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Effect of forest developmental stage on centipede communities

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Abstract

During a pitfall sampling campaign in 15 forests in "Voeren" (Belgium), a total number of 1535 centipedes belonging to 15 species were caught. The most recent forests, only seven years old, contained one to three species while seven to 12 species were present in forests of 14 years and older. *Lamyctes emarginatus* was the most characteristic species for the recent forests while *Lithobius dentatus* was only abundant in the older forests. *Cryptops parisi* was only common in the forests older than 228 years. While about 15 years is needed before a reasonably diverse centipede community develops, it seems to take more than 23 years before a typical woodland species like *C. parisi* can develop a stable population.

Key words: Belgium, Chilopoda, community analysis, forest age, species diversity

Introduction

As a measure within the framework of the European rural development policy, by 2007 the Flemish nature and forest policy is planning an extension of the area of sustainable forest by 10,000 ha through ecologically justified afforest. In addition, another 10,000 ha afforest is planned on agricultural land. Presently, spontaneous forest development is preferred over classical forestry practices because of the supposed higher ecological value. Also forest development controlled by grazing is currently often formulated as an objective. However, few data are available about the ecological advantages and disadvantages of classical versus spontaneous forest extension. To compare classical and spontaneous forest extensions, a case-study was performed in "Voeren". One part of this project was devoted to the inventory of soil invertebrates that were sampled by means of a pitfall sampling campaign (DEKONINCK *et al.*, 2005).

Despite their importance as invertebrate predators in soil ecosystems (WEIDEMANN, 1972; WIGNARAJAH & PHILLIPSON, 1977; ALBERT, 1979; POSER, 1988; SCHAEFER, 1990), centipedes are often neglected in ecological studies and therefore only few data are available about the ecology of this group. In the present study, the centipedes of 15 forests in the Voeren-region were studied. The aim of the inventory was to investigate the effect of forest developmental stage on the centipede communities.

Materials and methods

Sampling

The 15 sampling stations in the forests of "Voeren" (Belgium) that were sampled are listed in Table 1. Per station, 3 pitfall traps with a diameter of 9.5 cm were placed in a row, spaced 4 m apart. A 4 % formaldehyde solution was used for killing and fixation and some detergent was added to lower the surface tension. Pitfalls were emptied every two weeks and sampling lasted from April till October 2003.

Statistical methods

Diversity was calculated as HILL's diversity numbers (HILL, 1973). This set of indices incorporates the most widely used diversity measures in a continuum of indices of the orders - to +. The indices differ in their tendency to include or to ignore the relatively rarer species: the impact of dominance increases and the influence of species richness decreases with an increasing order of the diversity number. Of particular interest are:

$N_0 = S$	with S = the number of species
$N_1 = e^H$	with H = Shannon-Wiener index $H = -\Sigma\ p_i \ln(p_i)$ (p_i = the relative abundance of the i^{th} dominant species)
$N_2 = SI^{-1}$	with SI = Simpson's dominance index $SI = \Sigma\ p_i^2$
$N = p_1^{-1}$	with p_1 = the relative abundance of the most abundant species.

The stations were classified into clusters according to species composition, using the classification program TWINSPAN (Two-Way INdicator SPecies ANalysis) (HILL, 1979). TWINSPAN also yields indicator species characterizing the various assemblages. The cut levels used in this analysis correspond to the total number of centipedes that were captured at each locality: 1 = 1; 2 = 2-4; 3 = 5-9; 4 = 10-19; 5 = 20-39; 6 > 39. To check the stability of the TWINSPAN results, the Detrended Correspondence Analysis (DCA) option from the pro-

Table 1 — List of the sampled forests with indication of the used numbers, forest name, description, age (years) and Hill's diversity numbers.

N°	Forest	Description	Age	N_0	N_1	N_2	N_∞
1	"Altenbroek"	Old oak & birch forest	>228	8	6.2	5.3	3.5
2	"Altenbroek"	Self-sown birch & willow on former agricultural land Extensive grazing with cows	7	1	1.0	1.0	1.0
3	"Altenbroek"	Spontaneous forest on former pasture, extensive grazing with cows	7	3	2.2	1.8	1.4
4	"Altenbroek"	Spontaneous forest on former agricultural land Intensive summer grazing with cows	7	2	1.4	1.2	1.1
5	"Altenbroek"	Planted oak & beech	14	7	3.3	2.4	1.6
6	"Altenbroek"	Old humid forest	>228	12	9.5	7.9	4.8
7	"Alserbos"	Old oak & birch forest	>228	11	6.7	5.1	3.2
8	"Alserbos"	Spontaneous forest extension on former pasture	23	11	7.2	5.3	2.9
9	"Alserbos"	Spontaneous forest extension on former agricultural land	23	12	7.1	4.8	2.5
10	"Alserbos"	Planted cress	16	11	7.9	6.8	4.5
11	"Alserbos"	Spontaneous forest extension on former agricultural land	23	9	6.7	5.6	3.3
12	"Alserbos"	Planted oak	16	10	5.2	4.3	3.0
13	"Alserbos"	Old forest	>228	9	6.1	5.2	4.1
14	"Alserbos"	Old forest	>228	10	7.0	6.0	4.3
15	"Veursbos"	Old oak & beech forest	>228	8	5.7	4.4	2.5

gram package CANOCO (TER BRAAK, 1988) was applied on the log transformed data. A log transformed was applied prior to DCA to normalize the data. Also a group-average sorting cluster analysis was performed on the log transformed density data.

Results

Centipede species

In total, 1535 centipedes belonging to 15 species were caught during a pitfall sampling campaign in 15 forests. The centipede diversity in the three most recent forests of seven years old was considerably lower than the diversity in the forests of 14 years and older (Table 1). In the young forests, one to three species were found, while the older forests contained seven or more species.

Community analysis

In the first division of TWINSPAN (Table 2), two of the most recent forests were separated from the other forests which all contained the indicator species *Lithobius dentatus*. The "Alserbos" forests, 16 and 23 years of age, were split off in the second division and these were characterised by high numbers of the indicator species *L. forficatus*. In the subsequent divisions, a 7 year old "Altenbroek" forest and the 14 year old "Altenbroek" forest were separated from the forests more than 228 years old. The old forests were characterised by high numbers of the indicator species *Cryptops parisi*.

Group average sorting cluster analysis (Fig. 1) yielded similar results. In the first division, the "Alserbos" forests of 16 and 23 years of age were separated from the other forests. In the subsequent divisions, the "Altenbroek" forests of 7 years of age and in the next divisions also the "Altenbroek" forest of 14 years of age were separated from the forests older than 228 years.

Table 2 — TWINSPAN table (cut levels correspond with the total number of centipedes captured on each locality: 1 = 1; 2 = 2-4; 3 = 5-9; 4 = 10-19; 5 = 20-39; 6 > 39, with cut levels of indicator species in bold). The abbreviations of the localities are explained in Table 1.

	11 1 11 1 01892 173564 5 4 23
Lithobius crassipes (Koch, 1862)	56646 21-214 - - -1
Lamyctes emarginatus (Newport, 1844)	----- ----1- - - 23
Lithobius tricuspis (Meinert, 1872)	45342 22-111 - - --
Lithobius muticus (Koch, 1847)	55352 -2--21 3 - --
Lithobius forficatus (Linnaeus, 1758)	**56446** -21-22 1 3 --
Lithobius calcaratus (Koch, 1844)	53-2- --1--- - - --
Lithobius microps (Meinert, 1868)	22325 --2-23 5 - --
Lithobius macilentus (Koch, 1862)	46555 **444334** 3 - --
Lithobius dentatus (Koch, 1844)	**24463 254534** 6 1 --
Lithobius agilis (Koch, 1847)	45342 2223-1 3 - --
Strigamia acuminata (Leach, 1814)	--24- 11-31- - - --
Strigamia crassipes (Koch, 1825)	--321 -342-2 1 - --
Geophilus electricus (Linnaeus, 1758)	----- ----2- - - --
Cryptops parisi (Bröleman, 1920)	2---- **444434** - - --
Schendyla nemorensis (Koch, 1837)	1-231 322-2- - - -1
	00000 000000 0 0 11
	00000 111111 1 1
	000000 0 1
	000000 1

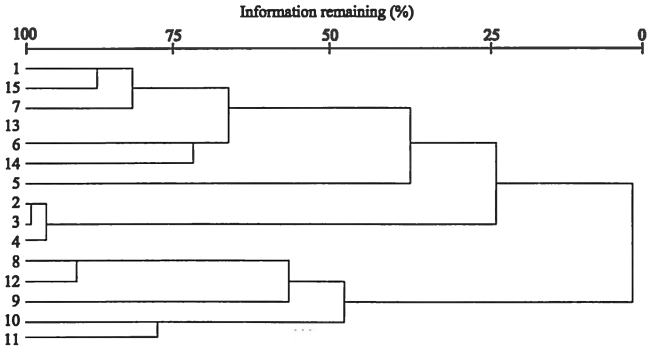

Fig. 1 — Group average sorting cluster analysis. The abbreviations of the localities are explained in Table 1.

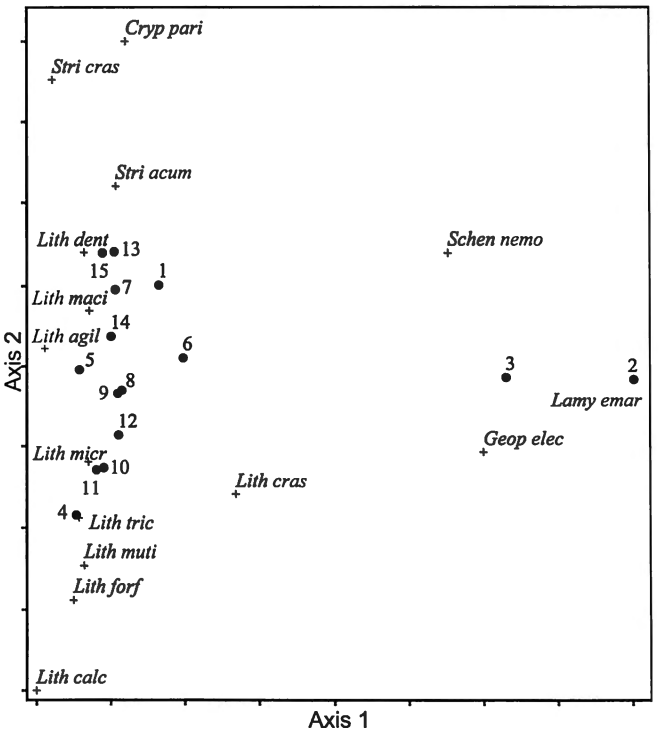

Fig. 2. — Biplot of the sample scores and the species scores (Detrended Correspondence Analysis). The abbreviations of the localities are explained in Table 1.

Along the first axis of the Detrended Correspondence Analysis (Fig. 2), two seven year old forests were separated from the other forests. *Lamyctes emarginatus* is the most characteristic species for these recent forests. Along the second axis, the forests older than 228 years are separated from the more recent forests. *C. parisi* is the most characteristic species for the older forests while *Lithobius calcaratus* and *Lithobius forficatus* are the most characteristic for the more recent forests.

Discussion

The most recent forests of seven years old contained only one to three species while forests of 14 years and older contained at least seven species. *L. emarginatus*, a parthenogenetic species that is a fast colonizer which can complete its life cycle within a few months (LOCK, 2001), was the most characteristic species for these young forests. This species is also most resistant to inundation and can therefore be found in the most humid habitats (LOCK, 2001).

LOCK *et al.* (2001) divided the forests of Flanders into three regions on the basis of their centipede communities: the Campine region, sandy Flanders and the loamy region. Geographically, "Voeren" is situated in the loamy region. Two species are characteristic for the loamy region: *L. dentatus* and *C. parisi* (LOCK *et al.*, 2001). *L. dentatus* was only abundant in the forests of 14 years and older while *C. parisi* was only common in the forests older than 228 years.

It can be concluded that forests only develop a centipede community over time: after seven years only a few species are present and only after about 15 years a more diverse community develops, however, it seems to take more than 23 years before a typical woodland species like *C. parisi* can develop a stable population.

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