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CHANGES IN ABUNDANCE AND DISTRIBUTION OF DRAGONFLIES (ODONATA) IN THE NETHERLANDS DURING THIS CENTURY *

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Introduction

We have investigated during the last few years the dragonfly fauna of the Netherlands, especially material present in collections of museums of natural history and some personal collections. Data from the literature have been excluded until now.

The aim of our study was to describe the abundance and distribution of each species and, as far as possible, to investigate the dynamics of the distribution patterns and frequency of records. This fits in with the aim of the 'Centraal Bureau Nederland van de EIS' to collect data for the use in nature preservation and nature management.

It is our intention to publish the results of this study (maps, keys, data on life histories and number of records from this century) shortly (Geijskes & Van Tol 1982). We will present here some of our results which show the severe decline of this group during this century.

Methods

In principle all specimens present in museums and personal collections were included. The identification of each specimen was carefully checked by us; some smaller collections were identified for the first time. In total c. 10,000 specimens have been studied. We did not include data from the literature to ensure the reliability of each record. We will, however, include all reliable observations in the follow-up project in cooperation with a number of amateurs.

All data have been transmitted on IBM punch-cards, using the format of the European Invertebrate Survey in the Netherlands (van Tol 1979). The following data were noted of each specimen: species, locality, date, habitat, collector, identifier, collection, source, stage, plant species and the number of specimens. The computer program EISVSPRS2 of the Centraal Bureau Nederland was used to compile maps and

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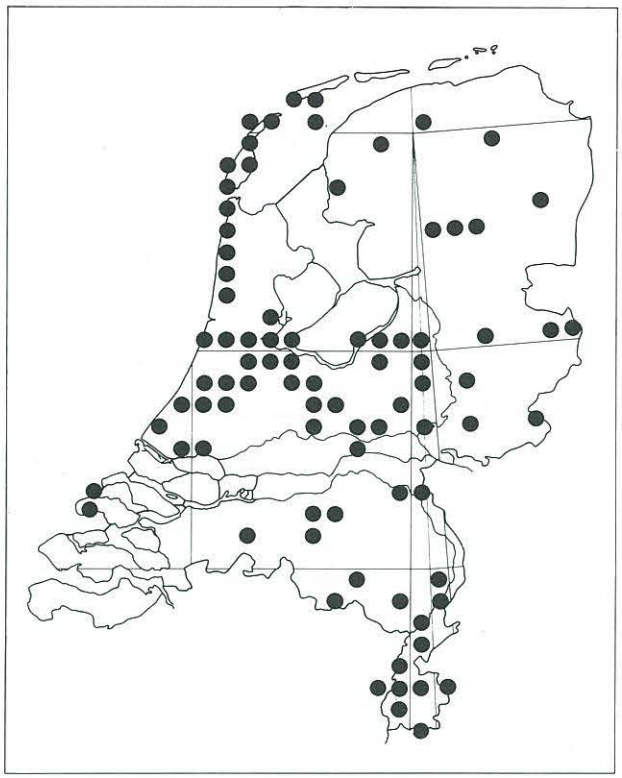


Fig. 1. *Ischnura elegans*. Records until 1950.

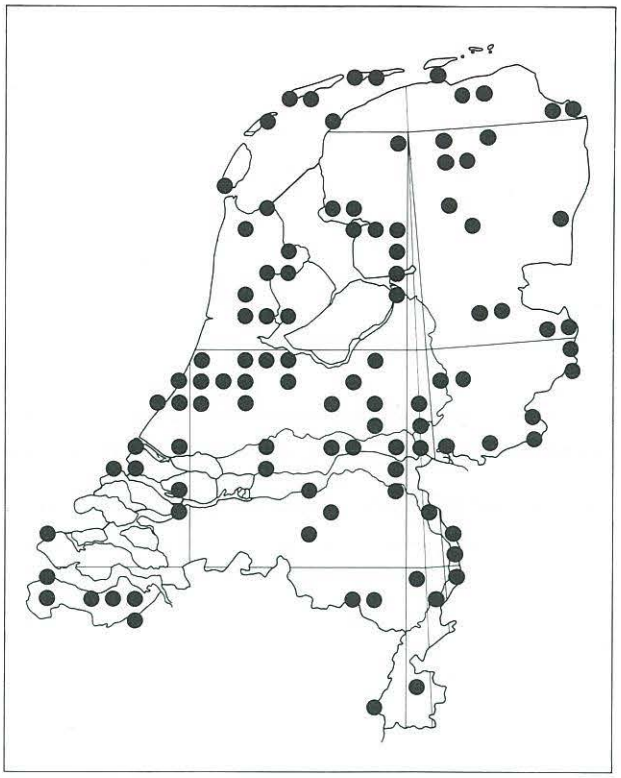
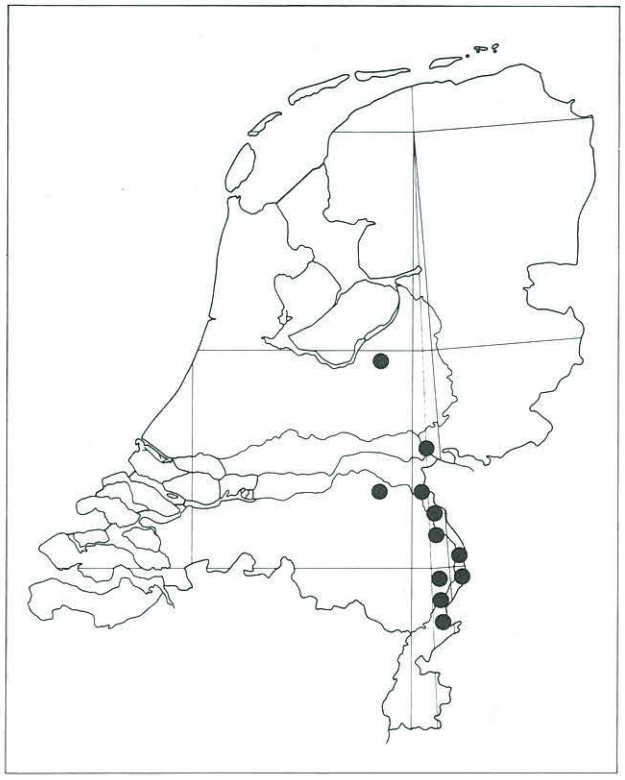


Fig. 2. *Ischnura elegans*. Records 1950 onwards.

Fig. 3. *Ophiogomphus cecilia*. Records until 1950.



surveys of records in each month of each period of ten years. This program combines all data of a species from one locality collected on one day in one habitat to one record. This definition of record is used here in this paper.

Apart from the year/month tabulation we also determined the relative abundance of each species for each period of ten years. The definition of relative abundance is

$$\text{R.A. (A)} = \frac{\text{Number of records of species A}}{\text{Number of records of all species}} .100\%$$

R.A. (A) means the relative abundance of species A.

The evident advantage of this method is that one is able to detect increase or decrease in the abundance of species independent of the sample size per period. Of course the reliability increases as the number of records increases.

Results

Maps

First we will present some maps of species from which the distribution pattern has obviously changed during this century. Also we will discuss some other aspects, viz. the development in the number of records during the same period.

Our data have been devided into the period before 1950 and that from 1950 onwards. The year 1950 may be considered an important one with relation to the development in industrial activities, resulting in increasing consumption of raw materials and chemicals and increasing production of waste-products causing pollution of the aquatic environment.

First we will give an example of a species of dragonfly that has survived very well until now, the Common ischnura (*Ischnura elegans*) (Fig. 1 and 2). It is evident that this eurytopic species is still present everywhere in the Netherlands, as it was before 1950. Not infrequently it is the only dragonfly living in a pool or pond. It inhabits e.g. waters with a high amount of chloride, temporary pools and polluted waters. It is one of the few species present in the Delta-area (province of Zeeland). The maps of this *Ischnura* give an impression of the distribution of the records included.

As an example of a species that has severely decreased during this century, we show the map of *Ophiogomphus cecilia* (Fig. 3). This species, formerly found in eleven localities in the eastern part of our country, has not been collected since 1936. Undoubtedly its decline must be caused by pollution and canalization of its habitats, sandy places in brooks and rivers.

Another species of streams, the Banded agrion (*Calopteryx splendens*), although decreasing rapidly in some areas, has survived until now in other parts of the Netherlands (Fig. 4 and 5). The distribution pattern has obviously changed during this century. It inhabits almost exclusively flowing waters, although it can also be observed on the banks of larger lakes in other countries. In the Netherlands it has been collected in almost the whole of the country until 1950, also in the surroundings of the big cities as 's-Gravenhage (The Hague) and Amsterdam. Indeed clear brooks were present even in the western part of the country, e.g. along the coast near the sand dunes. These flowing waters of good quality are missing now in this area due to drying up caused by waterworks for drinking-water supply. Now this species can only be observed in the south-eastern part, but the population size is decreasing also in the places where it can still be found.

Another example of a species that is severely endangered is *Somatochlora flavomaculata* (Fig. 6 and 7). It inhabits mainly peat moors and was present on a number of localities in the southern part of the Netherlands until 1950. Locally it was abundant. And just like the other species it is now known from only a fraction of the earlier places. Disturbance and pollution of the peat moors must have played a rôle in this decrease.

Records in the course of years

After the compilation of the maps it seemed

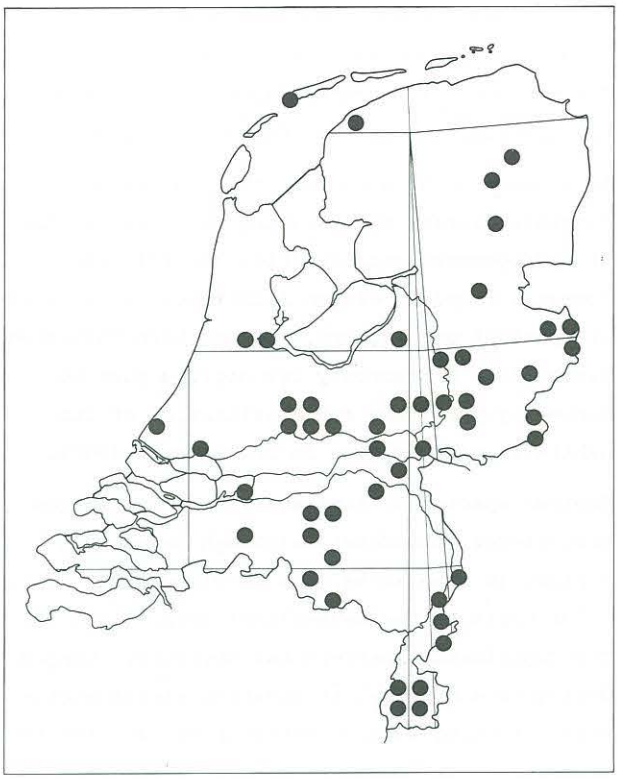


Fig. 4. *Calopteryx splendens*
Records until 1950.

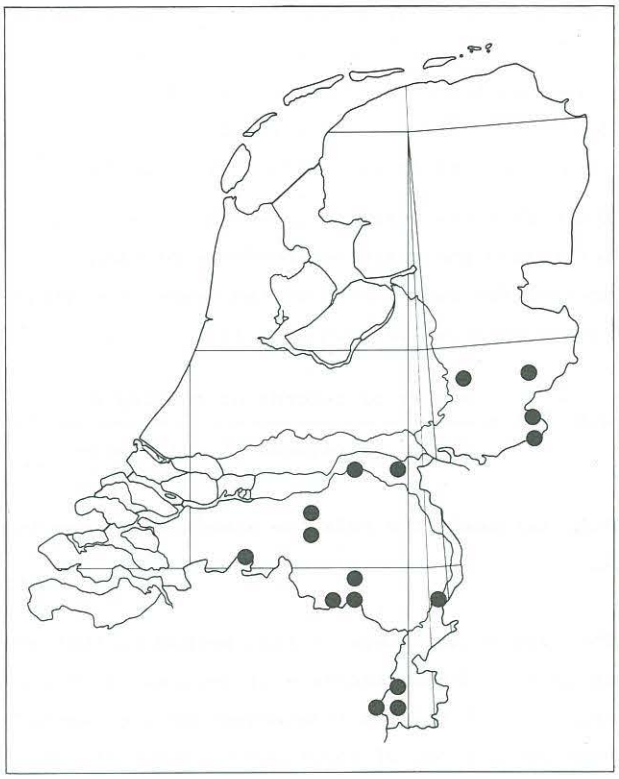


Fig. 5. *Calopteryx splendens*.
Records 1950 onwards.

Fig. 6. *Somatochlora flavomaculata*
Records until 1950.

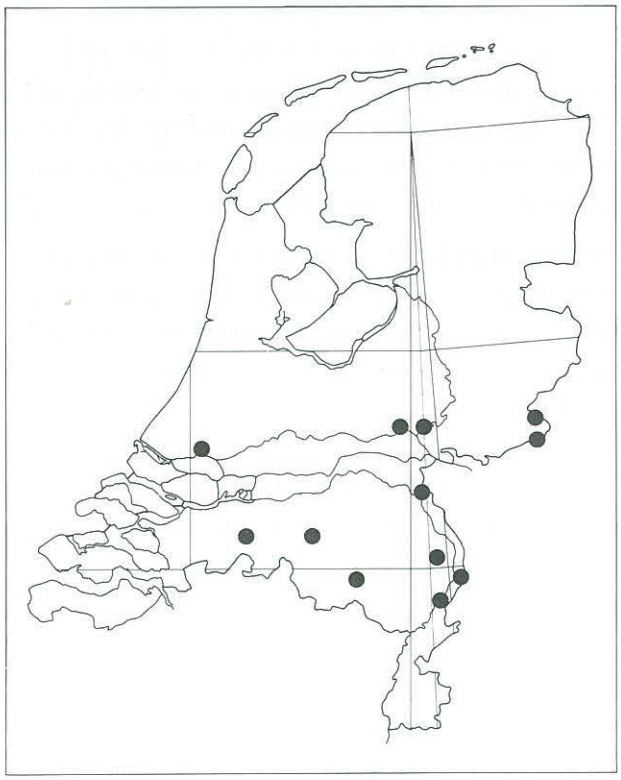


Fig. 7. *Somatochlora flavomaculata*.
Records 1950 onwards.

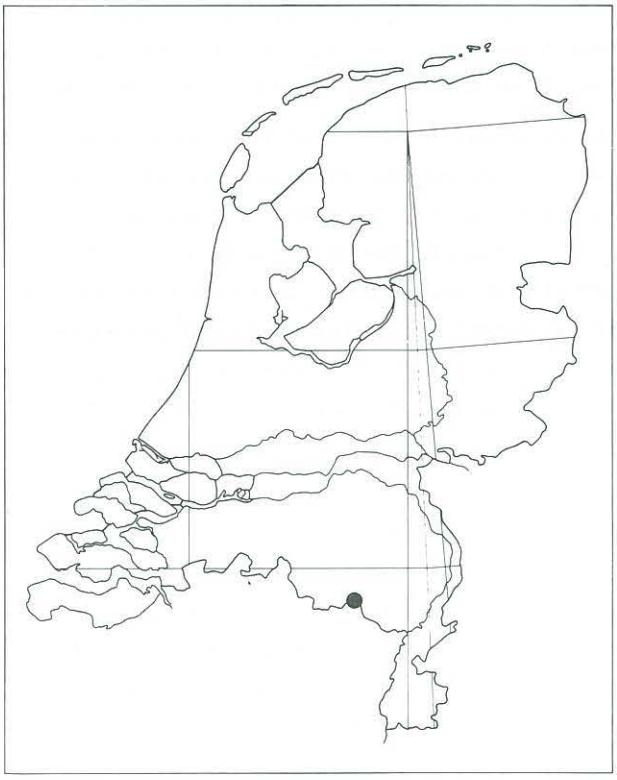


Table 1

Survey of records included in this study

Period	Number of records
Until 1900	550
1900 - 1909	258
1910 - 1919	451
1920 - 1929	1500
1930 - 1939	569
1940 - 1949	637
1950 - 1959	398
1960 - 1969	1081
1970 - 1979	638
Total	6082

worth while to investigate the development of the records of each species in the course of this century. As we have argued earlier, the relative abundance per period of ten years appeared to be a useful approach. The total number of records included in this study is listed in Table 1.

The relative abundance of *Calopteryx splendens* (Fig. 8) shows a continuous decline during this century, as could be expected. The same holds for another species of clear running waters, *Gomphus vulgatissimus*, be it on another level (Fig. 9). Other species seem to maintain a more or less even population, e.g. *Lestes sponsa* (Fig. 10). The group of species that can still be found in large numbers shows an evident increase in the relative abundance. Two examples are *Sympetrum vulgatum* (Fig. 11) and *Ischnura elegans* (Fig. 12). At the moment one of every six records of a dragonfly belongs to the last mentioned species!

Increase or decrease since 1950

The relative abundance of each species has been calculated for both periods before 1950 and 1950 onwards. When we compare these periods we have established that until 1950 66 species of dragonflies have been recorded and since that

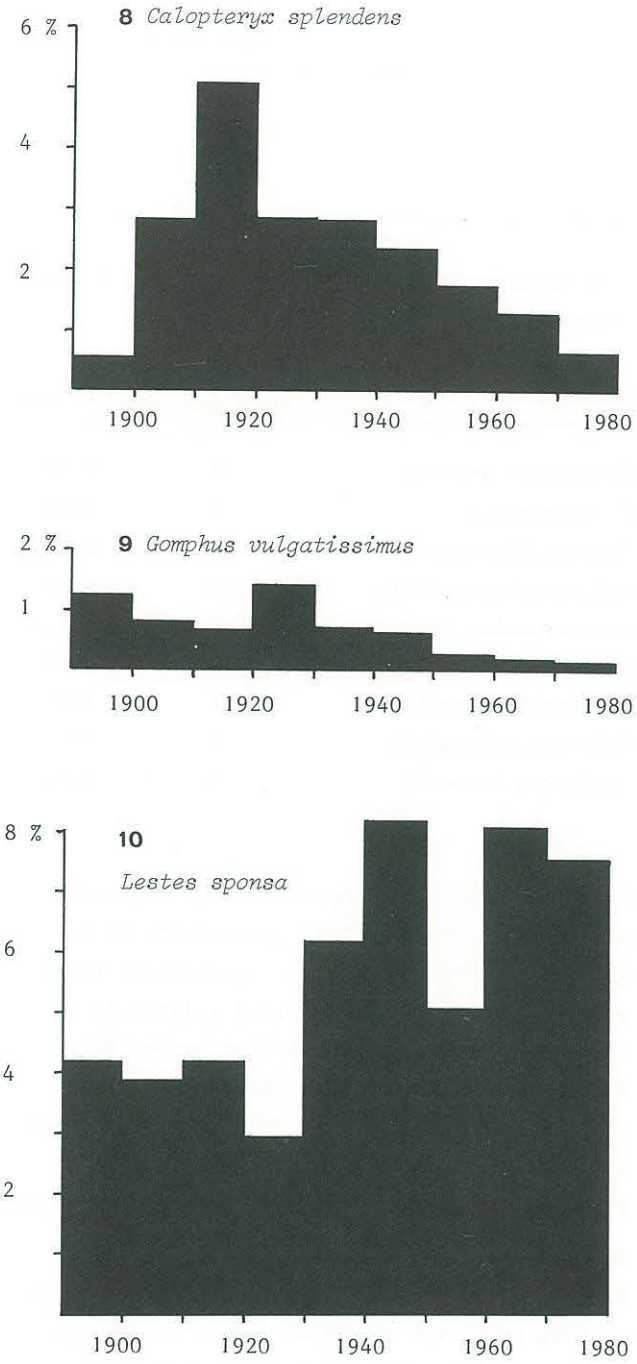


Fig. 8, 9 and 10

Relative abundance per period of ten years (records until 1900 summarized) of *Calopteryx splendens* (8), *Gomphus vulgatissimus* (9) and *Lestes sponsa* (10).

year 59 species. In total 68 species are known from our country, so nine species have disappeared since 1950 (Table 2).

Table 2

List of missing species no more observed in the Netherlands since 1950

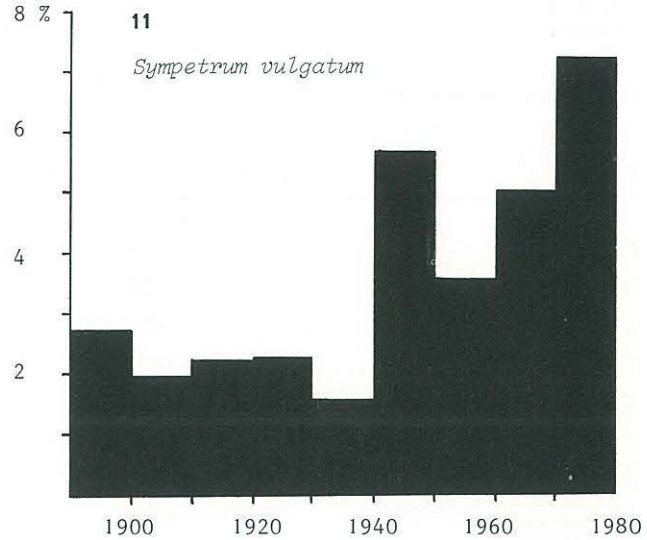
Species	Records	Last record
Coenagrion armatum	2	1924
C. mercuriale	1	1903
Gomphus flavipes	6	1902
Ophiogomphus cecilia	19	1936
Onychogomphus forcipatus	2	1947
Anax parthenope	1	1938
Somatochlora arctica	3	1945
Epitheca bimaculata	1	18..
Orthetrum brunneum	5	1902

Apart from the rare migrants (e.g. *Sympetrum meridionale*) these are all inhabitants of the undisturbed habitats. Table 3 enumerates those species that have been recorded relatively at least two times more before than since 1950. Rare species, forming less than 1% of all records in both periods are excluded. The seven species fulfilling these conditions are also inhabiting flowing or meso-/oligotrophic waters.

The last group, listed in Table 4, has become relatively more common since 1950. Most species of this group are regarded as more or less eurytopic, probably with the exception of *Aeshna juncea*, a species more common in oligotrophic conditions, but well collected during recent decades by its resemblance with the rare and much sought *Aeshna subarctica*.

Conclusions and discussion

The data here presented indicate that the number of records of species of undisturbed habitats, e.g. flowing streams and oligotrophic pools have severely decreased during this century. Also their distribution patterns have changed in that



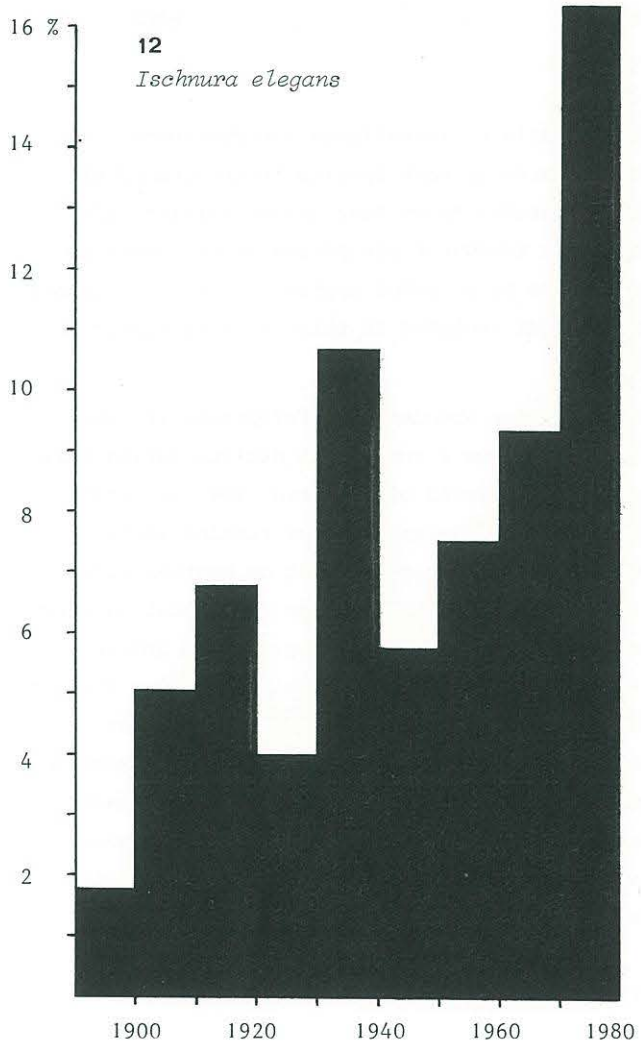


Fig. 11 and 12

Relative abundance per period of ten years (records until 1900 summarized) of *Sympetrum vulgatum* (11) and *Ischnura elegans* (12).

Table 3

List of species with an evident decrease* in the number of records in the Netherlands since 1950, as compared with before that year

Calopteryx splendens
Sympecma fusca
Lestes dryas
Ceriagrion tenellum
Gomphus vulgatissimus
Aeshna isosceles
Libellula fulva

* Of these species the relative abundance was at least two times higher before 1950 than since that year, being more than 1% at least in one of these periods.

period. In particular the western, most cultivated part of the Netherlands has lost a number of species.

The interpretation of the data is somewhat affected by presuppositions inherent in the use of relative abundance. The method needs random sampling with relation to species and to the distribution of samples in space and time, both during months and years. Thus each habitat and each part of the country must be investigated equally during each period. Although on the one hand our data obviously deviate from these conditions, on the other hand we have no indication that the methods of collecting have changed in the course of this century, at least since the 1920's. The steady decreasing of the relative abundance of a number of species also indicates a cause other than accidental circumstances.

Table 4

List of species with an evident increase* in the number of records in the Netherlands since 1950, as compared with bofore that year

Ischnura elegans
Aeshna juncea
Enallagma cyathigerum
Sympetrum vulgatum
Lestes sponsa
Lestes viridis
Sympetrum danae

* Of these species the relative abundance was at least two times higher before 1950 than since that year, being more than 1% at least in one of these periods.

We are inclined to relate the steady decrease in the number of records and the changes of the distribution patterns of the species of unpolluted habitats to the increasing urbanization, water pollution and canalization of brooks and rivulets in the course of this century (cf. also Van Tol 1981). It may be noted here that the species of the large rivers, e.g. *Gomphus flavipes*, last recorded in 1902, have disappeared first. Later on species of smaller flowing waters and meso- and oligotrophic environments seem to be affected.

Our conclusion is that human activities have strongly influenced the distribution patterns of the indigenous species of the Netherlands and also considerably reduced the species richness.

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