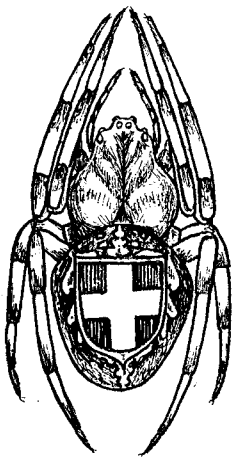
8. Internationaler Arachnologen-Kongreß

Wien 1980



SEPARATUM

THE ROLE OF SPIDERS AS INSECT PREDATORS IN CEREAL FIELDS NEAR ZURICH (SWITZERLAND)

M. Nyffeler & G. Benz

Introduction

Spiders represent an important component of the arthropod fauna of many ecosystems (11),(17),(20), (a.o.). Although numerous studies on the spider fauna in agro-ecosystems already do exist (3),(5),(6),(9),(14),(18),(22), the importance of spiders as insect predators cannot yet be estimated, as too little information on the feeding-ecology of spiders of agro-ecosystems has been collected through field observation. This field study should impart insights into the colonization and feeding-ecology of spiders in Swiss cereal fields.

Methods

The studies were conducted in the years 1976-1979 in cereal fields (wheat, barley, rye, oats, corn) on the outskirts of Zurich. The spiders' population densities were determined by counting the spiders within a defined area. The family composition and species composition of the spiders belonging to the vegetation stratum were explored through direct observation. The spider populations living on the ground were studied with the help of pitfall traps (diameter: 7 cm; preservative: 4% formaldehyde). The dispersion of the spiders was calculated after MORISITA (10). The spectrum of prey and the prey catching rate were found by observing the spiders in the fields by day and by night.

Results

The spiders of cereal fields live in two strata: in the vegetation stratum, and epigeic on the surface of the ground. Different spider families and species were found in the two strata.

Colonization of the fields

The eggs of the spiders deposited on the cereal stalks are destroyed at the end of July or beginning of August during combine-harvesting. For this reason, the fields have to be recolonized from uncultivated biotopes each spring. For spiders belonging to the vegetation stratum there remains, from the moment of colonization until harvest, each year a period of 60-70 days of undisturbed development in the cereal fields (except for corn fields harvested later in the year).

As a result of the periodic destruction of the vegetation stratum through yearly harvesting, the vegetation stratum of cereal fields is usually thinly colonized: about 0.1-0.6

spiders/m^2. It has not been examined yet, whether or not soil cultivation (plowing etc.) has a negative effect on the epigeic spiders. We estimate the density of epigeic spiders to vary from 10 to 50 spiders per m^2.

Family composition and species composition

In the vegetation stratum of cereal fields, we found mainly web spiders of the families Argiopidae (*Araneus cucurbitinus* (Clerck 1757), *Araneus ceropegius* (Walckenaer 1802), *Nuctenea cornuta* (Clerck 1757), *Mangora acalypha* (Walckenaer 1802)), Tetragnathidae (*Tetragnatha extensa* (Linnaeus 1785), *Tetragnatha pinicola* (L. Koch 1870)), Theridiidae (*Theridion impressum* L. Koch 1881, and other *Theridion* spp.), and Linyphiidae (*Linyphia* spp.).

Significantly rarer were hunting spiders of the family Thomisidae (*Xysticus* spp.).

On the ground dominated hunting spiders of the family Lycosidae (*Pardosa agrestis* (Westring 1861), *Pardosa palustris* (Linnaeus 1785), a.o.) and web spiders of the family Micryphantidae (*Erigone atra* (Blackwall 1841), *Erigone dentipalpis* (Wider 1834), *Oedothorax apicatus* (Blackwall 1850)). Somewhat less often, Tetragnathidae (*Pachygnatha degeeri* Sundevall 1830) and Linyphiidae (several species) were found.

Horizontal distribution pattern

In 1979, the horizontal distribution of the spiders living in the vegetation stratum was studied by the method of squares in a 2 ha field of winter wheat; a Morisita index of I_δ= 0.67 resulted. This means that the spiders are regularly distributed throughout the field.

An earlier study of several months conducted in 1977 in a 2 ha field of winter wheat revealed that in regard to Lycosidae and Micryphantidae there are no statistically significant differences between the number of spiders caught on the border and in the middle of the field ($p>0.05$). From this we gather that the spiders on the border exert about the same pressure on their prey populations as the spiders in the centre.

Calculated from the data collected with pitfall traps, the horizontal distribution of the Micryphantidae throughout the field did not greatly differ from a Poisson-distribution (Morisita index I_δ= 1.15-1.41). The horizontal distribution pattern of Lycosidae on the other hand corresponded to a clumped dispersion (Morisita index I_δ= 1.65-6.71).

The prey spectra

Quantitative analyses revealed that the dominant spiders of the vegetation stratum largely feed on small Diptera (70-90% in the case of orb web spiders) but also destroy pest insects, such as aphids, phytophagous bugs, grasshoppers, Thysanoptera, Lepidoptera, Elateridae, Tipulidae etc.

as well as beneficial insects, such as Chrysopidae, Coccinellidae and Syrphidae. The food of many species of web spiders in gardens, vineyards and meadows around Zurich consists also mainly of small Diptera (13),(14).

In cereal fields, Lycosidae and Micryphantidae mainly fed on small soft bodied insects. The prey spectrum of both families is principally composed of collemboles, aphids and Diptera. Cannibalism could be observed with Lycosidae. In cultivated meadows and woods near Zurich, the prey spectrum of Lycosidae and Micryphantidae also consisted of collemboles, aphids, and dipteres mainly (15). Larger arthropods (e.g. Carabidae) cannot be overcome by Lycosidae and Micryphantidae. In contrast, the comb-footed spider *Theridion saxatile* C.L. Koch 1834, which catches its prey with ingenious tangled webs, was often observed catching carabides (*Amara* spp.) and staphylinides in cereal fields.

Prey catching rates

The largest spiders of the vegetation stratum of cereal fields are the two orb web spiders *A. ceropegius* and *N. cornuta*. With their large orb webs of about 500 cm^2 they catch on the average 10-20 insects/web/day.

On the other hand, the webs of the epigeic Micryphantidae *F. atra*, *E. dentipalpis*, and *Oe. apicatus* have a surface of only 1-3 cm^2 and a prey catching rate of usually less than one prey individual/web/day. NYFFELER & BENZ estimated that the catching rate of Lycosidae amounts also to one prey individual/spider/day (15).

Discussion

Since the population density of spiders in the vegetation stratum of cereal fields is very low and because pest insects add up to only a small percentage of the spiders' food, the spiders living in the vegetation stratum of cereal fields near Zurich cannot be considered to exert a significant effect on the population of pest insects.

In German asparagus fields (2) and Polish cultivated meadows (5),(6) it had also been observed that the spiders of the vegetation stratum have no important effect on the mortality of insect populations. According to KOVAL crab spiders in potato fields of the USSR constitute a significant component of the predator-complex against the Colorado potato beetle (8).

In contrast to the vegetation stratum, the spiders living on the surface of the ground of cereal fields show relatively high population densities. Together with the carnivore Carabidae and Staphylinidae they belong to the most frequent epigeic predators in cereal fields near Zurich. The prey spectra of the epigeic spiders overlap in part with those of epigeic predatory carabides and stapylinides which also eat Collembola, aphids, and Diptera. Further

investigations will be needed to establish whether or not this epigeic predator-complex exerts a siginificant influence on pest insects (e.g. aphids). Possibly, as assumed by the American ecologist RIECHERT, this epigeic predator-complex has a stabilizing effect on insect pest populations (16).

Several American scientists have come to the conclusion that spiders are of great importance in American agro-ecosystems (1),(12),(21). In Japan (7) and the Philippines (4) it could be demonstrated that spiders have an important rôle as pest predators in rice fields. According to a report of the Chinese News Agency Xinhua of August 15, 1979, in the Peoples Republic of China, spiders are introduced into rice field as biological control agents of rice pests.

References

(1) BAILEY, C.L. and H.L. CHADA (1968): Spider populations in grain sorghums. Ann.Ent.Soc.Am. 61, 567 - 571.

(2) DINGLER, M. (1935): Die Tierwelt des Spargelfeldes. Z.ang.Ent. 21, 291 - 327.

(3) HUHTA, V. and M. RAATIKAINEN (1974): Spider communities of leys and winter cereal fields in Finland. Ann.Zool.Fenn. 11, 97 - 104.

(4) INTERNATIONAL RICE RESEARCH INSTITUTE (1976): Ann.Report for 1975. Los Banos, Philippines.

(5) KAJAK, A. (1971): Productivity investigation of two types of meadows in the Vistula Valley. IX. Production and consumption of field layer spiders. Ekol.Pol. A 19, 197 - 211.

(6) KAJAK, A., A. BREYMEYER and J. PETAL (1971): Productivity investigation of two types of meadows in the Vistula Valley. XI. Predatory arthropods. Ekol. Pol. A 19, 223 - 233.

(7) KIRITANI, K. (1979): Pest management in rice. Ann. Rev.Ent. 24, 279 - 312.

(8) KOVAL, G. (1976): Biologische Bekämpfung des Kartoffelkäfers. Zascita Rastenij 21, 29; Moskau.

(9) LUCZAK, J. (1979): Spiders in agrocoenoses. Pol.ecol. Stud. 5, 151 - 200.

(10) MORISITA, M. (1962): I_δ-index, a measure of dispersion of individuals. Res.Popul.Ecol. 4, 1 - 7.

(11) MOULDER, B.C. and D.E. REICHLE (1972): Significance of spider predation in the energy dynamics of forest-floor arthropod communities. Ecol.Monogr. 42, 473-498.

(12) MUNIAPPAN, R. and H.L. CHADA (1970): Biological control of the greenbug by the spider *Phidippus audax*. J.Econ.Ent. 63, 1712.

(13) NYFFELER, M. and G. BENZ (1978): Prey selection by the web spiders *Argiope bruennichi* (Scop.), *Araneus quadratus* Cl. and *Agelena labyrinthica* (Cl.) on fallow land near Zurich, Switzerland. Rev.suisse Zool. 85, 747 - 757.

(14) NYFFELER, M. and G. BENZ (1979a): Studies on the ecological importance of spider populations for the vegetation of cereal and rape fields. Z.ang.Ent. 87, 348 - 376.

(15) NYFFELER, M. and G. BENZ (1979b): Overlap of the niches concerning space and prey of crab spiders (Araneae: Thomisidae) and wolf spiders (Araneae: Lycosidae) in cultivated meadows. Rev.suisse Zool. 86, 855 - 865.

(16) RIECHERT, S.E. (1974): Thoughts on the ecological significance of spiders. BioScience 24, 352 - 356.

(17) SCHAEFER, M. (1974): Experimental studies on the importance of interspecies competition between three wolf spider species (Araneida: Lyosidae) in a salt marsh. Zool.Jb.Syst. 101, 213 - 235.

(18) THALER, K., J. AUSSERLECHNER and F. MUNGENAST (1977): Comparative pitfall trapping of spiders and beetles on plots of arable land and meadow near Innsbruck (Austria). Pedobiologia 17, 389 - 399.

(19) TURNBULL, A.L. (1966): A population of spiders and their potential prey in an overgrazed pasture in eastern Ontario. Can.J.Zool. 44, 557 - 583.

(20) VAN HOOK, R.I. (1971): Energy and nutrient dynamics of spider and orthopteran populations in a grassland ecosystem. Ecol.Mongr.41, 1 - 26.

(21) WHEELER, A.G. (1973): Studies on the arthropod fauna of alfalfa. V. Spiders (Araneida). Can.Ent. 105, 425 - 432.

(22) WHITCOMB, W.H. (1974): Natural populations of entomophagous arthoropods and their effect on the agroecosystem. In: MAXWELL, F.G.; HARRIS, F.A. (Eds.). Proc.Summer Inst.Biol.Control Plant Insects and Diseases. Jackson: University Press of Mississippi, 150 - 169.

Addresses:

Dipl. Ing.-Agr. Martin NYFFELER, Department of Entomology, Swiss Federal Institute of Technology, ETH-Zentrum, CH-8092 ZURICH, Switzerland.

Prof. Dr. Georg Benz (same address).