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REPRODUCTIVE STRATEGIES AND SPATIO-TEMPORAL PATTERNS OF TERRESTRIAL ISOPOD POPULATIONS

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Introduction

Woodlice (Isopoda, Oniscidea) are the most successful invaders of terrestrial habitats among Crustaceans. This group of animals is worth for special attention in both biogeographical and ecological respects. Although their dispersion abilities are highly limited, they are widely distributed: their occurrence involves all kind of habitats from the sea through sea shores into the main land, some species are adapted even to desert circumstances. Isopods being a polyphyletic group have diverse life-history strategies adapted to life on land. Different structural, morphological, physiological and behavioural adaptations help them in possessing the mentioned wide variety of habitats. The most important among them are the development of brood pouch and pseudotracheae which mean high protection for their offspring and the possibility of air respiration, respectively. They also have a wide range of behavioural adaptations: they are able to follow the changes of the most important environmental factors by their diurnal, and seasonal rhythm. Their within habitat distribution is changing from time to time in accordance with environmental pressure. Humidity is of crucial importance in choosing their habitat. The existence of necessary humidity is the key limiting factor, more important than any other environmental factors (e.g. food resources, temperature).

Reproduction is perhaps the most important element of their diverse adaptation of life style. The timing, frequency of reproduction, the rate of reproducing females are varying among species within their iteroparous or semelparous reproduction strait. This variety which appears very often within species, among habitats, between different years within the same population, respectively, means a high plasticity.

The role of woodlice within biological communities stays in their decomposing activity. They feed generally on dead organic material, first of all on detritus. Their assimilation efficiency is rather low, their importance stays not really in the decomposition of dead plant material but in the exposure, breakdown or microorganism inoculation of that.

Woodlice appear practically in all habitat types due to their mentioned wide adaptation abilities. They can be found in cryptozoic microsites within the given habitat. To avoid desiccation — as main stress — they aggregate in so called shelter sites of high humidity.

Aims of the study

Three main problems were raised in the study. All of these concerns events on population level and their possible background factors on different scales.

(1) The first group of questions regarding the inner mechanism of populations:
- can we determine the actual reproductive potential of different species;
- is it possible to quantify the decrease in the number of offspring during the different phases of reproduction;
- are the intra- and interpopulational reproductive differences in connection with any environmental factor;
- what is the background mechanism of these population processes staying in?

(2) The second group of questions concern the dynamics of populations and communities:
- how can we describe the dispersion of certain isopod populations within a habitat, by which factors is it determined in the different geographical regions;
- how does the spatial distribution of populations depend on the heteromorphy of habitats;
- what is characteristic for population densities in the investigated habitat-types;
- do the certain population characteristics change in time (e.g. sexual rate, age group distribution, number of offspring);
- what is the composition of isopod communities look like at larger scale, in inter-habitat comparison;
- what are the qualitative and quantitative relations of communities determined by;
- is there any dependent relation between species, are there any real isopod assemblages?

(3) The third group of questions concerns the assemblages of macrodecomposer animals.

The next problems were raised on the basis of sampling in 29 habitats of Kiskunság region:
- is it possible to characterize the habitats by the composition of their decomposer fauna;
- can the habitats of same character be concentrated into groups on the basis of their similarity;
- how do the members of communities reflect the possible habitat heteromorphy?

Study sites and methods

In the frame of diversity monitoring and state assessments samplings were done on 29 sites in the southern part of the Great Hungarian Plain (Kiskunság, Békés regions) and in the Mediterranean region (North-Israel), respectively. These samples provided data not only for isopods but also for faunistic characterization of other epigeic macrodecomposer groups (Diplopods, Gastropods).

The phytocoenoses studied were all nature close, most of them under nature protection. In the case of three, typical lowland habitats regular samplings (for 1 or 2 years) provided the basic data sets.

Among sampling methods there were both pit-fall trapping, grid sampling and soil sample extractions corresponding to the particular aims. For evaluation of data sets different statistical methods, population and community characteristics were used: similarity evaluations by clustering (based on CHEKANOWSKI and JACCARD indices), computing correlations, χ^2 probe for testing the results and to investigate the species associations; SHANNON-WIENER diversity index and dispersion index for characterization of communities and spatial distribution of populations, respectively.

Female individuals were dissected to state reproductive characteristics, that is number and developmental stage of oocytes, embryos and mancas. The field data of three common species (*Trachelipus nodulosus, T. rathkei* and *Armadillidium vulgare*) were used for comparison of their reproductive periods.

The effects of photoperiod and temperature on *Porcellio ficulneus* were studied under laboratory conditions.

Summary of new scientific results

Reproduction

(1) The number of oocytes before vitellogenesis that is during a "resting" stage was stated in the case of 14 populations of 11 species using the technique of dissection. It was proved that the number of oocytes is increasing in accordance with the females' size not only within but also among species.

(2) Data were presented for the actual reproductive potential of isopods. From the number of oocytes in the ovary we can deduct to the number of future offspring. Under field conditions 80% of oocytes develop into fit descendants.

(3) The recognition and description of oosorption, the determination of it's rate is new for the literature in the case of isopods. It was proved convincingly by experiments that the effects of environmental factors may be effective through the process of oosorption. Oogenesis does not start under certain light/temperature conditions (here: 10 °C/ 10 h light). Both high temperature and prolonged light decreased significantly the length of the different stages of reproduction, but it caused the significant decrease of offspring numbers in all cases.

The structure and spatio-temporal changes of isopod populations

(1) The temporal fluctuations among years, the changes in abundance, spatial dispersion within habitats, changes in age structure and sex ratio of populations and their possible background factors were characterized. Both fluctuations, spatio-temporal and density changes are in accordance with microclimate fluctuations influenced by macroclimate. The size of shelter sites is also fluctuating being smallest during the most extreme summer period when the dispersion of woodlice within their habitat is usually highly aggregated.

(2) The seasonal spatial density replacements in a habitat and a possible diurnal migration of isopods among habitat patches was not mentioned before in the literature.

(3) It was stated that the sites of aggregation under our climatic conditions are marked by the size and placement of shelter sites differently to the "best quality food" theory under more equalized climate.

(4) The macrodecomposer taxa with epigeic activity (Gastropoda, Isopoda, Diplopoda) reflect environmental heterogeneity on the same scale as vegetation but on a different way: while isopods and diplopods indicate heterogeneity by their individual numbers, gastropods change also their species composition.

The distribution of terrestrial isopods at different scales

(1) By scale of distribution we may speak about "minidistribution", the distribution of certain species and their individuals within habitat patches, shelter sites;

(2) "microdistribution" means the dispersion of species within a habitat;

(3) "macrodistribution" is the distribution of species among similar and different habitat types within a geographical region;

(4) and the geographical scale what belongs already to the zoogeographycal categories. From ecological point of view the first three scales mean an operative method. The within-population processes need mini-, or microscales, while inter-population comparisons need a macro one.