratulae* (RAMBUR, 1839) - Avant (○) et après (●) 1960.

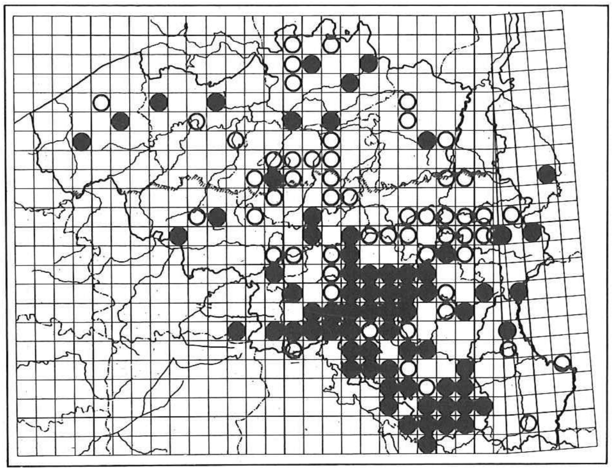

Fig. 5. Distribution de *Pyrgus malvae* (LINNÉ, 1758) - Avant (○) et après (●) 1960.

Conclusion

La révision des connaissances acquises dans la littérature au sujet du genre *Pyrgus* et l'examen minutieux des spécimens conservés dans les collections ont permis de mieux cerner la répartition belge de ces espèces et de mieux appréhender leur statut ancien et actuel dans notre région. Sur les cinq espèces de *Pyrgus* observées jadis dans notre pays, deux seulement peuvent encore y être retrouvées. Si l'une d'elles (*Pyrgus malvae*) présente encore une distribution assez large, l'autre est essentiellement confinée dans la province de Namur.

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Faunistics and ecology of the grasshoppers and crickets (Saltatoria) of the dunes along the Belgian coast

by Kris DECLEER & Hendrik DEVRIESE

Abstract

Hitherto a total number of 23 species were recorded in the coastal dune area; this is about half of the Belgian Saltatoria fauna. Despite the overall deterioration of the former semi-natural dune landscape during the past decades, still 18 species were found after 1980. The actual presence of 3 additional species needs confirmation. Three species seem to have become extinct: *Decticus verrucivorus, Gryllus campestris* and *Mecostethus grossus*. Both in a Flemish and Belgian perspective, the coastal dunes still form a stronghold for several rare species, e.g. *Conocephalus discolor, Platycleis albopunctata, Tetrix ceperoi, Chorthippus albomarginatus* and *Oedipoda caerulescens*.
The importance of particular microclimatological conditions for the occurrence of most grasshoppers is stressed. The cessation in the beginning of the century of the agricultural practice of cattle grazing in the inner-dunes undoubtedly played an important role in the extinction process or the decrease of several species. An increased effort to remove considerable parts of dense scrub vegetations in former dune grasslands and the re-use of extensive grazing as a management practice can therefore strongly be recommended.

Résumé

La faune des criquets et sauterelles (Saltatoria) du district des dunes littorales comprend 23 espèces, soit environ la moitié de la faune belge. Malgré la détérioration complète des paysages semi-naturelles des dunes durant les dernières décennies, 18 espèces ont encore été observées après 1980. L'éventuelle présence de 3 autres espèces doit être confirmée. Trois espèces peuvent être considérées comme disparues: *Decticus verrucivorus, Gryllus campestris* et *Mecostethus grossus*. Du point de vue de la situation en région flamande et en Belgique, les dunes littorales englobent encore des populations importantes d'espèces rares, p.ex. *Conocephalus discolor, Platycleis albopunctata, Tetrix ceperoi, Chorthippus albomarginatus* et *Oedipoda caerulescens*.
L'importance des conditions micro-climatologiques pour la présence de la plupart des criquets et sauterelles est soulignée. L'abandon des pratiques agraires traditionnelles au début du siècle est probablement responsable de la disparition ou la raréfaction de plusieurs espèces. Le débroussaillage de superficies importantes et le paturage extensif constituent des mesures de gestion recommandées pour les dunes littorales.

Introduction

Most Saltatoria are thermophilous. Consequently, in countries with a temperate climate such as Belgium, grasshoppers are very strongly related to habitats with a warm and sunny microclimate. Chalk grasslands and habitats with open sandy soils, such as we find them in the dunes along the coast, or in the heathlands in the Campine area, are potentially very rich in species. The Saltatoria fauna of the Belgian chalk grassland district has already been discussed by HOFMANS *et al.* (1989). In this contribution we focuss on the dune habitats along the Belgian coast. Ancient records of grasshoppers were gathered by checking both literature and museum collections. On the other hand, since 1980, several grasshopper enthousiasts performed a lot of field work in the dunes. Results of these surveys will be discussed here in a historical and ecological context.

The deterioration of the Belgian coast

The Belgian coast line measures only 65 km. With the growing tourist industry along the coast and due to a failing physical planning, the original dune landscape changed dramatically since the beginning of the century. From the original 5000 ha of dunes only 2700 ha are left nowadays. Only 33 km of the coastline are still bordered by primary marram dune (VERMEERSCH, 1986). Fragmentation and isolation are not the only problems faced by the Belgian dunes. Due to water abstraction groundwater levels declined in formerly wet dune valleys. The original custom of the local inhabitants to use large parts of the inner dunes for cattle or horse grazing was abandoned in the beginning of the twentieth century. This resulted in a spontaneous dereliction of the grasslands and a drastic increase of shrub vegetations, combined with a strong tendency to increased stability of larger mobile dunes, and the disappearance of smaller patches of open sand (DE RAEVE, 1989). On the other hand a large recreational pressure has induced local erosion, combined with subsisting small patches of very short grassland (trampled and overgrazed by rabbits), apart from an overall disturbance of the remaining Belgian dunes. Finally, a lot of dune areas were afforested (mostly with pines). Recently, both the government and private organisations started to preserve as much dune habitat as possible by establishing nature reserves. However, by these efforts the damage inflicted on the Belgian dune ecosystem can only partly been repaired.

The fragmentation of the dune landscape is evident from fig. 1. Only in the east and especially in the west, some large dune areas do still exist. The dune areas in the middle part of the Belgian coast are mainly afforested and have therefore lost a great deal of their original ecological value. Except for some small areas, all Belgian dunes are characterised by calcareous soils.

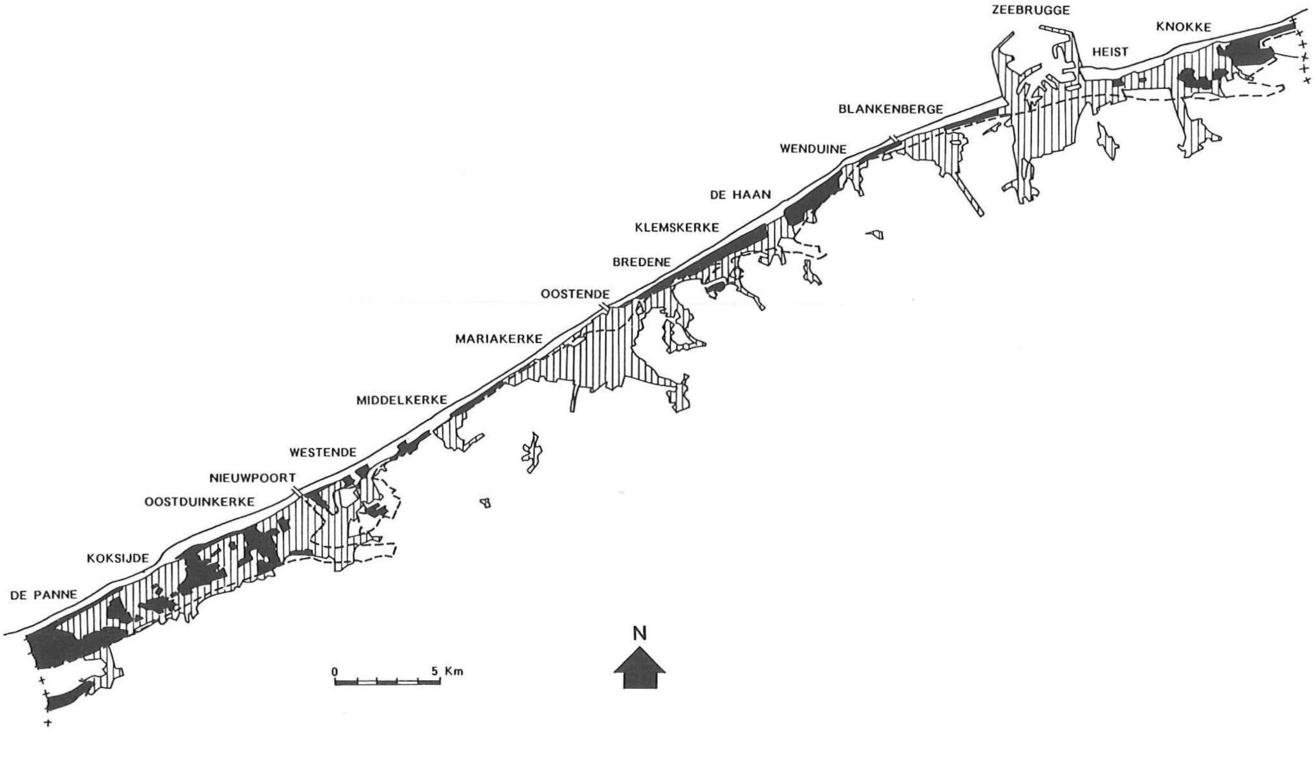

Fig. 1. Fragmentation of the Belgian dune landscape (black) by the explosive an chaotic growth of the coastal municipalities (shaded). The broken line indicates the geographical border of the dune region.

Faunistic account

Distinction was made between ancient records (roughly the period 1850-1950) and recent records (period after 1980). From the period between 1950 and 1980 only very few records were available.
In particular the collections of DE SELYS-LONGCHAMPS and GOETGHEBUER, preserved at the Royal Belgian Institute of Natural Sciences, were usefull as a source for ancient data on the distribution of this insect group along the coast. These records and other ancient data, mostly from the first half of the century, were already listed in DEVRIESE (1988). The maps published in DUIJM & KRUSEMAN (1983) were also consulted for reliable additional information. Records after 1980 mainly consist of unpublished data from both authors, supplemented with data kindly provided by some other orthopterists. Difficult species were checked by one of the authors before admission in this publication.

Table 1 summarizes all records of Saltatoria from the period 1850-1950 (most records originate from the turn of the century) and all records after 1980. A total number of 23 species were ever recorded in the Belgian dunes. Records from an additonal species (*Chorthippus mollis*) could not be confirmed by the authors up to now. Nevertheless, 23 species is about half the number of species ever recorded in Belgium (DEVRIESE, 1989) and about two thirds of the number of species ever recorded in Flanders (DECLEER *et al.*, 1989). This already gives an idea of the importance of the coastal dunes for this insect group in a wider geographical perspective.

Three, maybe five species seem to be extinct in the dunes nowadays: *Decticus verrucivorus, Gryllus campestris, Mecostethus grossus, Tetrix subulata* and *Omocestus viridulus*. The last two species are mentioned with some restriction since there are some recent data available but these could not be confirmed up to now.

After 1980, 18 species were recorded in the dunes. Two species were not found here previously: *Lepthophyes punctatissima* and *Gryllotalpa gryllotalpa*. In a Flemish perspective, 3 species are restricted to the coastal dunes: *Conocephalus discolor, Platycleis albopunctata* and *Tetrix ceperoi*. Of all 23 species, at least 14 are considered to be rare or endangered in Flanders. *Decticus verrucivorus* is even believed to be extinct in Flanders nowadays (DECLEER *et al.*, 1989).

Compared to the Dutch coast, which is much longer, only *Nemobius sylvestris* was never recorded in the Belgian dunes. On the other hand, *Conocephalus discolor* and *Omocestus rufipes* are unknown to the Dutch dunes up to now (KLEUKERS pers.comm.; DUIJM & KRUSEMAN, 1983). Coincidence or not, three species extinct along the Belgian coast seem also to be extinct along the Dutch coast: *Decticus verrucivorus, Gryllus campestris* and *Mecostethus grossus*.

It is also interesting to note that a few of the commoner species of the Belgian and Dutch coast have not crossed the Channel. Indeed, no single record from Britain is known of *Chorthippus biguttulus* and *Oedipoda caerulescens*.

Distribution and ecology

The habitat choice of most grasshoppers is well defined. Except for arboreal species such as *Leptophyes punctatissima* and *Meconema thalassinum* (and to a lesser extent also *Tettigonia viridissima*) most species in the dunes can be found in grassland habitats. Two factors are known to be of major importance to explain the occurrence of a species: humidity and vegetation structure. The latter determines the microclimatological conditions which are essential for the development of both eggs and juvenile animals. By dividing both humidity and vegetation structure in three categories, nine different combinations of (simplified) ecological circumstances can be distinguished (table 2). Preferences for one or more of these combinations of all non-arboreal species are also presented in table 2, based on observations in the field and on literature data.

Details on the distribution and the ecology of the 14 rare, endangered or extinct species in Flanders will be discussed briefly.

Conocephalus discolor

The Belgian coast forms the northernmost limit of its distribution area on the continent. At the moment it is known from 3 different dune areas at the west and middle coast (De Panne, Bredene, Middelkerke). Habitats where this elusive species was found in considerable numbers are: tall sedges in a wet dune valley, tall grassy vegetation along pathways, amongst dense *Ammophila arenaria* vegetations in the fore-dunes (even on the sea-side), derelict grassland. In Belgium this species is further only known from the extreme south of the country (Gaume region), where it occurs in tall chalk grassland vegetation. Most probably, warm macroclimatological conditions form the limiting factor for its distribution in this part of Europe.

Decticus verrucivorus

In Flanders no recent records of this large bush-cricket are known. This species must have been widespread in the coastal dunes around the turn of the century (at least 6 localities are known: Knokke, Heist, Oostende, surroundings of Blankenberge, Nieuwpoort and De Panne). As far as we know the last record in the Belgian dunes dates from 1921 (Knokke). Everywhere in Western Europe the species is now considered as very much endangered because of its strong decline during the past decades (BELLMANN, 1985; DUIJM & KRUSEMAN, 1983; MARSHALL & HAES, 1988). From Wallonia no more than 3 recent records are available at the moment.
In grasslands *D. verrucivorus* is confined to mosaic vegetations with both very short, open turf (75%) and smaller patches of tussocky vegetation (25%), all exposed to a very warm and sunny microclimate (CHERRILL & BROWN, 1990). According to this publication, especially males and juveniles are mostly found in the patches of dense vegetation, while short (<5 cm) turf vegetation is needed for the ovipositioning females and afterwards for the development of the eggs. This vegetation pattern is a typical result of moderate to rather intensive grazing by cattle or horses in dune grassland with creeping willow or a result of rather extensive grazing of grassland in combination with intensive grazing by rabbits. Since this kind of agricultural management has disappeared in the dunes, the vegetation structure changed to a more dense and tall grassy vegetation invaded by shrubs. Apparently, small-scale grazing activities of rabbits were not able to sustain the presence of a suitable habitat for the species. Minor macroclimatological changes may have played a role in its extinction as well, although there is no clear evidence for this.

Apart from the inner dune grasslands, *D. verrucivorus* occurs also in other habitats such as heathland, chalk grassland and edges of extensively used agricultural fields, as long as the typical alternation of vegetation structure and the proper microclimatological conditions are available.

Metrioptera roeseli

The distribution pattern of this species in Belgium is very disjunct. The species is abundant in the youngest polder areas in the eastern part of the coastal area, connected with vast populations on the other side of the border. Along the Belgian coast the species becomes scarcer to the west and it has never been recorded beyond the river IJzer. Inland there are only scattered records available while, in the extreme south of the country, the species becomes more abundant again. Derelict grassland vegetations, both dry and moist, especially verges of roads and ditches, are its favourite habitat. This species is perhaps not a true dune species: most records originate from the transition zone dune-polder.

Platycleis albopunctata

In Belgium this species is recently only known from the coast and the chalk grassland region in the south. In the western and central dune areas *P.albopunctata* may occur in large numbers, while, for unknown reasons, in the east it seems to be much rarer. Except for the erosive fore-dunes at the sea-side, the species is mostly found in *Ammophila*-vegetations or all kinds of ruderal dry grassland.

Gryllus campestris

The Field-cricket used to be common in most parts of Belgium but showed a drastic decline during the past decades. Parts of the province Limburg are its last stronghold in Belgium, where it mainly occurs at warm and sunny spots in heath-land areas. In the dunes, *G. campestris* occupies more or less the same habitat as *D. verrucivorus*. Its presence was known from at least one locality (surroundings of Nieuwpoort, DUIJM & KRUSEMAN, 1983). Due to the almost complete loss of its habitat, the species was, apparently, not able to survive. The neighbouring countries have the same tendency of decline in common, which could, eventually, also be explained by a combination of habitat loss and macroclimatological events such as the occurrence of successive cold summers.

Gryllotalpa gryllotalpa

This large, but elusive animal is supposed to be rare in Belgium, but this may be an underestimation. Nowadays, the species is almost exclusively confined to horticultural areas and vegetable gardens with preference for slightly moist soils. Its underground way of living makes it a difficult species to monitor. Adults are supposed to have a good flight capacity. In the dunes the species was recently recorded at two localities. At Knokke, the species was attracted by the light of a moth trap; at De Haan it is known from a photograph of the bird *Upupa epops* with the Mole-cricket as a prey in its bill. Thus, for both localities, there is no absolute certitude that a population of the species really exists within the borders of the dune region.

Tetrix subulata

This small grasshopper lives in tall marsh vegetations and is widespread in Belgium, but rather rare in Flanders, especially in the western part. Most of the coastal dune valleys used to be very wet due to high groundwater levels and several temporal ponds used to be present. Due to water abstraction most of the tall marsh vegetations which could be found in this situations have disappeared. Except for one ancient record (1901) from Heist, there are no data available for this species. As a consequence of habitat loss it may have died out in the dunes, although further investigations remain necessary to be sure of this.

Tetrix ceperoi

Closely resembling the previous species, *T. ceperoi* is extremely rare outside the coastal dunes. In wet dune slacks with sparse and short vegetation, however, it can be found in large numbers. The sandy soil in these dune slacks is permanently been blown out down to the groundwater table, so a suitable habitat for this species is nearly always guaranteed. It can be assumed that *T. ceperoi* has a good pioneering capacity, since it can also be found in young or small habitats.

Chorthippus albomarginatus

Outside the coastal dunes this species is very rare as well. In the dunes it is rather ubiquitous, but it never occurs in situations without vegetation. The few inland populations (most of them situated in the Campine area), however, are all located on marshy or moist grounds. Presumably the air moisture along the coast is sufficiently high to enable the species to survive on dry soil. This grasshopper can therefore be considered as a so-called 'diplostenoecious' species (sensu DUFFEY, 1968).

Chorthippus mollis

This rare grasshopper can only be identified with certainty by its song. The occurrence of this species in the dunes is most probable but, apart from some visual identifications by others, its song has never reliably been recorded up to now. Open, dry grounds with sparse vegetation are its favourite habitat. Outside the dunes the species only occurs in heathland. Along the Dutch coast, *C. mollis* has been recorded several times (KLEUKERS, pers.comm.).

Mecostethus grossus

This conspicuous grasshopper from marshy grounds has only been recorded from Heist (date unknown, GOETGHEBUER, 1953). The species belongs to the same ecological group as *Tetrix subulata*. Unfortunately, its probable habitat at Heist has been destroyed. Most certainly the species is now extinct in the coastal dunes. Large populations of this rare species fortunately still persist in some river valleys in different parts of the country (DECLEER, 1990).

Myrmeleotettix maculatus

Stable, open sandy soils with sparse vegetation and a warm and sunny microclimate are its usual habitat. Locally, this grasshopper is abundant in the dunes. Inland, it is confined to heathland areas.

Oedipoda caerulescens

This spectacular species with striking blue wings occurs in the same kind of habitat as the latter species, only, it needs a more extensive surface of suitable habitat and, except for some moss vegetations, the soil is often totally bare. The coastal dunes form an important stronghold for the species. In different dune areas large populations still persist, but large density fluctuations may occur from year to year.

Omocestus viridulus

Although this grasshopper is common in the southern half of Belgium, it is much rarer in the north, especially in the northwest. In the dunes there is only one ancient record available (De Panne, date unknown). Recent records (Knokke, De Panne, Oostduinkerke, De Haan) need confirmation since no one of the authors saw a specimen up to now. Confusion with green coloured forms of *Chorthippus biguttulus* is likely in most cases. Mesophilous grassland with sparse to dense vegetation is its favourite habitat.

Omocestus rufipes

One ancient record (Heist) and one recent record (Knokke) are available. The species is confined to heathland areas and chalk grasslands in the other parts of the country. The presence of both short and tall patchy vegetation is essential. It may well be considered as a relict species from the former extensive dune grasslands grazed by cattle. However, compared to *D. verrucivorus* and *G. campestris*, occasionally it can also be found in the transition zone to more dense and tall vegetations and even scrubs.

Conclusions

Despite the severe deterioration of the coastal dunes, a lot of grasshopper species were able to persist up to now. From the zoogeographical point of view, the Belgian dune region yields important meta-populations of several species: *Conocephalus discolor, Metrioptera roeseli, Platycleis albopunctata, Tetrix ceperoi, Chorthippus albomarginatus, Myrmeleotettix maculatus, Oedipoda caerulescens* and *Omocestus rufipes*. *Chorthippus mollis* may be added in the future. At short term, only *O. rufipes* must be considered as endangered. Removal of scrubs and restauration of the former grazing practices in some parts of the dunes can be recommended for the preservation of the species (the only record originates from the "Zwinbosjes" at Knokke). Species from open short turf grounds will also benifit from grazing management (e.g. *Chorthippus brunneus, Chorthippus mollis, Myrmeleotettix maculatus, Oedipoda caerulescens*). Unfortunately, two indicator species for this kind of habitats already died out during the past decades, possibly enhanced by the occurrence of some successive cold summers (*Decticus verrucivorus, Gryllus campestris*).

Wet dune slacks are the favourite habitat of a smaller group of grasshopper species. Unfortunately, *Mecostethus grossus*, already became extinct (and this could also be the case for *Tetrix subulata*). The loss of suitable habitat can be indicated as the main cause but, anyhow, it can be assumed that *M. grossus* never was very abundant in the dunes. Adequate conservation of this group of species should include that water abstraction is limited or abandoned.

The drastic change of the ancient dune landscape due to the cessation of the traditional agricultural management practices, probably had positive effects on the species which are confined to, or at least which are able to survive in taller and denser (and therefore colder) grassland vegetations and scrubs. *Tettigonia viridissima, Chorthippus albomarginatus, Chorthippus biguttulus* and *Chorthippus parallelus* are such (very) abundant ubiquists. The absence of ancient records of the arboreal *Leptophyes punctatissima* may also be seen as an illustration of this phenomenon.

In order to create an appropriate policy for the conservation of the Saltatoria fauna in the fragmented and isolated dune areas along the Belgian coast, studies will be very useful in the future on the dispersal power of the different species. It is of course essential that management plans should take the characteristic microclimatological requirements of each species into consideration. A lot of other (mostly rare) thermophilous invertebrates surely will benefit from a management policy partly based on Saltatoria.

To other countries, the example of the Belgian coast may be an illustration of the surprising "tolerance" of many species, in spite of the mass destruction that man performed to the original semi-natural dune landscape.

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Table 1. Faunistic account of the Saltatoria fauna of the Belgian coastal dunes (B) in the period 1850-1950 and after 1980, compared to the actual Dutch situation (NL) after KLEUKERS, pers.comm. For each species the exact number of known localities (dune areas) is given and between brackets the number of records. Symbols: - = no records available; x = species is recorded at least once; ? = record(s) need confirmation. Ancient Dutch records are presented between brackets (according to DUIJM & KRUSEMAN, 1983).
For each species a valuation category for Flanders is indicated according to DECLEER *et al.* (1989). Different categories: 1 = common everywhere; 2 = widespread; 3 = rare; 4 = endangered; 4? = possibly extinct.

	Valuation Category	B 1850-1950	B > 1980	NL
Tettigoniidae				
Conocephalus discolor	4	1	3(8)	-
Conocephalus dorsalis	2	5(9)	6(11)	x
Decticus verrucivorus	4?	6(7)	-	- (1)
Leptophyes punctatissima	2	-	6(6)	x
Meconema thalassinum	2	4(4)	2(2)	x
Metrioptera roeseli	3	2(3)	5(7)	x
Platycleis albopunctata	4	6(7)	18(31)	x
Tettigonia viridissima	1	3(4)	22(32)	x
Gryllidae				
Gryllus campestris	4	1	-	- (5)
Acheta domesticus	2	1	3(3)	x
Nemobius sylvestris	4	-	-	x
Gryllotalpidae				
Gryllotalpa gryllotalpa	4	-	2(3)	x
Tetrigidae				
Tetrix subulata	3	1	?	x
Tetrix ceperoi	4	3(4)	8(18)	x
Tetrix undulata	1	2(2)	6(7)	x
Acrididae				
Chorthippus albomarginatus	3	7(10)	9(14)	x
Chorthippus biguttulus	2	6(9)	26(49)	x
Chorthippus brunneus	2	3(3)	6(6)	x
Chorthippus mollis	3	1?	?	x
Chorthippus parallelus	1	4(4)	19(21)	x
Mecostethus grossus	4	1	-	- (1)
Myrmeleotettix maculatus	3	4(6)	11(22)	x
Oedipoda caerulescens	4	7(11)	7(10)	x
Omocestus viridulus	3	1	?	x
Omocestus rufipes	3	1	1	-
Minimum number of species		21	18	19
Maximum number of species		22	21	22

Table 2. Preferential ecological conditions of the non-arboreal Saltatoria species in the Belgian coastal dunes, defined by nine combinations of humidity and vegetation structure. Combinations between brackets are of minor importance.
Chorthippus mollis is not known with certainty from the Belgian dunes up to now, but its presence is suspected. *Acheta domesticus* is not mentioned in the table since it lives inside houses and other buildings.

Humidity	Vegetation structure		
	No vegetation	Sparse	Dense/High
Moist	1	2	3
Dry	4	5	6
Extremely dry	7	8	9

Tettigoniidae									
Conocephalus discolor	.	.	3	.	.	6	.	.	9
Conocephalus dorsalis	.	.	3	.	.	.	.	.	.
Decticus verrucivorus	.	.	.	.	5	.	.	8	.
Metrioptera roeseli	.	.	3	.	.	6	.	.	.
Platycleis albopunctata	.	.	.	.	.	6	.	.	9
Tettigonia viridissima	.	.	.	.	.	6	.	.	9
Gryllidae									
Gryllus campestris	.	.	.	.	5	.	.	8	.
Gryllotalpidae									
Gryllotalpa gryllotalpa	.	.	.	see text			.	.	.
Tetrigidae									
Tetrix subulata	.	2	3	.	.	.	.	.	.
Tetrix ceperoi	1	2	.	.	.	.	.	.	.
Tetrix undulata	1	2	(3)	4	5	(6)	.	.	.
Acrididae									
Chorthippus albomarginatus	.	2	3	.	5	6	.	8	9
Chorthippus biguttulus	.	.	.	(4)	5	6	(7)	8	9
Chorthippus brunneus	.	.	.	4	5	.	7	8	.
Chorthippus mollis	.	.	.	(4)	(5)	.	7	8	.
Chorthippus parallelus	.	2	3	.	5	6	.	8	9
Mecostethus grossus	.	2	3	.	.	.	.	.	.
Myrmeleotettix maculatus	.	.	.	(4)	(5)	.	7	8	.
Oedipoda caerulescens	.	.	.	4	(5)	.	7	(8)	.
Omocestus viridulus	.	(2)	(3)	.	5	6	.	.	.
Omocestus rufipes	.	.	.	.	5	6	.	.	.

The current state of knowledge of the taxonomy and distribution of non-marine molluscs in Belgium

by J.L. VAN GOETHEM

Abstract

A short historical overview emphasizes the existence of continuous malacological studies in Belgium from 1827 up to the present date.
A total of 199 species of non-marine molluscs are confirmed to be living in Belgium: 172 species of gastropods and 27 species of bivalves. This is an increase of 20 species (11 %) compared to our knowledge in the sixties. It is suggested that more species could be found living nowadays in Belgium, 10 of which are tentatively listed. Distributional data on landsnails are given: nearly 10,000 records of landsnails pre-1950 are available, distributed over 65 % of the 10 km UTM-squares; records from 1950 onwards represent a total of more than 30,000, distributed over more than 98 % of the 10 km UTM-squares, 376 squares cover the whole Belgian territory.
As approximately 50 species of landsnails are probably declining after 1950, it may be assumed that the faunal composition of landsnails in Belgium has changed considerably during the last four decades. It is suggested to take advantage of the potential offered by non-marine molluscs and to use them for nature conservation issues, especially in the field of site protection.
Key-words: non-marine molluscs, taxonomy, distribution, faunistics, Belgium.

Introduction

Malacology in Belgium has a long standing tradition, especially in the field of taxonomy, morphology and faunistics. A survey of the literature on Belgian molluscs reflects continuous studies and field work from 1827 up to the present date.

Leading malacologists in the second half of the 19th century decided to create in 1863 the "Société Malacologique de Belgique", which offered an excellent forum for the promoting and favoring of malacology. At the beginning of the 20th century, the scope of the "Société Royale Malacologique de Belgique" broadened, which was confirmed by two changes of the society's denomination (1904 and 1922). The center of malacological interest and study was thus shifted to the "Musée Royal d'Histoire naturelle de Belgique", presently the Royal Belgian Institute of Natural Sciences (R.B.I.N.S.), Brussels. A detailed historical review of malacological studies in Belgium up to 1947 is found in ADAM (1947). A review of current malacological research in Belgium is presented in VAN GOETHEM (1989).

The aim of this contribution is to provide information on the present knowledge of the non-marine molluscs of Belgium, and to suggest making better use of the potential of these animals within the field of nature conservation and the continuous struggle for the protection of sites.

Taxonomy

ADAM (1947) gave a very detailed revision and compilation of the non-marine molluscs in Belgium with a complete bibliography. ADAM (1960) remains the principle identification manual, which is still fairly accurate. However, the nomenclature of the treated species has changed considerably, and some twenty species which are nowadays found in Belgium, are not listed. VAN GOETHEM (1987; 1988) presented updated annotated checklists, useful tools in combination with ADAM (1960) and KERNEY *et al.* (1983). A complete bibliography of non-marine molluscs in Belgium from 1943 onwards is in preparation (NIJS *et al.*, in prep.).

At present, a total of 199 species of non-marine molluscs are confirmed to be present in Belgium: 172 species of gastropods, 27 species of bivalves. Amongst the gastropods, 120 species are terrestrial, 41 are freshwater species, 7 brackish water species, and another 4 can be found in either fresh or brackish water.
Amongst the bivalves, 25 species live in freshwater and 2 in brackish water (VAN GOETHEM, 1989, p. 84, see also remarks on p. 83). Some so called typical freshwater species show, however, a tolerance for slightly brackish water. On the other hand it is known that some species of gastropods and even bivalves (*Pisidium* spp.) have an amphibian way of life, making a strict separation between terrestrials and aquatics a difficult matter. *Assiminea grayana* FLEMING, 1828 and *Lymnaea (Galba) truncatula* (MÜLLER, 1774) are classical examples.

It is strongly believed that at the present time, even more species are present in Belgium, either autochtonous or more or less recently introduced species, which are currently known from regions close to our borders. Examples from the first category are a.o. *Granaria frumentum* (DRAPARNAUD, 1801), *Vallonia enniensis* (GREDLER, 1856), *Chondrula tridens* (MÜLLER, 1774), *Tandonia sowerbyi* (DE FÉRUSSAC, 1823) and several Helicidae. Imported or introduced species could easily be expected in water bodies or on land, especially in gardens or other synanthropous surroundings: *Gyraulus parvus* (SAY, 1817), *Gyraulus chinensis* (DUNKER, 1848), *Milax nigricans* (PHILIPPI, 1836), *Deroceras sturanyi* (SIMROTH, 1894), *Deroceras lothari* GIUSTI, 1971, *Deroceras rodnae* GROSSU & LUPU, 1965, a.o. Furthermore, it is evident that a better taxonomical knowledge of certain families could lead to the discovery of new species, e.g. after the unraveling of species complexes within the genera *Arion*, *Trichia*, etc.

Identification manuals useful for Belgian non-marine molluscs are: ADAM (1960), CAMERON & REDFERN (1976), ELLIS (1978), GITTENBERGER *et al.* (1984), GLÖER *et al.* (1987), GRAHAM (1971), JANSSEN & DE VOGEL (1965), KERNEY & CAMERON (1980), KERNEY *et al.* (1983), THOMPSON & BROWN (1976).

Distribution

ADAM (1947) presented distribution maps for 162 species of non-marine molluscs based on the material present in the collections of the R.B.I.N.S. and on data from the literature.

In DE WILDE, MARQUET & VAN GOETHEM (1986) a total of 131 species and species-complexes of terrestrial gastropods are considered, each of them with a distribution map based on the UTM-grid with 10 x 10 km squares. A total of 376 UTM-squares are considered for Belgium, including squares with partial covering of Belgian territory and some trapezoïdal spaces in the eastern part of the country inherent to the UTM grid. Records are indicated by six different symbols. This atlas is mainly based on the general collections of the R.B.I.N.S., including the vast quantity of material collected by R. MARQUET *et al.* during the period 1977-82, additional data from private collections, all data from the literature pre-1947, some data from the literature from 1947 onwards, and few data from localities just across the Belgian border.

The atlas of terrestrial gastropods of Belgium (*op. cit.*) is described as "preliminary" because coverage of the literature is still in progress, while many additional records are currently being registered.

At present, about 10,000 records of landsnails pre-1950 are available (Fig. 1), distributed over 65 % of the 10 km squares. Records from 1950 onwards total more than 30,000, distributed over more than 98 % of the 10 km squares (Fig. 2).

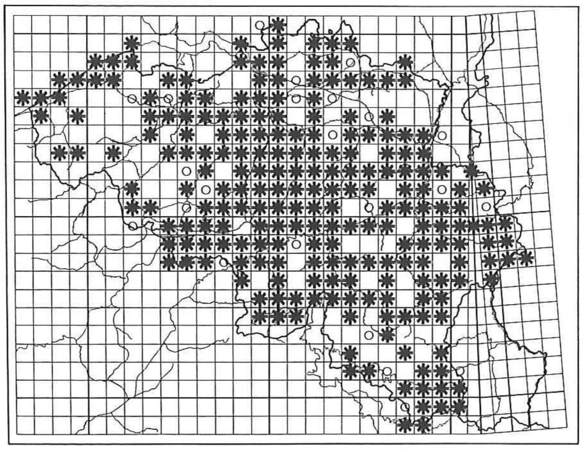

Fig. 1. All 10 km UTM-squares with records on landsnails pre-1950 only.
O records based on data from the literature
✱ records based on collections.

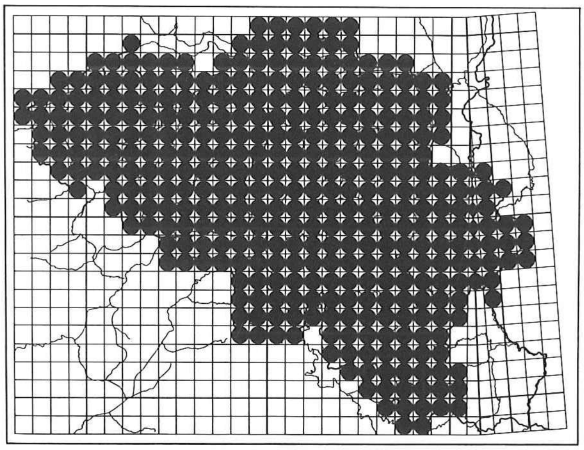

Fig. 2. All 10 km UTM-squares with records on landsnails 1950 onwards
● records based on collections or observations
Situation 31 December 1991.

It is obvious that landsnail collecting was more intensive and wider spread in Belgium after 1950. Nevertheless, many maps present a lot of "pre-1950" symbols, not covered by "1950 onwards" symbols, thus indicating that the species concerned were no longer found after 1950. Such comparisons have to be done extremely careful, but at least three general trends are apparent.

1. Some, but not all, of the previously so-called rare or very rare species in Belgium, appear to be more widespread, probably as a result of a more intensive survey of landsnails from 1950 onwards, e.g. *Zonitoides excavatus* (ALDER, 1830) and *Oxychilus alliarius* (MILLER, 1822).
2. On the contrary, for at least 50 species the maps reflect an obvious decrease regarding their overall presence in the 10 km squares from 1950 onwards. This is the case with large species [*Helix pomatia* LINNAEUS, 1758, *H. aspersa* MÜLLER, 1774, *Cepaea nemoralis* (LINNAEUS, 1758), *Helicigona lapicida* (LINNAEUS, 1758), *Arion rufus* (LINNAEUS, 1758), etc.]; as well as with small species [*Vallonia pulchella* (MÜLLER, 1774), *Vertigo antivertigo* (DRAPARNAUD, 1801), etc.].

3. Introduced species, which within a few years became established and widespread members of the Belgian fauna are also known, *Boettgerilla pallens* SIMROTH, 1912, (first record in Belgium in 1967) and *Deroceras caruanae* (POLLONERA, 1891) (first record in Belgium in 1968). For further information, see DE WILDE *et al.* (1986a, 1986b); VAN GOETHEM *et al.* (1984); DE WILDE *et al.* (1983), VAN GOETHEM (1972 ; 1974).

For further analyses and comments on declining species, refer to VAN GOETHEM *et al.* (1987) or MARQUET *et al.* (1987).

In regard to fresh and brackish water molluscs, a long term project aiming at the realization of an atlas similar to the one of the landsnails of Belgium, was undertaken at the R.B.I.N.S. in 1987. Some maps are already presented in SABLON & VAN GOETHEM (1989; 1992). For further information refer to pp. 195-198 of this book.

Conclusions

ADAM (1947; 1960) presented a complete review of the taxonomical and faunistic knowledge of Belgian non-marine molluscs at his time. The author and his collaborators have been involved for a number of years in compiling an updated, complete review of the Belgian molluscan fauna (VAN GOETHEM, 1989). Therefore it is apparent that the recent non-marine Belgian Mollusca are reasonably well known.

Presently however, taxonomical confusion still exists in certain families and genera. This is especially the case in certain species complexes, e.g. within the genera *Arion*, *Trichia*. Bearing this in mind, as well as the possibility of several new species occurring in the Belgian fauna, identification must proceed carefully.

A preliminary distribution atlas exists for the terrestrial snails and slugs, which is currently being updated and completed. Work is underway at the Malacology section of the R.B.I.N.S. on a similar distribution atlas for fresh and brackish water molluscs.

On the basis of a preliminary analysis on the distributional data of terrestrial molluscs, the hypothesis is put forward that approximately 50 species have declined since 1950. However, other species are less rare than previously suspected. Introduced species can rapidly become widespread members of the Belgian fauna.

As many species of non-marine molluscs only occur in a narrow range of biotopes, are relatively easy to collect and identify, a greater use should be made of molluscs in nature conservation issues. Faunistic studies of sites of special scientific interest should include molluscs, as well as the classical groups of insects and spiders.

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Towards a compilation of an atlas of the freshwater molluscs of Belgium: a preliminary report

by Rose SABLON & J.L. VAN GOETHEM

Abstract

After the publication of a preliminary atlas of the land snails of Belgium, a long term project aiming at the realization of a similar atlas of the freshwater molluscs was started.
Investigations as well as checking and compiling the records began with the family Lymnaeidae. Preliminary distribution maps for five species of Lymnaeidae are presented.
There are large gaps in our knowledge of the occurrence and distribution of freshwater molluscs in Belgium. This is regrettable since many species of freshwater molluscs are considered valuable bio-indicators.
Key-words: atlas, freshwater molluscs, Belgium.

Samenvatting

Na de publikatie van de "Voorlopige atlas van de landslakken van België" werd op de afdeling Malacologie van het Koninklijk Belgisch Instituut voor Natuurwetenschappen begonnen aan de voorbereiding van een gelijkaardige atlas van de zoetwatermollusken.
Het onderzoek, het nazicht en het samenbrengen der gegevens begon bij de familie Lymnaeidae. Voorlopige verspreidingskaarten voor vijf soorten Lymnaeidae worden hier voorgesteld.
De kennis inzake het voorkomen en de verspreiding van zoetwatermollusken in België vertoont grote lacunes. Dit is te betreuren vooral indien men weet dat vele soorten zoetwatermollusken beschouwd worden als waardevolle bio-indicatoren.
Trefwoorden: atlas, zoetwatermollusken, België.

Introduction

After the publication of a preliminary atlas of the land snails of Belgium (DE WILDE, MARQUET & VAN GOETHEM, 1986), we started to compile an atlas of the freshwater molluscs of Belgium. Obviously this will turn out to be a long term project, for there are still large gaps in our knowledge of the occurrence and distribution of the Belgian freshwater molluscs.

Material and methods

We are currently 1) revising and updating the K.B.I.N. collection of Belgian freshwater molluscs; 2) studying material obtained during recent field excursions or put at our disposal by individuals, laboratories and institutions; 3) screening the literature and 4) compiling all additional information.

Thus far, records from over 4,000 localities have been studied.

Distributional data are presented by standard maps with an UTM-grid (Universal Transverse Mercator), as used in the context of the European Invertebrate Survey project (EIS). The UTM-grid is composed of 10 x 10 km squares of which 376 pertain to the Belgian territory, those partly located in Belgium and some trapezoïdal spaces in the eastern part of the country included.

Results and discussion

We started our investigation with the family Lymnaeidae of which nine species can be found in Belgium (VAN GOETHEM, 1988, p. 12 ; VAN GOETHEM, 1989, p. 84). At this moment we can present preliminary distribution maps for five of these species.

Lymnaea truncatula (MÜLLER, 1774), Fig. 1, map based on 2,766 specimens from 216 localities.

Lymnaea glabra (MÜLLER, 1774), Fig. 2, map based on 480 specimens from 50 localities.

Lymnaea auricularia (LINNAEUS, 1758), Fig. 3, map based on 1,514 specimens from 190 localities.

Lymnaea stagnalis (LINNAEUS, 1758), Fig. 4, map based on 3,930 specimens from 426 localities.

Myxas glutinosa (MÜLLER, 1774), Fig. 5, map based on 413 specimens from 29 localities.

Furthermore, SABLON & VAN GOETHEM (1989, p. 114) presented two preliminary distribution maps for *Anisus leucostomus* (MILLET, 1813) and *Anisus spirorbis* (LINNAEUS, 1758).

Although our compilation of locality data is far from complete, the distribution maps show that some areas haven't been sampled adequately. Especially from 1950 to 1970 data are scarce. However in the early seventies new information became available due to the activities for the atlas of the land snails from Belgium. In addition some collections resulting from a project carried out by a university or resulting from individual investigations (theses, dissertations, ...) have been put at our disposal. Yet a regular cooperation with students or volunteers still does not exist.

The disposal of old collections supplemented by more recent material will enable us to process and compare information of a period of about 100 years of field explorations, which in turn can give us an idea on possible distributional changes. These data are very useful, because freshwater molluscs are widely used as biological indicators in environmental studies.

Conclusion

At present any conclusion about the actual distribution of the above mentioned freshwater species and their evolution is premature. Data on other species of freshwater molluscs are currently being compiled. Hence we would appreciate to receive any additional collection or information on the subject.

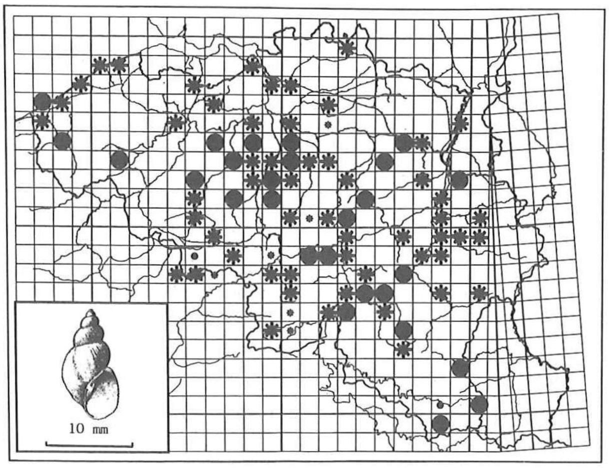

Fig. 1. *Lymnaea truncatula.*

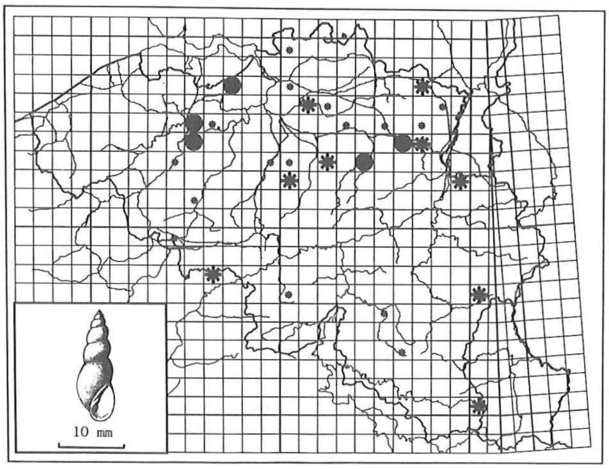

Fig. 2. *Lymnaea glabra.*

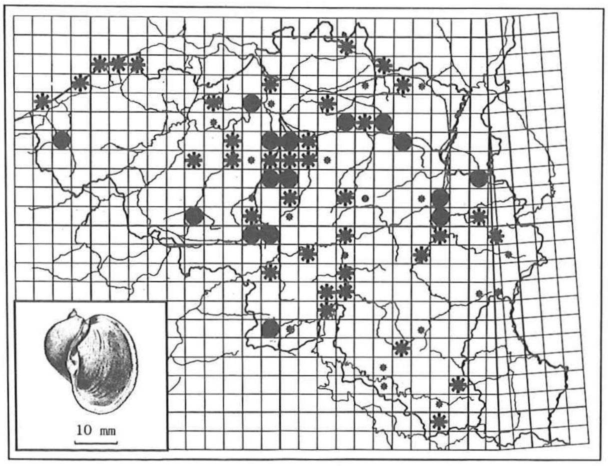

Fig. 3. *Lymnaea auricularia.*

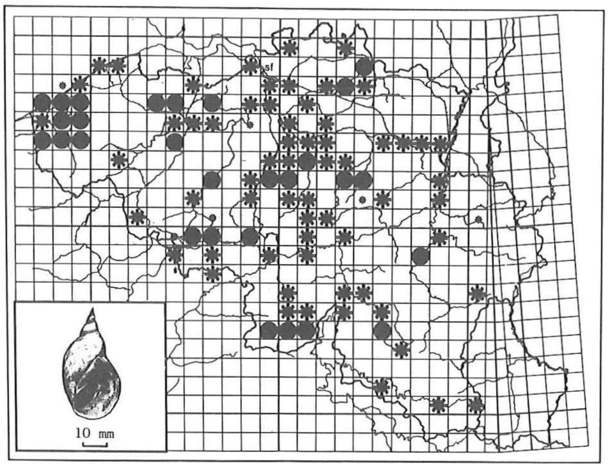

Fig. 4. *Lymnaea stagnalis.*

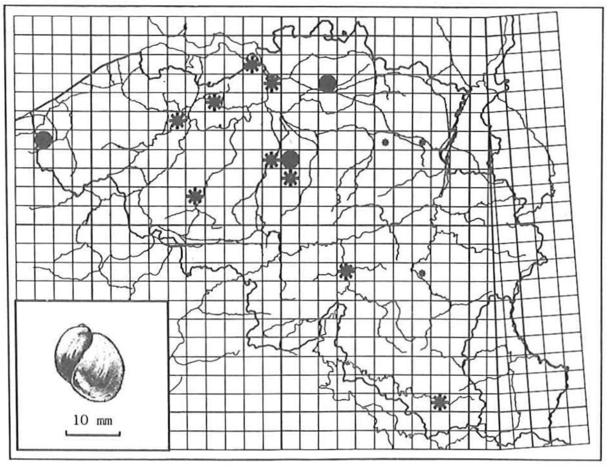

Fig. 5. *Myxas glutinosa.*

Legend

pre 1950, empty shells, decoloured or broken

pre 1950, collected alive or observed alive

1950 onwards, empty shells, decoloured or broken

1950 onwards, collected alive or observed alive

sf subfossil

Acknowledgements

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Distribution of Belgian Rotifera

by M. De Ridder

Abstract

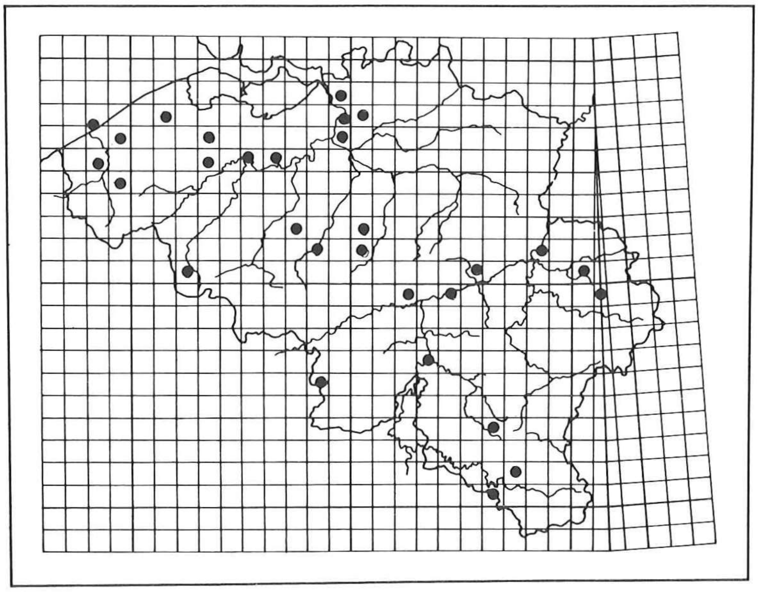
New distribution data are given for 166 Rotifer species or *formae* in Belgium. For one species, *Keratella quadrata*, a map, giving these data, is added.
Key-words: Rotifera, distribution, Belgium

Résumé

Dans cet article, de nouvelles données concernant la présence de 166 taxons (espèces ou formes) de Rotifères en Belgique sont énumérées. Pour l'espèce *Keratella quadrata*, une carte représentant ces données, est ajoutée.
Mots-clés: Rotifères, distribution, Belgique.

Introduction

In the present contribution, new distribution data for Rotifer species and/or *formae*, are added to those already published in De Ridder (1973) and De Ridder (1987). We excerpted all recent publications on Rotifers which we could trace, as well as some older papers, which were unfindable at the time or which were overlooked. In this way we came across new data for 166 species or *formae*. Taxa, new for Belgium, are marked with an asterisk. References to authors are indicated with the number of the paper in question in the bibliography. For the sake of simplicity, we only note the UTM co-ordinates when a locality appears for the first time in our list. For the "Meuse liégeoise" we choose the co-ordinates of Tihange, as this locality is the central point in Baiverlin's (1984) investigations. For one species (*Keratella quadrata*) a distribution map based on De Ridder (1987) and the present paper is given. It is complementary to map 93 in De Ridder (1973).



Map 1. Occurrence of *Keratella quadrata* in Belgium, after the data in De Ridder (1987) and the present paper.

Species list

In the following list, species/*formae* are noted in alphabetical order; as often as possible, not only the locality, but also the biotope where they were encountered are presented.

Taxon	Locality	UTM co-ordinates	Bib. ref.
Anuraeopsis fissa	Gent (boatracing canal)	ES.55	5
(GOSSE, 1851)	Merksem (moat of fort)	ES.97	11
	Overmere (lake Donk)	ES.65	14
Ascomorpha ecaudis	Woumen (lake Blankaart)	DS.94	9
PERTY, 1850			
Ascomorpha saltans	Overmere (lake Donk)		14
BARTSCH, 1870	Woumen (lake Blankaart)		9
Asplanchna herricki	Woumen (lake Blankaart)		9
DE GUERNE, 1888			
Asplanchna priodonta	Denderleeuw (lake Gates)	ES.73	15
GOSSE, 1850	Gent (river lieve)		13
	Gent (boatracing canal)		5,8,25
	Gent (ponds Bot. Garden)		26
	Hoboken (moat of fort 8)	ES.97	10,12
	Merksem (moat of fort)		11
	Meuse liégeoise (Huy-Lixhe)	FS.50	2
	Overmere (lake Donk)		4,14,16,21,22
	Overmere (newly dug pond)		18
	Tournai (artificial crater Lake)	ES.20	3
	Woumen (lake Blankaart)		9
Asplanchnella brightwelli	Hoboken ("grote vijver" of fort 8 moat)		10
(GOSSE, 1850)	Hoboken ("kleine vijver" of fort 8 moat)		12
	Merksem (moat of fort)		11
	Meuse liégeoise (Huy-Lixhe)		2
	Overmere (lake Donk)		14
	Woumen (lake Blankaart)		9
Asplanchnella girodi	Gent (boatracing canal)		5,24
(DE GUERNE, 1888)	Overmere (lake Donk)		21,22
Brachionus angularis	Gent (boatracing canal)		5,7,8,24
GOSSE, 1851	Gent (river Lieve)		13
	Hoboken (ponds moat fort 8)		10,12
	Merksem (moat of fort)		11
	Meuse liégeoise		2
	Overmere (lake Donk)		4,14
	Overmere (newly dug pond)		18
	Woumen (lake Blankaart)		9
Brachionus bennini	Overmere (lake Donk)		4
DE BEAUCHAMP, 1939			

Brachionus bidentatus	Overmere (lake Donk)	4
ANDERSON, 1889		
Brachionus calyciflorus	Gent (boatracing canal)	5,7,8,24,25
PALLAS, 1766	Gent (river Lieve)	13
	Hoboken (pond of moat of fort 8)	12
	Merksem (moat of fort)	11
	Meuse liégeoise	2
	Overmere (lake Donk)	4,14,21,22
	Tournai (artificial crater lake)	3
	Woumen (lake Blankaart)	9
Brachionus calyciflorus	Gent (boatracing canal)	7
PALLAS f. *amphiceros* EHRENBERG, 1838		
Brachionus diversicornis	Meuse liégeoise	2
(DADAY, 1883)	Overmere (lake Donk)	14,21,22
Brachionus leydigi	Gent (boatracing canal)	5,7,24
COHN, 1862	Meuse liégeoise	2
	Overmere (lake Donk)	14
Brachionus quadridentatus	Gent (boatracing canal)	5,24
HERMANN, 1783	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Meuse liégeoise	2
	Overmere (lake Donk)	6,14
	Woumen (lake Blankaart)	9
Brachionus quadridentatus	Woumen (lake Blankaart)	9
HERMANN f. *brevispinus* (EHRENBERG, 1832)		
Brachionus quadridentatus	Woumen (lake Blankaart)	9
HERMANN f. *cluniorbicularis* SKORIKOV, 1894		
Brachionus rubens	Gent (boatracing canal)	5,7,24
EHRENBERG, 1838	Gent (ponds of Bot. Garden)	23
	Woumen (lake Blankaart)	9
Brachionus urceolaris	Gent (boatracing canal)	5,7,24
(O.F.MÜLLER, 1773)	Gent (river Lieve)	13
	Gent (ponds Bot. Garden)	26
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Meuse liégeoise	2
	Overmere (lake Donk)	4,6,14
Brachionus variabilis	Gent (boatracing canal)	5,24
HEMPEL, 1896	Woumen (lake Blankaart)	9
Cephalodella auriculata	Meuse liégeoise	2
(O.F.MÜLLER, 1773)		
Cephalodella catellina	Woumen (lake Blankaart)	9
(O.F.MÜLLER, 1786)		
Cephalodella forficula	Gent (ponds Bot. Garden)	23
(EHRENBERG, 1832)	Gent (tap water)	28
Cephalodella gibba	Gent (river Lieve)	13
(EHRENBERG, 1832)	Gent (ponds Bot. Garden)	23
	Gent (tap water)	28
	Meuse liégeoise	2
	Overmere (lake Donk)	14
	Woumen (lake Blankaart)	9

Cephalodella gracilis	Gent (tap water)		28
(EHRENBERG, 1832)	Postel (Nature Reserve "Ronde Put")	FS.58	28
* *Cephalodella ventripes*	Gent (ponds Bot. Garden)		23
DIXON-NUTTALL, 1901	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Overmere (lake Donk)		14
Collotheca ornata	Overmere (lake Donk)		6
(EHRENBERG, 1832)			
Collotheca ornata	Overmere (lake Donk)		14
(EHRENBERG) f. *cornuta* (DOBIE, 1849)			
Collotheca pelagica	Hoboken (ponds of moat of fort 8)		10,12
(ROUSSELET, 1893)	Merksem (moat of fort)		11
	Overmere (lake Donk)		14
Colurella adriatica	Gent (ponds of Bot. Garden)		23
EHRENBERG, 1831	Overmere (lake Donk)		6,14
Colurella colurus	Gent (tap water)		28
(EHRENBERG, 1830)	Overmere (lake Donk)		14
Colurella obtusa	Assebroek (Nature Reserve "Leiemeersen")	ES.17	28
(GOSSE, 1886)	Gent (ponds of Bot. Garden)		23
	Gent (tap water)		28
	Meuse liégeoise		2
	Overmere (lake Donk)		6,14
Colurella uncinata	Assebroek (Nature Reserve "Leiemeersen")		28
(O.F.MÜLLER, 1773)	Gent (ponds of Bot. Garden)		23
	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Overmere (lake Donk)		14
* *Conochilus dossuarius*	Hoboken (pond of moat of fort 8)		12
HUDSON, 1888			
Conochilus natans	Hoboken (ponds of moat of fort 8)		10,12
SELIGO, 1900	Overmere (lake Donk)		14
Conochilus unicornis	Overmere (lake Donk)		14,22
ROUSSELET, 1892	Overmere (newly dug pond)		18
Cupelopagis vorax	Gent (ponds of Bot. Garden)		23
(LEIDY, 1857)			
* *Dicranophorus epicharis*	Gent (tap water)		28
(HARRING & MYERS, 1928)			
Dicranophorus forcipatus	Overmere (lake Donk)		14
(O.F.MÜLLER, 1786)			
Dicranophorus grandis	Gent (tap water)		28
(EHRENBERG, 1832)			
* *Dicranophorus secretus*	Gent (tap water)		28
DONNER, 1951			

* *Encentrum mustela* (MILNE, 1885)	Gent (tap water)	28
Epiphanes senta (O.F.MÜLLER, 1773)	Gent (boatracing canal)	25
	Gent (river Lieve)	13
	Meuse liégeoise	2
	Overmere (lake Donk)	4
	Woumen (lake Blankaart)	9
Euchlanis dilatata EHRENBERG, 1832	Gent (boatracing canal)	5,24
	Gent (ponds Bot. Garden)	23
	Meuse liégeoise	2
	Overmere (lake Donk)	6,14
	Tournai (artificial crater lake)	3
* *Euchlanis lyra* HUDSON, 1886	Merksem (moat of fort)	11
	Overmere (lake Donk)	14
Euchlanis pyriformis GOSSE, 1851	Overmere (lake Donk)	14
Euchlanis triquetra EHRENBERG, 1838	Overmere (lake Donk)	14
* *Filinia hofmanni* KOSTE, 1980	Tournai (artificial crater lake)	3
Filinia longiseta (EHRENBERG, 1834)	Gent (boatracing canal)	5,7,8,24
	Meuse liégeoise	2
	Overmere (lake Donk)	14
	Overmere (newly dug pond)	18
	Woumen (lake Blankaart)	9
Filinia terminalis (PLATE, 1886)	Gent (boatracing canal)	5,8
	Overmere (lake Donk)	4
	Overmere (ponds near to lake)	21
Gastropus hyptopus (EHRENBERG, 1838)	Overmere (lake Donk)	14
	Tournai (artificial crater lake)	3
Gastropus stylifer IMHOF, 1891	Overmere (lake Donk)	14
	Woumen (lake Blankaart)	9
Habrotrocha bidens (GOSSE, 1851)	Overmere (lake Donk)	14
Kellicottia longispina (KELLICOTT, 1879)	Denderleeuw (lake Gates)	15
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Meuse liégeoise	2
	Overmere (lake Donk)	14,22
	Overmere (newly dug pond)	18
	Tournai (artificial crater lake)	3

* *Keratella americana*	Overmere (lake Donk)		14
CARLIN, 1943			
Keratella cochlearis	Denderleeuw (lake Gates)		15
(GOSSE, 1851)	Gent (boatracing canal)		5,7,8,24
	Gent (river Lieve)		13
	Gent (ponds Bot. Garden)		23,26
	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Meuse liégeoise		2
	Overmere (lake Donk)		4,14,21,22
	Overmere (newly dug pond)		18
	Oudenburg (lake Keyaart)	DS.96	27
	Virelles (Nature Reserve	ER.94	20
	"Etang de Virelles")		
	Woumen (lake Blankaart)		9
Keratella cochlearis	Overmere (lake Donk)		22
(GOSSE) f. *macracantha* (LAUTERBORN, 1900)			
Keratella eichwaldi	Diksmuide (river Yzer)	DS.85	27
(LEVANDER, 1894)	Diksmuide (Handzame canal)		27
	Woumen (lake Blankaart)		9
Keratella quadrata	Denderleeuw (lake Gates)		15
(O.F.MÜLLER, 1786)	Gent (boatracing canal)		5,7,8,24
	Gent (ponds Bot. Garden)		23,24
	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Meuse liégeoise		2
	Oudenburg (lake Keyaart)		27
	Overmere (lake Donk)		4,14,21,22
	Overmere (newly dug pond)		18
	Tournai (artificial crater lake)		3
	Woumen (lake Blankaart)		9
* *Keratella quadrata*	Woumen (small pond near lake Blankaart)		9
(O.F.MÜLLER) f. *dispersa* CARLIN, 1943			
Keratella tecta	Overmere (lake Donk)		22
(GOSSE, 1851)	Woumen (lake Blankaart)		9
Keratella testudo	Oudenburg (lake Keyaart)		27
(EHRENBERG, 1832)			
Keratella ticinensis	Oudenburg (lake Keyaart)		27
(CALLERIO, 1920)			
Keratella tropica	Woumen (lake Blankaart)		9
(APSTEIN, 1907)			

Lacinularia flosculosa	Meuse liégeoise		2
(O.F.MÜLLER, 1758)			

* *Lecane acus*	Postel (Nature Reserve "Ronde Put")		28
(HARRING, 1913))			
* *Lecane agilis*	Postel (Nature Reserve "Ronde Put")		28
(BRYCE, 1892)			
Lecane arcuata	Assebroek (Nature Reserve "Leiemeersen")		28
(BRYCE, 1891)	Gent (tap water)		28

Lecane bulla	Gent (ponds Bot. Garden)	23
(GOSSE, 1886)	Overmere (lake Donk)	6
Lecane closterocerca	Assebroek (Nature Reserve "Leiemeersen")	28
(SCHMARDA, 1859)	Gent (ponds Bot. Garden)	23
	Gent (tap water)	28
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Overmere (lake Donk)	6
Lecane cornuta (O.F.MÜLLER, 1786)	Overmere (lake Donk)	14
Lecane flexilis	Gent (boatracing canal)	5
(GOSSE, 1887)	Gent (ponds Bot. Garden)	23
	Gent (tap water)	28
	Overmere (lake Donk)	6
Lecane galeata (BRYCE, 1892)	Postel (Nature Reserve "Ronde Put")	28
* *Lecane glypta* (HARRING & MYERS, 1926)	Gent (ponds Bot. Garden)	23
Lecane gwileti (TARNOGRADSKY, 1930)	Assebroek (Nature Reserve "Leiemeersen")	28
Lecane hamata	Gent (ponds Bot. Garden)	23
(STOKES, 1896)	Gent (tap water)	28
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Overmere (lake Donk)	6
* *Lecane intrasinuata* (OLOFSSON, 1917)	Gent (tap water)	28
Lecane luna	Gent (ponds Bot. Garden)	23
(O.F.MÜLLER, 1776)	Merksem (moat of fort)	11
	Overmere (lake Donk)	6,14
Lecane lunaris	Gent (ponds Bot. Garden)	23
(EHRENBERG, 1832)	Overmere (lake Donk)	6,14
* *Lecane lunaris* (EHRENBERG) f. *perplexa* AHLSTROM, 1938	Gent (tap water)	28
* *Lecane opias* (HARRING & MYERS, 1926)	Assebroek (Nature Reserve "Leiemeersen")	28
* *Lecane pyriformis* (DADAY, 1905)	Gent (ponds Bot. Garden)	23
Lecane quadridentata (EHRENBERG, 1832)	Overmere (lake Donk)	14
Lecane stichaea HARRING, 1913	Gent (tap water)	28
Lecane subulata (HARRING & MYERS, 1926)	Postel (Nature Reserve "Ronde Put")	28
Lecane tenuiseta HARRING, 1914	Overmere (lake Donk)	6

* *Lepadella amphitropis* HARRING, 1916	Postel (Nature Reserve "Ronde Put")	28
* *Lepadella apsida* HARRING, 1916	Gent (ponds Bot. Garden)	23

* *Lepadella costata* (WULFERT, 1940)	Gent (ponds Bot. Garden)	23
Lepadella minuta (MONTET, 1918)	Assebroek (Nature Reserve "Leiemeersen")	28
Lepadella ovalis (O.F.MÜLLER, 1786)	Assebroek (Nature Reserve "Leiemeersen")	28
	Gent (ponds Bot. Garden)	23
	Meuse liégeoise	2
	Overmere (lake Donk)	14
Lepadella patella (O.F.MÜLLER, 1786)	Gent (ponds Bot. Garden)	23
	Gent (tap water)	28
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Overmere (lake Donk)	6
* *Lepadella patella* (O.F.MÜLLER) f. *oblonga* (EHRENBERG, 1834)	Overmere (lake Donk)	14
	Woumen (lake Blankaart)	9
* *Lepadella quadricarinata* (STENROOS, 1898) f. *sexcarinata* KLEMENT, 1959	Gent (ponds Bot. Garden)	23
* *Lepadella rhomboides* (GOSSE, 1868)	Gent (ponds Bot. Garden)	23
	Woumen (lake Blankaart)	9
* *Lepadella triba* MYERS, 1934	Assebroek (Nature Reserve "Leiemeersen")	28
	Gent (ponds Bot. Garden)	23
Lepadella triptera (EHRENBERG, 1830)	Assebroek (Nature Reserve "Leiemeersen")	28
Limnias melicerta WEISZE, 1848	Gent (ponds Bot. Garden)	23
* *Lindia torulosa* DUJARDIN, 1841	Gent (ponds Bot. Garden)	23
Lophocharis salpina (EHRENBERG, 1834)	Overmere (lake Donk)	14
Monommata longiseta (O.F.MÜLLER, 1786)	Meuse liégeoise	2
	Overmere (lake Donk)	14
Mytilina bicarinata (PERTY, 1850)	Overmere (lake Donk)	14
	Virelles (Nature Reserve "Etang de Virelles")	19
* *Mytilina compressa* (GOSSE, 1851)	Gent (ponds Bot. Garden)	23
Mytilina mucronata (O.F.MÜLLER, 1773)	Gent (ponds Bot. Garden)	23
Mytilina ventralis (EHRENBERG, 1832)	Gent (ponds Bot. Garden)	23
	Overmere (lake Donk)	14

Notholca acuminata (EHRENBERG, 1832)	Assebroek (Nature Reserve "Leiemeersen")	28
	Diksmuide (river Yzer)	27
	Gent (boatracing canal)	5,24
	Meuse liégeoise	2
	Overmere (lake Donk)	4,14,21,22
	Woumen (lake Blankaart)	9
Notholca squamula (O.F.MÜLLER, 1786)	Gent (tap water)	28
	Meuse liégeoise	2
	Overmere (lake Donk)	14
	Woumen (lake Blankaart)	9
Notholca striata (O.F.MÜLLER, 1786)	Diksmuide (river Yzer)	27
Notommata aurita (O.F.MÜLLER, 1786)	Meuse liégeoise	2
Notommata cyrtopus GOSSE, 1886	Meuse liégeoise	2
	Overmere (lake Donk)	14
* *Notommata glyphura* WULFERT, 1935	Gent (ponds Bot. Garden)	23
Philodina citrina EHRENBERG, 1832	Meuse liégeoise	2
	Overmere (lake Donk)	14
Philodina megalotrocha EHRENBERG, 1832	Meuse liégeoise	2
Philodina roseola EHRENBERG, 1832	Meuse liégeoise	2
	Overmere (lake Donk)	6,14
Platyias quadricornis (EHRENBERG, 1832)	Gent (ponds Bot. Garden)	23
	Overmere (lake Donk)	14
* *Pleurotrocha petromyzon* EHRENBERG, 1830	Gent (ponds Bot. Garden)	23
	Meuse liégeoise	2
Ploesoma hudsoni (IMHOF, 1891)	Tournai (artificial crater lake)	3
Polyarthra dolichoptera IDELSON, 1925	Gent (boatracing canal)	5,24
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Overmere (lake Donk)	14
	Overmere (newly dug pond)	18
	Virelles (Nature Reserve "Etang de Virelles")	20
	Woumen (lake Blankaart)	9
Polyarthra euryptera WIERZEJSKI, 1891	Hoboken (ponds of moat of fort 8)	10,12
	Overmere (lake Donk)	14,22
Polyarthra longiremis CARLIN, 1943	Woumen (lake Blankaart)	9

Polyarthra major	Overmere (lake Donk)		14,21,22
BURCKHARDT, 1900			
Polyarthra remata	Hoboken (pond of moat of fort 8)		10
SKORIKOV, 1896	Merksem (moat of fort)		11
	Overmere (lake Donk)		14
	Virelles (Nature Reserve "Etang de Virelles")		20
	Woumen (lake Blankaart)		9
Polyarthra vulgaris	Gent (boatracing canal)		5
CARLIN, 1943	Gent (ponds Bot. Garden)		23
	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Meuse liégeoise		2
	Overmere (lake Donk)		14,22
	Overmere (newly dug pond)		18
	Robertville (impoundment)	KA.99	19
Pompholyx complanata	Overmere (lake Donk)		14
GOSSE, 1851	Overmere (newly dug pond)		18
Pompholyx sulcata	Gent (boatracing canal)		5,7,8,24
HUDSON, 1885	Gent (river Lieve)		13
	Hoboken (ponds of moat of fort 8)		10,12
	Merksem (moat of fort)		11
	Overmere (lake Donk)		21,22
	Tournai (artificial crater lake)		3
Proales decipiens	Overmere (lake Donk)		14
(EHRENBERG, 1832)			
Proales reinhardti	Meuse liégeoise		2
(EHRENBERG, 1834)			
Ptygura brevis	Overmere (lake Donk)		14
(ROUSSELET, 1893)			
Ptygura crystallina	Overmere (lake Donk)		14
(EHRENBERG, 1834)			
* *Ptygura furcillata*	Gent (ponds Bot. Garden)		23
KELLICOTT, 1889			
Ptygura melicerta	Overmere (lake Donk)		6,14,17
EHRENBERG, 1832			
Ptygura pilula	Overmere (lake Donk)		14
(CUBITT, 1872)			
Rhinoglena frontalis	Meuse liégeoise		2
EHRENBERG, 1853	Overmere (lake Donk)		14
Rotaria macrura	Gent (river Leie)		1
(SCHRANK, 1803)	Overmere (lake Donk)		14
Rotaria neptunia	Gent (river Leie)		1,13
(EHRENBERG, 1832)	Meuse liégeoise		2
	Woumen (lake Blankaart)		9

Rotaria rotatoria	Gent (river Leie)	1,13
(PALLAS, 1766)	Meuse liégeoise	2
	Overmere (lake Donk)	4,6,14
	River Scheldt off Overmere	4
Rotaria tardigrada	Meuse liégeoise	2
(EHRENBERG, 1832)		
Scaridium longicaudum	Overmere (lake Donk)	14
(O.F.MÜLLER, 1786)		
* *Sphyrias lofuana*	Gent (ponds Bot. Garden)	23
(ROUSSELET, 1910)		
* *Squatinella lamellaris*		
(O.F.MÜLLER, 1786)		
var. *mutica* (EHRENBERG, 1832)	Gent (ponds Bot. Garden)	23
var. *tridentata*	Gent (ponds Bot. Garden)	23
(FRESENIUS, 1858)		
Squatinella rostrum	Gent (ponds Bot. Garden)	23
(SCHMARDA, 1846)		
Stephanoceros fimbriatus	Tournai (artificial crater lake)	3
(GOLDFUSZ, 1820)		
Synchaeta oblonga	Overmere (lake Donk)	14
EHRENBERG, 1831	Overmere (newly dug pond)	18
Synchaeta pectinata	Gent (boatracing canal)	7,8
EHRENBERG, 1832	Hoboken (pond of moat of fort 8)	10
	Meuse liégeoise	2
	Overmere (lake Donk)	14,22
	Overmere (ponds near lake Donk)	21
	Overmere (newly dug pond)	18
Synchaeta tremula	Overmere (lake Donk)	14
(O.F.MÜLLER, 1786)	Overmere (newly dug pond)	18
* *Synchaeta tremula*	Overmere (lake Donk)	22
(O.F.MÜLLER) f. *kitina* (ROUSSELET, 1902)		
Testudinella elliptica	Gent (ponds Bot. Garden)	23
(EHRENBERG, 1834)	Woumen (lake Blankaart)	9
Testudinella mucronata	Overmere (lake Donk)	14
(GOSSE, 1886)		
Testudinella parva	Overmere (lake Donk)	14
(TERNETZ, 1892)		
Testudinella patina	Gent (boatracing canal)	5,7,24
(HERMANN, 1783)	Gent (ponds Bot. Garden)	23,26
	Hoboken (ponds of moat of fort 8)	10,12
	Merksem (moat of fort)	11
	Overmere (lake Donk)	14

	Woumen (lake Blankaart)	9
* *Testudinella reflexa* (GOSSE, 1887)	Assebroek (Nature Reserve "Leiemeersen")	28
Trichocerca capucina WIERZEJSKI & ZACHARIAS, 1893	Overmere (lake Donk)	14
Trichocerca cavia	Gent (ponds Bot. Garden)	23
(GOSSE, 1886)	Overmere (lake Donk)	14
Trichocerca cylindrica (IMHOF, 1891)	Gent (ponds Bot. Garden)	23
Trichocerca elongata	Gent (ponds Bot. Garden)	23
(GOSSE, 1886)	Overmere (lake Donk)	14
Trichocerca longiseta (SCHRANK, 1802)	Overmere (lake Donk)	14
Trichocerca porcellus (GOSSE, 1886)	Overmere (lake Donk)	14
Trichocerca pusilla	Hoboken (pond of moat of fort 8)	10
(LAUTERBORN, 1898)	Merksem (moat of fort)	11
	Overmere (lake Donk)	14
	Virelles (Nature Reserve "Etang de Virelles")	20
Trichocerca rattus (O.F.MÜLLER, 1776)	Overmere (lake Donk)	14
* *Trichocerca rattus*	Merksem (moat of fort)	11
(O.F.MÜLLER) f. *carinata* (EHRENBERG, 1851)	Overmere (lake Donk)	14
Trichocerca similis (WIERZEJSKI, 1893)	Hoboken (ponds of moat of fort 8)	10,12
Trichocerca stylata (GOSSE, 1851)	Overmere (lake Donk)	14
Trichocerca tigris (O.F.MÜLLER, 1786)	Overmere (lake Donk)	14
Trichotria pocillum	Meuse liégeoise	2
(O.F.MÜLLER, 1776)	Overmere (lake Donk)	14
	Tournai (artificial crater lake)	3
Trichotria tetractis (EHRENBERG, 1830)	Overmere (lake Donk)	14

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The evolution of the water quality in the west of Belgium: results of a ten year survey

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Abstract

The use of the occurrence of macro-invertebrates in the biomonitoring of freshwater ecosystems is applied to a river basin in the extreme west of Flanders. Water quality was assessed by using the Belgian Biotic Index, a highly standardized method based on the presence of specific macro-invertebrates. During a ten year survey (1980-1990) 78 sites were followed in detail.
In 32 sites (41%) water quality improved considerably. It is shown that this is due to (i) the installation of several wastewater treatment plants from 1985 onwards and (ii) a better control on the discharge of all kinds of wastewater. In only 14 sites (18%) the Biotic Index decreased. We believe this is mainly due to the fact that a lot of riverbanks were reinforced with concrete. For 20 sites (26%) a status quo was noted.

Key-words: water quality, macro-invertebrates, Belgian Biotic Index, wastewater.

Samenvatting

Het gebruik van het voorkomen van macro-invertebraten in biomonitoring van zoetwaterecosystemen werd toegepast op een rivierbekken in het uiterste westen van Vlaanderen. De waterkwaliteit werd bepaald door middel van de Belgische Biotische Index, een gestandaardiseerde methode gebaseerd op de aanwezigheid van specifieke macro-invertebraten. 78 stations werden gedurende tien jaar continu gevolgd (1980-1990).
In 32 stations (41%) werd een aanzienlijke verbetering van de waterkwaliteit vastgesteld. Er wordt aangetoond dat dit voornamelijk te wijten is aan (i) het in werking stellen van verschillende rioolwaterzuiveringsinstallaties vanaf 1985 en (ii) een betere controle op het lozen van allerlei soorten afval. In slechts 14 stations (18%) bleek de Belgische Biotische Index te dalen. Dit is vermoedelijk een gevolg van normalisatiewerken aan de rivier- en beekoevers. Voor 20 stations (26%) werd een status quo vastgesteld.

Trefwoorden: waterkwaliteit, macro-invertebraten, Belgische Biotische Index, afvalwater.

Introduction

One of the tasks of the Flemish Environmental Company is the management of the water quality of all water bodies belonging to the public hydrographic network in Flanders. In order to be able to realise an efficient and structured management of the water quality in Flanders, a continuous investment in research is necessary. The researchers involved have to provide detailed data on the actual status of the water quality of the surface waters in Flanders. Moreover, it is necessary to follow the evolution of the water quality in the long term. Both biological and chemical methods are used in this kind of studies. The results finally supply a solid base which can be used for an efficient management of the water quality of Flemish surface waters.

On October, 21st 1987, the Flemish Government approved a resolution which divided the surface waters in Flanders into different categories: water intended to be used for swimming, fishing, mollusc rearing or for the production of drinking water. This resolution states that the basic water quality of these different categories should be reached by 1995. This implies a minimal level of the Belgian Biotic Index of 7 (BBI, see Material and methods). Because water quality is one of the major factors influencing the environment, it is clear that this statement is of great importance for nature conservation.

Material, methods and study area

In this contribution we only report on results of the water quality obtained by biological methods. Water quality was measured by using a highly standardized method, namely the Belgian Biotic Index, BBI (DE PAUW & VANHOOREN, 1983). This index is based on the presence of aquatic macro-invertebrates which are relatively easy to identify (DE PAUW & VANNEVEL, 1991). For each measurement, a number ranging from 1 to 10 is assigned, indicating the degree of pollution (1 = highly polluted, 10 = not polluted). The index assesses water quality in an ecological way and this is why the method has certain advantages over a purely chemical measurement. For discussion on the method as well as on the sampling techniques used for the collecting of macro-invertebrates, we refer to ANONYMUS (1984), DE BRABANDER & DE SCHEPPER (1981), DE PAUW & VANHOOREN (1983), DE PAUW & VANNEVEL (1991), TACHET *et al.* (1980) and VANHOOREN (1982).

During ten years an area in the extreme west of Flanders was surveyed. The studied area, is limited by the river IJzer in the east and south, the North Sea and the French border in the west (Fig. 1). 78 sites were followed in detail.

The network investigated is made up of typical polder rivers. They are usually deep and wide with a thick mud layer on the bottom. Until recently, they were characterized by a well developed reed vegetation (*Phragmites australis*), but the area of this kind of effective river bank vegetation has shrinked considerably. The water level of most of these polder rivers is regulated in function of agricultural needs. This implies that the water level is kept low during winter. As a consequence, stream velocity increases.

In some areas, such as Nieuwpoort, the influence of the sea should not be neglected. Moreover, due to the artificial management of the water level, the direction in which the water runs can change temporarily for some rivers or brooks. All these factors have a considerable influence on the ecosystem and its faunal composition.

Results and discussion

General results

In order to be able to illustrate the evolution of the water quality of this part of the IJzer river basin, the results of the measurements effectuated at five year intervals are analysed. They are presented respectively in Fig. 1 for 1980, Fig. 2 for 1985 and Fig. 3 for 1990. The corresponding frequency distributions summarizing the number of samples within each water quality category (BBI) are shown in Fig. 4.

Of the 78 samples surveyed during the last decade, 41% showed a considerable improvement in water quality. For 18% the Biotic Index decreased and for 26% a status quo was noted. Table 1 provides more details on the evolution of the procentual frequencies within each BBI class.

Table 1. Percentual frequencies of the Belgian Biotic Index (BBI) for 1980, 1985 and 1990 respectively.

BBI	0	1	2	3	4	5	6	7	8	9	10
1980	-	5.0	10.0	-	20.0	20.0	35.0	10.0	-	-	-
1985	1.5	-	7.4	1.5	4.4	27.9	38.2	16.2	2.9	-	-
1990	1.4	-	1.4	2.8	12.5	19.4	25.0	34.7	-	-	-

The evolution of the water quality in some important parts of the area

All names used in this paragraph are situated in Fig. 1.

▸ *The Langeleed river bassin*

The Langeleed enters the Belgian territory in a polluted state (BBI 5). The presence of the recreation park 'De Meli' has an additional, negative influence on the water quality of this stream. At this point, only some Tubificidae and Chironomidae were present. Recently, there seems to be a slight improvement of the water quality. This is due to the installation of the wastewater treatment plant of Adinkerke (1986) and Wulpen (1987) both connected with 'De Meli', resulting in the occurrence of Asellidae and Hirudinea. Further east, in the direction of Nieuwpoort, the Langeleed recovers a lot and reaches a BBI of 7 to 8.

▸ *The channel of Duinkerke-Nieuwpoort*

Due to the installation of the Proostdijk-collector in 1982, the Channel of Duinkerke-Nieuwpoort received a high amount of additional wastewater previously discharged in the Proostdijkvaart. As a consequence its water quality decreased considerably (BBI 2). Afterwards, in the period 1985-1990, water quality of the channel improved. This is easily explained by the fact that the treated water of the wastewater treatment plant of Wulpen is discharged in the channel. This means a high input of purified water which stimulates natural recovery.

▸ *The Grote Beverdijk system*

At its origin, near Fintele, the Grote Beverdijk has a rather good water quality (BBI 6-7). At this point a lot of different Coleoptera and Mollusca which are relatively sensitive for pollution, can be found. Downstream, water quality decreases till a BBI of 5-6. This situation maintains till Nieuwpoort. During 1985 works were effectuated at the Grote Beverdijk in order to increase its carrying off capacity of water. This resulted in a lower BBI in 1985 (BBI 5). An improvement was however noticed in 1990 probably due to natural recovery (BBI 7).

The most important tributary rivers of the Grote Beverdijk are Ramskapellegeleed, Kleine Beverdijk, Reigersvliet, Oostkerkevaart, Vlavaart, Zaadgracht, Duikervaart, Slopgatvaart (with the Oostwandelaarsgang and Sint-Machuitsbeek), Aardenvaart en Reepdijk. Most of these small rivers and brooks improved significantly during our ten year survey reaching a BBI of 7 in 1990. It is worth mentioning that the Vlavaart and Reepdijk are highly polluted at their origin (BBI 2), but that they recover very quickly (BBI 6).

▸ *The Koolhofvaart and Proostdijkvaart systems*

Both channels demonstrate a rather stable BBI of 5-6 indicating a mediocre water quality. The same is true for most of their tributary rivers and brooks. Identical results were also obtained for the Bergenvaart and the Ringsloot.

Conclusions

Generally, our results demonstrate a slight improvement of the water quality for the period 1980-1990. Actually, almost one third of the sampled sites shows a BBI of 7 or 8, which corresponds with the whishes expressed by the Flemish Government in its resolution of 21.10.1987.

The observed improvement is due to:

▸ the installation of several new wastewater treatment plants in the area,

▸ a better and more severe control on the discharge of all kinds of wastewater.

The rest of the sites under study have a medium (BBI 5-6) to low water quality (BBI 1-4). A large part of the pollution observed in these sites is caused by the import of different kinds of manure combined with an artificially low water level, especially during winter. This results in thorough eutrofication with extreme abundances of algae and considerable fluctuations in oxygen concentration. It is evident that this influences the aquatic animal community as well.

The highest pollution was encountered at Veurne, but due to the installation of the wastewater treatment plant of Wulpen (Koksijde) during 1987, an improvement of the water quality can already be noticed.

Another problem is the reinforcement of river banks with concrete at the cost of well established reed vegetations. This kind of reinforcements aims to increase the carrying off capacity of the river. It is thought that reed vegetation has a negative influence on the stream velocity.

Although much work remains to be done, it is clear that more improvement of the water quality in the IJzer area is to be expected. In this way an increase of the ecological value of the area could be established. This area has therefore considerable potentials in the frame of nature conservation. However, a continued survying of the water quality remains necessary in the future. Moreover, it is suggested that an important positive effect could be gained from a closer synchronisation of water quality management and water quantity management.

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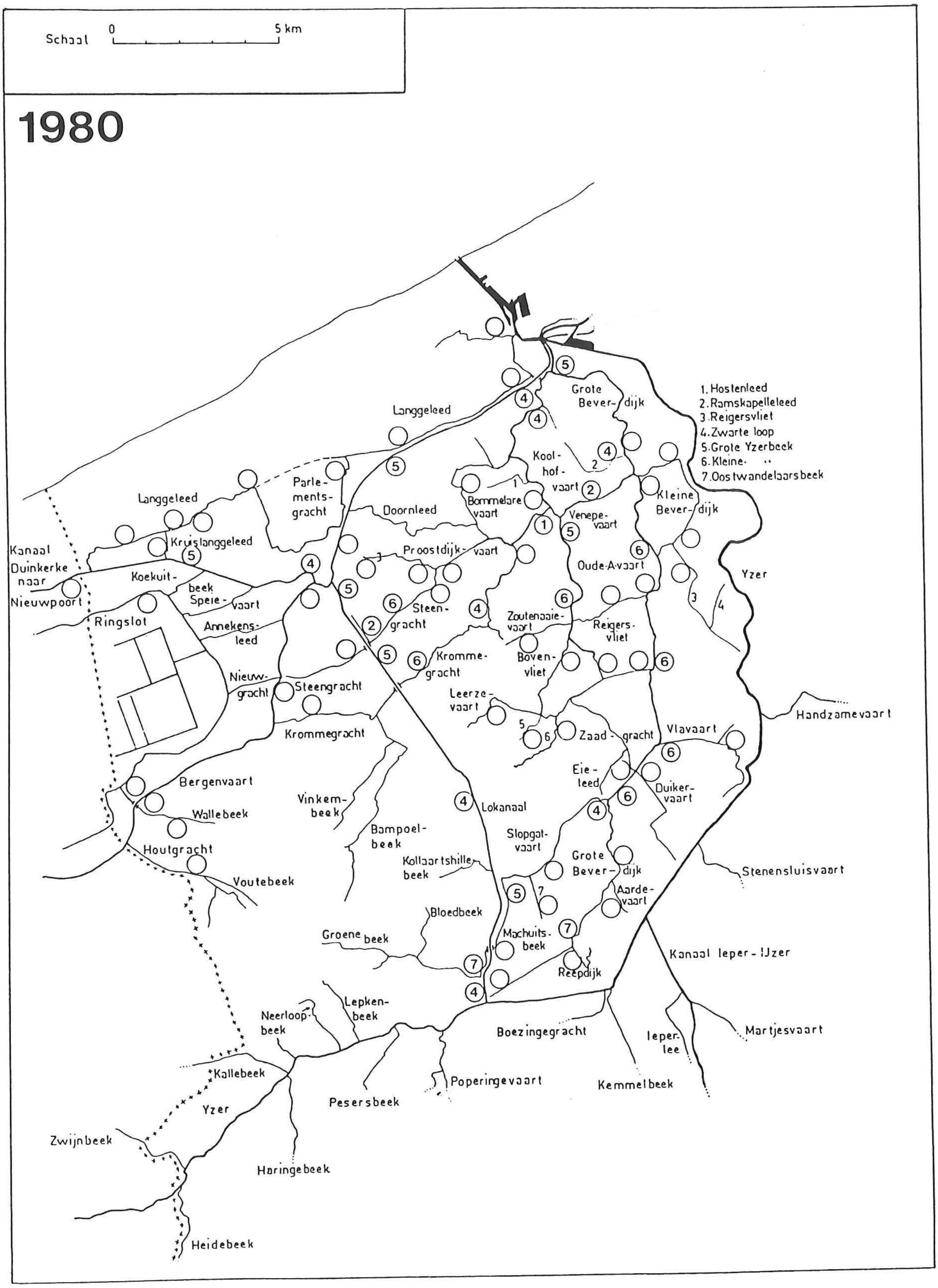


Fig. 1. Water quality in the western basin of the IJzer in 1980. Based on the Belgian Biotic Index: BBI 0-2 = extremely polluted, 3-4 = highly polluted, 5-6 = polluted, 7-8 = moderate water quality, 9-10 = good water quality.

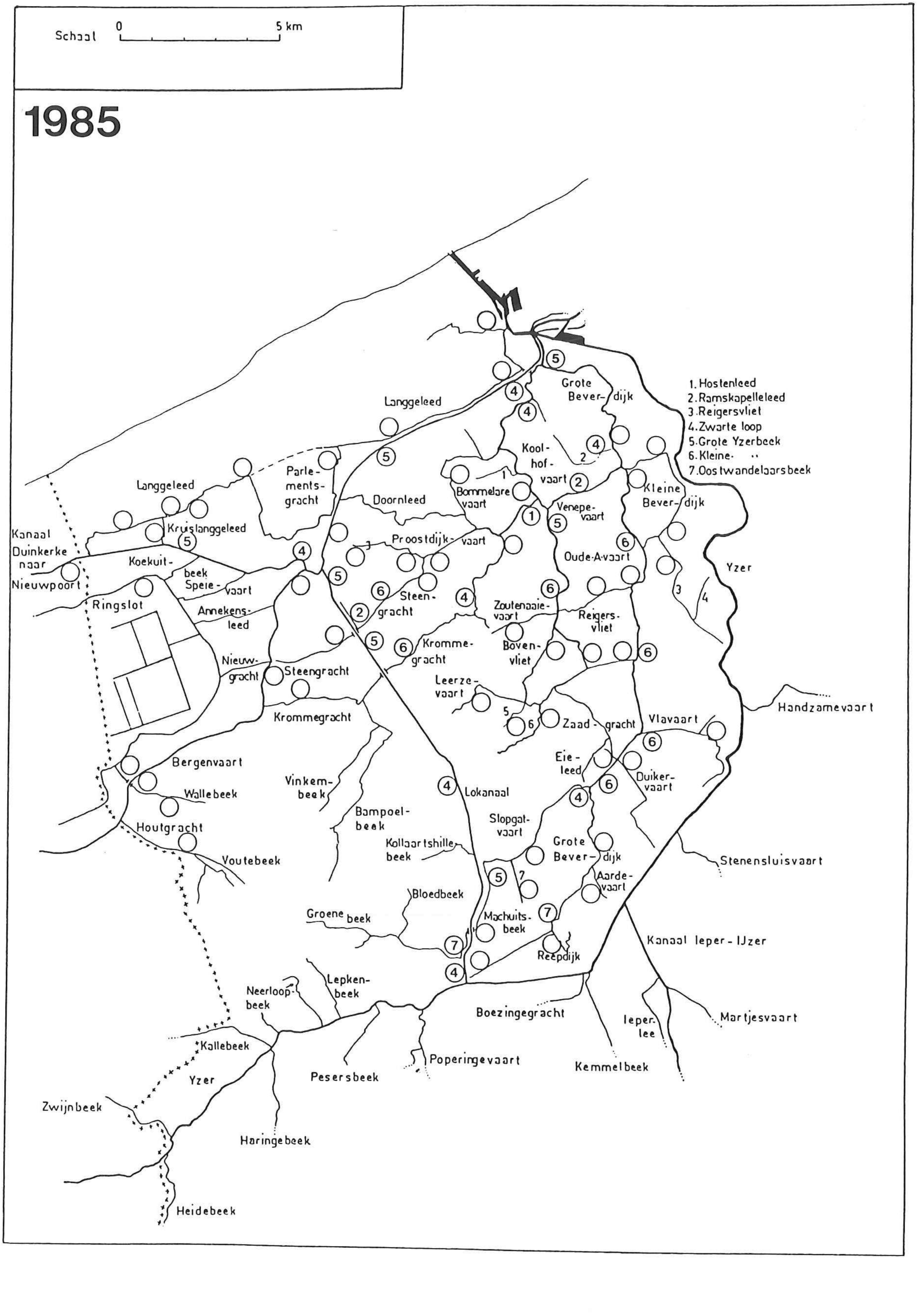


Fig. 2. Water quality in the western basin of the IJzer in 1985. BBI 1-10 = see legend Fig. 1.

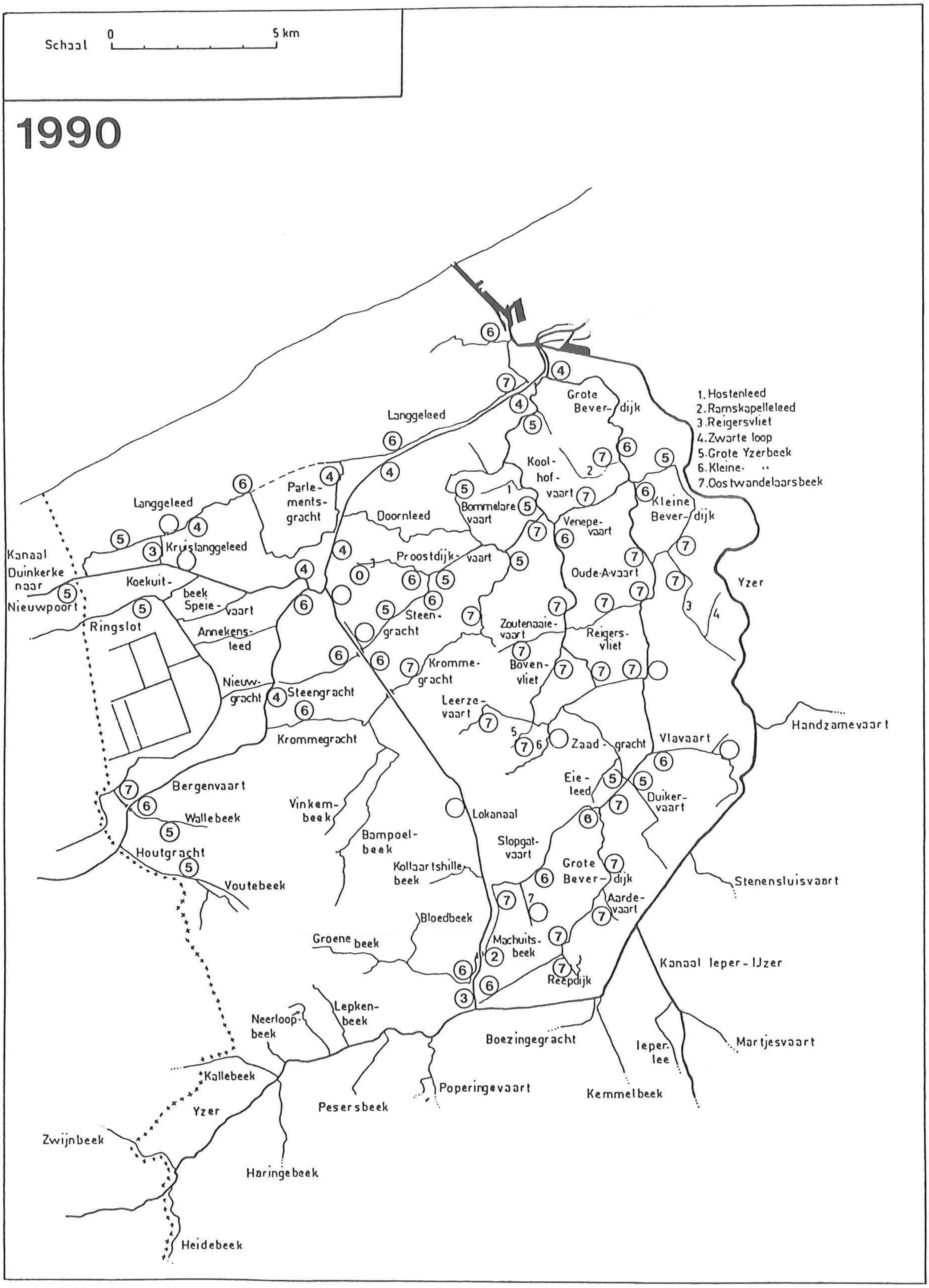


Fig. 3. Water quality in the western basin of the IJzer in 1990. BBI 1-10 = see legend Fig. 1.

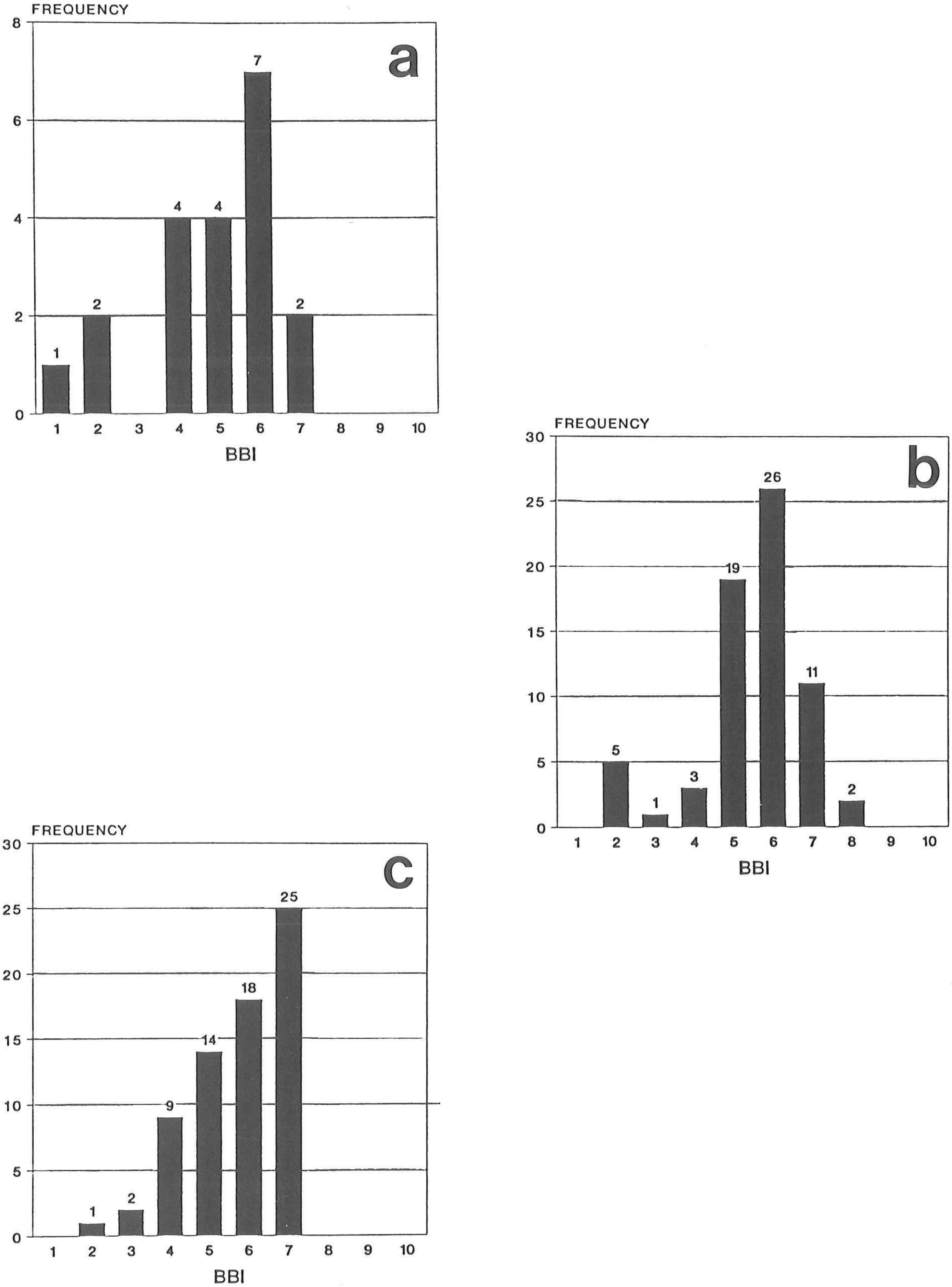


Fig. 4. Frequency distribution of the Belgian Biotic Index observed in the western basin of the IJzer during (a) 1980, (b) 1985, (c) 1990. BBI 1-10 = see legend Fig. 1.

Colonization pattern by vegetation and relationships with faunal inventory in an old sand quarry

by Thierry HANCE, Jean-Marie DUMONT, Luc HANCE, Luc RENIER & Philippe GOFFART

Summary

Colonization of bare soil by plants corresponds to a dynamic process involving a gradual transformation of the soil substrate through humus formation. Changes in vegetation structure and in soil organic matter content both induce a succession of peculiar soil fauna assemblages. The Champ'taine site at Chaumont-Gistoux (Belgium) is ideal for analysing such relationships. It is an old sand quarry (12 ha) which exploitation was stopped in 1976. Subsequently, vegetation has progressively but not uniformely colonized the sandy soil. At the present day, the different colonization stages are still present on relatively large areas. This succession is: 1) bare sand, 2) tuffets of *Corynephorus canescens*, 3) grassland with *Deschampsia flexuosa*, 3) clumps of *Calluna vulgaris* and *Sarothamnus scoparius*, 4) birch grove, 5) oak-beech grove. Carabids were chosen as indicators of soil fauna succession according to those five vegetal formations. Fifteen stations were sampled during two weeks.

On the whole, 40 species (192 individuals) of Carabidae were caught. At each colonization stage corresponds a group of species. For example, *Cicindela hybrida* and *Microlestes maurus* were found on the unsettled sandy soil of the well exposed excavation slopes, while *Cychrus caraboides* and *Carabus problematicus* were only present in the oak-beech grove. This obvious relationship between the succession of plant assemblages, soil formation and fauna gives a great scientific and didactic interest to the site, and the creation of a nature reserve is planned. To assess the biological quality of the site, insect of other families were sampled. Twenty species of Lepidoptera and 6 species of Orthoptera were identified, indicating the great diversity in habitats of the Champ'taine quarry site.

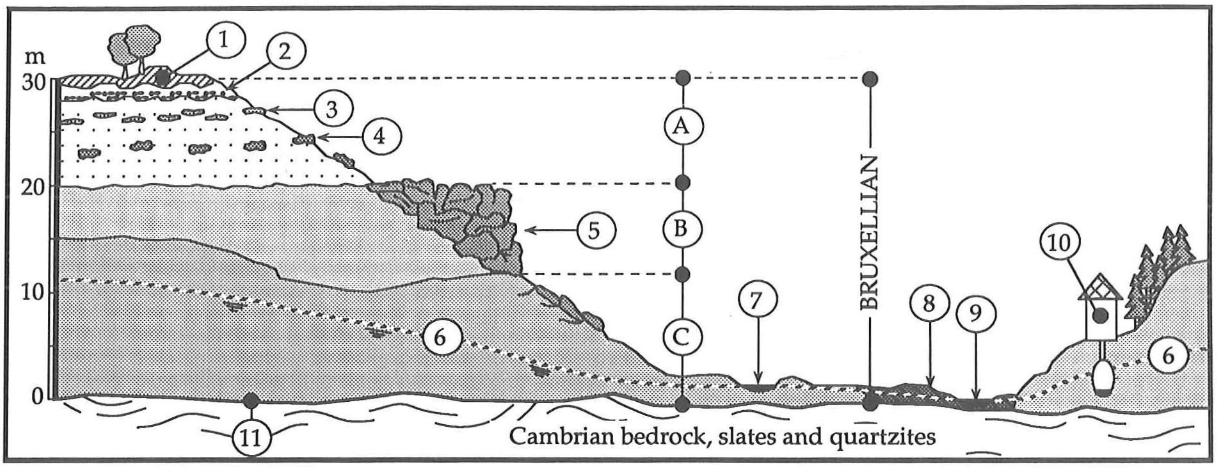
Introduction

Champ'taine quarry at Chaumont-Gistoux is an old sand quarry which exploitation was stopped in 1976. Since then, the reconversion of the site has become the subject of a large debate between the neighbours, the municipality and potential users such as sport clubs. Numerous propositions were made such as motocross circuit, permanent clay shooting field, dog training area, recreation site or nature reserve.

Such diversity of interest and the consequently conflicting situation require to realize a global evaluation of the biological quality of the site prior any decision. This was the purpose of the present study. As an exhaustive evaluation of the site would be too time-spending, we have limited our analysis to a functional description of the site, with emphasis on indicatory groups: Carabidae, Lepidoptera and Orthoptera. Thus, the following description is not only a list of species, but it takes into account the relationships between flora and fauna in a dynamic point of view.

Description of the site

The 12 ha sand quarry is situated at Chaumont-Gistoux (45 km S.-E. from Brussels) in the Bruxellian (Tertiary: Eoceen) decalcified sands. Its geological description has been realized by HANCE *et al.* (1989). Figure 1 shows a transversal section illustrating the geological setting of the quarry. The soil substrate is not uniformous in constitution, moisture and sun exposition. Three main layers (A, B, C) can be distinguished regarding granulometry and development of sandstone beds or concretions. The bottom of the quarry is situated at 95 m above sea level and the top at 125 m.



A. Fine sand
B. Ferrugineous sandstone
C. Medium sand
1. Quaternary silt with Silex pebbles
2. Tongrian sands with fossiliferous gravels at the base
3. Discontinuous thin sandstone layer locally vacuolated
4. Sandstones concretions
5. Ferruginеous sandstone
6. Piezometric level
7. Pool
8. Alluvion
9. Ry du pré Delcourt
10. Water harnessing
11. 95 m above sea level

Fig. 1. Transverse section of the quarry.

Since the exploitation stopped, vegetation has progressively colonized the bare sandy soil and has thus led to a progressive constitution of the pedological horizons. The more striking appearance is given by the slopes which covers 3.50 ha and where some parts are not yet stabilized (Fig. 2). In consequence, the different stages of plant recolonization may still be observed. This succession is represented by: 1) bare sand, 2) tuffets of *Corynephorus canescens*, 3) grassland of *Corynephorus canescens* with some species like *Hypochoeris radicata* and *Polytrichum piliferum*, 4) grassland with *Deschampsia flexuosa*, 5) clumps of *Calluna vulgaris* and *Sarothamnus scoparius*, 6) birch-grove, 7) oak-beech grove. This is the typical succession usually met on sandy decalcified soil. In fact, the possibility to observe all these stages in a quite limited area is exceptional in Belgium and thus reveals an outstanding scientific and didactic interest.

Such colonization of bare soil by vegetation corresponds to a dynamic process involving a gradual transformation of soil substrate through humus formation (Tab. 3). The succession of soil transformations may be described as following: 1) bare and moving sand, 2) fixed sand, 3) settled organic layers, 4) progressively thickening and differentiating pedological layers.

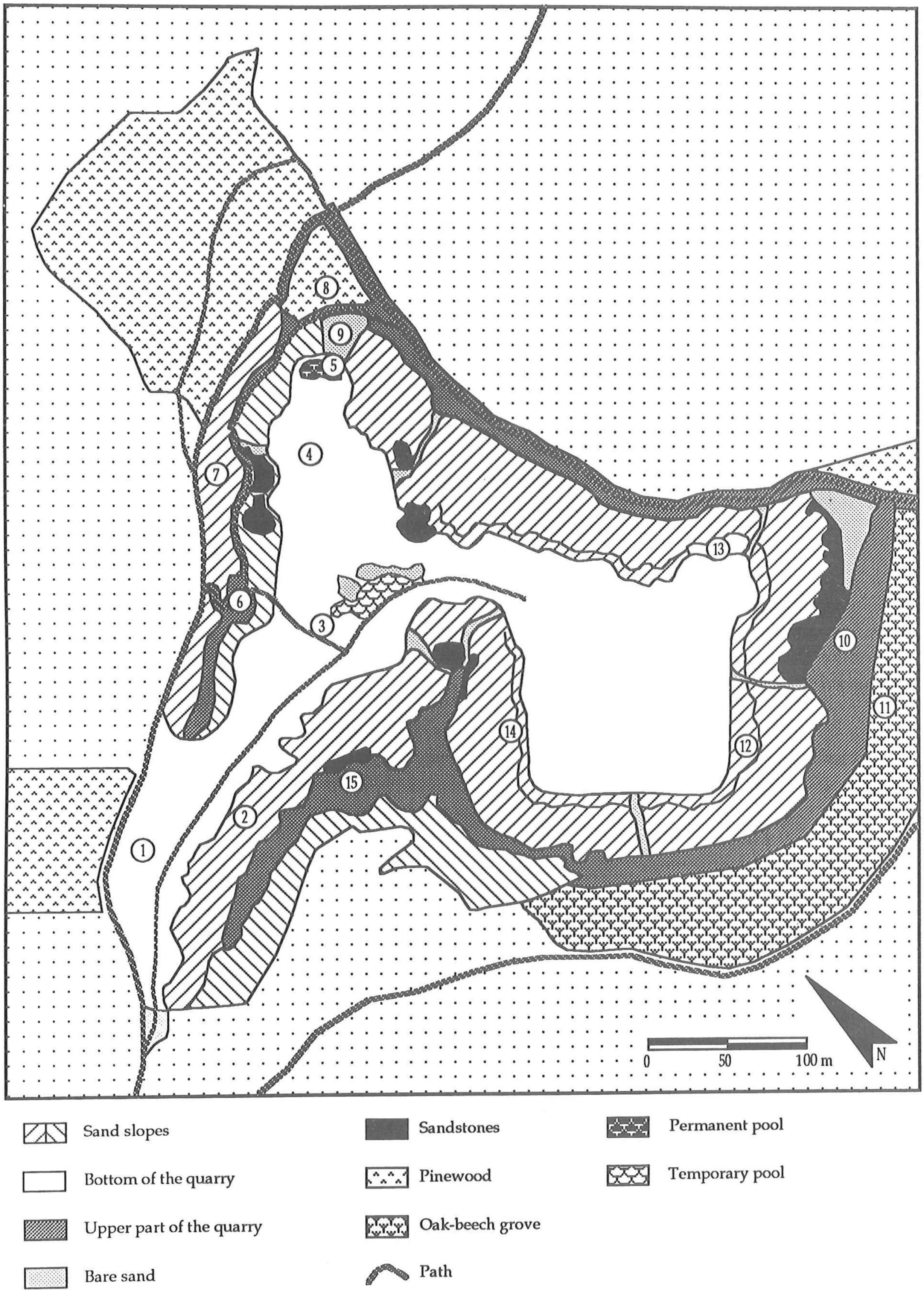


Fig. 2. Map of the quarry. The numbers indicate the position of the Carabid sampling stations.

Exploitation was stopped when it has reached the underground water level. A permanent but not very deep pool has been created in this way and is presently surrounded by some alders (*Alnus glutinosa*) and willows (*Salix sp.*). Typical plants of such milieu have also appeared; for instance, *Glyceria notata, Typha latifolia, Juncus effusus* and *Veronica beccabunga*. Another pool is present in the middle of the quarry but this one dries up in summer. It is partially colonized by big tuffets of *Juncus effusus* and in some places by *Glyceria notata*; besides, some muddy areas remain free of vegetation. Finally, the laying out of the quarry presents a ruderal vegetation as it is constituted by spoil and has been partially filled by agricultural soil.

Faunistical inventory

Both phenomena, i.e. changing in vegetation structure and in soil organic matter content, should induce a succession of peculiar soil fauna assemblages. Moreover, the great diversity in habitats should involve an important faunistic diversity. In order to analyse these hypotheses, three insect groups were chosen as indicators: Carabids and Orthoptera for soil fauna, and Lepidoptera for vegetation diversity.

Material and methods

Carabid sampling

Fifteen stations were selected among the different vegetation stages and near the pools. The stations are described in Annex 1 and located in Figure 2. In each station, two pitfall traps were placed. They consist in plastic jars (8.5 cm diameter and 14 cm deep) that are filled to 1/3 with a 5 % formaldehyde aqueous solution. The distance between each trap was approximately 2.5 m. The traps were placed on 25.05.1988 and were collected on 02 and 10.06.1988. The sampling was limited in time in order to avoid possible disturbance of the site.

Other insect samplings

Orthoptera were hand caught on 17.08.1988 and they were identified in the field using the systematic keys of DUIJM & KRUSEMAN (1983) and BELLMAN (1985). External morphology as well as song patterns were used. The Tetrigidae were not considered in this work.

Lepidoptera were caught alive with a butterfly net, twice a month from early May until last October. They were identified in the field and then released.

Results

Characterization of the Carabid fauna

Although the short period of trapping, 40 species and 192 individuals of Carabidae were caught (cf. Annex 3). This reflects the ecological diversity of habitats in the quarry. But, in consequences of the short period of trapping, the relationships found between fauna and vegetation will only be indicative and based on the beetle presences. Table 1 shows those relationships between soil formation, succession of vegetation and carabid presence. First appear carabid species with strong ecological requirements (stenotopic species) such as dry sand and scarse vegetation. This species assemblage is constituted by *Cicindela hybrida, Calathus erratus, Harpalus smaragdinus* and *Microlestes maurus*. They are followed by species bound to dry grasslands such as *Harpalus tardus* and *Bembidion lampros*. Then, in the birch grove appear species commonly found in woodland: *Abax parallelepipedus* and *Pterostichus oblongopunctatus*. Finally, some taller species are found in the oak-beech grove such as *Cychrus caraboides* and *Carabus problematicus*. The damped zone possess also a well characterized carabid population with riparian species; the most trapped were *Elaphrus riparius, Agonum viduum, Bembidion varium* and *Bembidion dentellum* (Tab. 2). In Table 3, species are listed according to their main habitats requirements, as described by DESENDER (1986a, b, c, d).

Grasshopper and cricket fauna

Orthoptera are influenced by microclimatic conditions which are linked to the vegetation structure of their habitat and on soil composition. Six species were identified, 2 crickets (Ensifera) and 4 grasshoppers (Caelifera) (Tab. 4). Each of them are related to defined habitats present in the quarry. *Chorthippus mollis* is clearly associated with dry *Corynephorus canescens* grassland well exposed to sun light and more generally to scattered herbaceous vegetation and heath. In Belgium, this species has only been recorded in similar habitats in the Campine region (DEVRIESE, 1988). In the Champ'taine quarry, *Chorthippus mollis* lives close to three other species, *Chorthippus biguttulus, Chorthippus brunneus* and *Chorthippus parallelus*. The two species of Ensifera found are linked to dense vegetation. *Tettigonia viridissima* lives on threes and bushes (*Sarothamnus scoparius* clumps or the young birch grove) as well as in ruderal vegetation. *Pholidoptera griseoaptera* was more confined to shrubs showing undercover with dense vegetation (especially *Rubus sp.*).

Lepidoptera

Although 20 species of Rhopalocera were caught (Annex 2), the Lepidoptera fauna is constituted by widespread species. Indeed, it is mainly composed by eurytopic, mesophilic or nemoral species and by species characterizing ruderal environments, such as most common Nymphalidae. Nevertheless, the diversity of habitats is pointed out by the presence of woodland species (*Pararge aegeria*), close to grassland species (*Maniola jurtina*). *Aphantopus hyperanthus* requires shaded grassland while *Thymelicus lineolus* is common on rough and well drained grassland on every type of soil. The most interesting observation was the presence of *Callophrys rubi*, a relatively scarce Lycaenidae in Brabant which caterpillars feed notably on *Sarothamnus*, *Rubus* and *Lotus* species.

Conclusions

Generally, botanical inventory, including scarce plant species is the main criterion used to evaluate the biological quality of a site, and indeed, it has brought numerous information in this case, particularly on the dynamic process of vegetation colonization. This constitutes the main interest of the quarry. But floral inventories may be notably completed by pointing out the relationships between fauna, vegetation structure and pedological constitution. The three groups chosen as indicators for this study (Carabidae, Orthoptera, Lepidoptera) appear to be suitable for completing botanical information. They show the importance of each vegetation assemblage regarding the biological quality of the site. For instance, the ruderal vegetation found in the bottom of the quarry, despite it has a quite limited botanical interest, is favourable for Lepidoptera fauna. Even the bare sands show their own typical fauna with species as *Cicindela hybrida*.

One of the main characteristics of quarries is that they usually show a wide spectrum of environmental conditions and particularly combination of extreme physical features. So, they could provide ideal habitats for a large number of plants and animals endangered by the agricultural intensification, industrial and housing development (RANSON & DOODY, 1982). In this context, the Champ'taine quarry presents many interesting aspects of strong associations between insect fauna, vegetation and soil substrate. The general ecological quality of the site revealed by this study has led the municipal authorities to take the protection of the site into account, planning the constitution of a nature reserve. Presently, a local association has been constituted with the goal of carrying on the full description of the site and of planning its future management.

Acknowledgements

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Table 1. **Relationship between soil formation, plant successions and Carabid fauna.**

SOIL		STATION	VEGETATION	CARABID FAUNA
bare and unstable sand	C	9	tuffets of *Corynephorus canescens*	*Harpalus tardus* *Cicindela hybrida* *Microlestes maurus*
stable sand	C	6 13	grassland with *Corynephorus canescens*	*Cicindela hybrida* *Calathus erratus* *Harpalus tardus* *Harpalus griseus* *Harpalus rupicola* *Microlestes maurus* *Harpalus smaragdinus*
layer of organic matter	O C	14	grassland with *Deschampsia flexuosa*	*Harpalus tardus* *Amara consularis* *Microlestes maurus* *Bembidion lampros*
differentiation and thickening of the pedologic layers	O A C	15	clumps of *Calluna vulgaris* and *Sarothamnus scoparius*	*Harpalus tardus* *Amara consularis* *Microlestes maurus* *Bradycellus harpalinus*
	O A C	2	Birch grove	*Abax parallelepipedus* *Leistus rufomarginatus* *Pterostichus oblongopunctatus*
	O A C	7 10 11	Oak-beech grove	*Calathus piceus* *Notiophilus rufipes* *Cychrus caraboides* *Leistus ferrugineus* *Abax parallelepipedus* *Carabus problematicus* *Pterostichus oblongopunctatus*

Table 2. Relation between habitat and the Carabid fauna found in the quarry.

SOIL	STATION	VEGETATION	CARABID FAUNA
Damped areas			
1) mud soil	3	*Glyceria nototа* *Juncus effusus* *Rumex crispus*	*Agonum viduum* *Elaphrus riparius* *Bembidion dentellum* *Panagaeus crux-major*
2) damp soil	5	damped grassland	*Pterostichus minor* *Agonum gracile* *Harpalus anxius*
Areas with anthropic impact			
1) bottom of the quarry	1 & 4	grassland	*Harpalus tardus* *Pterostichus niger* *Bembidion lampros* *Harpalus autumnalis*
2) layer filled with agricultural soil	12	grassland with lupin	*Harpalus tardus* *Harpalus rubripes* *Calathus erratus* *Bembidion lampros*
3) pine forest	8	pine	*Harpalus rufipes* *Carabus problematicus* *Pterostichus oblongopunctatus*

Table 3. Habitat preferences of the Carabid species caught in the Champ'taine site.

Habitat preferences according to DESENDER (1986 a,b,c,d)	Species
dry sandy soil	*Cicindela hybrida* *Calathus erratus* *Harpalus griseus* *Harpalus rupicola* *Microlestes maurus* *Harpalus smaragdinus*
dry habitat, eurytopics	*Harpalus tardus* *Leistus ferrugineus* *Bembidion lampros*
woodland	*Cychrus caraboides* *Abax parallelepipedus* *Leistus rufomarginatus* *Pterostichus oblongopunctatus*
riparian and humid habitat	*Agonum viduum* *Elaphrus riparius* *Bembidion varium* *Bembidion dentellum*
humid grassland	*Panagaeus crux-major*

Table 4. Habitats of the six species of Orthoptera caught in the quarry.
Index of abundances:

+	scarcely present
++	present but in small number
+++	abundant
++++	very abundant

Location of observations	Index of abundance	Species
dry grass land of *Corynephorus canescens* and stable slopes with sarce vegetation	+++ +++	*Chorthippus mollis* *Chorthippus brunneus*
Stable slopes with herbaceous vegetation	++	*Chorthippus biguttulus*
Trees, bushes and dense ruderal vegetation	+++	*Tettigonia viridissima*
Bushes and dense vegetation cover (*Rubus sp.*, ...)	++++	*Pholidoptera griseoaptera*
open habitats	++++	*Chorthippus parallelus*

Annex 1. Description of sampled stations for Carabid fauna.

Station 1 : Bottom of the quarry with ruderal grassland
Station 2 : Birch-grove associated *Deschampsia flexuosa*, North exposition
Station 3 : Temporary pool with *Glyceria notata* and *Rumex acetosella*
Station 4 : Bottom of the quarry with ruderal grassland
Station 5 : Border of the permanent pool
Station 6 : Dry grassland with *Corynephorus canescens*
Station 7 : Oak-beech grove underwood with *Calamagrostis epigejos* and *Epipactis helleborine*
Station 8 : Pine forest
Station 9 : unstable sand cliff with tuffets of *Corynephorus canescens*
Station 10: Oak-Beech grove, border with *Corynephorus canescens* grasland
Station 11: Underwood, oak-beech grove
Station 12: Ruderal grassland with lupins
Station 13: Dry grassland with *Corynephorus canescens*, stable sands
Station 14: Grassland with *Deschampsia flexuosa* and *Holcus mollis*
Station 15: Heath

Annex 2. List of Rhopalocera observed in the quarry; the last column gives common names.

Papilionidae	*Papilio machaon* (L.)	Swallowtail
Hesperiidae	*Thymelicus lineolus* (Och.)	Essex Skipper
	Ochlodes venata (Bremer)	Large Skipper
Pieridae	*Pieris brassicae* (L.)	Large White
	Pieris rapae (L.)	Small White
	Pieris napi (L.)	Green-veined White
	Anthocharis cardamines (L.)	Orange Tip
	Gonepteryx rhamni (L.)	Brimstone
Nymphalidae	*Aglais urticae* (L.)	Small Tortoiseshell
	Polygonia c-album (L.)	The Comma
	Araschnia levana (L.)	European Map
	Cynthia cardui (L.)	Painted Lady
	Vanessa atalanta (L.)	Red Admiral
	Inachis io (L.)	The Peacock
Satyrinae	*Maniola jurtina* (L.)	Meadow Brown
	Aphantopus hyperantus (L.)	The Ringlet
	Coenonympha pamphilus (L.)	Small Heath
	Pararge aegeria (L.)	Speckled Wood
	Lasiommata megera (L.)	The Wall
Lycaenidae	*Callophrys rubi* (L.)	Green Hairstreak
	Lycaena phlaeas (L.)	Small Copper
	Polyommatus icarus (ROOT.)	Common Blue
	Quercusia quercus (L.)	Purple Hairstreak

Annex 3. List of Carabidae and number of individuals trapped in each station.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	tot
Cicindela hybrida LINNAEUS						5			1							6
Carabus problematicus HERBST								1			3					4
Cychrus caraboides (LINNAEUS)										3						3
Leistus ferrugineus (LINNAEUS)							4									4
Leistus rufomarginatus DUFTSCHMIDT		1						1								2
Notiophilus rufipes CURTIS							1	1								2
Elaphrus riparius (LINNAEUS)			9													9
Dyschirius angustatus (AHRENS)													1			1
Bembidion dentellum (THUNBERG)			6													6
Bembidion guttula (FABRICIUS)			1													1
Bembidion lampros (HERBST)				2								2	2	2		9
Bembidion tetracolum SAY			1		1											2
Bembidion varium (OLIVIER)			5													5
Pterostichus minor (GYLLENHAL)					1								2			3
Pterostichus niger (SCHALLER)	1															1
Pterostichus oblongopunctatus (FABRICIUS)		3						2		1						6
Abax parallelepipedus (PILLER & MITTERPACHER)		11					4			1	7		1			24
Calathus erratus (SAHLBERG)						12			6	1		3				22
Calathus piceus (MARSHAM)					1		2									3
Agonum dorsale (PONTOPPIDAN)					1											1
Agnonum gracile (GYLLENHAL)					1											1
Agnonum muelleri (HERBST)			1													1
Agonum viduum (PANZER)			9													9
Amara aenea (DE GEER)				1												1
Amara aulica (PANZER)			1													1
Amara consularis (DUFTSCHMIDT)												1		1	1	3
Amara plebeja (GYLLENHAL)				1												1
Bradycellus harpalinus (SERVILLE)															1	1
Acupalpus meridianus (LINNAEUS)			1													1
Harpalus anxius (DUFTSCHMIDT)					1											1
Harpalus autumnalis (DUFTSCHMID)	1															1
Harpalus griseus (PANZER)						1										1
Harpalus latus (LINNAEUS)			1													1
Harpalus rubripes (DUFTSCHMIDT)				1								2				3
Harpalus rufipes (DE GEER)								1								1
Harpalus rupicola STURM													1			1
Harpalus smaradginus (DUFTSCHMIDT)						4										4
Harpalus tardus (PANZER)	3					1			1			1	2	4	1	13
Panagaeus crux-major (LINNAUES)			3													3
Microlestes maurus (STURM)						16				1		4	1	3	7	32
Total																192

Faunistic results of a light-trap survey of the Trichoptera from the Meuse river in Belgium

by Giovanna RICCIARDONE & Philippe STROOT

Abstract

A light-trap survey of the Trichoptera from the Meuse river was carried out from April to mid-October 1991. Thirty-one species were identified, among which *Hydroptila angulata* MOSELY, 1932, new for the Belgian fauna, *Hydroptila sparsa* CURTIS, 1834 and *Hydroptila simulans* MOSELY, 1920, each with one single previous record in Belgium, and *Athripsodes leucophaeus* (RAMBUR, 1842), formerly thought to have disappeared from the Meuse river. Given the considerable variability observed in specimens of *Ceraclea alboguttata* (HAGEN, 1860), a previous record of *Ceraclea albimacula* (RAMBUR, 1842) in the Meuse river has been reconsidered, resulting in its withdrawal from the list of the Belgian Trichoptera.
Key-words: Trichoptera, light-trap, faunistics, Meuse river, Belgium.

Résumé

Un relevé faunistique des Trichoptères de la Meuse a été effectué au piège lumineux pendant la période s'étendant d'avril à mi-octobre 1991. Parmi les 31 espèces identifiées figurent *Hydroptila angulata* MOSELY, 1932, nouvelle pour la faune belge, *Hydroptila sparsa* CURTIS, 1834 et *Hydroptila simulans* MOSELY, 1920, qui n'avaient été mentionnées qu'à une seule reprise en Belgique, et *Athripsodes leucophaeus* (RAMBUR, 1842), qu'on croyait éteinte en Meuse. Suite à l'observation d'une considérable variabilité morphologique chez *Ceraclea alboguttata* (HAGEN, 1860), la citation antérieure de *Ceraclea albimacula* (RAMBUR, 1842) en Meuse a été vérifiée et a abouti au retrait de cette espèce de la liste des Trichoptères de Belgique.
Mots-clés: Trichoptères, piège lumineux, faunistique, Meuse, Belgique.

Introduction

Trichoptera are one of the most important groups of insects in many watercourses, including large rivers like the Meuse in Belgium, provided their water quality is sufficient. Until recently, only larvae have been surveyed in the Meuse river (MEURISSE-GENIN *et al.*, 1987), the sole data on adults referring to the older and isolated records gathered in STROOT (1985). However, due to the difficulties in adequately sampling and identifying larvae, studies using adult Trichoptera for river quality monitoring have been initiated in the Meuse river (STROOT & LEJEUNE, 1990; RICCIARDONE, 1991) as in other large European rivers (CHANTARAMONGKOL, 1983; USSEGLIO-POLARERA, 1989, ...). The faunistic results presented here bear on one season of sampling. They constitute the first systematic inventory of the adult Trichoptera from the Meuse river in Belgium.

Material and methods

The study area is the Belgian part of the Meuse river, from near its entry in belgium to the stretch below Namur. Three sampling sites, Waulsort, Tailfer and Andenne, were investigated from April to mid-October 1990.

In each site, sampling was carried out by means of a light-trap modified after FONTAINE (1982). The mixed UV-visible light was provided by a TL tube "Sylvania F8/350". Each light-trap (height 0.46 m) was placed on the infrastructure of a ward and oriented downstream, north-east and towards the middle of the river. The light-traps were operating one night every week from June to July, and one night every two weeks during the remaining of the sampling period.

Results

A total of 85,784 caddis flies belonging to 31 species (Tab. 1) were captured during this survey.

Of these species, one is new for the Belgian fauna: the hydroptilid *Hydroptila angulata* MOSELY. The closely related *Hydroptila sparsa* CURTIS and *H. simulans* MOSELY are other interesting captures, each with a single previous record in Belgium, respectively "Bruxelles 1907" and "Hoyoux river 1918" (MARLIER, 1949; STROOT, 1985). These three hydroptilid species are small (2.5-3.5 mm long) and have a more or less scattered palearctic distribution (MARSHALL, 1978, 1979). Their larvae are insufficiently known to allow distinction from other larvae of the genus. Under-reporting of hydroptilids is frequent, and the list of the hydroptilids from Belgium and adjacent areas is probably still far from complete.

The capture of the leptocerid *Athripsodes leucophaeus* (RAMBUR) is also of importance. It is a typical potamic species. Its only records in Belgium refer to sites located on the Meuse river (STROOT, 1985). However, these are old records, as well as most citations from other large European rivers, and *A. leucophaeus* was thought to be extinct in the river Meuse. Its larva is unknown.

Other species apparently rare in Belgium are *Athripsodes bilineatus* (LINNAEUS), *Oecetis notata* (RAMBUR) and *Oecetis testacea* (CURTIS).

Except for a few of the rarest ones, virtually all species captured in this survey had already been reported from the Meuse river, either at larval or adult stage, and are more or less exclusively potamophilous. The limnephilid *Limnephilus auricula* CURTIS is an exception; however, since this good flyer more typical of smaller water bodies was only represented in our samples by one individual, its presence there is attributed to contamination from other aquatic environments.

It is finally worth mentioning here the extreme variability observed in the characteristics of the genitalia of *Ceraclea alboguttata* (HAGEN) from the Meuse river. The shape of the median part of the trilobated apex of the Xth segment ranges for instance from typically short, round and barely incised to large and deeply subdivided, as recently observed by YANG & MORSE (1988) on Chinese specimens. Since the character was formerly presumed distinctive for the *Ceraclea* of the *alboguttata* group (see MORSE, 1975), this new observation prompted us to reconsider the status of the species of this group in Belgium. As a result, the nymph from "Houx (la Meuse), 14.09.1983" identified as *Ceraclea albimacula* (RAMBUR, 1842) in STROOT (1985) appeared to be a rather extreme form of *Ceraclea alboguttata*. Therefore, in absence of any further evidence of its presence in Belgium, *C. albimacula* should be withdrawn from the list of the Belgian Trichoptera.

Table 1. Check-list of the Trichoptera light-trapped on the Meuse river in Belgium, from April to mid-October 1990.

Rhyacophilidae
Rhyacophila dorsalis (CURTIS, 1834)
Glossosomatidae
Agapetus ochripes CURTIS, 1834
Hydroptilidae
Agraylea multipunctata CURTIS, 1834
Agraylea sexmaculata CURTIS, 1834
Hydroptila angulata MOSELY, 1932, **Belg. Fauna n.sp.**
Hydroptila simulans MOSELY, 1920
Hydroptila sparsa CURTIS, 1834
Hydropsychidae
Cheumatopsyche lepida (PICTET, 1834)
Hydropsyche contubernalis MCLACHLAN, 1865
Hydropsyche exocellata DUFOUR, 1841
Hydropsyche siltalai DÖHLER, 1963
Polycentropodidae
Neureclipsis bimaculata (LINNAEUS, 1758)
Polycentropus flavomaculatus (PICTET, 1834)
Cyrnus trimaculatus (CURTIS, 1834)
Psychomyidae
Psychomyia pusilla (FABRICIUS, 1781)
Lype reducta (HAGEN, 1868)
Tinodes waeneri (LINNAEUS, 1758)
Ecnomidae
Ecnomus tenellus (RAMBUR, 1842)
Limnephilidae
Limnephilus auricula (CURTIS, 1834)
Leptoceridae
Athripsodes albifrons (LINNAEUS, 1758)
Athripsodes aterrimus (STEPHENS, 1836)
Athripsodes bilineatus (LINNAEUS, 1758)
Athripsodes cinereus (CURTIS, 1834)
Athripsodes leucophaeus (RAMBUR, 1842)
Ceraclea alboguttata (HAGEN, 1860)
Ceraclea dissimilis (STEPHENS, 1836)
Mystacides azurea (LINNAEUS, 1761)
Mystacides longicornis (LINNAEUS, 1758)
Mystacides nigra (LINNAEUS, 1758)
Oecetis notata (RAMBUR, 1842)
Oecetis testacea (CURTIS, 1834)

Conclusions

The light-trap survey of the adult Trichoptera carried out on the Meuse river during the 1990 season revealed the presence of 31 species, of which 30 certainly originate from the Meuse river itself. Of these species, one is new for the Belgian fauna, two had only been reported once before

the present study and one other, now apparently rare in most European rivers, was nearly considered extinct in the Meuse river.
These data tend to indicate the efficiency of the light-trap as a tool to inventory caddis flies in large rivers.

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MARBEL, a plea for a catalogue of the Belgian marine fauna

by Guido RAPPÉ

Abstract

The European Invertebrate Survey in most, if not in all of the countries participating, seems largely to neglect the very diverse marine invertebrate fauna. This is a serious shortcoming since some phyla only have marine representatives. In Belgium many efforts have been made this century to collect marine material. Nevertheless taxonomical data on most groups still remain scattered, incomplete or out-of-date. An up-to-date catalogue on the MARine fauna (and flora) of BELgium (MARBEL) is needed, for faunistic/biogeographical studies, ecological/environmental and conservation issues.
Keywords: E.I.S., Belgium, marine fauna.

Résumé

Dans le cadre du "European Invertebrate Survey", la grande diversité de la faune marine n'attire guère l'attention de la plupart des pays. Cette lacune est assez grave, car plusieurs groupes zoologiques sont exclusivement marins. En Belgique, beaucoup de récoltes de matériel ont été faites depuis le début du siècle. Néanmoins, des révisions de la plupart des groupes taxonomiques font défaut. Un catalogue à jour de la faune (et de la flore) marine de la Belgique (MARBEL) s'avère nécessaire. Un tel instrument serait utile dans plusieurs domaines: études faunistiques et biogéographiques, écologie, environnement, conservation de la nature, ...
Mots-clefs: E.I.S., Belgique, faune marine.

Introduction

At present the European Invertebrate Survey almost exclusively covers terrestrial and freshwater invertebrate groups. In most, if not in all of the countries participating, the very diverse marine invertebrate fauna seems largely to be neglected, although in the British Isles the distribution of some marine invertebrate groups is studied using large maritime areas (e.g. SEAWARD, 1982). This is the more surprising since some phyla only have marine representatives, such as Echinodermata. For obvious reasons of completeness one should expect that at least some of these groups in at least some of the countries are treated within E.I.S. In fact none of this happens. In this way our knowledge of a considerable part of the invertebrate taxa remains ephemeral, despite an initiative like E.I.S.

Situation in Belgium

In Belgium many efforts have been made the last two centuries to collect marine fauna, mainly during two periods:

- "Exploration de la Mer" started in the late 1890's, under the guidance of G. GILSON, former director of the Royal Museum of Natural History (at present: Royal Belgian Institute of Natural Sciences, Brussels). This campaign lasted untill the 1930's. Part of this rich collection still remains

unstudied. Several checklists based on this material have been published, but are now outdated (a.o. HOLTHUIS, 1950; LELOUP, 1941).
- During the past twenty years several marine biology units were founded at various universities. A vast quantity of samples, mainly for ecological studies, have been taken. Most of these are turned into ash-free dryweight, while some of them are only superficially identified or lumped together in higher taxonomic levels. Only minor efforts are made to store a representative species collection of the marine fauna of Belgian waters in a national collection. In the extreme case of wrong identifications no means of correcting them are available.
When scanning the literature of the past 25 years for checklists or review articles of marine invertebrates, we see that only a very limited number of groups received some attention, most of them at the occasion of the Symposium "Invertebrates of Belgium" held in November 1988. The number of contributions strictly devoted to marine and/or brackish-water invertebrates published in the proceedings of this symposium (WOUTERS & BAERT, 1989) reflects the general lack of interest: only 12,5 % of the total or 1 "marine" versus 7 "terrestrial/freshwater" contributions. A wealth of recent information is available though, but it is contained within ecological papers or in grey literature.
The following list comprises all recent checklists and review articles on Belgian marine fauna we were able to trace, published during the past three decades.

CNIDARIA: Scyphozoa and Hydrozoa Siphonophora (RAPPÉ, 1989a)

CTENOPHORA: (RAPPÉ, 1989a)

PLATHELMINTHES: freeliving species (SCHOCKAERT *et al.*, 1989)

NEMATODA: freeliving species, together with non-marine species (COOMANS, 1989)

TARDIGRADA: together with non-marine species (HASPESLAGH, 1989)

MOLLUSCA: (BACKELJAU, 1986), brackish-water species (DUMOULIN, 1989), Littorinidae (WARMOES *et al.*, 1989).

CRUSTACEA: brackish-water Copepoda (together with non-marine species) (DUMONT, 1989), Cirripedia Thoracica (VAN FRAUSUM, 1989), Isopoda (RAPPÉ, 1989b), Decapoda Brachyura (ADEMA, 1991)

ECHINODERMATA: (MASSIN & DE RIDDER, 1989).

Furthermore, we are aware of the existence of at least two unpublished manuscripts: on Polychaeta (excl. Archiannelida) and Bryozoa.
The reader is requested to read the above list in between the lines; the list of recently, non-treated groups is much longer.

Final plea

We urge scientific institutes and universities to pay considerably more attention to the species composition of the Belgian marine fauna and flora. This can be done in many ways, e.g. by depositing the collected and no longer needed animals in the national collection of the Royal Belgian Institute of Natural Sciences in Brussels, by stimulating students to review a particular group (or do

it yourself if you happen to be specialised in a certain group)... The first step could be a catalogue. If this is possible in a country like Great Britain (HOWSON, 1987), with its longer coastline and much richer fauna, this should be possible in a country with a total coastline of 67 km. Recognizing and monitoring the fauna of our seas is of the utmost importance for measuring possible changes (e.g. pollution, 'Global Change', ...). Indeed many marine species have proven to be excellent biological indicators, e.g. many species of Chaetognatha.
Contributions to a better knowledge of the Marine fauna (and flora) of Belgium (MARBEL) can be published anywhere, referring or not to MARBEL. In the former case a continuing numbering of contributions as started by the author (RAPPÉ, 1989a; 1989b) at the above mentioned symposium could be a useful and stimulating feature. This would only require a minimum of co-ordination. MARBEL has at present no bounds with any particular institute, association or person. MARBEL is a plea in favor of some discriminated minorities. Some interest and support from professional biologists to fill the big gap in the knowledge of marine invertebrates would be more than welcome.

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Conclusions and recommendations
EIS meeting / Brussels Colloquium September, 1991

by Martin C.D. SPEIGHT

At the Brussels Colloquium and European Invertebrate Survey meeting of September, 1991, it was decided to transmit to the Secretariat of the Bern Convention certain conclusions and recommendations relating to certain aspects of protection of invertebrates under the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats). A first draft of these conclusions and recommendations was drawn up at the end of the EIS meeting and a final version was produced following receipt of additional comments from those who participated in the discussion. The organizing committee of the Brussels Colloquium has decided to reproduce the text of these conclusions and recommendations as part of the Proceedings of the Colloquium. The text is as follows:

At its 1991 meeting in Brussels the EIS discussed the lists of invertebrate species included in Annexes II en III of the Bern Convention and in particular the basis upon which species might be selected for inclusion in these Annexes. It was agreed that the outcome of this discussion be sent to the Secretariat of the Bern Convention, with the request that our conclusions be brought to the attention of the Specialist Group in Conservation of Invertebrates at its 1992 meeting.

The EIS notes that inclusion of threatened invertebrates in the appendices of the Bern Convention has already had a very positive influence, in stimulating an increased interest in invertebrates and their conservation. The concept of a list of "flagship" species, allowing inclusion in the appendices of selected invertebrate species that are not threatened at European level but are well-known and recognisable, has also clearly been of benefit in this respect. However, we recognise that the uses to which the Bern species lists would be put were not easy to predict and that some difficulty is now arising due to use of all the listed species in the same way in work on site evaluation. We would point out that a different meaning attaches to the presence on a site of threatened and non-threatened species, so that these two groups require to be clearly distinguished from one another in the Annex lists. We recommend either of the following courses of action:

i) invertebrate species that are threatened at the European level should be asterisked in the Bern Convention Annex lists,

or

ii) the Annex lists of invertebrates should each be divided into two sections, A and B, section A listing the species threatened at European level and section B listing the "flagship" species which are nor threatened at European level.

A third alternative would be to remove the non-threatened "flagship" invertebrate species from the appendices. But we would regard this as the least desirable option since the role of these species within the framework of the Convention is as yet far from played out. We note also that many vertebrates which are not threatened at European level are included in the Bern Convention Annex lists, so that in their present content the invertebrate lists conform to the approach adherred to elsewhere in the Convention. However, we would observe that at the moment there would not seem to be a need to increase the number of "flagship" invertebrates listed in the Bern Convention Annexes, whereas the serious plight of many threatened species leads us to recommend strongly that the number of threatened invertebrate species listed in the Bern Convention Annexes should be increased. Given that invertebrates are now being incorporated into site evaluation processes we consider that this role of invertebrates should be taken into consideration when any additions to the Bern invertebrate lists are contemplated.

In considering the concept of species threatened at the European level, we conclude that there is no simple, universally applicable set of criteria which could be used to decide the degree of threat to which any invertebrate is subject, but that any criteria used will have to be tailored to each major taxonomic group under consideration. We also feel that in each instance the criteria used should be clearly expressed.

Assuming that lists of species threatened at the European level can be derived for major groups of invertebrates in addition to those already surveyed, it is our conclusion that, in considering these threatened species as potential candidates for inclusion on the Bern Convention Annex lists, there is justification for giving high priority to species which would fall into the following categories:

a) threatened species known to have undergone serious decline in Europe during the present century,

b) species endemic to Europe which are also known to be threatened (we would stress that endemic species should not automatically be listed because they are endemic - endemic species are not necessarily threatened species).

In considering invertebrates endemic to Europe we recommend the following:

a) any state within whose territory the entire world population of any invertebrate species is known to be confined should be reminded of their particular obligation to ensure that this endemic species is adequately protected,

b) listings of European endemic invertebrates confined to individual states should be prepared as a matter of priority.

We also note that considerable biogeographic and evolutionary interest attaches to particular genetically distinct, isolated, relict populations of invertebrates whose other European populations are not recognised as threatened. There may well be difficulties in addressing the problem of protection of such threatened infra-specific taxa through the medium of the Bern Convention, but we feel there is an urgent need to draw attention to them and recommend that, at the very least, some international initiative to this end be set in motion.

Further, we would wish to note that, in the series of studies the Council of Europe has commissioned on invertebrates, it has performed an invaluable service to the cause of invertebrate protection in Europe. However, we do not feel that the results of these studies are adequately reflected in the existing Bern Convention Annex species lists and urge re-examination of the lists of species recognised as threatened at European level in those studies (i.e. the studies on threatened European butterflies, dragonflies, saproxylics, aculeate Hymenoptera and non-marine Mollusca), with a view to augmentation of the lists of invertebrate species included in the Bern Convention Annexes. We would also urge the initiation of further such studies in the context of the Bern convention's work on invertebrates, with the explicit intention of providing a reliable basis for further increasing the number of threatened invertebrates included in the Bern Convention Annexes, in particular in relation to broadening their role in site evaluation work. We recommend that both particular taxonomic groups and particular biocoenoses be considered for study, and consider that there are sufficient data, interest and expertise, internationally, for European studies of the following topics to be carried out without delay:

a) threatened European cavernicolous invertebrates,

b) threatened European Trichoptera (Insecta),

c) threatened European Neuroptera (Insecta).

Finally, we would note that little attention seems yet to have been paid to the situation of Europe's fauna of marine invertebrates. We conclude that urgent measures require to be taken to provide an overview of the situation in the intertidal/subtidal zones, and recommend that a sub-committee be constituted to report back to the specialists group with recommendations for action. We are establishing a sub-group within EIS to cooperate in any such initiative.

We hope that the content of this letter will provide a useful contribution to discussion at the next meeting of the Bern Specialists Group in Invertebrate Conservation and reaffirm the continued interest of EIS in helping in whatever ways it can, in respect of efforts to protect Europe's invertebrate fauna through the provisions of the Bern Convention. The recommendations contained in this text may be given in summary form as follows:

EUROPEAN INVERTEBRATE SURVEY MEETING, BRUSSELS, 1991: SUMMARY OF RECOMMENDATIONS CONCERNING PROTECTION OF INVERTEBRATE SPECIES UNDER THE BERN CONVENTION

1. Species threatened at the European level should be clearly distinguished from the non-threatened "flagship" species listed in the existing appendices, either by means of asterisks, or by separating the two groups into different sub-appendices.

2. The "flagship" species, which are not threatened at European level, should be removed from listing in the Bern Convention Annexes when it is felt that their role in popularising the principle of the need to protect European invertebrates has been adequately played-out.

3. If further species are to be added to the appendix lists, the additional species should all be species threatened at the European level.

4. The number of species in the appendices should be increased, as the number of species reliably identified as under threat at European level increases.

5. In deciding whether species are under threat at the European level, the criteria employed should be tailored to the particular taxonomic groups under consideration and should permit application of the IUCN threat categories.

6. The criteria used in identifying species as under threat at European level should be clearly expressed.

7. In selecting species for inclusion in the appendices, from among species listed as threatened at European level, the following categories of species should be given high priority for inclusion:

a) threatened species known to have undergone serious decline in Europe during the present century,

b) threatened species which are endemic to Europe,

c) threatened species which would be particularly indicative of elements of site quality not so easily detected using plants or vertebrates.

8. Listings of invertebrate species endemic to individual European states should be prepared as a matter of priority.

9. Any European state which has ratified the Bern Convention, and to which the entire world population of an invertebrate species is confined, should be reminded of its particular obligation under the Bern Convention, to ensure that this endemic species is protected.

10. There is an urgent need to address the question of how the protection of infra-specific taxa of biogeographic and evolutionary significance might be better achieved under the Bern Convention.

11. The results of completed European Studies on threatened butterflies, dragonflies , saproxylics, aculeate Hymenoptera and non-marine Mollusca should be reappraised, with a view to deriving a more comprehensive list of threatened invertebrates appropriate for inclusion in the Bern Convention Annexes.

12. Further European Studies of threatened invertebrates should be conducted by the Council of Europe/Bern Convention Committee, with the explicit intent of identifying species requiring to be added to the appendices of the Bern Convention.

13. The following groups should be considered as particularly worthy of study at the European level:

a) threatened European cavernicolous invertebrates,

b) threatened European Trichoptera (Insecta),

c) threatened European Neuroptera (Insecta).

14. Urgent consideration should be given to the setting up of a sub-group, to report on the situation of Europe's marine invertebrates.

Martin C.D. SPEIGHT
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