# Spider diversity and community structure in the forest of Ename (Eastern Flanders, Belgium)

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## Abstract

The relationship between environmental variables and the occurrence of soil dwelling spiders of woodland in the forest of Ename was studied during a complete year cycle. Pitfall trapping at 13 stations during the complete year cycle revealed 6311adult spiders belonging to 101 species. By means of the multivariate techniques DCA and TWINSPAN we obtained a classification and an indirect gradient analysis, yielding an easier interpretation of the distribution of the most abundant species in the sampled habitats. Species can be grouped in a number of specific habitats, in the first place based on a gradient from open to more densely vegetated habitats. Because this division is mainly based on catches in an adjacent grassland (which influenced the rest of the data) and not merely on catches in the rest of the sites (all situated inside the forest), this parameter cannot be considered of major importance in explaining the spider community structure of the forest sites. Division of the forest sites (excluding the grassland-site) was based on a humid-dry gradient. Of minor importance, but still detectable, is the influence of vegetation structure and composition in the forest stands. Hydrological characteristics are thus mainly responsible for the occurrence of the spider faunas in the forest. Compared with another forest (the "Walenbos") this diversity is rather low. This can partially be explained by means of ecological and historical data: the greater heterogeneity of the "Walenbos" and the relatively short historical existence of the Ename forest. Indeed, after being exploited almost completely, this woodland was replanted in the 19th and 20th century, mainly with monotonous poplar plantations.

**Keywords:** spiders, Araneae, woodland, community structure

## Résumé

La relation entre les variables abiotiques et la présence d'araignées dans la forêt d'Ename a été étudiée pendant une cycle annuel. Un échantillonage avec pièges à Barber dans 13 sites pendant ce cycle annuel nous a apporté 6311 araignées appartenant à 101 espèces. Avec les techniques statistiques DCA et TWINSPAN, nous obtenons une classification et une analyse graduelle indirecte qui peut nous fournir une explication plus simple de la distribution des espèces les plus abondantes dans les habitats que nous avons échantillonés. Les espèces peuvent être groupées selon un nombre de sites spécifiques, en premier lieu selon un gradient du taux de couverture de la végetation. Parce que le division est fondée sur les espèces qui sont attrapeés dans le pelouse (influencant les captures des autres sites) et pas seulement avec les sites qui se trouve tous dans l'intérieure du forêt, ce parametre ne peut pas etre considérée comme tres importante explainant le structure communutaire des araignées dans les sites forèstiere. La division entre les sites dans le forêt est fondée sur un gradient humidité-sècheresse. La structure et la composition de la végétation jouent un rôle moins important sur la distribution des espèces d'araignées. Le taux de couverture de la végétation est, plus que les caractéristiques hydrologiques, responsable pour la présence de la fauna aranéologique. Comparée avec la forêt "Het Walenbos", le forêt d'Ename montre une diversité plus baisse. Dans ce cas présent, cela peut être expliqué par le fait que la foret d" Ename est de date plus récente. Après une déforestation presque complète, la forêt a été replantée (dans le 19ème et 20ème siecle) avec une plantation monoculture de *Populus*.

**Mots-clefs:** araignées, Araneae, forêts, structure communautaire

## Introduction

Sampling of the forest of Ename took place during one year (March 1994-April 1995) by means of pitfalls. Earlier reports on the faunal assemblages of this forest include diplopods (ALDERWEIRELDT, 1997) and ground beetles (DESENDER & VANDEN BUSSCHE, 1998). Spiders therefore form the third group published of the fauna of this forest.

The forest is very well documented in several aspects (TACK *et al.*, 1993, 1996) but no studies of arthropod groups were undertaken until 1994. Therefore we will discuss the results of spider faunas obtained from a one year sampling campaign on 13 sites of the forest (representing the main vegetation types present in the forest). We will comment on the spider diversity and the presence of important Red List species (MAELFAIT *et al.*, 1998) and make comparisons with an intensive sampling campaign of the riverine forest "Walenbos" (DE KNIJF, 1993).

## Material and methods

The forest of Ename is situated in the southern part of eastern Flanders near the city of Oudenaarde. An exact distribution of the sampled sites (A-M) is given in Figure 1. A detailed description of sites and their vegetation structure is given in DE BAKKER (1995) and DESENDER & VANDEN BUSSCHE (1998) and a summary is given in Table 1.

The history of the forest is extensively discussed in TACK *et al.* (1993, 1996) and DE BAKKER (1995) and a brief overview is given by DESENDER & VANDEN BUSSCHE (1998).

Sampling in each site took place with three pitfall traps (glass jars with a diameter of 9.5cm) placed in a straight

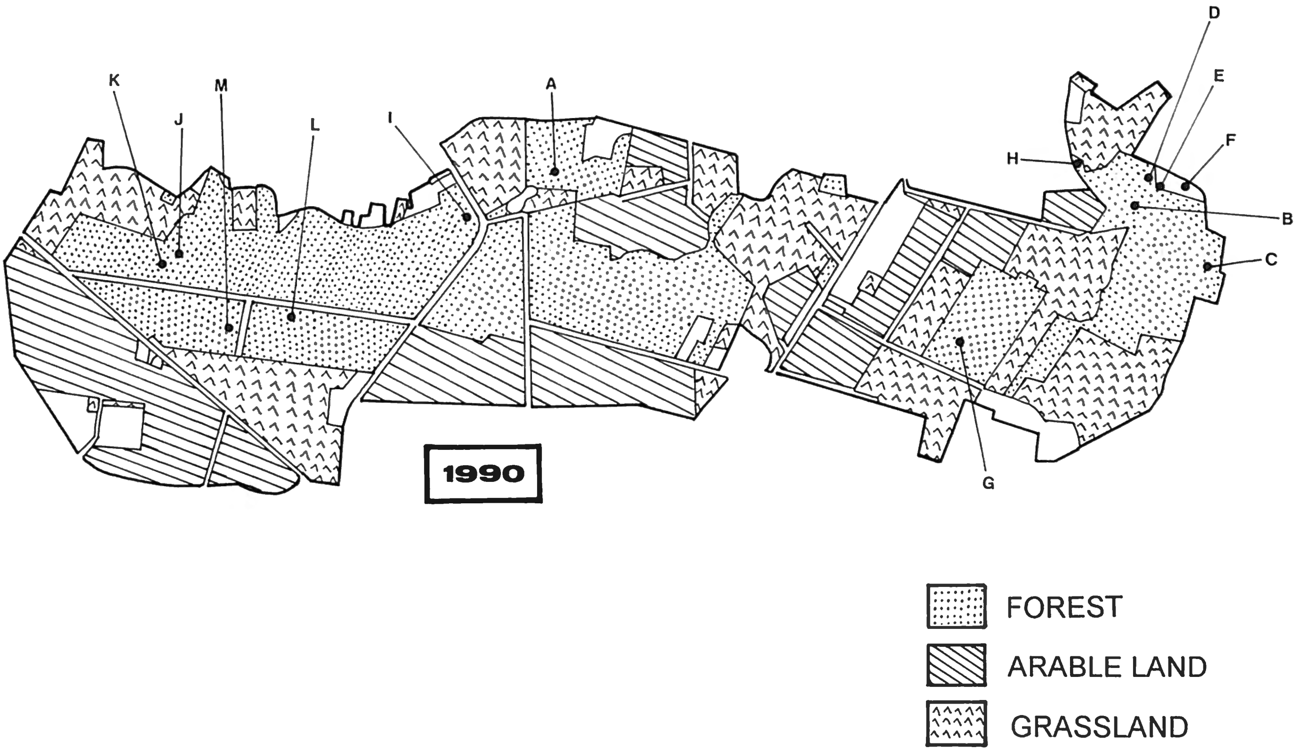


Fig. 1 — Position of the sampled station in the forest of Ename with indication of ground use in 1990.

line. The traps were filled with a 4% formaldehyde solution acting as a killing and preservative agent. The theory of pitfall trapping in catching spiders is very well documented by MAELFAIT & BAERT (1975) and a extensive overview of this trapping method is given in DE BAKKER *et al.* (2000). The advantages of deducing habitat preferences and phenology using this method can be summarised as follows: (1) the catches of males and females give a good picture of phenology of the species (peak of activity), (2) an abundantly caught species in a certain habitat can give indications of the habitat preferences of that species and (3) catches of species do not allow a comparison of abundance of species between each other. This is because each species has a different activity pattern in which more active species are caught more abundantly in pitfall traps without giving an indication of

Table 1. Characterisation of the sampled forest stations with main tree species and an indication of soil humidity.

| Site | Main tree species | Humidity |
|---|---|---|
| Station A | *Populus x Canadensis/Fraxinus excelsior* | Very humid |
| Station B | *Castanea sativa/Populus x canadensis* | Humid |
| Station C | *Populus x Canadensis/Fraxinus excelsior* | Very humid |
| Station D | *Castanea sativa/Populus x canadensis* | Humid |
| Station E | *edge station with Prunus spinosa and Rubus fruticosus* | Humid |
| Station F | *Open grassland* | Dry |
| Station G | *Populus x Canadensis/Fraxinus excelsior* | Humid |
| Station H | *large hedge linked to forest with Populus x Canadensis* | Dry |
| Station I | *Acer pseudoplantanus/Fraxinus excelsior* | Dry |
| Station J | *Fagus sylvatica* | Dry |
| Station K | *Populus x canadensis* | Very humid |
| Station L | *Fraxinus excelsior* | Very humid |
| Station M | *open stand (edge of pond) with few Populus x canadensis* | Very humid |

abundance. Another species, with the same abundance, but less active can be caught less in pitfall trapping and therefore conclusions about densities should be avoided. Also species which are living in higher strata (herbs, branches of trees,...) are not commonly caught or absent in pitfall traps so that this kind of trapping is no indication of total spider diversity of a certain habitat. A few drops detergent were added to the traps to reduce surface tension because certain spider families (eg. wolf spiders) can run over the formaldehyde without falling into the solution (TOPPING & LUFF, 1995). The traps were emptied at fortnightly intervals between 13 April 1994 and 15 April 1995. General meteorological data is obtained from the nearest meteorological station te Kruishoutem and results are discussed in DESENDER & VANDEN BUSSCHE (1998).

All adult spiders were sorted out and identified to species level. Identification took place by means of the following works: LOCKET & MILLIDGE (1951, 1953), LOCKET *et al.* (1974) and ROBERTS (1985, 1987).

Species composition and abundance were compared between sampling sites by means of the statistical methods TWINSPAN (Two Way INdicator SPecies ANalysis; HILL, 1979). TWINSPAN performs a two-way divisive and hierarchical classification whereby the total group of samples is split up based on indicator species (HILL, 1979). Species relative abundance, habitat preferences, community structure and composition were also compared in DCA-analysis (Detrended Correspondence Analysis; TER BRAAK, 1988; JONGMAN *et al.*, 1995). Analysis was done with help of the program PC-ORD (MCCUNE & MEFFORD, 1995). Both the TWINSPAN and DCA analysis were performed on the most abundant species from all forest sampling stations (36 species from 12 sites with a total of at least 18 adult individuals) and on a gradient from forest to an adjacent grassland (30 species from 3 sites with a total of at least 6 adult individuals). Environmental variables (litter depth, incident light, soil moisture,...) were not available or measured at the time of samling and so a more direct analysis of these variables with the spider communities was not performed.

Data was transformed to percentage occurrence within each species. This gives each species the same weight prior to both TWINSPAN and DCA analysis. This is to avoid the influence in the analysis of very few numerous species which may not possess obvious habitat preferences. Species caught in very low numbers in many cases can be interpreted as accidental immigrants anyway (cf. DESENDER & BAERT, 1995; DESENDER, 1996).

## Results and Discussion

### *1. Spider diversity*

In total, 6311 adult spiders belonging to 101 species have been caught during the year sampling. Table 2 gives an overview of the number of caught species in each sampling station. *Pachygnatha degeeri* (Family Tetragnathidae) was most abundantly caught with 882 individuals representing 14% of the total number of individuals caught. Almost all individuals of this species were caught in the open dry grassland (see details of caught numbers in Table 2) which is also its prefered habitat. The most abundant families were the Linyphiidae represent 59% (60 species) of the total number of species caught and the Lycosidae which represent only 8% (8 species). The other 12 families represent the other 33%. Spider biodiversity is rather low in comparison with earlier intensive sampling campaigns in forests in Flanders (JOCQUÉ, 1973; SEGERS, 1986; BOSMANS & POLLET, 1986; POLLET & HUBLÉ, 1987; SEGERS & POLLET, 1988; ALDERWEIRELDT, 1988; ALDERWEIRELDT *et al.*, 1989; VAN KEER & VAN KEER, 1990, 1993; DE KNIJF, 1993) and this is probably due to the absence of heterogenous or patchy environments (which seems to be very important for an increase in spider diversity) in the forest because of the planting of monotonous poplar (*Populus x canadensis*) stands in the late 19th century in large parts of the forest after it has been almost completely cleared (TACK *et al.*, 1993) and the short history of the forest. It is only about 100 years since planting with Poplar trees and maybe certain species have not found their way to the forest yet.

Certain species are of faunistic importance because of their presence on the Red List of spiders of Flanders (MAELFAIT *et al.*, 1998). It concerns the following species: *Coelotes terrestris*, *C. inermis, Histopona torpida, Hahnia pusilla, Robertus neglectus*, *Saloca diceros* and *Leptorhoptrum robustum.*

Details of their preferential habitat and Red list category are listed below (Table 3). Most Red List species are typical for deciduous forests (wet or dry) with the exception of *Leptorhoptrum robustum.* Although *Coelotes inermis* and *Histopona torpida* have no clear habitat preference in the mentioned Red List, other sampling campaigns in a variety of habitats indicate these species as being mainly or only present in woodlands. *Hahnia pusilla* has been found more frequently in other habitats (DE BLAUWE & BAERT, 1981).

### *2. Statistical results*

A first analysis was conducted on the 39 sampling units present in the forest and a adjacent grassland during the year sampling in 1994-1995. A clear separation of the grassland traps (station F) and the stands present in the forest was observed. Although the main explanatory variable seems to be the open or closed character of the vegetation, we must be aware that the difference between the stands is mainly caused by the presence of the grassland site F. We discarded data from station F for several reasons in the following illustrated analyses: (1) the adjacent grassland F was not representative for the rest of the sampled stands (which were all situated in the forest), (2) the station had specific spider species (most of them indeed characterised by their preference for all kinds of open habitats and certainly no forest species were present) and (3) we were more interested to look

Table 2. Species list of the forest of Ename with the number of individuals per station.

| SPECIES | A | B | C | D | E | F | G | H | I | J | K | L | M | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family Dictynidae** | | | | | | | | | | | | | | |
| *Cicurina cicur (*Fabricius, 1793) | 2 | | 5 | 1 | 1 | 1 | | 2 | | 1 | 1 | 2 | | 16 |
| *Lathys humulis* (Blackwall, 1855) | | | | 1 | | | | | | | | | | 1 |
| *Nigma flavescens* (Walckenaer, 1825) | | | | | | | | 1 | | | | | | 1 |
| **Family Clubionidae** | | | | | | | | | | | | | | |
| *Clubiona compta* C.L. Koch, 1839 | 1 | | | | 1 | | 1 | 1 | 1 | 2 | | | 1 | 8 |
| *Clubiona lutescens* Westring, 1851 | | | | | 1 | | | | | | | | | 1 |
| *Clubiona pallidula* (Clerck, 1757) | | 1 | 1 | 1 | | | | 1 | | 1 | 1 | | | 6 |
| *Clubiona terrestris* Westring, 1862 | | 2 | | | | | 1 | 2 | | 5 | | | | 10 |
| **Family Liocranidae** | | | | | | | | | | | | | | |
| *Agroeca brunnea* (Blackwall, 1833) | | | | | | 4 | | | | | | | | 4 |
| **Family Anyphaenidae** | | | | | | | | | | | | | | |
| *Anyphaena accentuata* (Walckenaer, 1802) | 1 | | 1 | | | | 1 | | | | | | | 3 |
| **Family Thomisidae** | | | | | | | | | | | | | | |
| *Ozyptila praticola* (C.L. Koch, 1837) | | | | | 1 | | | 17 | 1 | 2 | 1 | | | 22 |
| *Ozyptila trux* (Blackwall, 1816) | | | 1 | 5 | 10 | 6 | | | | | 3 | | | 25 |
| **Family Lycosidae** | | | | | | | | | | | | | | |
| *Xysticus cristatus* (Clerck, 1757) | | | | | | 35 | | | | | | | | 35 |
| *Alopecosa pulverulenta* (Clerck, 1757) | | | | | | 235 | | | | | | | | 235 |
| *Pardosa amentata* (Clerck, 1757) | | 1 | 6 | 5 | 6 | 181 | 1 | 10 | 1 | | 1 | | 15 | 227 |
| *Pardosa palustris* (Linneaus, 1758) | 1 | | | | | | | | | | 1 | | | 2 |
| *Pardosa pullata* (Clerck, 1757) | | | | | 1 | 484 | | 12 | | | | | | 497 |
| *Pirata hygrophilus* Thorell, 1872 | 1 | | 1 | 1 | | 8 | | | | 5 | 118 | 13 | 83 | 230 |
| *Pirata latitans* (Blackwall, 1811) | | | | 1 | 1 | 105 | | | | | | | | 107 |
| *Pirata piraticus* (Clerck, 1757) | | | | | | | | | | | | | 1 | 1 |
| *Trochosa terricola* Thorell, 1856 | | | | 2 | 10 | 111 | | 6 | 1 | 1 | 1 | | | 132 |
| **Family Agelenidae** | | | | | | | | | | | | | | |
| *Coelotes inermis* (L. Koch, 1855) | 16 | 18 | 41 | 24 | 8 | 17 | 16 | 32 | 17 | 14 | 27 | 17 | 12 | 259 |
| *Coelotes terrestris* (Wider, 1831) | 47 | 78 | 58 | 56 | 24 | 6 | 98 | 56 | 51 | 81 | 28 | 23 | 4 | 610 |
| *Histopona torpida* (C.L. Koch, 1831) | | 2 | 1 | | | | 2 | 49 | 2 | | | | | 56 |
| *Tegenaria picta* Simon, 1870 | | | | | | | | 1 | | | | | | 1 |
| *Textrix denticulata* (Olivier, 1789) | | 1 | | | | | | 1 | | 1 | | | | 3 |
| **Family Hahniidae** | | | | | | | | | | | | | | |
| *Antistea elegans* (Blackwall, 1811) | 4 | | | | | 1 | | | | | 6 | | | 11 |
| *Hahnia pusilla* C.L. Koch, 1811 | | | | 2 | 1 | | | | | | | | | 3 |
| **Family Mimetidae** | | | | | | | | | | | | | | |
| *Ero furcata* (Villers, 1789) | | | 1 | | 1 | | 1 | | 1 | | | | | 4 |
| **Family Theridiidae** | | | | | | | | | | | | | | |
| *Anelosimus vittatus* (C.L. Koch, 1836) | | | | | | | 1 | | | | | | | 1 |
| *Enoplognatha ovata* (Clerck, 1757) | | 1 | 1 | 1 | | | 2 | | 2 | 2 | 1 | | | 10 |
| *Enoplognatha thoracica* (Hahn, 1833) | | | | | | 1 | | | | | | | | 1 |
| *Robertus lividus* (Blackwall, 1836) | 22 | 3 | 7 | | 4 | | | 2 | 5 | | 3 | 5 | 3 | 54 |
| *Robertus neglectus* (O.P.-Cambridge, 1871) | | | 2 | | | | | | | | | | | 2 |
| **Family Nesticidae** | | | | | | | | | | | | | | |
| *Nesticus cellulanus* (Clerck, 1757) | | | | | | | 1 | | | | | | | 1 |
| **Family Tetragnathidae** | | | | | | | | | | | | | | |
| *Pachygnatha clercki* Sundevall, 1823 | 2 | 2 | 4 | | 2 | 8 | | 1 | | 1 | 3 | 1 | 8 | 32 |
| *Pachygnatha degeeri* Sundevall, 1830 | | | 1 | | 10 | 869 | | | | | 1 | | 1 | 882 |
| *Tetragnatha montana* Simon, 1871 | | | | | | | | | | 1 | 1 | | | 2 |
| *Tetragnatha obtusa* C.L. Koch, 1837 | | | | | | | 1 | | | | | | | 1 |
| *Meta mengei* (Blackwall, 1869) | | | | | | | | | 1 | | 1 | 1 | 1 | 4 |
| *Meta merianae* (Scopoli, 1773) | | | 1 | | | | | | | | | | | 1 |
| *Meta segmentata* (Clerck, 1757) | 1 | | | | | | | 1 | 5 | 2 | 1 | | 1 | 11 |
| **Family Linyphiidae** | | | | | | | | | | | | | | |
| **Subfamily Erigoninae** | | | | | | | | | | | | | | |
| *Ceratinella scabrosa* (O.P.-Cambridge, 1871) | 1 | 2 | 7 | 3 | 6 | 2 | 1 | 11 | 2 | | 1 | 1 | | 37 |
| *Dicymbium brevisetosum* Locket, 1962 | | | | | | | | | 1 | | | 1 | | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dicymbium tibiale* (Blackwall, 1836) | 2 | | 8 | 2 | 2 | 1 | | | 2 | | 6 | 11 | 1 | 35 |
| *Diplocephalus latifrons* (O.P.-Cambridge, 1863) | | 2 | 3 | | 1 | | 17 | 14 | 7 | | 1 | | | 45 |
| *Diplocephalus picinus* (Blackwall, 1811) | | 6 | 23 | 1 | | | 25 | 17 | | 2 | | 1 | | 75 |
| *Erigone atra* (Blackwall, 1811) | | 2 | 5 | 3 | 2 | 2 | 2 | 9 | | 5 | 5 | 3 | 49 | 87 |
| *Erigone dentipalpis* (Wider, 1831) | | | 7 | | | 4 | | 1 | | | | | 5 | 17 |
| *Prinerigone vagans* Audouin, 1826 | | | | | | | | 1 | | | | | 11 | 12 |
| *Gonatium rubellum* (Blackwall, 1811) | | | 8 | | 1 | | | | | | | | | 9 |
| *Gongylidiellum vivum* (O.P.-Cambridge, 1875) | | | | | | 1 | | | | | | | | 1 |
| *Gongylidium rufipes* (Sundevall, 1829) | 2 | | | | 14 | | | 1 | 1 | 3 | 13 | 1 | 9 | 44 |
| *Hylyphantes graminicola* (Sundevall, 1829) | | | | | | | | | | 4 | | | | 4 |
| *Maso sundevalli* (Westring, 1851) | | 1 | 9 | | | | 1 | 40 | | | | | | 51 |
| *Micrargus herbigradus* (Blackwall, 1851) | 2 | | 12 | 14 | | | 5 | 3 | 16 | 2 | 1 | 5 | | 60 |
| *Micrargus subaequalis* (Westring, 1851) | | | | | | | | 8 | | | 1 | | | 9 |
| *Monocephalus fuscipes* (Blackwall, 1836) | 15 | 45 | 69 | 41 | 80 | 31 | 52 | 12 | 38 | 3 | 3 | 3 | | 392 |
| *Oedothorax agrestis* (Blackwall, 1853) | | | | | | | | | | | | 13 | 1 | 14 |
| *Oedothorax apicatus* (Blackwall, 1850) | | | | | | | | | 1 | | 1 | | 1 | 3 |
| *Oedothorax fuscus* (Blackwall, 1831) | 4 | 3 | 11 | 2 | 2 | 3 | | | 1 | | 3 | 11 | 20 | 60 |
| *Oedothorax retusus* (Westring, 1851) | 8 | | 10 | 2 | 14 | 4 | 1 | 3 | 1 | 1 | 11 | 2 | 31 | 88 |
| *Pocadicnemis juncea* Locket & Millidge, 1953 | | | | 1 | | | | | | | | | | 1 |
| *Saloca diceros* (O.P.-Cambridge, 1871) | | 2 | | | | | | | | | 21 | | | 23 |
| *Troxochrus scabriculus* (Westring, 1851) | | | | | | | | 1 | | | | | | 1 |
| *Walckenaeria acuminata* Blackwall, 1833 | 12 | 13 | 23 | 19 | 11 | 5 | 5 | | 22 | 1 | 4 | 10 | 2 | 127 |
| *Walckenaeria atrotibiales* O.P.-Cambridge, 1878 | 6 | 24 | 50 | 27 | 47 | 7 | 3 | 3 | 8 | 1 | 15 | 6 | 10 | 207 |
| *Walckenaeria dysderoïdes* (Wider, 1831) | | | | | | | | 1 | | | | | | 1 |
| *Walckenaeria nudipalpis* (Westring, 1851) | 7 | 2 | 6 | 3 | 5 | 1 | | 1 | | | 7 | 8 | 3 | 43 |
| **Family Linyphiidae** | | | | | | | | | | | | | | |
| **Subfamily Linyphiinae** | | | | | | | | | | | | | | |
| *Agyneta conigera* (O.P.-Cambridge, 1863) | 2 | | | | | | | 1 | | | | | | 3 |
| *Agyneta ramosa* Jackson, 1912 | 17 | 23 | 8 | 17 | 5 | | | | 2 | | 2 | 4 | 1 | 79 |
| *Agyneta subtilis* (O.P.-Cambridge, 1863) | 1 | | | | | | | | | | | | | 1 |
| *Bathyphantes gracilis* (Blackwall, 1811) | 5 | 1 | 13 | 3 | 4 | 32 | 9 | 3 | 3 | | 9 | 10 | 15 | 107 |
| *Bathyphantes nigrinus* (Westring, 1851) | | | 1 | | | | | | | | 3 | | 1 | 5 |
| *Bathyphantes parvulus* (Westring, 1851) | | 1 | | | 1 | 1 | | | | | | | | 3 |
| *Centromerita bicolor* (Blackwall, 1833) | | | | | | 7 | | | | | | | | 7 |
| *Centromerus aequalis* (C.L. Koch, 1841) | | | | | | | | 1 | | | | | | 1 |
| *Centromerus prudens* (O.P.-Cambridge, 1873) | | 1 | 1 | | | | | | | | | | | 2 |
| *Centromerus sylvaticus* (Blackwall, 1811) | 5 | 3 | 16 | 3 | 35 | 11 | | | 2 | | 32 | 37 | 6 | 150 |
| *Diplostyla concolor* (Wider, 1831) | 35 | | 15 | | 2 | 6 | 1 | 19 | | | 31 | 36 | 27 | 172 |
| *Drapetisca socialis* (Sundevall, 1832) | | | | | | | | | 2 | | | 1 | | 3 |
| *Floronia bucculenta* (Clerck, 1757) | | | | | 1 | | | | | | | | | 1 |
| *Helophora insignis* (Blackwall, 1811) | | | 8 | | | | | | 3 | | | | | 11 |
| *Lepthyphantes ericaeus* (Blackwall, 1853) | | | | | | | | 1 | | | | | | 1 |
| *Lepthyphantes flavipes* (Blackwall, 1851) | | | | | | | | 24 | 1 | | | | | 25 |
| *Lepthyphantes insignis* O.P.-Cambrdige, 1913 | | | | | 1 | | | | | | | | | 1 |
| *Lepthyphantes minutus* (Blackwall, 1833) | | | | | | | 4 | 5 | 1 | | | | | 10 |
| *Lepthyphantes pallidus* (O.P.-Cambridge, 1871) | 16 | 4 | 14 | 13 | 9 | 6 | 6 | 8 | 10 | 5 | 20 | 11 | 7 | 129 |
| *Lepthyphantes tenuis* (Blackwall, 1852) | 3 | 1 | 8 | 6 | 9 | 8 | 1 | 9 | 7 | | 1 | 4 | 3 | 60 |
| *Lepthyphantes zimmermanni* Bertkau, 1890 | 7 | 46 | 50 | 7 | 6 | | 99 | 19 | 33 | 33 | 13 | 20 | 2 | 335 |
| *Leptorhoptrum robustum* (Westring, 1851) | 2 | 1 | | | | | | | | 1 | | | | 4 |
| *Nereine clathrata* (Sundevall, 1829) | | | | | | | 2 | | | | | | 1 | 3 |
| *Nereine peltata* (Wider, 1831) | | | | | 1 | | | | | 1 | 1 | 1 | | 4 |
| *Linyphia triangularis* (Clerck, 1757) | 2 | | 1 | | 1 | | | | 1 | 1 | | | | 6 |
| *Macrargus rufus* (Wider, 1831) | 1 | 1 | | 1 | | | 13 | 1 | 3 | 92 | | | | 112 |
| *Meioneta rurestris* (C.L. Koch, 1836) | | | | | | 2 | | | | | | | | 2 |
| *Microneta viaria* (Blackwall, 1811) | | 5 | 2 | 2 | 1 | | 1 | 1 | | 23 | | | | 35 |
| *Porrhomma convexum* (Westring, 1861) | 1 | | | | | | | | | | | | | 1 |
| *Porrhomma egeria* Simon, 1881 | 6 | | 4 | | | 1 | | | | 2 | | | | 13 |
| *Porrhomma pygmaeum* (Blackwall, 1831) | | | | | | | | | | | 2 | | | 2 |
| *Saaristoa abnormis* (Blackwall, 1811) | 14 | 12 | 7 | 2 | 1 | | 3 | | 7 | 2 | 5 | 7 | 2 | 62 |
| *Stemonyphantes lineatus* (Linneaus, 1758) | | | | | | 1 | | | | | | | | 1 |
| **Total per station** | 274 | 310 | 531 | 272 | 344 | 2208 | 377 | 413 | 263 | 301 | 411 | 269 | 338 | 6311 |

Table 3. List of sampled Red list species with the category they belong to (RL-categorie) and their preferential habitat (RL-habitat) (after MAELFAIT *et al.*, 1998).

| **Red list Species** | **Red List Category** | **Prefered habitat according to Red List** |
|---|---|---|
| *Coelotes terrestris* | Vulnerable | Dry deciduous forests with dead wood |
| *Coelotes inermis* | Geographically restricted | Northern limit of geographical range |
| *Histopona torpida* | Geographically restricted | Northern limit of geographical range |
| *Hahnia pusilla* | Indeterminate | |
| *Robertus neglectus* | Vulnerable | Verges of wet deciduous forests |
| *Saloca diceros* | Vulnerable | Wet deciduous forest with open character |
| *Leptorhoptrum robustum* | Vulnerable | Riparian habitat with bare ground |

for differences between forest sites. Now only 36 traps were taken into account. Each species which has been caught 18 times over the whole year (being the half of the amount of the traps) was used in the analysis. 36 species fulfilled this condition. The result of the DCA-analysis is shown in Fig. 2 and 3. The eigenvalue of the first axis is 0.56 and 0.29 for the second axis. The third axis had a low eigenvalue and is not discussed further. Percentage of explained variation is 18.1% for the first axis and 27.9% for the second axis. Further increase in explained variation is minimal. According to the first axis we see a division of the drier forest stations H, I and J (with stations J and H in an extreme situation, on the right side of the graph) from the more humid ones (stations A, L, M and K left on the graph). Exceptions are station C, that was very humid, but is situated more in the centre of the graph (semi-humid stations) and the humid station G which was between the drier stations I and H. Stations D, B and E are somewhere in between. Indicator species are *Saloca diceros*, *Walckenaeria nudipalpis* and *Pirata hygrophilus* for the very humid foreststands and *Maso sundevalli*, *Histopona torpida*, *Lepthyphantes flavipes* and *Diplocephalus latifrons* for the more drier stations. This is in accordance with most literature (for more detailed information concerning the biology and ecology of most of these species, see summaries in DE KNIJF, 1993; DE BAKKER, 1995; VAN WAESBERGHE, 1998; D'HERT, 2000). Along the second axis we see a distinction between station J (upper part of the graph), characterised with beech (*Fagus sylvatica*), with *Macrargus rufus* and *Microneta viaria* as indicator species (species which are indeed abundantly found in beech stands with a thick litter layer), and station H (lower part of the graph) consisted of poplar trees. Different tree species and coverage seems to be the second most explanatory factor for this division. The TWINSPAN-analysis confirms these results (Fig. 6) with this difference that also station B groups together with stations G, H and J. The sampling

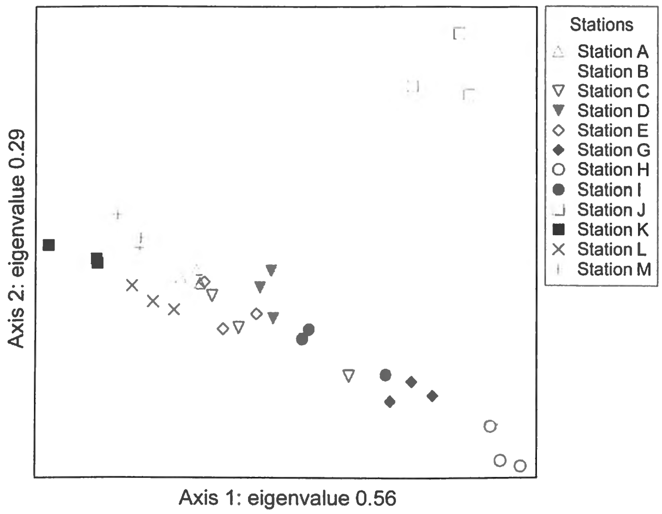


Fig. 2 — Distribution of the 12 sampled station (axis 1 and 2) of the forest of Ename according to the DCA-analysis.

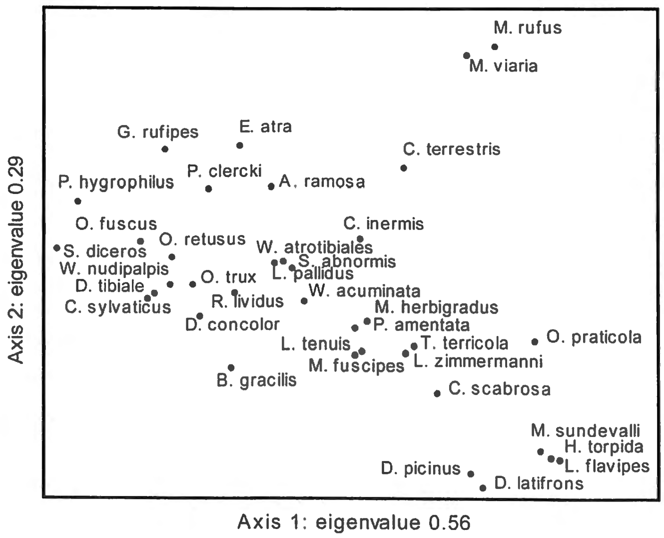


Fig. 3 — Distribution of the most abundant species (axis and 2) of the 12 sampled stations.

stations distributed over the two separate parts of the forest (see above) group together in agreement with topography giving a separation of the drier stations (on higher positions) and humid stations (lower, concentrated in valleys).

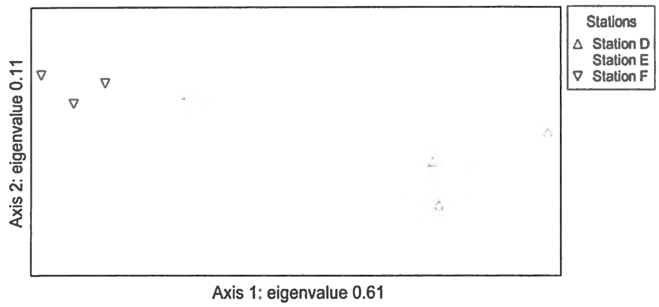


Fig. 4 — Distribution of the 3 sampled station (axis 1 and 2) of the forest of Ename according to the DCA-analysis.

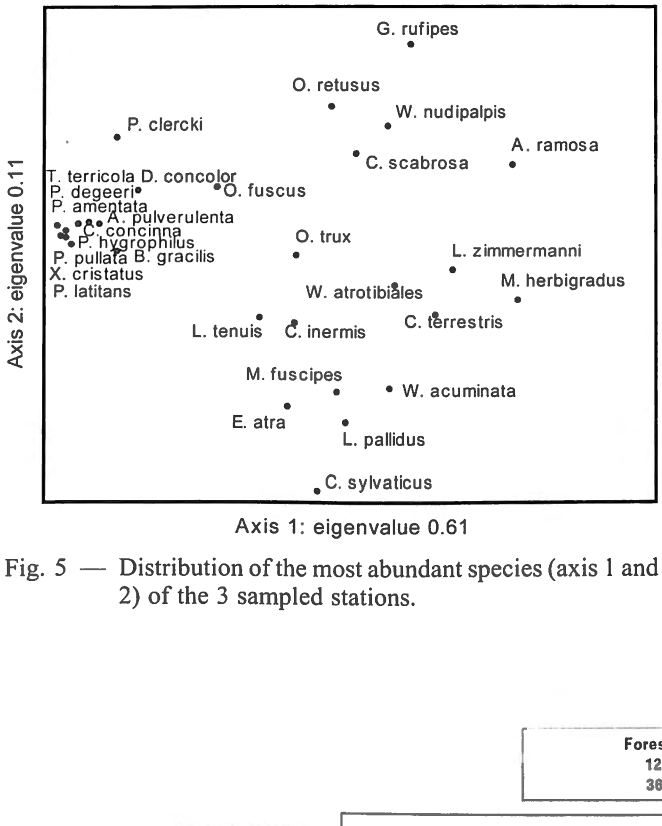


Fig. 5 — Distribution of the most abundant species (axis 1 and 2) of the 3 sampled stations.

A third analysis comprises of the gradient from a typical forest station (D) to a forest verge station (E) and further to a grassland (F). 30 species fulfilled the condition of being taken 6 times (half of the total amount of pitfall traps being 12). DCA-analysis is shown in Fig. 4 (distribution of stands) and 5 (distribution of indicator species). According to the first axis, there is a clear grouping of sampling units per station and spider faunas can be distinguished between the three stands with the fauna of station F being most different of that of station D and E. The same conclusion was obtained for carabid beetles (DESENDER & VANDENBUSSCHE, 1998). It seems that the spider fauna of forest stands and that of forest verges are more similar to each other than that of a totally different habitat. TWINSPAN-analysis confirms these results (Fig. 7). Here again we see a separation of the grassland spider fauna with the other stations. Typical species for the forest station (D) and the forest verge station (E) are *Lepthyphantes zimmermanni*, *Micrargus herbigradus*, *Coelotes terrestris*, *Agyneta ramosa* and *Walckenaeria acuminata*, species known to be bound to forest habitats or habitats with a more structured vegetation. Species typical for station F are *Alopecosa pulverulenta*, *Xysticus cristatus*, *Trochosa terricola* and *Pirata latitans*, all species of open landscapes.

### 3. *Comparison with the riverine forest "Walenbos"*

When comparing the results of this sampling campaign with those of the riverine forest "Walenbos" (DE KNIJF, 1993; MAELFAIT *et al.*, 1995), a striking difference was found. We see a clear difference between the two spider faunas. Sites in the "Walenbos" are separated due to humidity and water quality (mesotrophic-oligotrophic). The sites in the forest of Ename show less differences (between each other) than those of the "Walenbos". This is mainly due to the lesser degree of heterogeneity (discussed above) of our sampled sites while those of the "Walenbos" show a large variation in vegetation structures and hydrology. The difference between the two

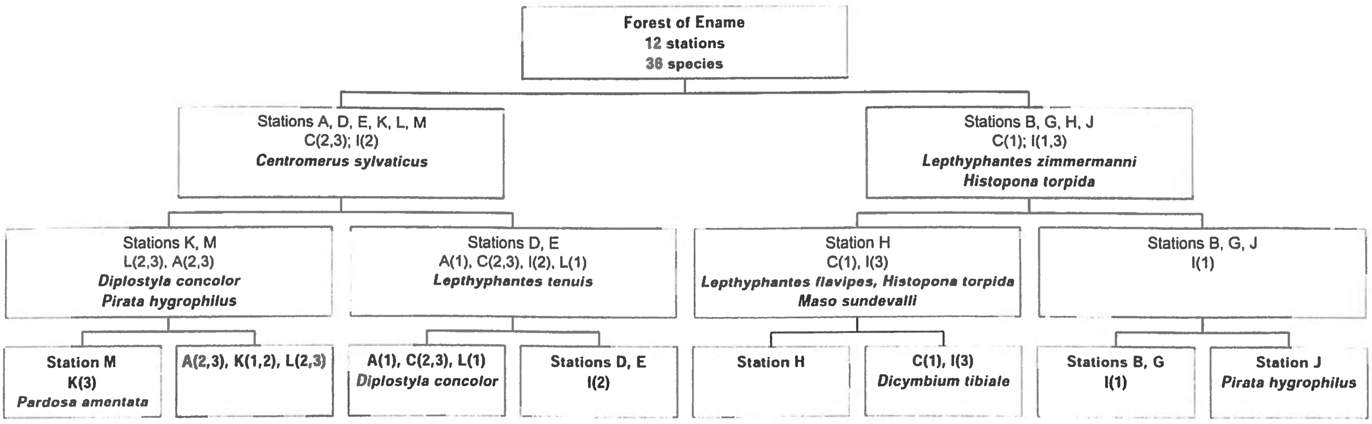


Fig. 6 — TWINSPAN-dendrogram of the 12 sampled stations.

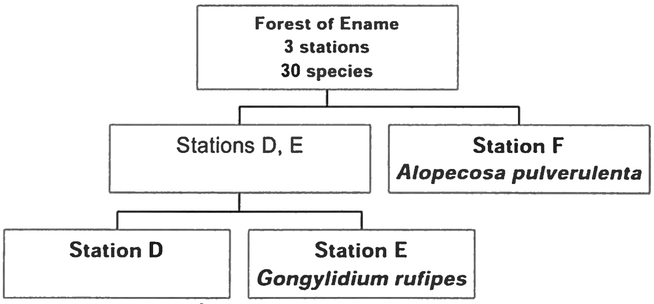


Fig. 7 — TWINSPAN-dendrograms of the 3 sampled stations.

forests can also be illustrated by the difference of species composition. Many species occur in the forest "Walenbos" which were not found in the forest of Ename. Species which can be only found in the "Walenbos" include *Lepthyphantes tenebricola*, *L. cristatus*, *Gongylidiellum latebricola*, *Hahnia helveola*, *Centromerus dilutus*, *Agyneta subtilis*, *Lophomma punctatum*, *Glyphesis servulus*, *Walckenaeria cucullata*, *W. cuspidata*, *Oedothorax gibbosus* and *Pardosa lugubris*. The number of species only occurring in the forest of Ename is lower and comprises only three species: *Coelotes inermis* (probably due to zoogeographic effects), *Diplocephalus latifrons* and *Ozyptila praticola*. We have to remark that also *Histopona torpida*, *Erigona atra* and *Oedothorax fuscus* are more abundant in the forest of Ename.

This leads us also to conclude that spider faunas differ from woodlands probably due to zoogeographical causes. Earlier research showed that the spider fauna of a given forest stand is not only influenced by the characteristics of the stand itself, but also by the nature of the surrounding forest and by the presence and/or absence of nearby open habitats. This causes the much greater richness of stands in small heterogeneous complexes in comparison with stands in more homogeneous complexes like the forest of Ename. Also, stands grouped together in agreement with the complexes they are part of. This means that spider faunas of similar sampled habitats (according to vegetation characteristics, ...) in different forest complexes are more different from each other while faunas of different sampled habitats, but situated in the same forest complex, are more comparable (MAELFAIT *et al.*, 1990, 1991).

## 4. *General Conclusions*

Although the forest of Ename is still rich in plant species (even old forest plant species), the spider fauna of the forest of Ename seemed to be very poor in species richness probably because of the short history of the forest and management politics leading to a decrease in different habitats (heterogeneous environment). Perhaps many species didn't survive the crisis when the previous forest was completely cleared and some stenotopic woodland species were not able to establish good populations in this forest due to a lack of suitable habitats. Statistical analyses on all sites showed that spider faunas differed in the first place according to their open or closed character. Because these findings were highly influenced by the presence of a grassland site, an analysis was made excluding this type of habitat. Then forest stands were mainly divided on basis of humidity (and corresponding vegetation) of the stands and on main tree species and coverage. When analysing a gradient from forest to grassland it was observed that each stand possesses its own fauna which is independent from the other and that edge faunas resemble more closely that of the forest. So, there seems to be no difference between the spider faunas of the two isolated parts of the forest in similar habitats so that we can conclude that the fragmentation has had no effect on the present spider fauna. Comparison of this fauna with that of the "Walenbos" showed a hugh difference between faunas even with comparable sampled habitats. This is also probably caused by the lack of different environments in the forest of Ename and zoogeographic reasons.

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