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Notes on the seasonal dynamics of the coprophagous Hydrophilidae (Coleoptera) in western Turkey, with first record of *Megasternum concinnum* for Turkish fauna

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Abstract: Five species of coprophilous Hydrophilidae are recorded in cow dung in two localities in western Turkey. Seasonal dynamics of three species, *Sphaeridium scarabaeoides* (LINNAEUS 1758), *S. marginatum* FABRICIUS 1787 and *Cercyon haemorrhoidalis* (FABRICIUS 1775) are evaluated and compared with published results from Europe. Occurrence of all three species was found to be affected especially by summer shortage of rainfall. *Megasternum concinnum* (MARSHAM 1802) is recorded for the first time from Turkey.

Key words: Coleoptera, Hydrophilidae, coprophagous, seasonal dynamics, faunistics, Turkey.

Introduction

The family Hydrophilidae contains about 3000 described species distributed world-wide (HANSEN 1987, 1991, 1999, 2004; SHORT & HEBAUER 2006). Many species, most of which are classified within the subfamily Hydrophilinae, inhabit aquatic or semiaquatic habitats, whereas most representatives of the subfamily Sphaeridiinae are terrestrial, even though still requiring high humidity of their habitats (ARCHANGELSKY 1999). In non-tropical regions of the northern hemisphere, most of the terrestrial Sphaeridiinae inhabit various kinds of decaying plant material (manure, leaf litter) and/or excrements of large herbivorous mammals and (much less often) birds.

Dung-inhabiting beetles are a frequent topic of many ecological studies and the bionomy as well phenology, population dynamics, dispersal abilities etc. are well-known for many species. Even though some data on the biology of the Hydrophilidae can be found in papers concerning the ecology of all dung-inhabiting insects and/or beetles (e.g. HAFEZ 1939a, HANSKI & KOSKELA 1977, SOWIG & WASSMER 1994, WASSMER 1995), most of the studies are focused on dung-inhabiting Scarabaeoidea, whereas other beetles including Hydrophilidae are mostly omitted or only marginally studied. The papers concerning the ecology of the coprophagous Hydrophilidae are quite scarce, and only in the genus *Sphaeridium* FABRICIUS 1775 more detailed studies have been performed (LANDIN 1967, OTRONEN & HANSKI 1983, SOWIG 1997, SOWIG et al. 1997, HOLTER 2004). The succession of the colonization of fresh excrements by some hydrophilid species was studied e.g. by HAFEZ (1939a) and HANSKI & KOSKELA (1997), the seasonal dynamics is

treated e.g. by HANSKI (1980), WASSMER (1994), ROMERO-ALCARAZ et al. (1997) and HOFFMANNOVÁ (2006).

Comparison of studies of seasonal dynamics of many dung-inhabiting Scarabaeoidea shows that the precise pattern of one species can differ according to geographic position of the studied localities (LANDIN 1961, ÁVILA & SANCHEZ-PIÑERO 1990, WASSMER 1994, HOFFMANNOVÁ 2006), between different years on the same locality (e.g. FLOATE & GILL 1998, HOFFMANNOVÁ 2006) or between the pastures on the same locality (HANSKI 1980). Comparison of much scarcer data seems to show similar variations also in the Hydrophilidae (HANSKI 1980, WASSMER 1994).

Up to now, no study focusing ecology of dung-inhabiting Hydrophilidae of any part of Turkey have been published, and the only published scarce data concern taxonomic and/or faunistic problems. Sixteen species of the subfamily Sphaeridiinae were recorded from Turkey, of which 12 species representing the genera *Cercyon* LEACH 1817, *Cryptopleurum* MULSANT 1844 and *Sphaeridium* FABRICIUS 1775 inhabit mammal excrements (HANSEN 1999, FIKÁČEK 2006). The aim of this study is to evaluate the Hydrophilidae fauna of cow dung at two locations at different altitudes in western Turkey. The results provide the first data on seasonal dynamics of these beetles in Turkey as well as the first record of the genus *Megasternum* MULSANT 1844 in Turkey.

Material and Methods

The seasonal activity of the adult hydrophilid beetles was monitored in 2004 and 2006 in two locations (ca 3 ha each) situated in different altitudes (600 m a.s.l. and 900 m a.s.l.) near Dagmarmara, Manisa province, Western Turkey. The coordinates of the locations at 600 m and 900 m are 38°23'37"N, 27°49'09"E and 38°20'09"N, 27°50'47"E, respectively (Fig. 1).

The location at 600 m a.s.l. is situated about 2 km north of Dagmarmara village within farm lands. From May to November there is a rainless period at this locality. There are pastures of various sizes situated among the plantations of *Pinus brutia* TEN., *Quercus* spp., *Castanea sativa* MILL. and the orchards of *Prunus avium* L., *Pyrus malus* L., *Cydonia vulgaris* PERS. on this locality. On the pastures, *Polypodium* sp., *Cistus creticus* L., *Trifolium bocconei* SAVI, *Medicago* × *varia* (MARTYN) ARCANG., *Rubus canescens* L. occur except of grasses. On the pasture where the samples were collected, cows feed all day long on the pasture and they are brought back to their shelters at night.

The location at 900 m a.s.l. is situated ca. 5 km southeast of the pasture at 600 m, out of the agricultural land and is therefore less impacted by human activities. The samples were collected on a large pasture surrounded by the forest of *Pinus nigra* (ARNOLD). Except of grasses, *Polypodium* sp., *Verbascum* sp., *Juniperus oxycedrus* L., *Pyrus amygdaliformis* VILL., *Rosa canina* L., *Cistus laurifolius* L. were common on the pasture. The cows on this pasture feed all day long without going back to their shelters at night from April up to November. The locality is more humid, with scarce rain even through summer period.

For this study, both localities were visited in ca. 14-day intervals from mid April to the end of November. During the winter, cow were not present on the pastures and the beetles were therefore not sampled in this period. Samples were collected randomly by a

handle shovel, placed into a plastic jars and transported to the laboratory, where the insects were separated from the dung. Fifteen samples of ca. 50 g of dung were collected during each visit on the locality. The material referred to in this study is deposited in the Lodos Entomological Museum (LEMT), Department of Plant Protection, Aegean University (Izmir, Turkey). Taxonomy and higher classification follows HANSEN (1999).

Results

Species composition

In total, 929 specimens of the Hydrophilidae were collected at both locations during 2004 and 2006, representing 5 species (Tab. 1) with the following numbers as percentage of the total catch: *Cercyon haemorrhoidalis* 10.12 %, *Megasternum concinnum* 0.64 %, *Sphaeridium marginatum* 10.23 %, *S. scarabaeoides* 78.36 % and *S. substriatum* 0.64 %.

Both locations were dominated by *Sphaeridium scarabaeoides* which made 71.94 % of total catch at 600 m and 81.47 % at 900 m. Concerning the relative abundance (at 600m / at 900 m), this species was followed by *Cercyon haemorrhoidalis* (13.53 % / 8.47 %) and *Sphaeridium marginatum* (12.87 % / 8.95 %). Remaining two species, *Megasternum concinnum* and *Sphaeridium substriatum* were collected only occasionally, with the abundance being less than 1 % for both species at both localities.

All mentioned species were recorded for the first time for the Manisa province. *Megasternum concinnum* is recorded for the first time from Turkey.

Tab. 1: Number of specimens collected at both altitudes during 2004 and 2006 for this study.

Species	2004		2006		Sum
	600 m	900 m	600 m	900 m	
<i>Cercyon haemorrhoidalis</i> (FABRICIUS 1775)	25	39	16	14	94
<i>Megasternum concinnum</i> (MARSHAM 1802)	2	3	0	1	6
<i>Sphaeridium marginatum</i> FABRICIUS 1787	20	39	19	17	95
<i>Sphaeridium scarabaeoides</i> (LINNAEUS 1758)	138	370	80	140	728
<i>Sphaeridium substriatum</i> FALDERMANN 1838	3	2	0	1	6
Total	188	453	115	173	929

Seasonal dynamics

Of five species recorded during this study, only *Sphaeridium scarabaeoides*, *S. marginatum* and *Cercyon haemorrhoidalis* were collected in higher numbers of specimens which allows us to evaluate their seasonal dynamics on the localities (Fig. 2). Whereas the data for *S. scarabaeoides* are continuous, those concerning *S. marginatum* and *C. haemorrhoidalis* are intermittent but still containing valuable information.

Sphaeridium scarabaeoides occurred in the whole period of sampling both in 2004 and 2006, with the peaks in the second half of April, first half of July and in first half of September in both years and on both localities. At 600 m, the species is generally less abundant and especially the peaks in September are much lower than at 900 m. On the other hand, an additional peak was noticed at the end of October in 2006 at the locality of 600m.

Sphaeridium marginatum occurred in the whole period of sampling, but it was absent or showing low abundance in the period ca. from first half of July to first half of September. The peaks were recorded at the end of April, during June and during second half of September and seem to coincide with peaks of *S. scarabaeoides* at least partly. The spring peaks in 2006 occur one or two weeks earlier at 600 m than at 900m.

Cercyon haemorrhoidalis was recorded in spring period (April to June) at both altitudes, but shows an additional occurrence in mid August and in autumn (October to November) at 900m. Phenology is similar in 2006, but the species was recorded in summer as well as in autumn even at 600 m.

Comparison with seasonal dynamics on European localities

The data on seasonal dynamics obtained by us for western Turkey can be compared with those from some European localities studied by other authors: Czech Republic, horse excrements (HOFFMANNOVÁ 2006); Germany, cow and sheep excrements (WASSMER 1994); southern Spain, cow excrements (ROMERO-ALCARAZ et al. 1997). Partial comparison with phenology in Scandinavia is also possible by comparison with data by HANSEN (1987). The results of this comparison is presented below, the localities mentioned refer to the results published in the above mentioned papers.

Sphaeridium marginatum: The species was found to occur during the whole sampling period, i.e. from April to November, in western Turkey. Data from winter and early spring are absent from our study and the occurrence could not be evaluated for this period. In spite of this, our findings agree with data from Europe. In all studies, this species was found to occur mainly from summer to autumn, from April to September-October in central Europe (in WASSMER (1994) under *S. bipustulatum*) and Scandinavia (in HANSEN (1987) under *S. bipustulatum*) and from May to November with a low number of specimens occasionally found during winter in Spain. There are principally two or three peaks of high abundance during the year, with the highest peak observed during late summer (August) in central Europe, but during May to June in Spain and Turkey. In Turkey, the abundance during late summer is very low or the species is absent in this period.

Sphaeridium scarabaeoides: The seasonal dynamics in western Turkey seems to agree

with data from central Europe – in both cases the species show summer-autumn phenological pattern similar to that described for *S. marginatum*. In contrast, the species occurs only in spring in Spain. In Turkey, the species shows three peaks as it also does in Germany, but the peaks appear earlier in Turkey (first peak in May, last in August) than in Germany (first peak in June, last in September). In Czech Republic, only one peak was observed during late June. In Scandinavia, the species is reported to occur from February to September.

Cercyon haemorrhoidalis: Winter to spring phenological pattern was found in Spain with the occurrence from December to March (with a peak in March). The occurrence limited to spring was found also by us in Turkey at 600 m, but an additional peak occurs also in autumn (September to November). In central Europe, the species appears earlier than other hydrophilid taxa and is present in low numbers also during the winter, but the main occurrence was found from March to July-August, with the highest peak in April-May. In Scandinavia, the species occurs from April to October.

Discussion

The Hydrophilidae are considered as univoltine by many authors, with the representatives of the Sphaeridiinae supposed to be bivoltine by some of them (e.g. HANSEN 1987). In the three species analysed in this study (*Cercyon haemorrhoidalis*, *Sphaeridium scarabeoides* and *S. marginatum*), similar phenological patterns were observed in various areas, typically with two to four peaks of abundance during the year. This would suggest the fixed patterns of seasonal dynamics with at least two or three generations per year rather than existence of single generation or numerous overlapping generations a year (WASSMER 1994). The species of the genus *Cercyon* can, however, show a considerable variation between different species in their population dynamics and number of generations per year (WASSMER 1994).

All Sphaeridiinae studied are characteristic by a short development of immature stages being ca. 10 days for *Sphaeridium* (ARCHANGELSKY 1997, HAFEZ 1939b) and 19-21.5 days for *Cercyon haemorrhoidalis* (SCHULTE 1985). The time distance between the peaks varies highly even within the species in the published studies as well as in our results, but generally ranges from 32 to 75 days for mentioned species. It is therefore probable that the hatched adults of all three species discussed need some considerable time (ca. 2 weeks at least) for feeding, spreading and maturation before they are able to mate and lay eggs.

As the seasonal dynamics was shown to vary even between rather closely situated pastures (HANSKI 1980) or between years on the same pasture (HOFFMANNOVÁ 2006, our study), it is difficult to evaluate the differences observed between various areas. Our results from Turkey differ from those from central and northern Europe especially in earlier onset of high abundance peaks and in low abundance or absence of the beetles during late summer. Most of the coprophilous Hydrophilidae prefer open areas (HOFFMANNOVÁ 2006) and their habitat are therefore affected by high radiation. At the same time, their immature stages require high moisture of the environment (ARCHANGELSKY 1999). Low abundance during summer is therefore most probably caused by the drought (lack of rainfall) together with high radiation and temperature, making the excrements unsuitable for the beetles (e.g. they may dry up too quickly).

Differences between the dynamics of the species at 600 m and 900 m in Turkey seem to support this explanation because both localities differ mainly in rain amount. Higher spring temperatures in Turkey in comparison with Europe may also cause the earlier onset of breeding season and the abundance peaks appear therefore earlier than in Europe. Observed differences in population dynamics between different years on the same locality also may be partly caused by differences in temperatures and rainfall during the respective years.

To sum up, even though the coprophilous Hydrophilidae exhibit some interspecific variation in their seasonal dynamics, they seem to have a rather fixed breeding pattern most often with at least two or three generations a year. The development of immature stages is rather rapid, followed by short non-breeding period of the adults. The temperature and moisture seem to affect considerably the seasonal dynamics, limiting the abundance of the beetles especially during the dry and hot summer period in lower latitudes.

Zusammenfassung

Fünf koprophile Hydrophilidae-Arten wurden an Kuhdung im Jahresablauf zweier westtürkischer Standorte untersucht. Die Ergebnisse von *Sphaeridium scarabaeoides* (LINNAEUS 1758), *S. marginatum* FABRICIUS 1787 und *Cercyon haemorrhoidalis* (FABRICIUS 1775) wurden mit jenen europäischer Untersuchungen verglichen. Ein Zusammenhang des Auftretens der Arten mit der Knappheit sommerlicher Regenfälle wurde erarbeitet. *Megasternum concinnum* (MARSHAM 1802) wurde erstmals für die Türkei nachgewiesen.

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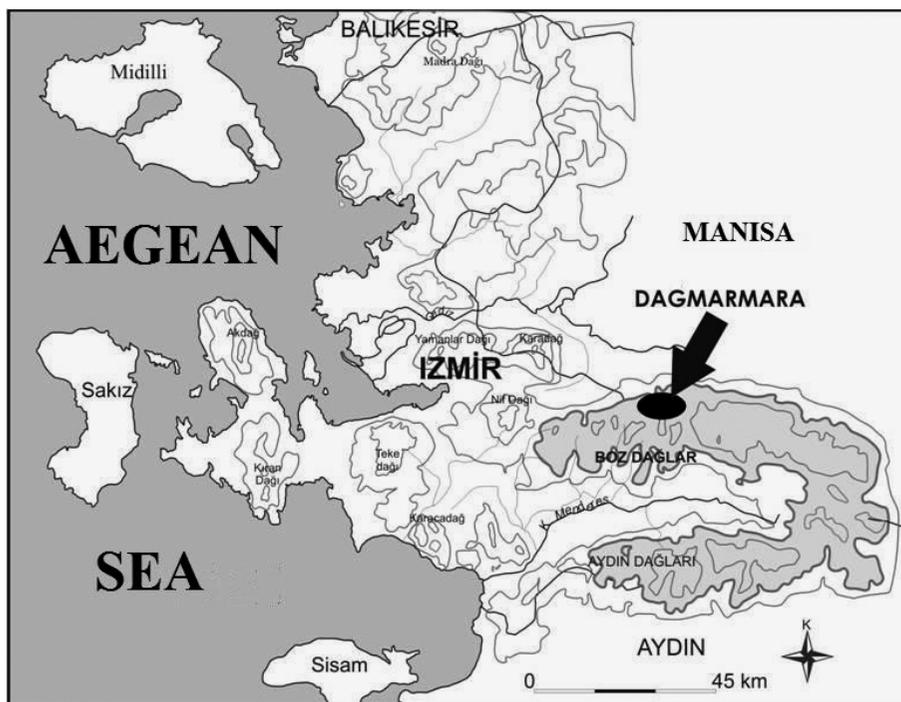


Fig. 1: Map of the study area, western Turkey.

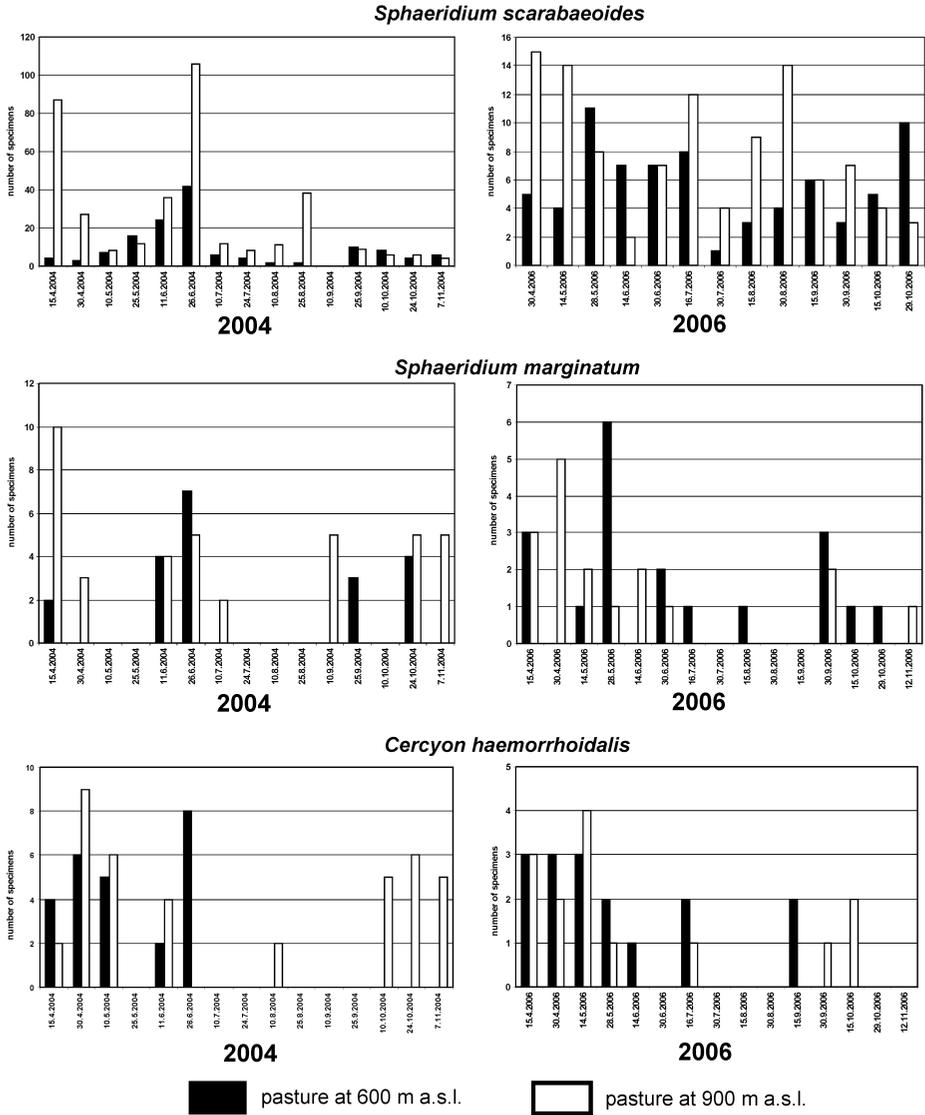


Fig. 2: Seasonal dynamics of *Sphaeridium scarabaeoides*, *S. marginatum* and *Cercyon haemorrhoidalis* on the studied localities in western Turkey during 2004 and 2006.