HOOFDSTUK 16 SUMMARY

THE ORTHOPTERA OF THE NETHERLANDS

From 1990 until 1994 more than 100 recorders participated in the collection of distributional data of Orthoptera in The Netherlands. In this book we present the results of this mapping scheme. The Dutch fauna comprises to date 45 indigenous species, four of which have become extinct during this century, viz.: *Psophus stridulus* (last seen in 1942), *Locusta migratoria* (1951), *Tetrix bipunctata* (1975), and *Gampsocleis glabra* (1987). By contrast three species were found for the first time during this project: *Conocephalus discolor* (in 1990), *Tettigonia cantans* (in 1992) and *Meconema meridionale* (in 1993). Other species such as *Phaneroptera falcata*, *Chorthippus apricarius* and *C. mollis* are markedly expanding their range within our country. This book describes the problems and successes of these species in our country, their biologies, their songs. The songs are also presented as digital recordings on the accompanying cd. Furthermore the book gives information on nature conservation issues and provides management advice, which should ameliorate the situation for Orthoptera.

1 INTRODUCTION

The scope of the book is outlined and the parties involved are introduced. The project was financed by the Ministry of Agriculture, Nature Management and Fisheries, and was carried out by the European Invertebrate Survey - The Netherlands (EIS-NL) in close cooperation with the National Museum of Natural History (NNM), Leiden, the Institute for Forestry and Nature Research (IBN-DLO), Wageningen and the Information and KnowledgeCentre for Nature Management (IKC-N), Wageningen. The project-coordinator was Roy Kleukers, who was supervised by two of the other authors: Erik van Nieukerken (EIS-NL) and Walter van Wingerden (IBN-DLO). Baudewijn Odé and Luc Willemse started as recorders and joined the author-team because of their respective specialities: sounds and taxonomy. See also colophon on page 408.

2 HISTORY OF ORTHOPTERA RESEARCH

This chapter provides a short account of the history of Orthoptera research, with special reference to the developments in the Netherlands prior to the launching of the mapping scheme in 1990. The oldest record of an orthopteran in The Netherlands was that of the mole-cricket *Gryllotalpa gryllotalpa* by Goedaerdt (1662) (fig. 2-2). *Meconema thalassinum* (Degeer, 1773) is the only species described from the Netherlands, with type-locality Utrecht. The first check-list was published by Bennet & Van Olivier (1825) (table 1), followed by those of Snellen van Vollenhoven (1859), Folmer (1900), Van der Weele (1907) and C. Willemse (1917, 1939). Fig. 2-1 shows the increase in number of species in each check-list.
During the first half of this century well known Dutch students of Orthoptera were D. Mac Gillavry and C. Willemse. After the Second World War the interest in Orthoptera diminished, until G. Kruseman began studying this group in the sixties. His work resulted in a book on the Orthoptera of the Benelux countries, with distribution maps, and (a novelty at the time), details of the songs of these insects (DUIJM & KRUSEMAN 1983). This publication provided an impetus for a group of young entomologist's, assembled in the Orthoptera study group of EIS-NL. This group started building a database with distributional records, which served as a basis for the current project.

3 SYSTEMATICS AND NOMENCLATURE

Various aspects of taxonomy are explained, illustrated by examples from the Orthoptera. Table 1 presents the taxonomic ranking of *Chorthippus brunneus brunneus*. Other examples, given in separate frames, include speciation problems and nomenclature of the *Chorthippus biguttulus* group. The systematic position of Orthoptera and its diversity are discussed. The Dutch fauna of 45 species is small compared with the 20.000 species worldwide. In comparison with most other orders of winged insects the Dutch proportion of Orthoptera is very low (table 2). A brief survey of Orthopteran classification follows, with special attention to the European families (tables 3 and 4). Attention is also paid to the related Orthopteroid orders.
In the checklist (p. 32) all species treated are presented in systematic order. The Dutch species are numbered, with some important synonyms in small italics. The numbers in 'superscript' refer to nomenclatural notes.

4 BIOLOGY

This chapter reviews current knowledge of Orthopteran biology. Attention is paid to reproduction, locomotion (with a paragraph on locusts), nutrition, predators, parasitoids and parasites. Table 1 summarizes biological characteristics of the Dutch species. Table 4 shows schematic lifecycles for eight different groups. Each top bar represents the egg stage *(ei)*, the middle one the nymphal stage *(nymf)* and the bottom one the adult *(imago)*.
Studies on parasitoids and parasites are almost absent from The Netherlands, this review therefore leans heavily on foreign literature.

5 SONG

Singing is one of the most characteristic features of bush-crickets, crickets and grasshoppers. Here we present the basic information on the stridulatory apparatus, the hearing organs, the function of singing and the different song types. The structure of the Orthoptera song is illustrated in oscillograms and analyzed on the basis of the movement of the stridulatory apparatus. In this we follow the modern school of Ragge and others.

6 ECOLOGY

Here we attempt to analyze the causes of differences in composition of grasshopper communities in various habitats. The factors governing the fitness of grasshoppers are discussed separately and in combination. They comprise abiotic factors such as temperature, moisture and toxic-chemicals, further biotic factors such as vegetation structure, food and natural enemies and finally 'spatial' factors,

viz. dispersal power in relation to the patchy distribution of inhabitable habitats. The key-factor in the ecology of grassland Orthoptera is microclimate, which is largely determined by the vegetation structure. It has been shown that temperature and moisture have a strong effect on the development of grasshopper eggs, and therefore the population densities. A separate paragraph deals with the ecological consequences of nature management.

7 THE ORTHOPTERA MAPPING SCHEME

In this chapter we describe the process involved from collecting field data to preparation of the distribution maps and graphs as presented in this book.
The history of the European Invertebrate Survey is briefly summarized and its structure outlined. More than 60 study groups, each formed by an organizer and co-workers, collect the data. The Central Office in Leiden coordinates the recorders, maintains the databases and issues a newsletter.

In 1989 EIS-NL received a grant from the Ministry of Agriculture, Nature Management and Fisheries for initiating the Orthoptera mapping scheme (1990-1994). For EIS-NL an additional objective was to raise the interest for the use of insects in nature conservation. Until now the priorities in nature conservation have almost exclusively been determined by information from angiosperms and vertebrates. The distributional data for these groups are by and large much better than for invertebrates, but for some groups of insects, this knowledge has been markedly increasing in recent years (table 7-1). We hope that this book facilitates the use of insects in nature conservation and contributes to the protection of vulnerable ecosystems in our country.

Recorders were recruited by means of lectures, announcements in natural history and entomology magazines and personal approach. All persons interested received recording-sheets (fig. 7-2, 3) and a manual. Each year we organised excursions for instruction. More than one hundred people contributed to the mapping scheme (appendix 1, p. 387). Collaborators were encouraged to investigate insufficiently studied areas. Occasionally we obtained a grant to hire researchers for filling these gaps. In addition to striving for complete coverage of the country (5km squares), we tried to obtain a balanced sampling of the different habitats. Therefore collaborators were asked not to restrict themselves to the well-known grasshopper habitats, such as heathland and dry grassland, but also to sample more marginal habitats, such as roadside verges, woods and the urban environment. The former distribution (1800-1980) was determined by studying all available Dutch collections and literature.

All these data were stored in a database, the structure of which, with the codes for the various fields and attributes is explained in the text-box on page 77 (codes in appendix 2, p. 388). For this project we have chosen to use UTM-grid rather than Dutch National Grid (referred to as 'Amersfoort-raster'). The differences can be seen in figs. 7-4 to 7-6. To reduce the number of inaccurate records inevitable in a project involving many different recorders, we used an extensive system of data-checking. Firstly, all forms were examined immediately upon receipt and in case of uncertainties or dubious findings we consulted directly with the recorder. After input, data were automatically checked for non-existing species codes, coordinates or dates. Preliminary prints of the distribution maps and phenology diagrams proved to be excellent checks for mistakes. All records outside the known distribution area of each species were re-examined, as were extremely early and late records. Each recorder was asked to check a printout of his or her records.
Collection of voucher specimens was not obligatory, since most species are easily recognized, often better by their the song than by morphology. We made it clear, nevertheless, that doubtful records would be excluded, if no voucher specimen, conclusive photograph or sound-recording was supplied. We think that in adopting this approach no major mistakes remain in the database, although some inaccuracies are bound to occur.
We faced some problems with old collection specimens. The single record of *Chorthippus binotatus* from Zeeland, is now attributed to a labelling error, together with all other specimens with the same label. The specimens probably originated from France (page 81: *Valkenisse 15 juni 1960*).

The coverage of the distribution maps differs greatly between the various periods as can be seen in figs. 7-7 to 7-12. Before 1980 data are available from 805 5km squares (from a total of 1688), while since 1980 records were collected in 1550 squares. It can be concluded that on the basis of 5km squares, the Netherlands are now well covered. However, there are still several regions where the Orthoptera fauna is insufficiently known, particularly on a smaller scale (fig. 7-12). Old records are more scanty, but the general patterns can nevertheless be seen.
For processing the records into distribution maps, diagrams, and measures for abundance and trend, several steps were required. In calculations we did not use the individual records, but summarized all records for one species with the same date, exact locality and habitat into so called 'unities of capture', or 'observations'. We adopted this approach because different sexes, stages and/or differences in data collection (sighting, collected specimen) lead to different records in the database, but still refer to the same 'collection-event'.

8 IDENTIFICATION

Here we provide a key, based on morphological features, for the identification of the species from The Netherlands and surrounding regions. In addition we provide a key to the songs. The key, based on study of dried specimens, is illustrated with many original drawings and photographs.

9 THE SPECIES

This chapter forms the core of the book: it provides the detailed information from the Orthoptera mapping scheme for each species. Furthermore appropriate data from the literature complete the treatment. In the first part the 45 native species are treated, thereafter 19 non-native species are discussed briefly. This section concerns species which have been found incidentally in our country and, additionally, species which are known from Belgium, Luxembourg or the German border area.

All native species follow the same lay-out over four pages, with the maps on the second page, and information on song on page 4. This lay-out, with the Dutch paragraph titles is explained below. The information in the categories morphology, biology, song, identification, distribution area and conservation are derived mainly from the literature, and are supplemented with observations from recorders, referred to by acronyms, explained in appendix 3 (page 392).

Header, Latin name and vernacular name
A general characteristic is given in the header, followed by the reference to the colour-plate.

Beschrijving (description)
Morphological description, aided by a table of measurements and number of stridulation-pegs *(stridulatietandjes)* in millimetres in the margin *(maten in mm). Voorvleugel* = forewing; *achtervleugel* = hindwing; *legboor*= ovipositor.

Biologie (biology)
cyclus (life-cycle)
Description of egg-laying, nymphal stages (REFERENCES) and data of adult phenology based on information from this project. The phenology is also illustrated in the graph in the left bottom-corner *(fenologie imago's).*
voedsel (food)
vlieg- en verbreidingsvermogen (dispersal power)
zang (song)
The song is here described briefly. ⊙ The symbol and number refer to the track on the enclosed cd.

Determinatie (identification)
A further aid for identification, in some cases with a table of characteristics of closely related species.

Page 2
Here we present a map of the distribution before 1980, a map of the distribution from 1980-1993, a map of the European distribution (based on literature, see appendix 4, p. 393) and a table of the current status. Translation (see also table 1 and 2):
voor 1980 = before 1980; *bfk* = class for number of squares, explained in table 9-1 (p. 120); *atlasblokken* = corrected number of 5km squares; *km-hokken* = number of 1km squares; *observaties* = number of observations in database; *Trend* = trend of occurrence in The Netherlands; *Rode Lijst* = Red Data List (see table 2)

Areaal (area of distribution)
Description of its world distribution, based on literature.

Voorkomen in Nederland
(occurrence in The Netherlands)
Described in the two periods, here many details from the project are provided.
biotopen (habitats)
Together with a graph representing the actual number of observations in 10 classes:
Duin (coastal dunes), *kalk* (limestone grasslands), *schraal* (nutrient poor grasslands), *hei* (heathland, *moeras* (marsh), *oevers* (shores), *bos* (woodland), *cultuur* (cultivated fields), *infrastr.* (infrastructural elements, road-verges, dykes, etc.), *stad* (urbane environment).
*achteruitgang (*decline).
Not given for all species.

Table 1
Dutch terms for noting frequency, as used in species treatments, with translation.

algemeen	common
minder algemeen	less common
uiterst algemeen	extremely common
uiterst zeldzaam	extremely rare
uitgestorven	locally extinct
vrij algemeen	fairly common
vrij zeldzaam	fairly rare
zeer algemeen	very common
zeer zeldzaam	very rare
zeldzaam	rare

Table 2
Red Data List: translation of Dutch categories (and acronyms) into iucn categories.

VN	uitgestorven	extinct from the wild
EB	ernstig bedreigd	critical
BE	bedreigd	endangered
KW	kwetsbaar	vulnerable
GE	gevoelig	susceptible
	thans niet bedreigd	no risk

Bescherming (protection)

Inventarisatie (inventory)
Here we give some general advice for recording this particular species. In the margin we give some figures which indicate how far the song will carry *(draagwijdte geluid)* for the human ear *(menselijk oor)* and bat-detector. We also give an indication for the setting of the frequency on the bat-detector.

Beschrijving geluid (description of song)
The detailed description of the song is based on personal observations by Baudewijn Odé and the literature. The oscillograms show 10 seconds of the song and a detail thereof. For all species, except for *Locusta migratoria* and *Oedipoda caerulescens,* which produce sound when disturbed or during courtship, respectively, the calling song is shown; for *Psophus stridulus* the oscillogram illustrates the wing-beating sound during flight. The duration of the different elements is shown by a dash followed by one of the following characters: E =echeme; ER =echeme-sequence; H =gap; P =pulse; S =syllable. An arrow indicates that this element continues until the end of the oscillogram.

An english *summary* with the common English name of the species concludes each treatment.

10 CHANGES IN THE DUTCH ORTHOPTERA FAUNA

The aim of this chapter is to show the dynamics of distribution patterns. The changes in climate and landscape during the Quaternary and the possible colonization of our country by Orthoptera is briefly discussed. The recent changes are illustrated by summarizing the data from the mapping scheme in table 10-1. The 45 native species are in table 10-1 arranged from declining to increasing. The various columns give: latin name, number of grid squares before 1980, since 1980, together in both periods, BFK class before 1980, BFK class since 1980, % of squares in which the species has not been recorded since 1980, % of squares in which not found before 1980, symbol for trend, Red Data List category and vernacular name.

The trend is also highlighted for the various habitats in figs. 10-3 to 10-8. Table 10-2 and figs. 10-9 to 10-14 give information on the number of species per square and the richest squares (with 19-28 species before 1950, and at most 19 species after 1980). Figure 10-15 to 10-24 provide information on the sampled habitat types: for each we give a map of distribution and a graph with the relative abundance of the species; the most characteristic are printed bold. Fig. 10-25 and 10-26 show the severe decline of species in wetlands and dry habitats (heathland), whereas fig. 10-29 shows the overall increase of species which thrive in cultivated habitats.

An important advantage of the detailed mapping was that we could detect short-term changes in distribution: some species were observed to expand their range markedly in our country. This is correlated with favourable weather conditions in the eighties and nineties. Only *Meconema meridionale* is believed to be transported accidentally by cars.

11 NATURE CONSERVATION

The authorities and organisations involved in determining conservation priorities are more and more inclined to use information from insects. Important tools for this objective are distribution atlases and Red Data Lists. Red Data Lists are available for several insect groups, including Orthoptera (ODÉ 1997). The species from the Red Data List are shown in table 11-1. The practical aspects of nature conservation for safeguarding Orthoptera are discussed. As woodland is the climax vegetation in our climate, it is argued that active conservation measures are needed for grasshoppers and other insects which mainly occur in grasslands and heathlands. Special attention should be paid to species which are threatened on a national, regional or local scale. For each habitat the most favourable measures are outlined.

12 THE REGIONAL ORTHOPTERAN FAUNA

The fauna of eight regions of the Netherlands is discussed (see maps). The species are listed according to the distribution within the region (widespread, regional/local, vanished). An asterisk indicates that a given species has its main distribution within the region. Table 12-1 presents an overview of the occurrence of the species in each region.

The dune area is, compared to sandy soils in the interior, not very rich. The most characteristic species are *Platycleis albopunctata* and the rare *Oedipoda caerulescens* which is still common here.

The clay soils in the western and northwestern parts of our country, mainly below sea level, are poor in species, but *Chorthippus albomarginatus* is remarkably abundant. Wetland nature-reserves sustain populations of *Chrysochraon dispar*, *Chorthippus montanus* and *Stethophyma grossum*.

The sandy soils of the northern, central and southern part of the country are very diverse. Although they share many species, there are also remarkable differences. For example, *Omocestus viridulus* is very abundant in the centre and north, but virtually absent from the same habitats in the south. On the other hand, *Omocestus rufipes* is much more abundant in the south. In the south, *Chorthippus parallelus* is very common in many different types of habitat, but in the north this species is restricted to dense grass-tussocks in heathland (fig. on p. 288).

Rivers create dynamic ecosystems in which several species of Orthoptera are found. The distribution patterns of *Pholidoptera griseoaptera* and both *Conocephalus* species indicate that they migrate along the rivers. Possibly the eggs of these species, which are laid in dead or living plants, are transported by flowing water.

The small patches of chalk downland in the south of the province of Limburg provide populations of rare species, such as *Stenobothrus lineatus*, *S. stigmaticus* and *Tetrix tenuicornis*.

Several species occur in the urban areas, in particular typical inhabitants of buildings like *Acheta domesticus* and *Tachycines asynamorus*. The composition of grasshopper communities in gardens differs per region. For example, in the central part of the country a wider range of species can be found than in the western part, including several *Chorthippus* species, *Leptophyes punctatissima* and *Meconema thalassinum*. In the western part however, *Gryllotalpa gryllotalpa* is locally common in vegetable gardens.

13 STUDYING ORTHOPTERA

This chapter explains the methods for studying grasshoppers, with the emphasis on mapping. Instructions are given for preparation for field-work, equipment and necessary period for effective recording. Locating, collecting and preparing of Orthoptera is discussed, with some attention to the use of songs in research. Methods for transferring field records into the EIS database are explained. We provide some information on computer software. In a separate paragraph we propose a new method for monitoring Orthoptera populations.