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COMPARISON OF THE LIFE CYCLE HISTORY OF THREE OEDOTHORAX - SPECIES (Araneae, Linyphiidae) IN RELATION TO LABORATORY OBSERVATIONS

SUMMARY

The seasonal activity pattern of three Oedothorax-species (Oedothorax fuscus (Blackwall), O. retusus (Westring) and O. apicatus (Blackwall)) was registrated in three types of agricultural ecosystems near Ghent (Belgium), namely an intensively grazed pasture, an Italian ryegrass field and a maize field. The observed patterns of the three species are very similar and the combination of this information with the seasonal occurrence of juveniles, resulted in a reconstruction of the life cycle.

The first generation hatches from eggs laid in spring. Adults appear in the beginning of the summer and reproduction takes place during the whole summertime. The descendants of this generation become adult mainly in the autumn (a little part also just after winter). Copulation occurs before winter in O. fuscus and O. apicatus (male activity peak in the autumn). On the contrary, O. retusus, having its matural moult somewhat later in autumn, mainly copulates after winter (male activity peak in spring). They all produce cocoons in spring.

In the laboratory, the juvenile development of the three species was compared. O. fuscus develops a bit faster than O. apicatus, but this does not give rise to perceptible differences in the field. O. retusus has the slowest developmental rate. This explains the fact that the second generation becomes adult later in the autumn. A positive correlation is demonstrated between the developmental time and the size of the three investigated species.

INTRODUCTION

In Belgium five representatives of the genus Oedothorax Bertkau can be found. O. gibbosus (Blackwall, 1841), O. agrestis (Blackwall, 1853), O. fuscus (Blackwall, 1834), O. apicatus (Blackwall, 1850) and O. retusus (Westring, 1851). O. tuberosus (Blackwall, 1841) has recently been synonymised with O. gibbosus (DE KEER & MAELFAIT, in press) and is therefore removed from the list. The first two species, O. gibbosus and O. agrestis, are rather rare, occurring mainly in very damp and swampy areas (LOCKET & MILLIDGE, 1953; WIEHLE, 1960). The other three species are on the contrary very abundant in different habitat types.

O. retusus occurs in relatively humid pastures often close to water (KNULLE, 1953; PALMGREN, 1975; WIEHLE, 1960). The hygrophilous character of this species is however not

always proved. The species also occurs in dryer situations for instance several types of agricultural fields such as sugar-beet, potato and winterwheat (COTTENIE & DE CLERCQ, 1977; LUCZAK, 1974; THORNHILL, 1983).

O. fuscus is very abundant in different types of pastures (e.g. DE KEER & MAELFAIT, 1987b; TRETZEL, 1952) although the species can also be found in other habitat types. The species is also present on intensively managed agricultural fields but in this type of habitat the numbers are by far surpassed by O. apicatus (ALDERWEIRELDT, 1987; COTTENIE & DE CLERCQ, 1977; LUCZAK, 1974; THORNHILL, 1983).

In this contribution a general comparison is made between the life cycle patterns of these three Oedothorax species based on field and laboratory observations. TRETZEL (1954) and SCHAEFER (1976) already provided some general information concerning the life cycles of the species discussed here. For O. fuscus the life cycle pattern was recently studied in much more detail (DE KEER & MAELFAIT, 1987b).

MATERIAL AND METHODS

In this contribution three types of agricultural land are taken into account. In the first place an intensively grazed pasture (measuring 90 x 450 m) was sampled from February 1982 until February 1983 by means of ten pitfall traps. The traps used have a radius of 30.5 mm and a depth of 170 mm. They were emptied at weekly intervals. Secondly a maize field and an Italian ryegrass field (each approximately 10 acres large) were sampled in 1986. In each field centre, six pitfalls were installed (radius 44 mm and depth 90 mm). Guiding plates were used to increase the catching efficiency. They were emptied at fortnightly intervals. Due to the intensive agricultural management taking place on both fields, discontinuities occur in the registrated seasonal activity patterns. In 1986, ploughing, harrowing, etc. took place in April and October on the maize field and in October on the Italian ryegrass field (sown before winter). For all the traps a 4 % formalin solution was used for fixation with some detergent added to decrease surface tension.

All the studied plots belong to the Experimental Farm of the State University of Ghent (Faculty of Agriculture). This farm is situated at Melle, 15 km south-east of Ghent. More details of the studied area can be found in MAELFAIT et al. (1986).

To make the registrated seasonal activity patterns comparable, the year was divided into 24 time periods of 15.21 days and the catches conformably adjusted. For statistical analyses, the program package BIOM was used (ROHLF, 1985) accompanying the text book Biometry (SOKAL & ROHLF, 1981).

Rearing experiments were done in the laboratory at a constant temperature of 20 degrees Celsius where the spiders were kept in petridishes (ø = 35 mm). The first two instars were fed with Collembola of approximately the same size as the spiders. Other instars were fed with Drosophila melanogaster.

An excess of prey was always provided. The relative humidity was close to 100 %.

RESULTS

a) Comparison of seasonal activity patterns :

The catches of males and females of the three Oedothorax-species in the three agroecosystems are presented in fig. 1. These activity courses are in some cases based on small numbers and for certain time periods data are lacking from the agricultural fields. We can however recognize a similar pattern for every species (for O. fuscus, see DE KEER & MAELFAIT, 1987b). The simultaneous activity increase of males and females in July-August indicates an increase of the reproductive activities of both sexes of a first generation (search for a copulation partner by males and for food and suitable sites to lay off cocoons by females, see MAELFAIT & BAERT, 1975). The descendants (second generation) become adult in the autumn. The copulation takes place before winter (activity peak of males in autumn) but the females deposit their eggsacs only during the next spring (activity peak of females in spring).

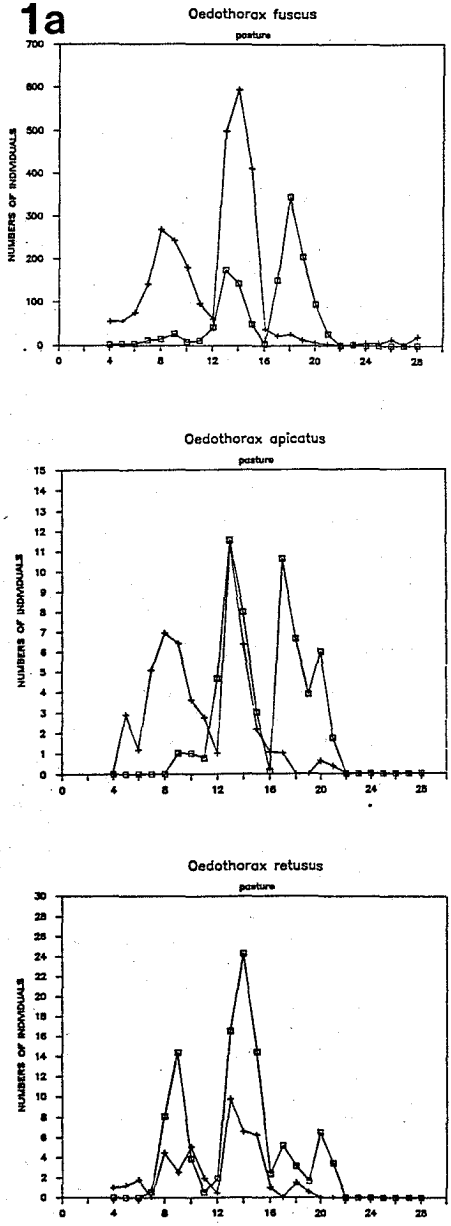
The activity peaks of males as well as females of the first generation (summer peak) arise at approximately the same time of the year for the three species. The activity peaks, considered as frequency distributions, were compared to the normal distribution with the KOLMOGOROV-SMIRNOV one sample test. The BARTLETT test was applied to see whether the variances of the different peaks are homogeneous. Our data meet the first assumption (normality) but seem to have heterogeneous variances. Therefore, all summer peaks were compared by using the GAMES & HOWELL method (test of the equality of means with heterogeneous variances, see SOKAL & ROHLF, 1981). It is clear that only certain comparisons make sense : comparison of the peaks of males and females within each species, of the peaks of males (or females) between the 3 Oedothorax-species within the same habitat and of the peaks of males (or females) observed in the maize field and the Italian ryegrass field within each species. Other combinations will not be discussed here, partly because meteorological conditions can influence the observed patterns of different years. On the other hand, it is clear that differences in activity of different species at different sites can be due to a combination of factors (influence of habitat, influence of species, influence of management, ...), making interpretations difficult. For almost all meaningful combinations, no differences could be shown ($p > 0.05$). Only the activity peak of males of O. apicatus observed on the maize field arises somewhat earlier than in the Italian ryegrass field ($p < 0.01$).

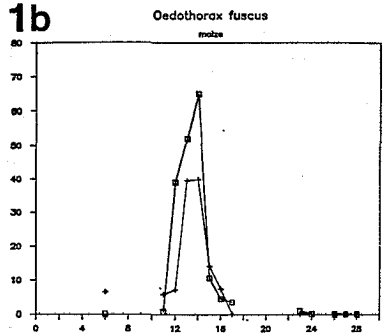
The activity peaks of the second generation can only be studied for the pasture. The patterns registrated on the agricultural fields are seriously disturbed by the intensive management practices taking place at that moment. The peaks of

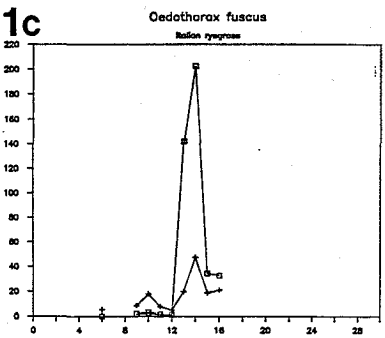
FIG. 1 : Seasonal activity patterns of Oedothorax fuscus (above), O. apicatus (middle) and O. retusus (below) in the three studied sites,

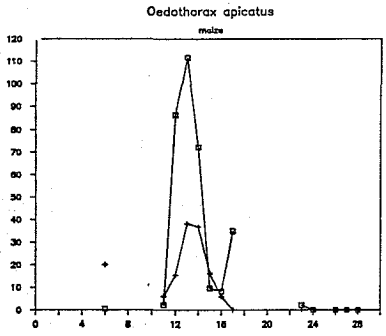
1a : the pasture,
1b : the maize field,
1c : the Italian ryegrass field.

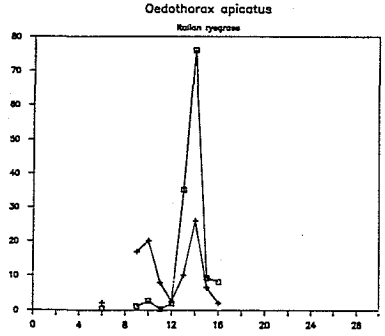
□ -□- □ = males,
+-+-+-+ = females.

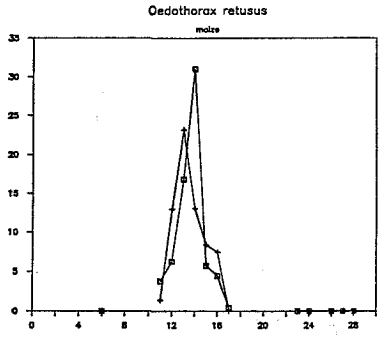


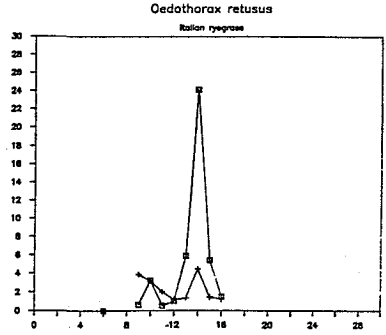

1b
Oedothorax fuscus
maize


1c
Oedothorax fuscus
Italian ryegrass


Oedothorax apicatus
maize


Oedothorax apicatus
Italian ryegrass


Oedothorax retusus
maize


Oedothorax retusus
Italian ryegrass

males in autumn are very similar for O. fuscus and O.apicatus. In contrast with these two species, males of O. retusus demonstrate low activity in the autumn, but they are mainly active in the spring. This is probably due to a longer developmental time of this last species. The males become adult later in the autumn (or even in summer) and less favourite meteorological conditions force them to wait till the next spring to copulate. The female activity peak for the three species arises in spring.

b) Laboratory observations on the juvenile development of the three Oedothorax-species.

For every species we determined the mean duration (± 95 % C.I.) of the juvenile development (defined as the period between hatching of the spiderlings and the matural moult) and the mean width in mm (± 95 % C.I.) of the carapace. The results are shown in fig. 2. The developmental time varies between 19 and 26 days. An obvious difference is found between the development of males and females within each one species, the males becoming adult some four days earlier than the females. The juvenile developmental times of the three species differ significantly. O. fuscus is the fastest species, reaching adulthood in 19.4 ± 0.4 days (males) and 23.7 ± 1.0 days (females). O. apicatus needs another 2 days to become adult (21.5 ± 0.4 days and 26.1 ± 0.5 days for respectively males and females) and O. retusus only reaches adulthood 22.6 ± 0.4 days (males) and 27.7 ± 0.8 days (females) after hatching. From fig. 2 we can deduce the existence of a close positive correlation between juvenile developmental time and carapace width, suggesting that the juvenile development, within this genus, largely depends on the size of the animals.

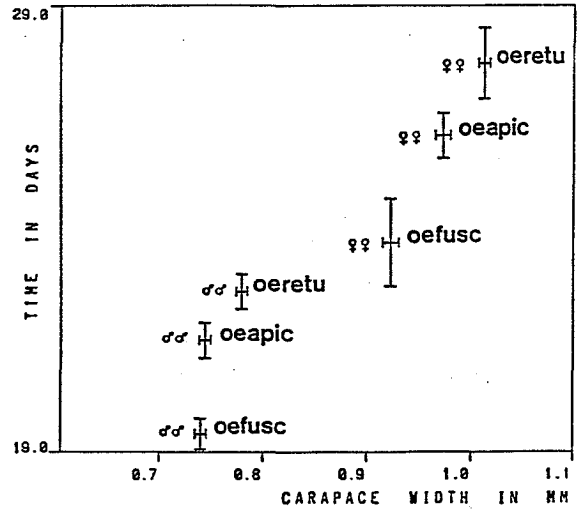


FIG. 2 : Juvenile developmental time in days (mean ± 95 % confidence limits) versus carapace width in mm (mean ± 95 % confidence limits) for the three Oedothorax species.

DISCUSSION

The differences in the activity patterns of the species we observe in the field are probably caused by differences in developmental time determined in the laboratory. The reproductive activity of the first generation seems to occur simultaneously for the three species. But due to the slower juvenile development of O. retusus, the males of the second generation of this species do not show serious activity in the autumn, like both other species, but after winter. The influence of temperature plays here an important role. Reproductive activity of O. fuscus (DE KEER & MAELFAIT, 1987a), O. apicatus (ALDERWEIRELDT, unpublished results) and most probably also O. retusus decreases drastically or even stops when temperatures are below 10 C. This means that when the second generation becomes adult late in the autumn (cfr. O. retusus) the low temperatures prevent them to be active at that moment. Obviously, this retardation of the copulation does not influence the time of cocoon production of the second and also of the first generation (we do not observe differences in the activity peak periods of the females). All females of the second generation have to wait in the spring till the temperatures are high enough to lay off cocoons. At that time of the year, the life cycle of the three species synchronizes.

A striking difference between the catches of the three studied agroecosystems is the observed sex ratio of O. fuscus. MAELFAIT & BAERT (1975) already noted that males disperse over a larger area than females during the reproductive period. They are frequently found outside their typical habitat, while females are more restricted to areas where they can find a sufficient food supply and suitable sites to deposit eggs. In this way the sex ratio gives an idea of the suitability of the habitat for the species concerned. Considering the peaks of the first generation, we see that O. fuscus females are much more caught than males (more than three times) in the pasture, while in the agricultural fields females are less abundant in the pitfalls than males. This may be due to the drastic disturbance (ploughing, harrowing, sowing, ...) happening on both fields. This management takes place during the reproduction peak of the second generation on the maize field, probably destroying most individuals and eggs. The first generation is most probably made up of individuals coming from less disturbed areas, such as the edge zones (cfr. ALDERWEIRELDT, 1987). The Italian ryegrass field is plowed in the autumn. During the winter and in early spring the second generation can colonize this field and reproduction can take place here in the spring. Due to this difference in management and due to the comparable vegetation structure between Italian ryegrass and pastures (where O. fuscus is very abundant), this crop is probably more easily colonized by males of O. fuscus during their search for copulation partners than maize. Indeed, higher numbers are caught in the Italian ryegrass field as compared to the maize field.

On the other hand O. apicatus is mainly caught on the maize field and O. retusus shows no clear preference. The high potential of O. apicatus to colonize pioneer habitats such as different types of highly cultivated crops is known (GACK & KOBEL-LAMPARSKI, 1984; THORNHILL, 1983).

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