

ABSTRACT

Soil animals (zoedaphone) are involved in key processes and changes, crucial for the life on Earth. Hence, they are a part of all categories of ecosystem services for humans.

A significant part of zoedaphone - earthworms (Lumbricidae) are involved in developing soil structure, nutrient circulation and primary production. By improving soil fertility they also significantly impact the quality of crops. They are a source of nutritious food for animals and, in some cultures, for people. They are also used in ecotoxicology and environmental biomonitoring. Multidimensional anthropogenic impacts lead to a loss of diversity among earthworm species. Yet, currently in Poland no Lumbricidae species are subject to legal protection.

The purpose of the doctoral thesis was to characterize Lumbricidae inhabiting selected anthropogenic areas in comparison to natural areas. The author applied the mixed method proposed by Zajonc [1970] to identify qualitative and quantitative structure of earthworms at three sites: meadow and farming field in Krasne near Rzeszów, reclaimed areas formerly comprising Machów S.A. sulfur mine in Jeziórko (Podkarpackie Province, Commune of Grębów) and within four types of Carpathian beech forests *Fagetum carpathicum* in the vicinity of Ustrzyki Górne in the Bieszczady Mountains. The analyses also included the dynamics of population size and biomass as well as vertical distribution of Lumbricidae at selected sites in a period of one year. Effectiveness of *octet* method was tested in an attempt to look for an environmentally friendly method of flushing earthworms out. The thesis also proposed basic operations aiming at protection of Lumbricidae in these locations.

At the relevant anthropogenic sites in Krasne and Jeziórko as well as at the natural site in the vicinity of Ustrzyki Górne there was a total of 12 earthworm species: at the agrocenoses in Krasne there were 7 earthworm species on the grassland, and 6 on the field with grain crops; in the area formerly occupied by sulphur mine in Jeziórko, 7 earthworm species were identified in Field II, the earliest one to have been reclaimed, and 5 were found in Field X. In the Carpathian beech forests near Ustrzyki Górne, depending on the phytocenosis there were 7 species in each (*F. c. festucetosum*, *F. c. typicum* and in *F. c. lunarietosum*) while in the humid beech forest with bear's garlic (*F. c. allietosum*) the species composition was most varied (10 species).

The earthworms identified at the sites in Krasne, in the vicinity of Ustrzyki Górne and in Jeziórko within Field II, which had been recultivated for the longest period of time, represented three morpho-ecological groups: *epigees* (litter dwellers), *endogeas* (horizontal

burrow dwellers) and *anecigues* (deep-soil dwellers). This is evidence for the existing complete soil profile at these sites.

The study investigated the dynamics of population size and biomass in a period of one year and vertical movements of Lumbricidae in the soil. The latter were mainly observed in late autumn, and were connected with a search for more convenient conditions for wintering.

Investigation of the specific species for the dynamics of their population size and biomass in a year cycle at the sites in Krasne and Jeziórko showed that maximum values for the average size and biomass of earthworms in the same morpho-ecological groups occurred at different times. This suggests there is a decrease in competition between species inhabiting the same ecological niche. Avoidance of competition protects against stress and loss of energy and ensures reproduction of well-nourished populations. The conclusion, even though it was encountered in earlier studies, should be reaffirmed by subsequent research.

Employed in order to compare their effectiveness, mixed method recommended by ISO, and *octet* method, applying the effects of electrical current, showed the same composition of earthworm species. Yet, some statistical differences demonstrated lower capacity of *octet* for identifying population size and biomass of earthworms in the investigated soil samples.

Relatively large populations of earthworms and their good condition at the investigated farming areas provide evidence for the adequacy of agricultural operations, such as organic fertilization, choice and rotation of crops, limited use of plant protection chemicals, preventing soil acidification, choice of suitable tools and farming equipment – all of these contribute to the biodiversity of soils, including Lumbricidae.

Monitoring of the land in Jeziórko with the use of Lumbricidae shows differences in the progress of reclamation. In the area of Field II, recultivated for the longest period of time, the identified earthworms represented three morpho-ecological groups: *epigees* (litter dwellers), *endogeas* (horizontal burrow dwellers) and *anecigues* (deep-soil dwellers). This is evidence for the complete soil profile of this site. Within Field X it was too early for deep-soil dwellers to successfully reappear, and it was only possible to find representatives of *epigees* and *endogeas* there. The study demonstrated the significance of relics of natural phytocenosis and zoocenosis populations for restoring their full composition in course of land reclamation. Within the open space of sites I, XX and XXI it was impossible to find any representatives of Lumbricidae, but small populations of these (made of one and/or two species) were discovered among branches of isolated trees still growing in the reclaimed land. This is evidence for the importance of groups of trees and shrubs to be preserved within degraded areas. These provide stable habitat for various biological species, including earthworms,

which can migrate and successively inhabit the degraded areas, and that will speed up the reclamation process.

The findings acquired in natural Carpathian beech forests suggest there is growing anthropogenic impact in that area, negatively affecting earthworms. A comparison of research findings acquired at present and in the 1980s may suggest a permanent decrease in the diversity of earthworm communities in course of twenty years. The reasons for this, despite the statutory operations conducted in that period (all the investigated sites are located within the Bieszczady National Park), may include direct and/or indirect impacts caused by human activity in this area. Due to these the most vulnerable species are directly in danger of extinction.