Diet specialisation and diversification of the spider genus *Dysdera* (Araneae: Dysderidae)

Summary of PhD. thesis

The main aim of my study is to present new knowledge about the diet specialisation and diversification of the spider genus *Dysdera*. This PhD. thesis, divided in two parts, is the summary of five papers.

1. Diet specialisation

1.1. Řezáč M., Pekár S. & Lubin Y.: **Morphological and behavioural adaptations for oniscophagy in *Dysdera* spiders (Araneae: Dysderinae)** [accepted by *Journal of Zoology*]

Very little is known about predators feeding on woodlice. Spiders of the genus *Dysdera* (Dysderidae) were long suspected to be oniscophagous, but evidence for their diet specialisation has been lacking. These spiders are characterised by an unusual morphological variability of their mouth-parts, particularly the chelicerae, suggesting dietary specialisation která ukazuje na potravní specializaci. Thus, we investigated the relationship between mouthpart morphology, prey preference and predatory behaviour of five species representing different cheliceral types. Results obtained suggest that studied *Dysdera* spiders differ in prey specialisation for woodlice. The species with unmodified chelicerae readily captured various arthropods but refused woodlice while species with modified chelicerae captured woodlice. Particularly, *Dysdera erythrina* and *D. spinicrus* captured woodlice as frequently as alternative prey types. *Dysdera abdominalis* and *D. dubrovninnii* significantly preferred woodlice to alternative prey. Cheliceral modifications were found to determine the grasping behaviour. Species with elongated chelicerae used a 'pincers tactic', i.e. inserted one chelicera into the soft ventral side and placed the other on the dorsal side of woodlouse. Species with dorsally concave chelicerae used a 'fork tactic': they tucked them quickly under woodlouse in order to bite the ventral side of woodlouse body. Species with flattened chelicerae used a 'key tactic': they inserted a flattened chelicera between sclerites of the armoured woodlouse.

1.2. Řezáč M. & Pekár S.: **Evidence for woodlice-specialisation in *Dysdera* spiders: behavioural *versus* developmental approach** [accepted by *Physiological Entomology*]

Dietary specialisation in a woodlouse-eating spider *Dysdera hungarica* Kulczyński (Araneae: Dysderidae) was studied using two types of laboratory experiments. In the first experiment, rate of development of spiderlings reared on one of three diets, 1. pure woodlice (composed of two species *Oniscus asellus* Linnaeus and *Armadillidium vulgare* (Latreille)), 2. pure flies (*Drosophila melanogaster* Meigen), and 3. mixed woodlouse-fly diet, was studied. Spiders developed significantly faster on the woodlice-containing diets, i.e. pure woodlice or mixed diet. In the second experiment,

the prey-choice for two woodlice species *(O. asellus* and *A. vulgare)* and a fly *(D. melanogaster)* was investigated. *Dysdera hungarica* spiders captured significantly more often flies than woodlice. These contrasting results reveal the different value of developmental and behavioural experiments. The dietary studies are supposed to provide better evidence of specialisation than behavioural experiments which might be misleading due to unnatural conditions. We conclude that *D. hungarica* is already adapted metabolically to feed on woodlice. This study thus provides the first evidence of nutritional specialisation on woodlice.

2. Diversification

2.1. Řezáč M., Král J. & Pekár S.: **Revision and speciation mode of the spider aggregate *Dysdera erythrina* (Araneae: Dysderidae): sibling species with sympatric distribution** [accepted by *Invertebrate Systematics*]

The extremely rich genus *Dysdera* is composed mainly of aggregates of sibling species. Interestingly, species of the aggregates often occur sympatrically. To understand the evolution of the aggregates, we performed an analysis of *D. erythrina* aggregate. We distinguished six morphologically very similar species, two of them are new. Areas of all species include southern France and northeastern Spain, which are thus probably the speciation center of the aggregate. We did not find any obvious differences in habitat preferences of study species; they occured together in some locations. All species fed on woodlice, but they exhibit differences in karyotype, sculpture of carapace, and body size, morphology of mouth-parts, and morphology of the groove accessing the spermatheca for sperm. Experimental crossing showed a partial precopulatory behavioral barrier between two species, namely *D. erythrina* and *D. lantosquensis*. We hypothesize chromosome rearrangements played a primary role in *Dysdera* speciation. The secondary contact of allopatrically evolved cryptic species likely led to evolution of recognition mechanisms. Carapace structure and the shape of endogynal medial groove might be involved in interspecific barrier. Sympatric occurrence of closely related species might be allowed by diet specialisation on different size or species of woodlice, documented by displacement of body size and shape of chelicerae.

2.2. Řezáč M., Král J. & Pekár S.: **The spider genus *Dysdera* (Araneae, Dysderidae) in central Europe: revision and natural history** [accepted by *Journal of Arachnology*]

Nine species of the genus *Dysdera* were found to occur in central Europe: *D. adriatica* Kulczyński 1897, *D. crocata* Koch 1838, *D. dubrovninnii* Deeleman-Reinhold 1988, *D. erythrina* (Walckenaer 1802), *D. ninnii* Canestrini 1868, *D. hungarica* Kulczyński 1897, *D. lantosquensis* Simon 1882, *D. longirostris* Doblika 1853, and *D. taurica* Charitonov 1956. Two species, *D. dubrovninnii* and *D. lantosquensis*, are newly recorded from central Europe. The original description of *D. hombergi* (Scopoli 1763), the name used for a common species of the genus *Harpactea*, probably refers to *D. ninnii*. Thus, we retain the name *D. ninnii* as a *nomen protectum*. *Dysdera hamulata*

Kulczyński 1897 appears to be a junior synonym of *D. maurusia* Thorell 1873. This North African species probably does not occur in central Europe, and a previous record from Slovakia is probably based on mislabeled material. A review of all species of *Dysdera* named from outside the Palearctic region demonstrated that *D. australiensis* Rainbow 1900 and *D. magna* Keyserling 1877 are junior synonyms of *D. crocata*, and that *D. bicolor* Tatzanovski 1874 and *D. solers* Walckenaer 1837 are erroneously placed in the genus *Dysdera*; the former is likely to be an oonopid and the latter a caponiid. In central Europe, *Dysdera* spiders prefer xerothermic forests, particularly sites enriched by calcium. All species probably have biennal life-cycles. The male karyotype of seven species were examined. Diploid chromosome numbers were found to be extraordinarily variable, ranging from 9 (*D. crocata*) to 40 (*D. longirostris*). Karyotypes consist of holocentric chromosomes.

2.3. Král J., Musilová J., Šťáhlavský F., Řezáč M., Akan Z., Edwards R. L., Coyle F. A., Ribera C.: **Evolution of the karyotype and sex chromosome systems in basal clades of araneomorph spiders (Araneae: Araneomorphae)** [*Chromosome Research*, 14: 859–880]

Concepts of spider karyotype evolution are based mostly on advanced and most diversified clade, the entelegyne lineage of araneomorph spiders. Hence the typical spider karyotype is supposed to consist exclusively of acrocentric chromosomes including the multiple X chromosomes. However, our data show considerable diversity of chromosome morphology and sex chromosome systems in basal clades of araneomorphs. Karyotypes of basal araneomorphs consist of holocentric (superfamily Dysderoidea) or normal chromosomes with localized centromere. In males of basal araneomorphs the prophase of first meiotic division includes a long diffuse stage. Multiple X chromosomes are less common in basal clades. The sex chromosome system of many families includes a Y chromosome or nucleolus organizer region that occurs rarely in the entelegyne spiders. A derived X1X2Y system with an achiasmatic sex-chromosome pairing during meiosis was found in the families Drymusidae, Hypochilidae, Filistatidae, Sicariidae, and Pholcidae. This suggests a monophyletic origin of the families. In some lineages the X1X2Y system converted into an X0 system, as found in some pholcids, or into an XY system, which is typical for the family Diguetidae. The remarkable karyotype and sex chromosome system diversity allows us to distinguish four evolutionary lineages of basal araneomorphs and hypothesize about the ancestral karyotype of araneomorphs.