# Regional variations in agrobiont composition and agrobiont life history of spiders (Araneae) within Hungary

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**Abstract:** Agrobiont spider species are well adapted to arable systems, which have fairly uniform vegetation structure and pest assemblages over continent-wide areas. We wanted to study, whether agrobiont spider sub-assemblages and the life history of the most prominent agrobiont, *Pardosa agrestis,* show any regional variation within Hungary, where only modest climatic differences exist between the NW and SE parts of the country. We studied agrobiont species of spider assemblages in 27 alfalfa and 21 cereal fields with suction sampling and pitfalls. The similarity structure of these agrobiont sub-assemblages (Sørensen distance measure) was congruent with the geographic distance matrices (Eucledian distance), as tested by Mantel tests. However, if we considered sub-assemblages consisting of the non-agrobiont species, this congruency was always higher. Thus, agrobionts responded only moderately to geographical variation if we compare them to non-agrobiont species. We studied the generation numbers and the occurrence of the first adult individuals in *P. agrestis*; the most common agrobiont spider in Hungary. This comparison involved comparing fields along a NW – SE gradient during 6 sampling years in pairwise comparisons, where in each year a northern and a southern population was compared with a minimum distance of 126 km in between. In generation numbers there was no difference; we found two generations across Hungary. In contrast, the first occurrence of adult individuals was on average 15 days earlier in both generations in the more southern populations. Thus, it can be concluded that agrobionts show a fairly stable and relatively low magnitude response over country-sized geographical ranges.

**Key words**: alfalfa, biological control, cereal, climatic gradient, natural enemy, *Pardosa agrestis*, regionality

Agrobiont spider species are well adapted to arable systems (SAMU & SZINETÁR 2002, KAJAK & OLESZCZUK 2004). Agricultural crops have a fairly uniform vegetation structure and pest assemblages over continent-wide areas (WECHSUNG et al. 1995). It is interesting to see how this large scale homogenisation of habitat structure affects spiders. On the one hand, the same crop might attract different spiders from the local fauna, whose species might contribute differently to the biological control potential of the natural enemy complex (BATÁRY et al. 2008, SAMU et al. 2008). On the other hand, uniform and low diversity spider assemblages of large crop areas might negatively affect nearby local natural assemblages (JEANNERET et al. 2003). Thus, information about the regional variation of crop spider assemblages is important both from biological control and nature conservation perspectives. Previous data indicates that spider assemblages even on the same crop plants vary within Europe (HÄNGGI et al. 1995, FINCH et al. 2008). However, the extent and scale of this variation is largely unknown.

*Pardosa agrestis* is the most common (c. 40 % dominance in arable fields) agrobiont spider in Hungary (SAMU & SZINETÁR 2002). However, this species is not an agrobiont in England and Western Continental Europe. It gains an agrobiont status along a NW-SE gradient in Central Europe (BLICK et al. 2000). The species has a second generation in Hungary (SAMU et al. 1998), while more northern populations are known to have a single generation (S. Toft pers. comm.). Although geographical details in the generation number shift have not yet been studied in detail, the fact that one generation populations are non-agrobionts or less dominant agrobionts (OBERG et al. 2008) suggests a relationship between generation number and the agrobiont status of the species. Since dominance increases from NW towards SE, and the existence of a second generation is known only from a starting point in Austria (ZULKA et al. 1997), we can infer the generation number to be an adaptation to climatic conditions. Since in Middle-Hungary the second generation was only facultative, i.e. part of the population had a one generation life-cycle, while the rest had two generations (KISS & SAMU 2005),

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we suspected Hungary to be in a transition zone. Therefore we wanted to know if populations in NW Hungary and SE Hungary have different generation numbers.

We decided to conduct observations over a modest geographical gradient within Hungary. We wanted to study responses to climatic differences existing between the NW and SE parts of the country. The objectives were (a) agrobiont sub-assemblages (only the agrobiont species out of all spider species) – where we studied the species composition – and (b) the life history (generation number and timing of generations) of the most prominent agrobiont, *Pardosa agrestis* (Westring, 1861).

## Material and Methods

### Regional differences in agrobiont sub-assemblages

We studied the agrobiont sub-assemblages in 27 alfalfa and 21 cereal fields located in various regions of Hungary. Datasets with comparable sampling efforts and at least one cropping season sampling were selected from the Hungarian spider database (SAMU 2000). The sampling method was either suction sampling or pitfall trapping, or both in parallel (Tab. 1). Standard parametric and multivariate community analyses (McCUNE & GRACE 2002) were run separately both by method and by the type of crop using PC-ORD, version 5.1.

Following SAMU & SZINETÁR (2002) we regarded a species as an agrobiont if its average dominance was higher than 1 % in arable fields and it occurred on at least 75 % of the fields. Thus the following species were arable agrobionts: *Pardosa agrestis* (Westring, 1861), *Meioneta rurestris* (C. L. Koch, 1836), *Oedothorax apicatus* (Blackwall, 1850), *Pachygnatha degeeri* Sundevall, 1830, *Erigone dentipalpis* (Wider, 1834), *Xysticus kochi* Thorell, 1872, and *Tibellus oblongus* (Walckenaer, 1802). The seven agrobiont species represented on average 75 % of the spider individuals in the studied fields (mean ± S.D. = 75.5 ± 16.05,

**Table 1**: Locations of fields considered in the study. Fields that belonged to the same settlement considered to have the same location. Fields by and large represent a NW-SW gradient, and pairings were made to maximise distance in this direction (see text for details).

| Settlement | Latitude (N) | Longitude (E) | # of fields sampled | alfalfa pitfall | alfalfa D-vac | cereal pitfall | cereal D-vac | *P. agrestis* study |
|---|---|---|---|---|---|---|---|---|
| Bánk | 47° 53' 39" | 19° 08' 50" | 1 | | | | 533 (18) | |
| Decs | 46° 16' 41" | 18° 46' 43" | 2 | 155 (13) | 277 (12) | 317 (10) | 203 (16) | 80 |
| Diósjenő | 47° 55' 30" | 19° 03' 01" | 1 | | 1961 (41) | | | |
| Felsőnána | 46° 27' 46" | 18° 32' 44" | 6 | 4145 (61) | 6348 (35) | 576 (24) | 660 (20) | 2826 |
| Fülöpszállás | 46° 48' 39" | 19° 11' 07" | 3 | 210 (19) | 2504 (42) | 200 (17) | 561 (26) | |
| Gencsapáti | 47° 16' 54" | 16° 35' 33" | 1 | | | | | 586 |
| Hatvan | 47° 41' 17" | 19° 36' 36" | 1 | | | 3713 (96) | | |
| Iclod | 40° 59' 21" | 23° 48' 52" | 1 | 1741 (40) | | | | |
| Kartal | 47° 39' 20" | 19° 32' 06" | 2 | | | 2700 (77) | | |
| Királyhegyes | 46° 17' 03" | 20° 41' 12" | 3 | 763 (40) | 244 (15) | 161 (18) | 111 (8) | 538 |
| Kunpeszér | 47° 03' 33" | 19° 17' 32" | 4 | 55 (8) | 81 (11) | | 118 (18) | |
| Kunszentmiklós | 47° 00' 53" | 19° 09' 17" | 2 | | 217 (10) | | 484 (16) | |
| Livada | 47° 00' 18" | 23° 50' 24" | 1 | 1489 (33) | | | | |
| Nagykovácsi | 47° 32' 52" | 18° 56' 03" | 4 | 2867 (63) | 8888 (76) | 1176 (40) | 1815 (39) | 5556 |
| Pásztó | 47° 55' 12" | 19° 44' 07" | 1 | | | | 146 (9) | |
| Páty | 47° 32' 11" | 18° 50' 49" | 4 | | 1259 (26) | | 313 (19) | |
| Rétság | 47° 54' 34" | 19° 05' 54" | 1 | | | | 333 (24) | |
| Romhány | 47° 54' 36" | 19° 12' 57" | 1 | | 1793 (41) | | | |
| Szekszárd | 46° 19' 27" | 18° 49' 23" | 2 | 132 (10) | | 301 (16) | 184 (13) | |
| Szombathely | 47° 14' 58" | 16° 38' 26" | 2 | | | 4179 (37) | | |
| Tevel | 46° 22' 45" | 18° 30' 28" | 5 | 392 (27) | 1474 (24) | 152 (16) | 96 (10) | 319 |

N = 48 fields), while the remaining 25 % of the spiders belonged to 246 non-agrobiont species. The rare end of any community is always the most difficult to sample, and most vulnerable to undersampling bias. Therefore, when statistically considering the non-agrobiont species of spider assemblages (= non-agrobiont sub-assemblage), we only included those species into these analyses for which the whole data set had a cumulated individual count ≥ 50. Applying the inclusion rule, for the possible crop/method combinations we achieved the following number of non-agrobiont species: 29 spp. in alfalfa/pitfall; 28 spp. in alfalfa/D-vac; 32 spp. in cereal/pitfall and 25 spp. in cereal/D-vac.

We tested whether spider assemblages changed with geographical location by performing Mantel tests, with Monte Carlo simulation to derive significance (MCCUNE & MEFFORD 2010). This tested for congruence between the geographical distance (Eucledian distance) of the study plots and the distance structure of the spider assemblages (Sørensen distance measure). Agrobionts and non-agrobionts were tested separately in the study plots.

We analysed data sets gained by the two sampling methods and in the two crops separately, and also treated the agrobiont and the non-agrobiont sub-assemblages separately.

**Regional differences in *Pardosa agrestis* life history**
We studied the generation numbers and the occurrence of first adult individuals in the common agrobiont wolf spider *Pardosa agrestis*. This comparison involved comparing fields along a NW – SE gradient during 6 sampling years (in the period 1993-2003) in pairwise comparisons, where in each year one northern and one southern population was compared, with a minimum distance of 126 km in between (see Tab. 1 for the sampling locations). Population samples were collected by pitfalls, emptied at weekly intervals.

## Results

### a) Regional differences in agrobiont sub-assemblages
The similarity structure of the analysed spider sub-assemblages was congruent with the geographic distance matrices, except for the alfalfa agrobiont sub-assemblage sampled by pitfalls. Relative to each other, the similarity between geographically close non-agrobiont sub-assemblages was always higher than it was between agrobiont sub-assemblages (Fig. 1).

Although average agrobiont similarity among fields was a moderate 37 % (Sørensen similarity, abundance data) it was nearly twice as high as the 20 % similarity among fields if non-agrobiont species were considered (a significant difference: paired t-test comparing average similarity – based on all possible field pairings – of the agrobiont and non-agrobiont sub-assemblages for each crop and sample method combination: t = 7.37, d.f. = 3, P = 0.005).
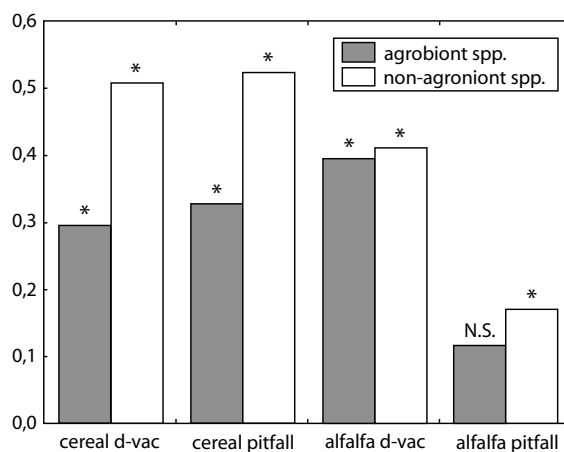


**Figure 1**: Standardised Mantel statistics of relationships between distances in the physical and in the community space separately analysed by (i) sub-assemblage type (agrobionts or non-agrobionts), (ii) crop type and (iii) collecting method. Asterisks denote the significance of the Mantel statistics at the P=0.05 level, obtained by Monte Carlo simulation.
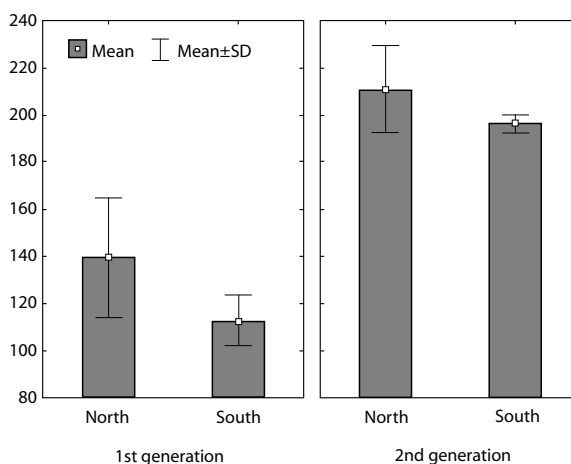


**Figure 2**: First occurrence of adult *P. agrestis* individuals in days counted from 1st January. Each year a new pair of northern and a southern populations (N = 6 pairs) were compared with a minimum distance of 126 km in between.

## b) Regional differences in *Pardosa agrestis* life history

Comparing the northern and southern populations we found two generations in each year. Thus the basic pattern of *P. agrestis* life-cycle seems to be uniform across the country. The first adult occurrence of *P. agrestis* was significantly earlier in the more southern populations, on average by 16 days in the first, and by 14 days in the second generation (Fig. 2). The multi-factor ANOVA revealed that the effect of years was marginal, while interestingly, males did not occur significantly earlier than females in the samples (Tab. 2).

**Table 2**: ANOVA analysis result between first occurrences of adult *P. agrestis* individuals. The six studied years were taken as random factors. (* indicated by asterisk).

| Source | SS | d.f. | F | P |
|---|---|---|---|---|
| Year* | 1273.77 | 5 | 1.7706 | 0.1503 |
| North-South | 2466.78 | 1 | 17.1442 | 0.0003 |
| Generation | 60704.8 | 1 | 421.9015 | 0.0001 |
| Sex | 0.44 | 1 | 0.003 | 0.9565 |

## Discussion

Agricultural habitats have very specific traits (such as special repeated pattern of disturbance (e.g. ploughing, harvest), monotypic, uniform vegetation structure, dominance of open soil surface, etc.), and the majority of the individuals – those belonging to agrobiont species – are adapted to these conditions (WISSINGER 1997). Since crops have the same traits over large geographic areas, we expected the agrobionts to show little variation. Indeed, in the present study we found that similarity between agrobiont sub-assemblages was less determined by regionality (geographical proximity) than was the case for the non-agrobiont sub-assemblages.

Between-field similarity of agrobionts was much higher than that of non-agrobonts. We interpret these results to mean that while both agrobiont species composition and non-agrobiont species composition change geographically, the agrobiont composition is much more conservative and stable in this respect.

Moulting to the adult stage occurred ca. two weeks earlier in the southern populations of *P. agrestis* in the present study. Although the facultative nature of the two generations could not be studied by simple pitfall trapping, it can be speculated that more southern populations had more time to successfully complete a second generation and become juveniles that are large-enough for successful overwintering (KISS & SAMU

2002). Based on this finding, it can be hypothesised that *P. agrestis* populations in the south of Hungary are likely to have two obligate generations per year.

To summarise, the effect of regionality on agrobiont assemblages seems to be scalable down to relatively small geographical areas, such as Hungary. However, at smaller scales the effects become more subtle. Both in the structure of agrobiont spider assemblages and in the life history of a prominent agrobiont species, small but consistent regional differences could be observed within the country. Agrobiont assemblages were less affected than non-agrobiont species, which indicates that agroecosystems host fairly stable animal assemblages, and in those assemblages the agrobiont component is mostly affected by large-scale factors, such as climate. As opposed to agrobionts, some 25 % of the assemblages in the studied fields consisted of a high number of non-agrobiont species, which showed much stronger regional variability; presumably they were more influenced by neighbouring habitats. We believe that both the agrobiont and non-agrobiont components are important in the relationship between agricultural and natural areas, because natural areas can give shelter and increase the number of both types of species, while large and uniform arable land will homogenise and reduce regional species pools, which may negatively influence nearby natural habitats.

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