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Wolf spiders (Araneae: Lycosidae) on the overgrowing peat bog in Dubravica (north-western Croatia)

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Abstract: Wolf spiders (Araneae: Lycosidae) on the overgrowing peat bog in Dubravica (north-western Croatia). The peat bog in Dubravica is of spread interest due to its overgrowing by the process of natural succession, causing the habitat to become dryer and shadier. The dominance structure and phenology of wolf spiders on the Dubravica bog was studied. The spiders were collected during the period 09.04.-9.10.1995, using 20 pitfall traps. Altogether 10 lycosid species were found among 723 adult individuals. For six more abundant species phenology graphs are presented. Three species are found to be eudominant: *Pardosa lugubris, Trochosa spinipalpis* and *Hygrolycosa rubrofasciata.* The lycosids habitat preferences and dominance structure according the habitat condition and species occurrences on some other European bogs are discussed. 55,2 % caught specimens are hygrophilous species, and only 7,6 % are photophilous. The lycosid fauna and dominance structure does reflect the habitat condition. As overgrowing is not fully progressed yet, the lycosid fauna of this bog is still relatively bog-characteristic.

Key words: Lycosidae, peat bog, overgrowing, phenology, aggregation, Croatia

INTRODUCTION

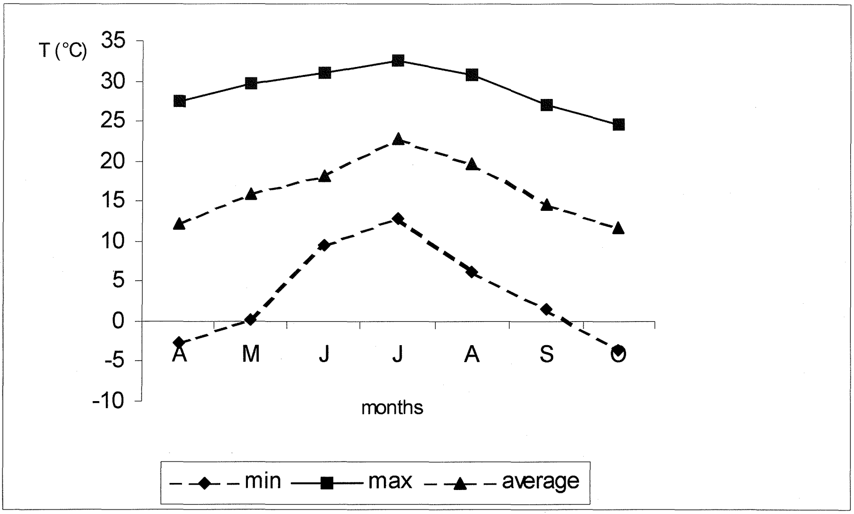
Bogs, mires and fens are relicts in Croatia, rare and exceedingly localised habitats (ILIJANIĆ 1996). The peat bog in Dubravica is an endangered and protected landscape, and has carried the status of a botanical reservation since 1966. During the last 50 years the area of the peat bog has significantly decreased. Surrounding alder and alder buckthorn seedlings have been slowly overgrowing the bog, changing the habitat in the process of natural succession. When communities change, abundance of species, whose demands are in accordance with the newly establishing conditions, increase. For groups of species whose demands correspond to the previous condition of the habitat decreasing of abundance takes place (RŮŽIČKA & ANTUŠ

1989). In accordance, with overgrowth of the bog the proportion of photophilous or peat bog species decrease in favour of scotophilous (often forest) ones (SCHIKORA 1994, KUPRYJANOWICZ et al. 1998).

For monitoring the situation and changes of bog habitats composition and abundance of dominant spider species (often lycosids) provide useful data (KOPONEN 1979, SCHIKORA 1994). Lycosidae are one of the dominant group of epigeic active Araneae. Light and moisture are two important abiotical factors limiting their abundance (TRETZEL 1952). The objectives of this paper were to establish the fauna of wolf spiders on this bog, and to investigate in what way the spider species dominance and abundance reflects the habitat condition. We also wanted to compare occurrence of lycosid species on this bog and some other European bogs (concerning the habitat requirements) and to contribute to the knowledge of the phenology and biology of some lycosid species. Furthermore, this is the first contribution to the arthropod fauna of Dubravica bog.

STUDY SITE

The bog in Dubravica is one of the most southern studied in Europe. The bog is located in sessile oak and hornbeam forest (association *Epimedio-Carpinetum betuli* (Ht38) Borh.63) near the village of Dubravica (45°57‘ N and 15°45‘ E) at an altitude of 160 m. The inclination of the bog‘s surface is 4-5° with a north-western exposure. At the location where the bog of 1630 square meters was found by HORVAT (1939), only a small bog of 605 square meters was in 1994 (HRŠAK 1996). The purple moor grass (*Molinia caerulea*) and peat moss (*Sphagnum subsecundum*) are the most dominant plant species. The alder and the buckthorn bushes are overgrowing the bog, changing the habitat slowly into the bushes, and possibly into the forest (site description according to HRŠAK 1996). The average monthly temperature and precipitation are given in Fig. 1.



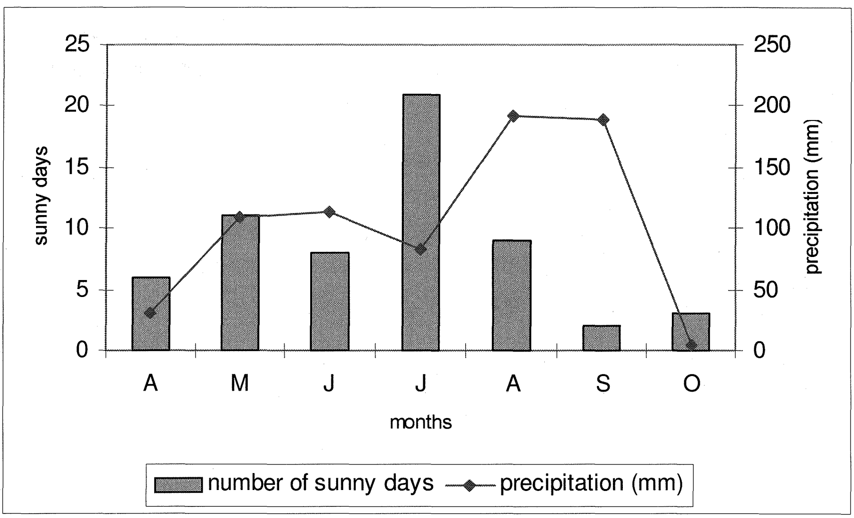


Fig. 1: a) Monthly temperature b) Precipitation and number of sunny days

MATERIAL AND METHODS

The material was collected with 20 pitfalls exposed during 5 months, from 9th April to 9th October 1995, dates coincident approximately with the growing season. Traps were emptied at 28.04., 14.05., 27.05., 17.06., 11.07., 05.08., 01.09., 20.09. and 09.10. Pitfalls were plastic cups (diameter 8,5 cm and 12 cm deep) set randomly across the whole bog area at 4-5 m spacing, each filled with 1,5 dl of mixture of water, formalin and EtOH as a preservative. In this paper we deal only with data on adult spiders. In the estimation of species dominance and seasonal dynamic we present numbers of adults in one pitfall per day (x100), as number of days and operating pitfalls were different during each exposure period. Dominance of each lycosid species was calculated as a percentage of all adult spiders. Morisita index of aggregation is calculated after KREBS (1989).

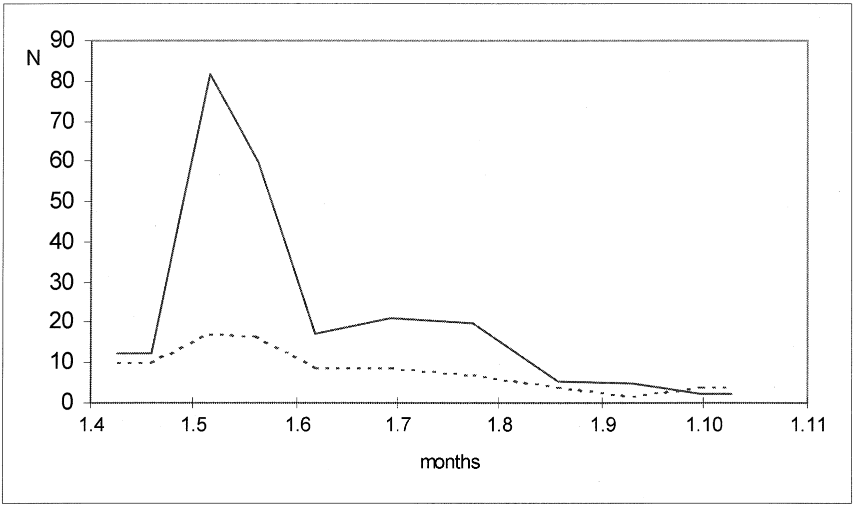
Because of the variability in morphology we did not determine the females of the genus *Trochosa* to the species level and we have calculated the average number of individuals of both *Trochosa* species according to the number of males. Data on females of both species are presented together.

RESULTS AND DISCUSION

Altogether 994 adult spiders were caught, within 72,7 % (723) were wolf spiders (Araneae: Lycosidae), among which ten species were found. The dominance of lycosids in the material varied from 38,1% to 82,8% throughout the season (Fig. 2). The abundance of other spiders did not vary in such extent. Their activity was slightly higher in spring.

Notes on species (given in dominance order with the dominance values in brackets)

Pardosa lugubris (Walckenaer, 1802) (23,8%) is a euryvalent forest species that often occurs on the habitats edging forests (THALER 1996). It is occasionally found on some wet habitats including bogs as well (FREUDENTHALER 1989, KUPRYJANOWICZ et al. 1998, KAJAK et al. 2000).



Legend: ————Lycosidae - - - - - - - other spiders
N- Average number of spiders in pitfalls per day x100

Fig. 2: Dominance of lycosids and other spiders trough trapping periods

Trochosa spinipalpis (F.O.P.-Cambridge, 1895) (18,8%) is a highly stenotopic species (BUCHAR & THALER 1995), usually inhabiting European peat bogs (KOPONEN 1979, SCHIKORA 1994, 1997, THALER 1996, KUPRYJANOWICZ et al. 1998, KAJAK et al. 2000, KOMPOSCH 2000). This is the third record for Croatia (NIKOLIĆ & POLENEC 1981, RUCNER & RUCNER 1995).

Hygrolycosa rubrofasciata (Ohlert, 1865) (15,8 %) commonly inhabits swampy alder forest. It is also found on bogs in Europe (BUCHAR & THALER 1995, KRONESTEDT 1996, KAJAK et al. 2000), often preferring shady habitats (SCHIKORA 1997, KUPRYJANOWICZ et al. 1998, KOPONEN et al. 2001). This is the first record of *H. rubrofasciata* in Croatia, and it is the most southeastern record in Europe. It has not been found in Slovenia (NIKOLIĆ & POLENEC 1981, KUNTNER & ŠEREG 2002), there is one record in northern Austria (BREUSS 1996), but it is distributed in southern Hungary (SZINETAR 2001). The hitherto most southern record in Europe is in northern Spain (PÉREZ ACOSTA 1914). *H. rubrofasciata* has, as eudominant species on Dubravica bog (but not widely distributed in this region) certainly found suitable ecological parameters in this habitat.

Pirata hygrophilus Thorell, 1872 (4,6%) is a typical species for alder forest (KOPONEN 1979), but it has been found on *Sphagnum* as well (KOPONEN 1968, CASELIUS & ITÄMIES 1993, KUPRYJANOWICZ et al. 1998). It prefers habitats with low evaporation, low temperature, and low light values (RENNER 1986). As both *H. rubrofasciata* and *P. hygrophilus* are alder forest species, it is not likely that their abundances would be negatively affected by a change of the habitat into an alder forest.

Alopecosa pulverulenta (Clerck, 1757) (4%) is a photophilous species that prefers meadow like vegetation and open habitats (ITÄMIES & RUOTSALAINEN 1985). It has been also frequently reported from peat bogs (FREUDENTHALER 1989, KRONESTEDT 1990, RŮŽIČKA & VANEK 1997, KAJAK et al. 2000, KOPONEN et al. 2001), often in greater abundance on open sites, or dry places close to the bogs (KOPONEN 1979, ITÄMIES & JARVA-KÄRENLAMPI 1989, KUPRYJANOWICZ et al. 1998).

Trochosa terricola Thorell, 1856 (4%) is a forest species noticed in smaller abundance on some bogs regularly (FREUDENTHALER 1989, KUPRYJANOWICZ et al. 1998, KOMPOSCH 2000) or immigrating from the nearby forest (KOPONEN et al. 2001).

Aulonia albimana (Walckenaer, 1805) (0,7%) usually prefers dry open habitats (THALER & BUCHAR 1996), but is also recorded on some peat bogs (FREUDENTHALER 1989, KOMPOSCH 1995), even as dominant species (KOPONEN et al. 2001).

Pardosa amentata (Clerck, 1757) (0,6%) is a hygrophilous species that favors open, light areas (CASELIUS & ITÄMIES 1993). Although not characteristic for bogs, it is often found on moist meadows (ITÄMIES & RUOTSALAINEN 1985, THALER 1996). One of the reasons for limited abundance of this species, as well as for smaller abundance of *A. pulverulenta* is clearly the shadiness of the bog.

Pirata uliginosus (Thorell, 1856) (0,2%) is a stenotopic species (THALER 1996), with clear preferences for *Sphagnum*. It is interesting that this species was subrecedent on Dubravica bog, while it is one of the characteristic and often abundant species on some other European peat bogs (DAHL & DAHL 1927, KOPONEN 1979, FREUDENTHALER 1989, THALER & BUCHAR 1996, SCHIKORA 1997, KAJAK et al. 2000, KOPONEN et al.

2001). This species prefers habitats with high temperature and high light values (RENNER 1986). Still, it is not certain if the low abundance of this species is connected with the overgrowing of the bog, since it is also found on shady wet habitats as well (BREYMEYER 1966a, KUPRYJANOWICZ et al. 1998), and SCHIKORA (1994) found *P. uliginosus* after overgrowing of a bog even in greater number. BAEHR & EISENBEIS (1985) suggest that *P. uliginosus* is less hygrophilous than *P. hygrophilus*, which is far more abundant in our material. This means that possible dryness caused by overgrowing is not the probable cause for its small abundance, either. Also, bogs inhabited by *P. uliginosus* are geographically widely distributed with different temperature conditions. So it could be that *P. uliginosus* is so rare on this bog due to some biotic factors (competition or predatory interaction). This is the third record of *P. uliginosus* in Croatia. It is already found more southern in Istria and eastern in Slavonija (RUCNER & RUCNER 1995). *Arctosa maculata* (Hahn, 1822) is a singleton species in our material. It usually lives under the stones on freshwater shores (BUCHAR & THALER, 1995) and we assume that one male caught in early summer came from the brook distanced app. fifty meters of the bog, and that this species does not normally inhabit the peat bog. It is not usually reported from European peat bogs either.

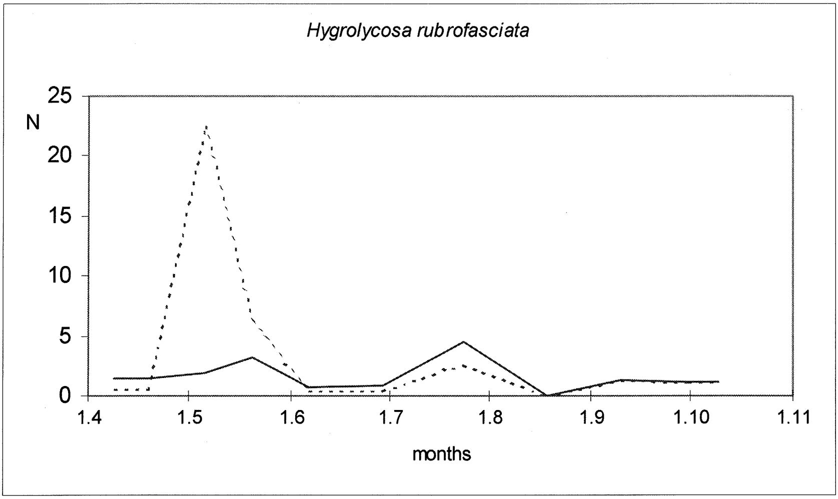
Altogether, five of the ten species found commonly inhabit European peat bogs; none of them is bog specific. Additionally, two eurytopic and one xerophilic species occasionally inhabit European peat bogs, one species is characteristic for moist meadows, and one is accidentally caught. The typical European peat bog lycosid species *Pardosa sphagnicola* was not found on this habitat, probably due to its more northern distribution.

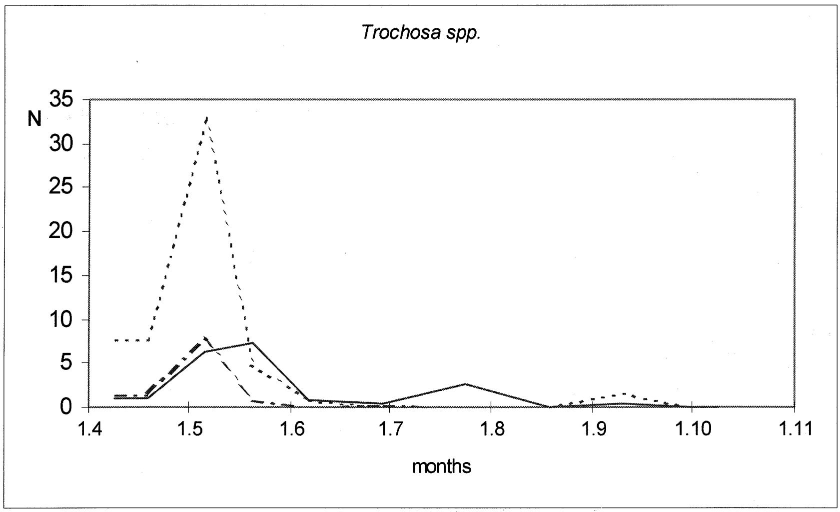
Shady peat bogs are often characterized by a low proportion of peat bog and photophilous species and high proportion of forest species; all peat bogs are characterized by a relatively high proportion of hygrophilous species (KUPRYJANOWICZ et al. 1998). The predominance of photophilous species is a typical feature of the terrestrial spider fauna on pristine bog biotopes (SCHIKORA 1994). Only 7,6 % of the caught lycosids are photophilous (*A. albimana*, *A. pulverulenta*, *P. amentata* and *P. uliginosus*). In accordance with the shadiness of the habitat none of them is among the dominant species. However, it is not sure if the small abundance of photophilous species is caused by the purple moor grass, which certainly decreases the insolation during the period from June to September, or if it is caused strictly by the presence of the alder and alder buckthorn bushes. Hygrophilous species are *T. spinipalpis, H. rubrofasciata, P. hygrophilus, P. amentata, P. uliginosus and A. maculata,* comprising 55,2% of all the lycosids. This indicates that the exsiccation of the bog is still not quite progressed.

Phenology

Phenology is presented (Fig 3.) only for six subdominant to dominant species (over 2 %), when data were substantial for some phenological conclusions. Males were generally active through a shorter period than females, usually with higher peaks, which are considered to be the time of copulation (BREYMEYER 1961). Their activity during summer and autumn was only sporadic. Females are known to lay eggs app. two weeks after copulation; they carry the egg-cocoon for six weeks and than the hatched juveniles for about one week on their backs (EDGAR 1971). For the more abundant species all of these events could be tracked in phenology pattern.

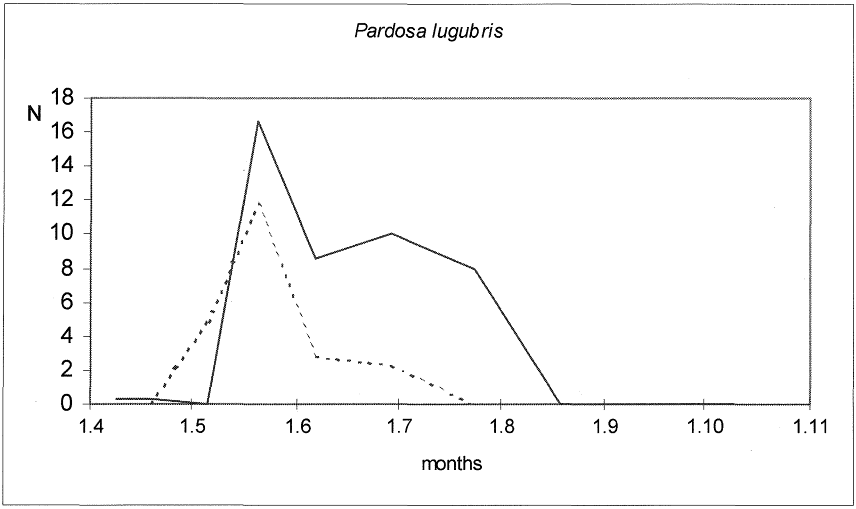
Trochosa spp. and *H. rubrofasciata* show the same pattern of phenology (Fig. 3.). In one short period (the first half of the May), there was the highest peak in abundance due to increasing activity of males. The onset of activity is surely influenced by the temperature conditions. This results in the same onset of activity of *Trochosa spp.* and *H. rubrofasciata*, which all overwinter as adults. Low number of females of all these species in traps in June indicate a period when females carrying the egg sacs decreased their activity. They were spending most of the time in a burrow in the ground (FUHN & NICOLESCU-BURLACU 1971). Their activity increases afterwards, what is probably the period of hatching juveniles, when females leave the burrow. The phenology of two *Trochosa* species was very similar. These are diplochronus species, but a second copulation period, noticed by some authors (BREYMEYER 1961) was not observed. *H. rubrofasciata* was the last species found to be active in autumn (October), and this was because of the appearing of a new generation of adults in autumn, which will mate during the next spring (KRONESTEDT 1984). The phenology pattern of *Trochosa spp.* and *H. rubrofasciata* coincide with other data of authors (BREYMEYER 1966b, FREUDENTHALER 1989, KÖHLER &

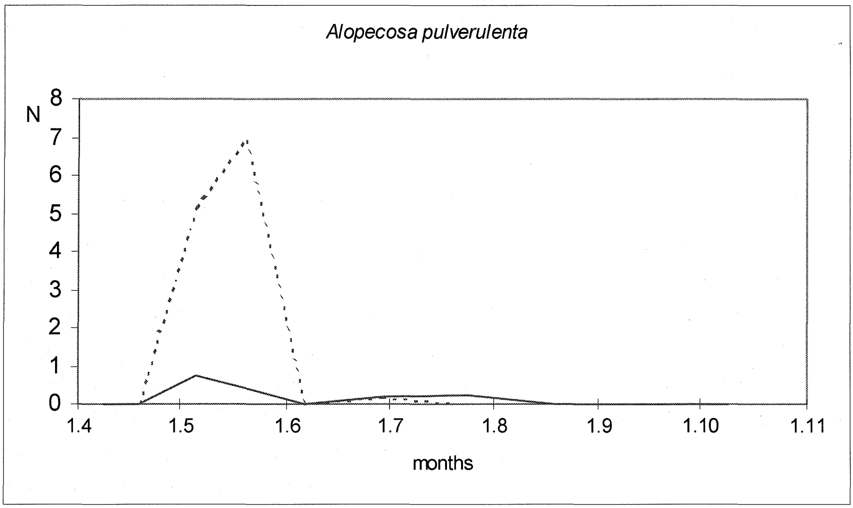




Legend: ————females - - - - - - - males – —*T. terricola* males
N- Average number of spiders in pitfalls per day x100

Fig.3: Phenology graphs





Legend: ——————females - - - - - - - males

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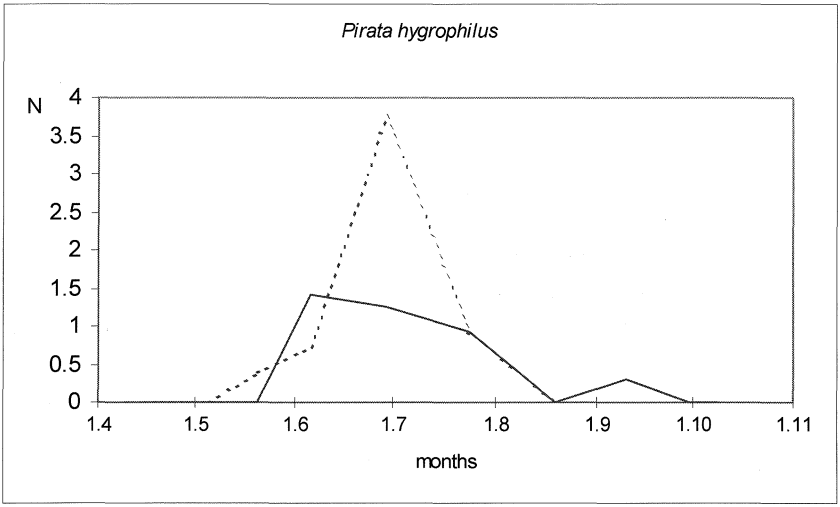

Legend: ————females - - - - - - - males
N- Average number of spiders in pitfalls per day x100

Fig.3: Phenology graphs

TEMBROCK 1987, KRONESTEDT 1996). For *P. lugubris* another pattern of phenology is shown (Fig. 3.). Only for this species an obvious increase of number of females in samples and an overlap of peaks in males and females activity were observed. This is also the only species with more females in the material. This could be because males preferred forest, females meadow like vegetation (ITÄMIES & RUOTSALAINEN 1985). According to BUCHAR (1970), females move during June from the forest to the more sunny places for worming their egg sacs. Actually, few weeks after the main peak in activity (indicating copulation), during June, the number of females in traps started to increase (Fig. 3.). This was approximately the period of eggs laying and the activity remained increased for six weeks while females were carrying egg-sacs.

All this, including a border effect (TISCHLER 1958), could explain the greater abundance of females in material as well as the fact that there are probably no real limits between forest and bog populations of this species.

Even when the total number of individuals of one species is smaller, the significant increase of the number of males in a short period indicating copulation is detectable, for *A. pulverulenta* and *P. hygrophilus* (Fig 3). Activity of *A. pulverulenta* adults started at end of April, with male activity peak in the middle of May what is in coincidence with some other authors' data (KRONESTEDT 1990). The latest in season was the copulation period of *P. hygrophilus*, in June.

Similarities of our results with other authors data on the phenology of *A. pulverulenta* and *T. terricola* indicate that the pitfall method can give representative phenology patterns for less abundant species too, at least higher peaks could be noticed.

Aggregation

For males of the species *T. spinipalpis* and *T. terricola*, *H. rubrofasciata* and *P. hygrophilus* we have noticed aggregation during their period of increased activity (indicating copulation period) as statistically significant ($p<0,05$) higher number of males in certain traps. During other trapping periods no significant differences in number of spiders in some traps were noticed. However, the number of caught specimens was significantly lower, decreasing the possibility of noticing aggregation.

During the peak activity of *T. spinipalpis* males, most of them (89,8 %- 80 of 89 individuals) were caught in 7 (nearby situated) of 17 working traps (trapping period 28.04.-14.05.1995). Standardized Morisita index of dispersion is 0,53. This indicates an aggregated pattern of activity or distribution. It is interesting that 71,4 % (15 of 21 individuals) of *T. terricola* males were caught in the same 7 traps. Correlation coefficient of the numbers of *T. spinipalpis* and *T. terricola* in traps during this period is 0,78 ($p<0,05$). Most of the females (88,2 %; 15 of 17 individuals) were caught during the same period in the same 7 traps. It is possible that this was influenced by the microhabitat selection, while on a main part of this bog area is a water filled gully, causing the highest humidity and greater insolation and the floristic composition was a bit different (see HRŠAK 1996). SCHIKORA (1994) also found that *Antistea elegans* shows clearly aggregated pattern of activity or distribution on a peat bog, correlated with the wet and open spot. ITÄMIES & RUOTSALAINEN (1985) caught half of specimens of *T. terricola* in a few traps located a few meters of each other, in the border zone between forest and clearing; but they were avoiding places that are too moist or too shady. *T. spinipalpis* and *T. terricola* are sibling species with different ecological preferences and it is not likely that the same microhabitat would suite best for both of the species. 77 % (47 of 61) *H. rubrofasciata* males were caught in 5 of 17 operating traps (Standardized Morisita index is 0,53). However, traps in which *H. rubrofasciata* males were caught, were not situated nearby each other, rather randomly spread on the bog area. KÖHLER & TEMBROCK (1987) found that males of *H. rubrofasciata* aggregate during the mating period on sunny, dry places, where they find appropriate substrate for drumming on dry leaves. Even though the abundant presence of the purple moor grass and alder and alder buckthorn bushes make this habitat shady during most of the vegetational season, at this time (the end of April, and first half of May) the ground is still quite insolated. Also, last years purple moor grass dry leaves could probably make a suitable substrate for precopulatory drumming. 77, 8 % (14 of 18) of *P. hygrophilus* males were caught in 1 of 20 operating pitfalls during their peak of activity (Standardized Morisita index is 0, 77). As this is one of the most hygrophilous species, it is interesting that this trap was not situated in the area of the highest humidity.

CONCLUSIONS

Considering dominance and ecological preferences of all species, the dominance structure of this guild does reflect the habitat condition. It is in accordance with one expected for a shady wet habitat. Although we have no knowledge on the lycosid fauna of this bog before the succession, we can presume that the change of habitat did influence spider species composition and dominance structure. With overgrowth of the peat bog the habitat becomes shadier and dryer which causes photophilous species to become less, and some forest species more abundant. Lycosid fauna of Dubravica bog is still relatively bog-characteristic. Our results confirm that wolf spiders are good ecological indicators of the habitat changes, but the dominance of all species has to be taken in consideration.

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