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Original article

Invertebrate communities (Annelida and epigeic fauna) in three types of Estonian cultivated soils

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ARTICLE INFO

Article history:
Received 23 April 2008
Received in revised form
9 September 2008
Accepted 10 September 2008
Published online 16 October 2008

Keywords:
Soil biodiversity
Soil type
Earthworms
Enchytraeids
Epigeic invertebrates
Ground beetles
Spiders

ABSTRACT

The abundance and diversity of invertebrate communities (annelids and epigeic fauna) in three types of cultivated soils were studied. Soil biota communities in the three most widespread soil types in Estonia (Calcaric Regosols, Calcaric Cambisols and Stagnic Luvisols) are influenced by environmental conditions, the factors connected to soil texture including moisture, organic matter content and pH being the most essential, and by the intensity of agricultural practice. Potentially high biological activity and low intensity of agricultural human activity of Calcaric Regosols occurs in parameters of communities of organisms not sensitive to soil which dries off, i.e. epigeic fauna living on the soil surface and preferring dry and warm habitat; temporarily dried off soil is not a suitable habitat for Oligochaeta. Both groups of Oligochaeta (earthworms, enchytraeids) appear to prefer Calcaric Cambisols where soil moisture conditions are more stable. The abundance of invertebrate communities is the highest and the diversity is the lowest in Stagnic Luvisols. Some trends occurred in community characteristics along the soil surface following a hypothetical gradient; the number of carabids per trap and diversity of spiders decreased from the edge to the centre of the field. The results presented here on spatial variability in distribution of soil organisms are preliminary.

1. Introduction

Biodiversity is the key factor of the structure and function of ecosystems [28,53]. Due to intensive agricultural practice, loss of biodiversity occurs in agricultural ecosystems compared to natural ecosystems. Soil biological and chemical properties and habitat conditions alter drastically when natural habitat is converted to agricultural; frequent tillage and use of agrochemicals have impact on soil organisms and habitats [7,28,36]. Agricultural activities have positive or negative impact on abundance, diversity and activity of soil fauna mostly following the changes in soil temperature, moisture, and quantity and quality of organic matter [17]. Fields which are more diverse, stable, isolated and managed with low intensity have preference for ongoing ecological processes compared with simple and disturbed agricultural systems. Uncultivated habitats between fields could enhance species diversity of many organism groups, and function as refuges

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1164-5563/$ – see front matter
doi:10.1016/j.ejsobi.2008.09.005

[24,25]. Spatial variability in dispersion of soil organisms can be a key to understanding the structure and function of soil biodiversity [10].

One of the most important challenges in agriculture today is to discover the heterogeneity of biota on field and regional scale to regulate pests using unique habitat conditions and entomofauna [1]. To date the data on soil invertebrate communities are incomplete in many regions. The aim of the present research was to determine the abundance and diversity of invertebrate communities (annelids and epigeic fauna) in three types of cultivated soils in Estonia, to investigate relationships between characteristics of invertebrate communities of fields and field edges and some soil-related ecological and agricultural factors, and qualitatively describe invertebrate fauna moving along the soil surface following a hypothetical gradient.

Questions asked were:

- How abundant and diverse are annelida and epigeic invertebrate communities in cultivated soils in Estonia?
- Is diversity of earthworm and epigeic invertebrate communities of cultivated soil influenced by soil type?
- How do carabid and spider diversities change along the soil surface following a hypothetical gradient?

2. Materials and methods

2.1. *Materials*

Estonian soil cover is highly variable due to the great variability of the soil ecological situation [38]. Twenty-four study areas of three most widespread soil types (by FAO-UNESCO (1994) terminology) all over Estonia [20,22] were selected. For each of three soil type groups—pebble rendzinas Calcaric Regosols, typical brown soils Calcaric Cambisols and pseudopodzolic soils Stagnic Luvisols—eight fields were selected for studies in 2003 (Enchytraeidae, Lumbricidae, epigeic fauna) and 2004 (Lumbricidae, epigeic fauna). The surface of each study field varied from 0.3 ha up to 85 ha, and soil type and texture was determined (Table 1). The cover crops and three-year history of agricultural management practice (tillage, amount of mineral and organic fertilizers, and pesticides used) were recorded and presented previously [51].

2.2. *Methods*

2.2.1. *Soil analyses*

In each studied field soil samples were collected randomly from the upper 20 cm layer with a soil corer (diameter 2 cm) [51]. Composite soil sample moisture content (105 °C), pH_{KCl}, organic matter content (in muffle furnace at 360 °C) [44], nitrogen concentration (by the Kjeldahl method) [35]), soluble phosphorus concentration (by lactate method [34]) and the concentration of potassium (by flame photometry [34]) were determined in all samples.

2.2.2. *Sampling*

For sampling of potworms (Enchytraeidae), five soil samples were taken from each field with a soil corer of 5 cm diameter, four samples from different parts and one sample from the centre of the field. The samples were divided according to soil depth: 0–2 cm, 2–5 cm, 5–10 cm and 10–15 cm. The samples

Table 1 – Soil characteristics of studied fields soil

Field no.	Soil type	Soil texture	Field size, ha	pH	Dry matter, %	Organic matter, %	Soluble P, mg per 100 g dry soil	Tot. N, %	K, mg per 100 g dry soil
1	CR	sl	1.00	7.12	74.7	9.18	44.5	0.491	40
2	CR	ls	4.70	7.56	94.9	2.95	10.1	0.152	10.4
3	CR	sl	1.20	7.4	79	20.21	15	1.366	60.2
4	CR	ls	1.20	7.48	92.5	3.82	13.1	0.218	17.1
5	CR	l	11.00	6.28	86	2.54	13.4	0.125	19
6	CR	cl	2.00	7	86.9	4.16	19.4	0.189	23.5
7	CR	cl	0.30	7	86.7	3.67	8.7	0.153	8.4
8	CR	cl	2.10	6.12	87.8	3.65	7.8	0.161	12.4
9	CC	sl	3.90	7.01	86.7	2.09	3.4	0.113	14.8
10	CC	l	85.00	6.8	87.6	3.99	12.5	0.097	21.5
11	CC	l	64.30	7.27	84.5	3.99	12.3	0.179	36.2
12	CC	l	25.30	6.68	82.6	4.48	22.4	0.213	30.8
13	CC	l	67.3	6.83	84.6	3.52	13.3	0.73	16.5
14	CC	cl	0.6	6.45	86.6	4.31	9.2	0.186	24.2
15	CC	cl	1.70	7.09	86.9	4.2	7	0.181	15.7
16	CC	cl	0.50	7.19	90	4.93	12.4	0.115	22.4
17	SL	l	3.60	6.21	83.3	2.45	9.4	0.115	22.4
18	SL	l	1.60	5.5	84.7	2.92	14.4	0.14	22.6
19	SL	sl	3.00	5.95	84.4	2.19	15.9	0.136	32.3
20	SL	ls	3.00	5	85.2	2.29	9.7	0.103	12.6
21	SL	l	0.30	7.35	75.9	4.55	3	0.226	10.9
22	SL	sl	1.80	7.09	83.2	3.86	49.4	0.171	17.2
23	SL	sl	4.00	6.06	83.3	3.16	21.5	0.148	18.8
24	SL	sl	15.00	5.33	86	2.1	15.7	0.099	12.7

Soil type: CR, Calcaric Regosols; CC, Calcaric Cambisols; SL, Stagnic Luvisols. Texture: sl, sandy loam; ls, loamy sand; l, loam; cl, clay loam.