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Ecological backgrounds for the distribution patterns of *Oedothorax fuscus* (Blackwall) and *Oedothorax gibbosus* (Blackwall) (Erigoninae, Araneae)

by R. DE KEER & J.-P. MAELFAIT

Summary

The distributions in Belgium of two congeneric species, *Oedothorax fuscus* and *Oedothorax gibbosus*, are compared. *O fuscus* is very common whereas the distribution of *O. gibbosus* is rather patchy. Possible explanations for this difference are proposed and further investigated : (1) the life cycle of both species is very different, (2) *O. gibbosus* is dependent on wet conditions, and (3) the quality of the water is very important for *O. gibbosus*. Based on field and laboratory observations we could show that the resistance to dry conditions and the quality of the water near which the species live are important factors influencing the distribution of these spiders.
Key-words : Araneae, distribution, life cycle, resistance to dryness, water quality.

Samenvatting

Ecologische achtergronden van het voorkomen van *Oedothorax fuscus* en *Oedothorax gibbosus* (Linyphiidae, Araneae) in België
Er wordt gezocht naar de fundamentele oorzaken van de beperktere verspreiding van *O. gibbosus* vergeleken met die van *O. fuscus*. Hierbij worden 3 mogelijkheden onderzocht : (1) de levenscyclus van beide soorten is sterk verschillend, (2) *O. gibbosus* is minder bestand tegen de droogte en (3) *O. gibbosus* stelt strengere eisen aan de kwaliteit van het water. Aan de hand van veldwaarnemingen en enkele laboratorium-experimenten wordt aangetoond dat de vochtigheid van het milieu en de kwaliteit van het water twee belangrijke factoren zijn die de verspreiding van deze spinnesoorten beïnvloeden.
Trefwoorden : Araneae, verspreiding, levenscyclus, droogteresistentie, waterkwaliteit.

Introduction

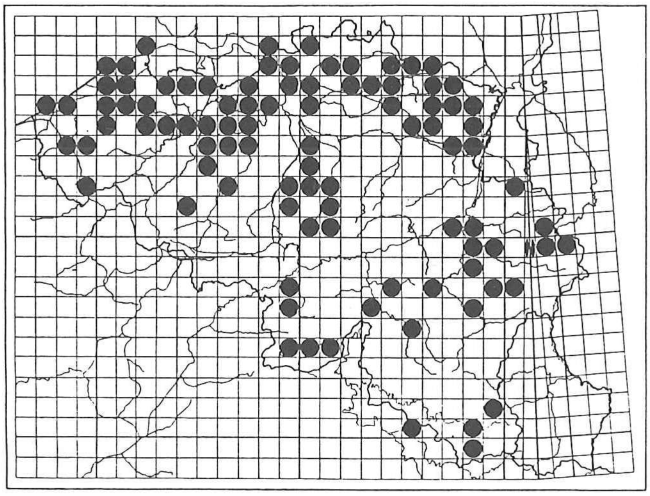
Oedothorax fuscus (BLACKWALL) and *Oedothorax gibbosus* (BLACKWALL) are Linyphiid spiders. Like all members of this family these spider species have a small size (approximately 2 mm) and live on the bottom surface, where they feed on small insects, especially springtails. In contrast with the majority of the species belonging to this familie they do not make use of a web to catch their prey. *O. fuscus* is a very widely distributed species, occurring in all kinds of open habitats, provided they are not too dry. *O. gibbosus* has a much more restricted occurrence. It can be found in low productive, wet grasslands and marshes. These wetland habitats have become very scarce in our country.

The purpose of this communication is to illustrate how we search for the more fundamental reasons behind these differences in distribution pattern. As demonstrated by earlier investigations, ecophysiological data can contribute to a better understanding of the distribution patterns of closely related species (ALMQUIST, 1970, 1971; ENGELHARDT, 1964; NORGAARD, 1951). In applied ecological research we think such kind of investigations to be necessary in order to understand better the factors threatening our fauna and flora. Such knowledge can offer a base for measures to be taken in order to prevent further degradation of our fauna.
In order to find out which are the more fundamental causes of the difference in distribution of both species we have up to now investigated the following possibilities :
1. The life cycle strategies of both species differ strongly. From earlier investigations (DE KEER & MAELFAIT, 1987a) it is known that *O. fuscus* has very fast development and reproduction rates. These enables the species to survive in habitats that are regularly disturbed or destroyed (pastures, arable fields). It is supposed that *O. tuberosus* has a much slower reproduction rate and is therefore dependent on stable environmental conditions.
2. *O. gibbosus* is possibly less resistant to desiccation and is therefore limited in its occurrence to very wet habitats.
3. *O. gibbosus* requires very clean water. Because this species occurs in habitats which frequently flood during winter, it is thinkable that the quality of that water is important for the overwintering of that species.

Material and methods

A detailed description of the methods used can be found in : DE KEER & MAELFAIT, 1987a, b; MAELFAIT et al., 1986. Only a short characterization is given when discussing the separate results.

Oedothorax fuscus



Oedothorax gibbosus

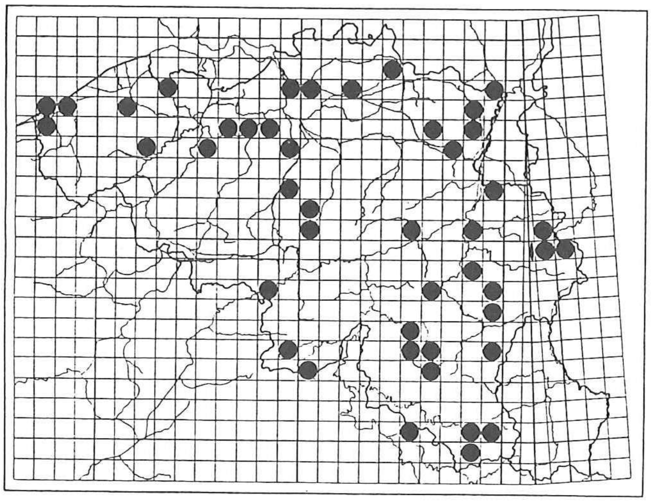


Fig. 1 : Distribution map of Oedothorax fuscus *and* O. gibosus *in Belgium.*

Results and discussion

To compare the occurrence of both species objectively we made up the distribution maps of records gathered by Dr. L. BAERT, Koninklijk Belgisch Instituut voor Natuurwetenschappen (fig. 1). The distribution map is, certainly for *O. fuscus*, still very incomplete. This results from a more general bias in the gathering of distribution data for invertebrates. More natural sites are sampled more intensively than agricultural and urban habitats. This often results in an underestimation of the commonness of species surviving in these man made habitats.

A first ecological character we compared is the seasonal activity pattern of both species. From earlier investigations we know how this pattern of *O. fuscus* has to be interpreted (see fig. 2). In figure 2 we also indicated when subadult and newly emerged adults were found. A first generation gets adult in June. The synchronous activity peak of males and females during July and August reflects that reproduction is going on. The male peak is the result of the search for copulation partners, females are active to lay off eggs. Eggs are found at the end of July and during August. These eggs give rise to a second generation, which gets adult in autumn. The males of that generation develop an activity which means that copulation occurs. The females of that cohort, however lay off their eggs only after winter.

We dispose of two year cycles of pitfall sampling for *O. gibbosus* (see fig. 3). In a marsh in the Gaume (BAERT et al., 1983), we find one clear activity peak in May. In a wet grassland at Bornem (Antwerp) (HUBLE, unpublished data), two peaks are found. It is possible that those peaks also imply two generations. To be sure, however, more observations are needed.

To learn more about life cycle differences we have studied juvenile development and reproduction of both species under laboratory conditions. In fig. 4 we have plotted the duration of juvenile development for three temperatures. For both species development is very fast at 20 C. Females of *O. fuscus* need 24 days to get adult, *O. gibbosus* females about 29 days. At lower temperature, development goes much slower. Below 20°C no individual gets adult. Development is thus for both species quite comparable.

Figure 5 shows the cumulative reproduction in function of the number of days after reaching the adult stage and that at 20°C. Reproduction of *O. fuscus* is, although not statistically significant, sowewhat higher than that of *O. gibbosus*. During the same time interval *O. fuscus* produces more cocoons than the other species. The number of eggs per cocoon is smaller. It seems plausible that this is an adaptation to a more unstable habitat. Fastly produced small cocoons would let the species reproduce during short periods between tho disturbances. In fig. 5 reproduction in function of time is plotted also for 15°C. At that lower temperature the reproduction of *O. gibbosus* is higher than that of *O. fuscus*. This is mainly caused because it takes *O. fuscus* longer to produce its first cocoon.

We thus have to do here with two very similar ways of reproduction. That is of course what we expect for two

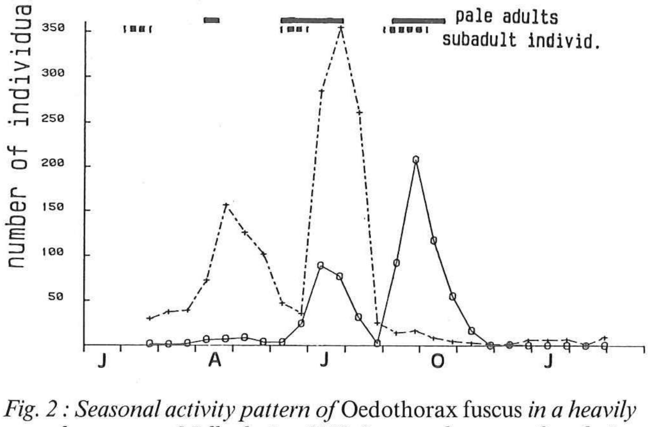


Fig. 2 : Seasonal activity pattern of Oedothorax fuscus *in a heavily grazed pasture at Melle during 1982 (— : males, ----- : females).*

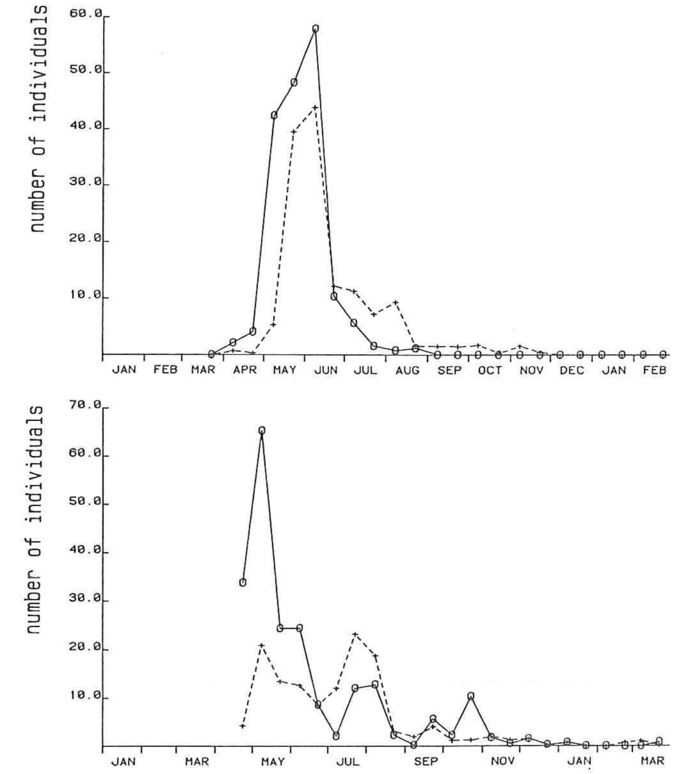


Fig. 3 : Seasonal activity pattern of O. gibbosus *in a marshland at Buzenol (the Gaume, 1981) (upper) and in a wet graasland at Bornem (Antwerp, 1982) (lower) (— : males, ---- : females).*

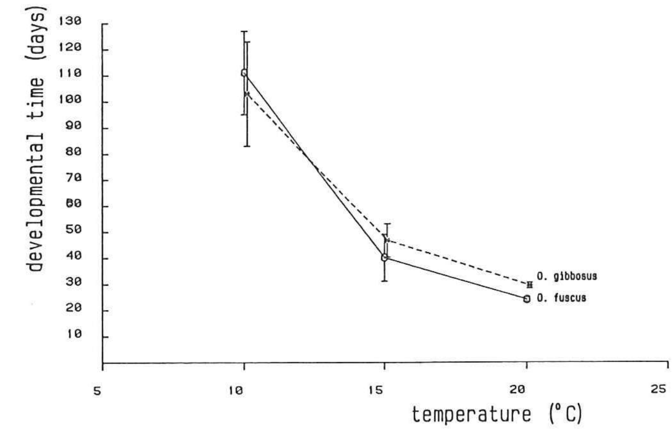


Fig. 4 : Duration of the total juvenile development (? 95$ C.I.) for three different temperatures.

congeneric species. There are however small differences. At higher temperature *O. fuscus* has a higher juvenile developmental rate than *O. gibbosus*. This is not valid any more at lower temperature. For this temperature *O. gibbosus* produces significantly more eggs than the other species. These seem to be adaptations linked to the specific habitat choice of those species. *O. fuscus* seems to be better adapted for reproduction in open habitats (at higher temperatures). On the contrary, *O. gibbosus* reproduces better at lower temperatures. This agrees with the temperatures we expect in the habitat of that species : between higher vegetation and close to water. The same phenomenom was observed by ENGELHARDT (1964) and HALLANDER (1970) : species with higher rates of water loss prefer places with lower temperatures (and higher relative humidity).

Another factor that we investigated is the resistance to desiccation. Of each species 10 individuals were each placed on a petri dish that was kept above a saturated solution of $Ca(No_3)_2$. Under these conditions, relative humidity is approximately 55%. Every hour the number of surviving animals was counted. There is a pronounced difference between both species. As can be seen in table 1 all individuals of *O. gibbosus* had died within six hours. The first individual of *O. fuscus* dies after 10 hours only. *O. gibbosus* is thus also physiologically bound to wetter places.

With a last experiment we investigated whether the quality of the water could play a role in the occurrence of both species. We know for instance that *O. gibbosus* occurs together with *O. fuscus* in a wet grassland in the rivulet valley "Zwarte Beek" (Koersel, Limburg), but not in a, at first sight, very similar wet grassland in "De Bourgoyen" (near Ghent), although *O. fuscus* occurs there in large numbers. We set up a number of experiments with water coming from each of both sites. A number of glass jars were for three quarters filled with water of each of both sites. In the middle of the water a thin plastic bar was placed. Going into the water could eventually occur with the aid of the bar which simulates a grass stem. A female was then placed on the water surface. The bottles were placed at a temperature of 5° C to simulate winter conditions. We determined (1) how long it takes before the individual sinks and (2) how long it survives under water.

The results of these experiments are summarized in table 2. The number of days before submerging varies largely. There seems to be no differences between the species and between the two water qualities. The number of days the animals survive under water is clearly dependent on the kind of water used. *O. gibbosus* as well as *O. fuscus* survive in the mean some 10 days in the water from the "Zwarte Beek", whereas they already die after a few days in the water from the "Bourgoyen Ossemeersen". *O. gibbosus* is the most sensitive to this last kind of water. That may be one of the reasons for its absence there. Although *O. fuscus* is only little less sensitive that may not be so crucial for its distribution because this species does not occur in the immediate vicinity of water.

We thus can conclude that humidity and the quality of the water near which they occur most probably are important factors influencing the distribution of the studied spider species. Other factors not investigated here may also play a role. One of them may be the aeronautic behaviour of *O. fuscus* by which this species can rapidly recolonize areas in which it disappeared after a heavy perturbation. Another phenomenon that may be of importance is that there are two morphs in the males of *O. gibbosus* (DE KEER & MAELFAIT, 1988). That population genetic character may also influence the habitat binding of the species. Further investigations are however needed to explore that further.

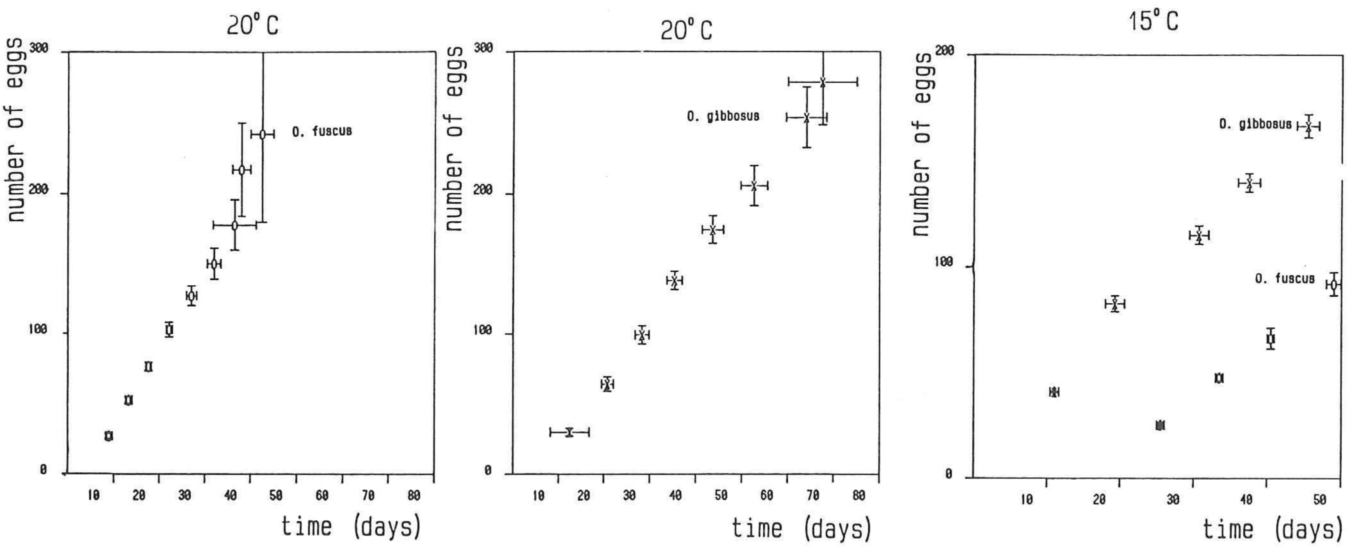


Fig. 5 : Cumulative reproduction versus time for O. fuscus *and* O. gibbosus *at 20 C (upper) and 15 C (lower).*

Table 1 : Survival of Oedothorax fuscus and O. gibbosus females at a relative humidity of 55.5 %.

	initial number of individuals	number of individuals that survives after 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 hours
O. fuscus	10	10	10	10	10	10	10	10	10	10	9	7	7	3	3	0
O. gibbosus	10	10	8	4	1	1	0	0	0	0	0	0	0	0	0	0

Table 2 : Number of days before sinking and number of days under water before death for O. fuscus and O. gibbosus.

	number of days before the spider sinks	number of days under water before the spider dies
O. fuscus		
water Zwarte Beek	8.5 ± 2.7	9.8 ± 1.2
water Bourg. Ossem.	6.0 ± 2.0	4.4 ± 0.8
O. gibbosus		
water Zwarte Beek	4.7 ± 2.0	10.3 ± 3.8
water Bourg. Ossem.	13.8 ± 11.6	2.2 ± 0.4

Acknowledgements

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