Ecotone spiders

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Introduction

Despite the vast literature on ecotones they are little known. This is also the opinion of Int. Projects on Landscape Boundaries, a joint work of UNESCO MAB and SCOPE. In 1987 the ecotone was defined by their Working group as a : "Zone of transition between adjacent ecological systems having a set of characteristics uniquely defined by space and time scales and by the strength of the interactions between adjacent ecological systems". Ecologists who make projects of this research for the nearest future are of an opinion that in the rapidly changing environments it is necessary to understand "the most sensitive parts of landscape interactions : the boundaries that are being shaped and reshaped by human action". Within the context of successive global crises the nation of ecotone is likely to become a core concept as regards both theory and practice - for early monitoring, understanding and managing this change (di Castri, Hansen and Holland, 1988). Hansen, di Castri and Naiman (1988), citing also Noss (1983), say that "boundary dynamics are very important for landscape ecology because ecotones may affect local and regional biotic diversity providing unique habitats, favourable for some species but inhospitable to others".

The authors also describe the phenomenon known as "edge effect" (well known from studies of Leopold in the nineteen thirties), although according to them "empirical studies of the edge effect are surprisingly few".

Almost all these generalities are known to ecologists working on the ecology of ecotones but I am citing these American authors because for the first time in ecology - theories, rules, empirical facts, questions and problems concerning the concept of ecotones and their importance in landscape ecology are treated very broadly, thoroughly and systematically. The research should terminate in 1996.

Authors of the Project do not know well the European literature. In Poland, e.g., some phytosociological and floristical works on the subject have been published (e.g. Paczoski, 1925 ; Traczyk, 1960 ; and others) and some zoological papers on birds (e.g. Wasilewski, 1961), insects (Dabrowska-Prot, 1962 ; Grüm, 1971), spiders and some dealing with microclimatic changes in ecotonal zone (e.g. Wojcik, 1973).

Results

The Laboratory of Ecological Bioindication published two papers :
1. On ecotones between two forest types concerning spiders and mosquitoes. We found the "edge effect" in relation to the abundance of all spiders and particular species but not to the number of species (Dabrowska-Prot and Luczak, 1968) (Table 1).

Table 1 : Number of spiders and their species in three belts of alder forest and oak-pine forest and in their margin belts (ecotones).

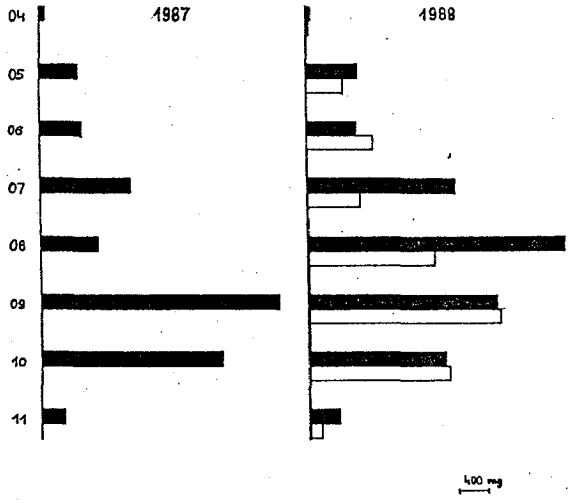
BELTS							
I	II	III	IV	V	VI	VII	VIII
Alder forest			Ecotones		Oak-pine forest		
INDIVIDUALS							
248	354	331	419	267	204	150	20
SPECIES							
21	24	29	27	27	21	30	23

2. The ecotone was a special habitat between alder forest and mid-forest meadow with its own floristical characteristics (Dabrowska-Prot, Luczak and Wojcik, 1973). Out of all 74 species caught only 16 were common for three habitats examined. The similarity coefficient QS was 26% between alder forest and meadow, 50% between alder forest and ecotone and 45% between meadow and ecotone. I found some forest and meadow spider species for which the ecotone is an unsurpassable barrier and some for which it is a "transition zone". There were no spider species living exclusively in the ecotone. By "ecotone species" I mean species having a distinctly greater density in the ecotone.

In our present two-years research we are examining the inner parts and margins (ecotones) of 5 forest islands in the agricultural landscape of recreational part of Poland - Mazury Lakeland. The ecotones are well marked as well as the boundaries between fields and forest islands. Forest islands are among the fields on which spiders are in general rarer than in other ecosystems (Luczak, 1979). Although on these fields spiders are very rare, some species are common for fields and forest island ecotones. So, here the ecotone is an integrated part of the forest island, a rather open marginal belt, 1 - 5m broad, with bushes and grasses. It has its own properties and differs from inner forest parts. Birch-aspen plant communities grow on wastelands of no agricultural use, on land depressions or on small elevations. Numbers and biomass of

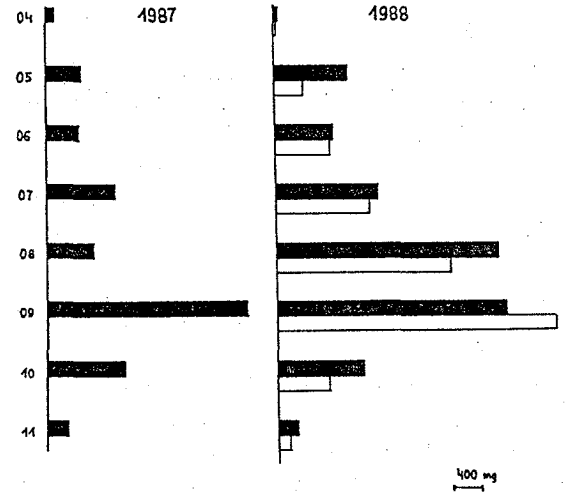
spiders in birch-aspen communities are slightly lower in ecotones (Figs 1 and 2).

Figure 1 : Biomass of birch-aspen island spiders in particular months of the seasons (0,5 ha forest island with island water in depression) in inner and ecotonal parts of the island.



Spider biomass in inner part Spider biomass in ecotonal part

Figure 2 : Biomass of birch-aspen island spiders in particular months of the seasons (0,5 ha forest island, dry, on the elevation) in inner and ecotonal parts of the island.



Spider biomass in inner part Spider biomass in ecotonal part

The comparison of numbers and biomass of spiders in three forest islands by means of Student's test shows that the differences between inner and outer (marginal) parts are not statistically important in September - the month of the greatest densities of plant-living spiders. For other months there are statistical differences. There are similar statistical differences between inner and ecotonal parts in the same months, in both birch-aspen islands (Table 2).

Table 2 : Student's test for the numbers of spiders in inner and marginal parts of *Pino-Quercetum* island (n°4) and birch-aspen islands (n°6 and 7) wet and dry. (n.s. = not significant differences - s. = significant differences)

	4	6	7
05	n.s.	s.	s.
06	n.s.	s.	s.
07	s.	s.	n.s.
08	s.	n.s.	n.s.
09	n.s.	n.s.	n.s.
10	s.	n.s.	n.s.
11	n.s.	s.	s.

Otherwise than in my earlier research, I have not observed the edge effect in the general abundance of spiders, only in the number of species generally higher in ecotones in the same species-area relationships.

As regards spider species much more numerous in the ecotone are : *Araneus patagiatus* and *Araneus cucurbitinus* in birch-aspen ecotones, *Araneus sturmi* in mixed forest (*Pino-Quercetum*) and *Tetragnatha extensa*, *Linyphia pusilla* (rare), *Neottiura bimaculata* and, in general, *Enoplognatha ovata* in all forest islands examined.

In the inner parts of forest islands more numerous are *Meta segmentata* and *Linyphia triangularis*, *Linyphia montana*, *Gongylidium rufipes*, *Bolyphantes alticeps* and *Helophora insignis* - the only abundant species found exclusively in the inner parts.

The number dynamics of dominant species differ in inner and marginal parts of forest ecosystems examined (Figs 3, 4, 5).

The percentage of dominant species in the spider community is everywhere smaller in ecotones. Also the abundance of common species in inner and outer parts of forests is everywhere smaller in ecotones. So in these properties they are more varied.

Figure 3 : The number dynamics of dominant species in inner and ecotonal parts of the *Pino-Quercetum* island (1 ha). Explanations : other eudominants and lack of *Erigonidium graminicola* in the inner part of the island.

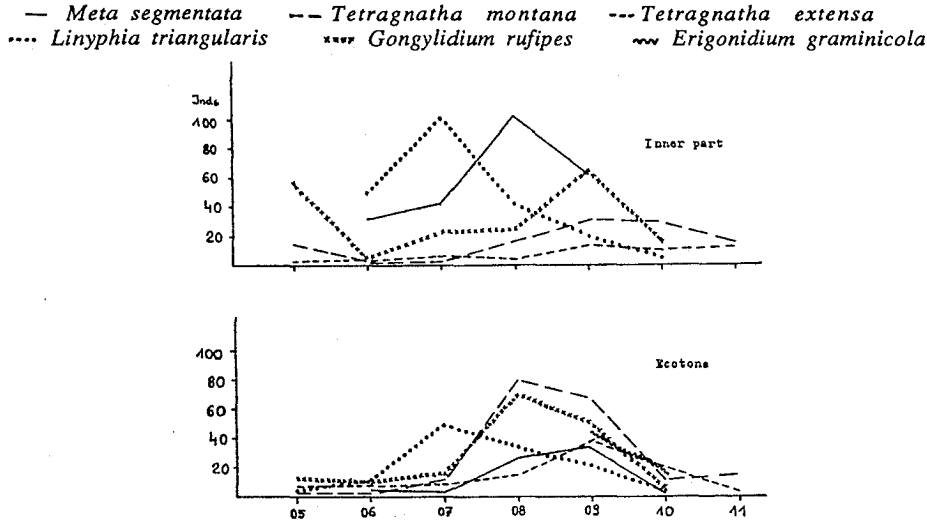


Figure 4 : The number dynamics of dominant species in inner and ecotonal parts of the wet birch-aspen island (0,5 ha). Explanations : lack of three dominant species in the ecotonal part of the island.

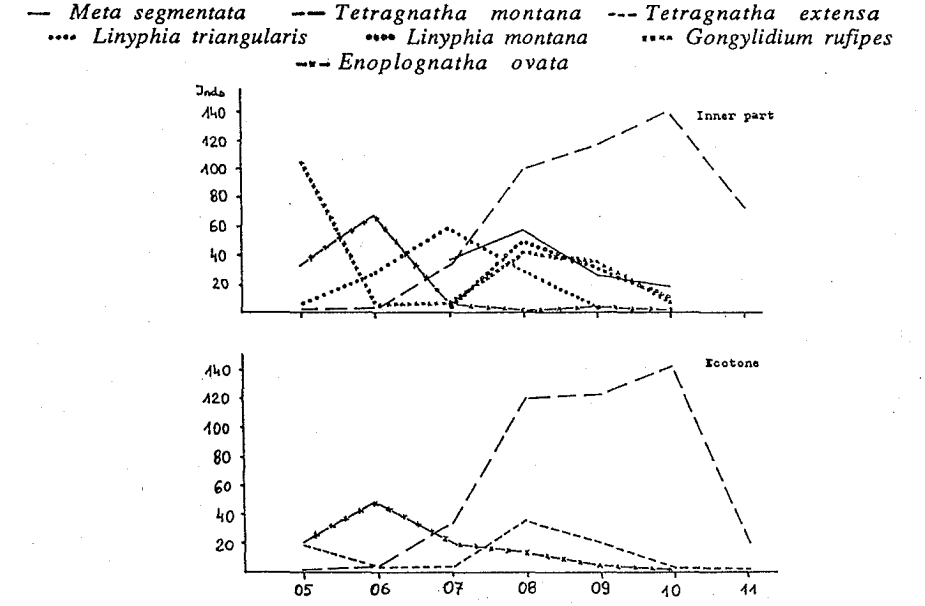
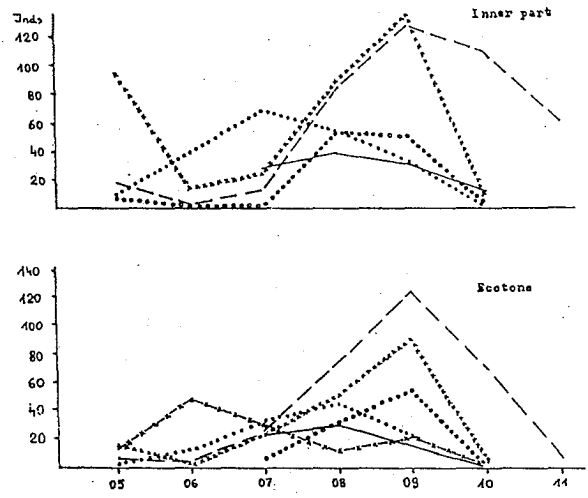


Figure 5 : The number dynamics of dominant species in inner and ecotonal parts of the dry birch-aspen island (0,5 ha). Explanations : lack of *Enoplognatha ovata* in the inner part of the dry birch-aspen island.



Conclusions

Our first results of the two-years research are an attempt to demonstrate two theses :

1. The ecotone is at the same time a habitat where many species live, feed and multiplicate during their whole life and a barrier zone preventing some species from spreading to adjoining ecosystems. Spiders of forest islands in fields are a good example of ecotone as a barrier. But the same ecotone is also a transition zone linking ecosystems because many animals such as birds, mammals and insects can pass through the ecotone zone to the neighbouring ecosystems. Ecotone acts like a sieve.
2. There are different types of ecotones depending on the quality of adjoining ecosystems with different ecological consequences as e.g. edge effect, and even in relation to the same species. In my research it is *Linyphia triangularis*, a most common and easily adopting species, which under some ecological circumstances prefers to create denser populations in the forest ecotone or in the inner part of the forest.

Ecotones are either strict habitats, relatively stable, gradually changing habitats or only boundaries between adjoining ecosystems ; they may be very large or very small.

Our projects for the next few years are not connected with the American Project and quite independant ; we want to prove these two theses by giving examples from insect, spider and prototoan groups and also from plant species and phytosociological associations. The general aim is to study the role of ecotones in the agricultural landscape divided into different smaller fragments (units).

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