

THE GROUND BEETLES OF THE NETHERLANDS

Distribution and ecology (Coleoptera: Carabidae)

This book treats the 380 species of ground-beetles (Carabidae) known from the Netherlands. The tradition of ecological research in this country by pitfall-trapping has yielded an enormous amount of ecological data. They form an important basis for the ecological summaries and conclusions in this book. For all species we provide a map of its distribution in the Netherlands, a map for Europe, and a phenological diagram. For many species we also provide a graph representing its habitat. Both drawings and photographs richly illustrate this book. In this summary we concentrate on information important for understanding the Dutch carabid fauna and the explanation of the format of the species' treatment.

1 INTRODUCTION

The present book is more than a pure faunistic atlas. It also provides general and specific information on ecology, biology and aspects of biological conservation. It aims at a wide public, not only the carabid specialists. An important goal is to summarise the ecological research carried out in the Netherlands between 1950 and 1980. This comprises some major projects, by the Netherlands Institute of Ecology (NIOO: part of the Royal Academy of Sciences) and the former Biological Station Wijster (BSW: part of the Agricultural University of Wageningen) and numerous smaller projects at various institutes.

History of the project

After initial work by P.J. Den Boer (fig. 53) in the first reclaimed IJsselmeerpolders, J. Haeck (figs. 54-57, 64) started to monitor the colonisation of the youngest polder 'Zuid-Flevoland' (reclaimed in 1967) by carabids; later R. Hengeveld joined the group. It soon became apparent that only a part of the carabid fauna was able to invade the new polders and therefore detailed information on the distribution of the ground-beetle fauna in the surrounding mainland was required, in particular of the colonising species. Inspired by the 'European Invertebrate Survey' (EIS) project, in 1971 the work on the first carabid atlas was started. (TURIN ET AL. 1977). It was the first computerised zoological atlas in the Netherlands; which initiated a series of similar projects and stimulated the foundation of the Netherlands' office of EIS in 1976.

2 WHAT ARE GROUND BEETLES?

This chapter provides a brief introduction into morphology, systematics and biology of Carabidae. It gives hints about the major literature and key-works (page 17). The check-list is given here, with some synonyms, as is a list of changes since the previous lists (table 1, page 18).

3 METHODS AND MATERIAL

This chapter describes methods and material used to compile the present work from old and new collection data, recent pitfall sampling (fig. 13) and literature. The previous mapping scheme was based on 52.000 faunistic records (TURIN ET AL. 1977). It soon became clear that a huge amount of unused information on carabids was still present in the Netherlands. A new project to build a data-

base of all available data from pitfall trapping, including site information on biotic and abiotic variables, was started accordingly. This initiative was supported by the Institute of Nature Management (IBN-DLO: now 'ALTERRA') during 1980-1982, and later by the 'Prins Bernhard Foundation' (1982-1985). From 1985 to 1990 again many new data were added and others were checked. Before writing this book, a new checklist for the Netherlands was published (TURIN 1990) and an ecological classification based on the extensive data. At this moment the database comprises 108,406 records from hand-sampling and 66,727 from pitfall trapping (fig. 16).

A critical account of the material is given, e.g. by showing the gaps in ecological data (because pitfalls do not function very well in wet habitats) and species distribution. It may be obvious that faunistic data, due to varying sampling intensity and variation of the landscape, are not distributed equally in time and space. The areas with highest diversity in the Netherlands are situated in the central and southern parts of the Netherlands, in general also the regions with the highest sampling intensity (HEIJERMAN & TURIN 1994B). It has been shown that according to the criterion of Heijerman & Ketelaar (1991) (at least 50 species per 10x10 km-square), 125 out of ca 390 squares (32%) can be characterised as insufficiently sampled (fig. 24, table 3).

From the 19th century onwards, sampling intensity increased almost linearly (fig. 21) and most records were obtained from the last three decades. In several papers dealing with time-trend analyses, correction methods were used. Heijerman & Turin (1998) proved that these methods are based on unrealistic assumptions and that even the data were incorrectly influenced. They concluded that such, statistically incorrect, methods should be avoided. Nevertheless, in many cases, the number of records of many species have declined, even when sampling intensity linearly increased in the same period. It would also be unrealistic to ignore such figures.

4 BIOLOGY AND ECOLOGY

This chapter summarises the most important literature on biology and ecology of ground-beetles in general. The chapter is divided in paragraphs on reproduction, behaviour and ecology, dispersion and population biology.

In the ecology paragraph, adaptations to biotic and abiotic factors are discussed on the basis of Thiele's (1977) important compilation, completed with many more recent papers and original data. The classical distinction between 'spring-breeders' and 'autumn-breeders', mainly based on adult activity, has been discussed according to the developmental types recognised more recently (fig. 42). Furthermore the information on developmental cycles has been linked to ecological features of species and the distribution of these characteristics over different habitat types (table 4, page 49). Special attention is given to aspects of dispersal ecology and colonisation of reclaimed polders as studied by Dutch carabidologists in the second half of this century. The consequences of differences in dispersal power, especially with respect to population biology as to landscape ecology have been discussed extensively. The chapter concludes with some examples of distribution of densities in the field.

5 THE DUTCH CARABID FAUNA

The carabid fauna of the Netherlands can be characterised as a typical lowland and river-delta fauna, dominated by hygrophilic species. A relatively high number of *Agonum*-, *Bembidion*- and *Dyschirius*-species occur throughout territory in the numerous water river-meadows, fenlands, bogs, coastal salt marshes and dune valleys. Especially, the halophilic fauna of the Netherlands is well developed, compared to the neighbouring countries. Although the Netherlands are known as a 'flat' country, biologists recognise a division between the 'lower parts', mainly in the central and western parts, consisting of especially alluvial, peat and clay soils, and, in the middle and East, the 'higher parts' with diluvial (pleistocene), sandy soil types, with a maximum altitude of ca 100 m above sea level. Other important components of the Dutch landscape are the costal dunes that stretch all along the western and northern coast, and a small, hilly, limestone area, reaching up to ca. 300 m, in the southernmost part of the province of Limburg. These higher parts with their heath-lands, drifting sands, a small area of limestone grasslands, enrich the fauna with xerophilic and thermophilic elements such as *Bradycephalus*-, *Ophonus*- *Harpalus* and *Cymindis*-species. In the East we can also find the remnants of a formerly vast moorland area, that was connected with the large moorlands in western Germany. The merely 10% of woodland that covers the territory, is mainly concentrated in the higher parts. Cultivated land covers a vast area of the Netherlands, that already for many decades happens to be the most crowded country, with the most intensive agriculture of Europe.

European patterns

In the paragraph biogeography, the European distribution patterns are divided into 10 types (HENGEVELD & HOGEWEG 1979). This 'areaalkarakteristiek', which has been mentioned for each species, is illustrated on maps in figures 66-75 (page 73-74, 'soort' = species, 'randareaalsoort' = fringe species).

In summary:

- Type 1: Species with a northern distribution.
- Type 2: Central European species.
- Type 3: Species of central and northern Europe.
- Type 4: Species of central and southern Europe.
- Type 5: Species covering most of Europe.
- Type 6: Atlantic-mediterranean species.
- Type 7: North-east European species.
- Type 8: Species with mainly a coastal distribution.
- Type 9: Species that are distributed in most of Europe.
- Type 10: Atlantic species/ West European species.

Species in the centres of their distributions meet better conditions for survival than near the fringes (HENGEVELD 1986, 1990). Therefore the abundance may fluctuate more heavily at the edges than in the centre and consequently the species may be expected to be more sensitive to (local) extinction under these marginal conditions. In the Netherlands, indeed 21 out of the 22 species that got extinct were fringe-species, while most increasing species (inhabiting unstable or agricultural biotopes and those colonising newly reclaimed polders) are 'central' species.

Dutch patterns

Some main types of distribution patterns that clearly differ from the spatial sampling intensity can be recognised. These groups have been listed and illustrated on pages 75-78. They are:

- Group 1: Distribution mainly along coast.
- Group 2: Distribution in the fenlands and sea-clay areas in the West.
- Group 3: Distributions following the large rivers.
- Group 4: Distribution only in South-Limburg.
- Group 5: Distribution in southern or south-eastern parts.
- Group 6: Eastern distribution.
- Group 7: Distribution on the higher, Pleistocene grounds.
- Group 8: Distribution of the sandy soils.
- Group 9: Distribution mainly in forests.
- Group 10: Distribution throughout The Netherlands.

Ecological classification

The ecological classification presented here was based on more than 1600 pitfall year-samples from over 900 sites all over the Netherlands, covering 285 species (TURIN ET AL. 1991). Although using different material and methods, the characterisations of most species gave similar results as in comparable classifications abroad, and moreover, these methods showed that the detailed descriptions of the habitats by Linstroth (1945), without the use of pitfall data or computers, were of an unbelievable accuracy. For the Netherlands, the sites were classified into 33 biotopes, divided in 7 main groups. Table 16 provides a translation of the biotope names, which are given with the number of pitfall-series (samples) and sites in table 8 (page 81). Fig. 86 (page 80) shows the relation between the main groups I-VII, resulting from clustering the 33 biotopes by TWINSPAN. For the detailed relationship within the seven groups compare figures 87, 93, 100, 106, 116, 122 and 129. These graphs are accompanied by a distribution map and photographs which illustrate these biotopes. Eurytopic species that occurred in most of the 33 biotopes have been treated separately (fig. 135, page 103).

Changes

The last part of this chapter discusses changes ('veranderingen') in the carabid fauna in Europe, The Netherlands (see figs. 136-139) and locally. During this century, and especially the last decades, eurytopic and hygrophilic species have in general increased, and species of forests and poor, dry, open habitats, such as heath-land and poor grasslands have declined. Fragmentation of the landscape corroborated by the effect of climatic changes caused (local) extinction, of these xerophilic species in particular, in many isolated nature reserves. Isolation has been a major threat to especially species with low dispersal powers, and was measurable on a national scale.

On page 109 a list of 30 extinct species is given (top right) and a list of expanding species (bottom right); at the left of seven rare or extinct species the nearest localities in Germany or Belgium are given, and on page 110 five species are listed which could be expected in the future to reach our country.

6 NATURE CONSERVATION

Carabids can be useful for monitoring the changes in nature, especially because of the following reasons:

- 1 A concise group of ca 350 species with a high variety of (often characteristic) habitat preferences.
- 2 Carabids are predators with an enormous variety in strategies and biological adaptations.
- 3 Relatively easy to catch by pitfall trapping, and therefore statistically testable.
- 4 Suitable for experimental work.; reliable ecological classifications are available.
- 5 Large databases over a long time-period available both nationally and internationally.

Rare and presumably extinct species are often placed on so called Red Data Lists, summarised in table 11. We have still serious doubts about the usefulness of such lists, as long as we do not know, how to calculate and test the significance of reliable time trends of occurrences or commonness of species, because data are not distributed equally in time and space. Therefore, we believe that trend of species' occurrences can only be estimated with varying reliability.

In general, we prefer not to use Red Data Lists, nor list of so called I-species (species for which a country has international responsibility), because these methods use specific information of selected species only. Making use of a Set-of-Reference, in this case congruent to the data-matrix of the ecological classification from table 8, we consider it possible to value results from pitfall sampling, by calculating similarities between the new data and the 33 biotopes of the Set-of-Reference. In this method, the similarity-scores can characterise the new data without making use of specific information, and will hardly be influenced by minor variation in the species list from one place to another and from year to year (see fig. 143 and table 12, page 114). The chapter concludes with nine recommendations for nature management of carabids in general.

7 THE SPECIES - INTRODUCTION

In chapter 8 (DE SOORTEN = THE SPECIES), all the 70 genera and 380 species have been treated in a uniform way. In chapter 7 the format is explained, which is here translated and explained for foreign readers. The species are arranged in systematic order (see list in chapter 2) and serially numbered. Figures are placed close to the relevant genus/species; the genus figures follow the general numbering of figures, but maps and graphs for species are referred to by the species-number. Unpublished sources are referred by means of initials, explained in Appendix (Bijlage) 2.

Genus descriptions

Algemeen (general information)

A short impression of the genus, sometimes accompanied by a drawing of a typical species., and/or reference to a colour plate.

Areaal (range)

A brief overview of the global distribution and that in the palearctic region and Europe in particular. Also the distribution within the Netherlands has briefly been summarised and mapped for more than one species.

Oecologie (ecology)

A rough impression of habitat preferences of the species within a genus. For most genera, this characterisation is

supported by a plot that illustrates the position of the species, relative to two main axes of an ordination by DECORANA, based on the same material that was used for the ecological classification. From the plot of all 285 species in the pitfall-material, the background of the ordination figures was reconstructed (plate 63; figure 144, in which all 'monotypic' genera are shown), indicating the position of the ecological groups. By presenting the plots per genus on the same background, the general character of the genus and the amount of variation within a genus are visualised. Eurytopic species are ordinated in the central part of the plots and highly specialised species towards the edge.

Biologie (biology)

A review of reproduction, development, rearing, dispersal power, especially if information is more general within a genus.

Taxonomie (taxonomy)

Deals with taxonomic problems and refers to the most recent keys and European revisions.

Species descriptions

Areaal (distribution area)

A short description of the global distribution in general terms, accompanied by a *European distribution-map*, always next to the Dutch distribution-map.

The maps are updated from the previously published maps (TURIN ET AL. 1977) with the literature listed on p. 118. Information obtained after 1995 could not be included.

Areaalkarakteristiek (distribution type)

This refers to a number, explained in fig. 145, and the relative position of the Netherlands in the general distribution: **marginaal**

marginal – the margin of the distribution area crosses Dutch territory

submarginaal

sub-marginal – the margin lies within 150 km from our borders

subcentraal

sub-central – the margin lies from 150-500 km from the border

centraal

central – the margin is more than 500 km away from the Dutch border, and the Netherlands are in the centre of the distribution area.

Voorkomen (distribution)

A short indication of the distribution pattern within the Netherlands is given, followed by the distribution in surrounding countries, more or less in clockwise order: British Isles - Denmark - Fennoscandia - Germany - Switzerland and Belgium. Where available, the occurrence on some Red Data Lists in this area is indicated (see references on p. 119). In some cases information of the Baltic region, Poland, Austria and France was included. Terms which were used to indicate the distribution in detail are explained, with their English equivalents, in table 14 (p. 120).

The data on the *Dutch distribution maps* have been divided in three periods: old records from the 19th century and undated localities, dated records from between 1900 and 1970 and records after 1970, see legend on page 633. Unreliable

Legend for maps of the Netherlands. Small dot: before 1900 or without date.

voor 1900 en niet

- gedateerde vondsten

• 1900 - 1969

• 1970 - 1999

Tabel 16

The seven main ecological groups (I-VII) and the 33 biotopes recognised, with translation of the Dutch terms (see table 8 and fig. 86). Latin names of plants are not repeated.

I	Hoogvenen en heiden	Peat moors and heathland
1	Hoogvenen	Peat moors
2	Heiden met pijpenstrootje (<i>Molinia caerulea</i>)	Heath with Purple Moor-grass
3	Vochtige heiden met dopheide (<i>Erica tetralix</i>)	Moist heath with Cross-leaved Heath
4	Droge heiden met struikheide (<i>Calluna vulgaris</i>)	Dry heath with Ling
5	Droge heiden met grassen (<i>Deschampsia flexuosa</i>)	Dry heath with Tufted Hair-grass
II	Duinen en stuifzanden	Dunes and drifting sands
6	Vegetaties met buntgras (<i>Corynephorus canescens</i>)	Vegetations with Grey Hair-grass
7	Zeeduinen, droog en open	Coastal dunes, dry and open
8	Duingraslanden	Dune grasslands
9	Duinbossen	Dune forests
10	Duininstruwellen, met duindoorn (<i>Hippophae rhamnoides</i>), kruipwilg (<i>Salix repens</i>) of liguster (<i>Ligustrum vulgare</i>)	Dune shrubs with Sea-buckthorn, Creeping willow or Wild Privet
11	Schrall graslanden op zand	Poor sandy grassland
III	Weinig bemeste cultuurlanden op zand	Slightly fertilized cultivated sandy soils
12	Bemeste graslanden op zand	Sandy fertilized pastures
13	Akkers op zand	Arable land on sand
14	Braaklanden op zand	Waste land on sand
15	Naaldbossen, jong, open (plantages)	Coniferous plantations, young, open
IV	BosSEN	Forests
16	Naaldbossen, droog	Coniferous forest, dry, mature
17	Naaldbossen, oud, vochtig	Coniferous forest, old, moist
18	Loofbos, eiken-berkenbossen	Deciduous forest, oak-birch
19	Loofbos, eiken-beukenbossen	Deciduous forest, oak-beech
20	Loofbos, eiken-haagbeukenbossen	Deciduous forest, oak-hornbeam
V	Kalkgraslanden, ruderale en beschaduwd vochtige terreinen	Limestone grasslands, ruderal and moist shady habitats
21	Loofbos, vochtig, populier	Deciduous forest, moist, poplar
22	Loofbos, vochtig-nat, wilgen en/of elzen	Deciduous forest, moist-wet, alder and/or willow
23	Struikvegetaties, vochtig, binnenland	Shrubs, moist, inland
24	Tuinen, parken, ruderaal-vochtig	Gardens, parks, ruderal-moist
25	Kalkgraslanden en dijkhellingen	Limestone grassland and slopes of dikes
VI	Rietlanden, jonge, drooggevallen gronden	Reedland, young reclaimed biotopes
26	Kruidenrijke graslanden, onbemest	Grassland with herbs, unfertilized
27	Rietlanden, Lauwersmeer polder	Reedland, Lauwersmeer polder
28	Rietlanden, IJsselmeer polders	Reedland, IJsselmeer polders
29	Akkers, IJsselmeer polders	Arable land, IJsselmeer polders
30	Jonge, drooggevallen gronden, opgespoten land	Young, reclaimed grounds, or raised with sand
VII	Overs, kwelders	Shores and salt marshes
31	Zandbanken bij zout water, groene stranden	Sand banks near sea, grassy beaches
32	Overs, binnenland	Inland shores, river banks
33	Kwelders, schorren	Salt marshes

data that have been omitted from the maps, are discussed after the heading 'Niet opgenomen'.

Status. After this heading there is a brief discussion about changes in occurrence; see also Desender & Turin (1989) where the changes in Denmark, the Netherlands and Belgium have been compared.

Oecologie (habitat)

The habitat-preferences are reviewed here (references p. 120). Despite the lack of mountains in the Netherlands, data on altitudinal distribution and shifts in habitat-preference have been cited as relevant information to understand the ecology of a species.

Habitatgrafiek (Ecological graph)

The ecological graph gives the distribution of data from pitfall traps over the 33 biotopes from the ecological classification (figs. 146, 147). The relative abundances, as well as the presence percentages have been given for most of the 285 species.

For the relative abundances (right Y-axis), the average natural logarithm of the number of Specimens per Decimeter pitfall edge per Year-sample (SDY) was calculated for each biotope. The logarithmic transformation has been carried out to diminish the influence of peaks in the occurrence of individuals (compare table 1). The SDY-correction was made, because the number of pitfalls per site, as well as the diameter of the pitfalls could vary all over the database. For calculation the mean of these relative abundances, only the samples have been used, in which the species was present and the value of the relative abundances can be expressed as $\ln(\text{SDY}+1)$ (+1, in order to avoid negative figures). The presence-percentages (left Y-axis) simply represent the percentage of the total number of year-catches per biotope in which the species was present, in spite of the number of individuals (TURIN ET AL. 1991).

Both Y-axes have been scaled for each species separately, so that when comparing species it is important to realise the differences in maximum values of the various Y-axes.

Vangpotten (pitfall traps)

The habitat in the Netherlands has been discussed on the basis of data of about 40 years of pitfall-trapping. This refers to 1616 year-samples from ca. 900 localities.

For the 226 species where sufficient data were found in this database, the following data are given:

Groep (ecological group)

A code according to Turin et al. (1991) (also fig. 148, table 15). This clustering is basically different from the one used for the ecological classification in chapter 5, in which 33 biotopes were clustered according to species-composition, whereas here (fig. 148, table 15) the species are classified in seven ecological groups of which the species have a similar distribution of abundance over the biotopes (e.g. typical forest species). This classification, for instance, forms the basis (background) of the ordination per genus (see above).

Below follows a brief translation of this classification, see table 15 for details (read 'species of' in front of each biotope):

A1	peat-moor and heath;
B1	coastal dunes and biotopes with <i>Corynephorus</i> ;
B2	extensive cultural country;
C1	open sandy biotopes;
D1	xerotherm (limestone) grasslands;
D2	limestone grasslands and forests;
D3	forests;
E1	disturbed, ruderal biotopes and moist forests;
F1	ruderal and ± open biotopes;
F2	moist and shady biotopes;
G1-G4	ruderal and shady biotopes;
H1-H2	reedland, polders and pioneer biotopes;
H3-H4	(inland) shores, and/or saltmarshes;

EU(A-H) eurytopic species, occurring in most of the 33 biotopes (wide ecological amplitude). The ecological group in which the species was originally clustered has been mentioned between brackets, e.g. EU(A) = most related to the A1-group;
Z(A-H) species with too low numbers in the Dutch pitfall database. Here, also the original group has been indicated between brackets: Z(A) = rare species of heath-like habitats.

Species that were not caught in pitfalls, mainly rare species and species of wet biotopes, have not been classified. After the ecological group, the number of pitfall year-samples in which the species was (series) and the number of specimens (individuen) have been mentioned. These are the totals on which all calculations have been made.

In the text reference to biotopes in which the species is present or absent is made by using square brackets [].

Eurytopie (eurytopity)

This measure is a rounded mean (x_{10}) of two estimates (both between 0.0 and 1), calculated from the data matrix over all year-samples (TURIN ET AL. 1991). PRES = number of biotopes in which present/33; SIM = the evenness of the values over the biotopes according to the Simpson (1949)-index. The value thus can vary from 0 (stenotopic) to 10 (most eurytopic).

Bodem (soil type)

A preference for a particular soil type has been calculated, recognising the following classes: **kalk** (limestone), **leem** (loamy soil), **rivierklei** (river-clay), **zeeklei** (sea-clay), **laagveen** (fen-peat), **zand** (sandy soils), **hoogveen** (peat-moor), **zandige klei** (sandy-clay). When a species appeared to have preference for two soil-types, combinations were given, e.g. **kalk/leem**, **laag-/hoogveen**, **rivier-/zeeklei** and **zand/veen** if a species prefers sandy as well as peaty soil-types. It has also been indicated if a species showed no special preference (**geen voorkeur**) or that the data were insufficient (**onvoldoende gegevens**).

Vocht (moisture/humidity)

Also this estimate has been calculated from the original data-matrix. Five classes were recognised: **1 = droog** (dry), **2 = droog/vochtig** (not abundant in moist to wet biotopes), **3 = vochtig** (most abundant in not too dry, not wet places), **4 = vochtig/nat** (moist/humid, not dry), **5 = nat** (wet biotopes).

'Geen voorkeur' means that it can be found throughout the range. **Onvoldoende gegevens** = insufficient data..

Begeleiders (accompanying species)

Under this sub-heading the species have been listed occurring together with the treated species in more than 70% of the pitfall year-samples. After the species name, the first figure presents the percentage of all samples concerning the present species, in which the accompanying species is present. Between brackets, the percentage of the samples concerning the accompanying species has been given in which the present species is present. Under the sub-heading 'Wederzijds >50%' the species have been mentioned where these percentages both are higher than 50%, indicating a strong mutual ecological relationship. The higher the percentages, the higher the relation and the lower, the more eurytopic a species is. Very eurytopic species have almost no accompanying species and stenotopic species have often many. The better the biotopes in the ecological classification have been defined, the stronger are the relationships.

Biologie (biology)

Biological characters of the species are given on basis of literature and original. Used works are listed on p. 123. If possible the following order was used:

- diurnal/nocturnal activity;
- periodicity, hibernation;
- reproduction, development;
- food, predation;
- reference to descriptions or keys of larvae.

Dispersie (dispersal power)

The most important references are given on p. 123, more data have been given on the CD-ROM . Explanation of terms:

macropteer	macropterous, all specimens fully winged;
brachypteer	brachypterous, all specimens unwinged;

dimorf

dimorphic, macropterous as well as brachypterous specimens occur;

polymorf

polymorphic, all transitions between brachypterous and macropterous may occur;

vliegspieren

flight muscles.

If available, the (unpublished) numbers of flight records from window trapping by the Biologican Station of Wijster have been listed per month or fortnight. (after the word 'vliegwaarnemingen'; a number after the name of a month gives the number of records).

The distribution of catches per month (only records from sampling by hand) is shown in graphs in the margin of the text for nearly all species (figs. 149, 150). This picture of the phenology is not exact, but merely an indication of the presence and activity of adults. Especially the numbers of records for winter-active species, such as *Bradyellus ruficollis* and *Bembidion nigriceps* are biased by low sampling intensity during winter. When comparing the graphs to the monthly catches from Denmark and Sweden, one has to keep in mind that the period in which the adults can be active, shortens towards the north (see fig. 25).

During the last decades, several detailed studies on biology and ecology (listed on page 127) of one or a few species have been published. For these species the paragraph 'biologie' can be lengthy.

Bedreiging (threats)

Aspects of nature conservation have been mentioned here, including threats and the possibilities to use the species as indicator for special biotopes.

Taxonomie (taxonomy)

In some cases variations or subspecies will be mentioned here, and only then, when of importance for the Dutch fauna. Also taxonomy concerning species that have been split or lumped and relevant revisions, have been referred here.