Seasonal changes in the relative abundance of some dung beetle species in faeces of the wild boar and mufflon (Coleoptera: Scarabaeoidea)

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Abstract: By means of baited pitfall traps and by extracting beetles with a Tullgren funnel, dung beetles were collected in the National Park De Hoge Veluwe. A total of 8092 specimens were taken, belonging to 30 species. These species are listed and their relative abundances are given for boar (*Sus scrofa*) and mufflon (*Ovis ammon musimon*) droppings, and for each method separately. From these data it can be concluded that the dung species studied do not show a preference for either kind of droppings, and also that there exists a specific pattern of seasonal succession.

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Introduction

Dung beetles are of great agronomic importance as removers of the faecal deposition of cattle. Fincher (1981): "Millions of hectares of pasture in the United States are lost to grazing each year because of dung accumulation and contamination". Also pest flies may constitute a problem caused by the accumulation of dung. As a solution for these and similar problems, foreign species have been introduced to aid the native fauna with the removal of dung (e.g. Fincher, 1981, Fincher et al., 1981, Bornemissza, 1976). It is not surprising therefore, that much work has been carried out on the ecology of dung beetles and their communities. There is also a lot of experimental work on the effects of dung beetles on dung removal (e.g. Holter, 1977, Mc Kinney & Morley, 1975, Fincher, 1981). Much of this work was done in the United States or in tropical regions. In Europe ecological studies are known from e.g. Landing (1961), Lumaret (1978) and Holter (1982).

A search through the literature, however, reveals that relatively little is known about the faunistics of the Dutch dung beetles. One of the most recent works is that of Krikken (1978), who studied the scarab fauna of dung from Dutch red deer (*Cervus elaphus hippelaphus* Linnaeus) and wild boar (*Sus scrofa* Linnaeus) in the forested region south of Apeldoorn.

This paper will present the results of a survey of dung beetles in faeces of the wild boar and the mufflon (*Ovis ammon musimon* Linnaeus) in the National Park De Hoge Veluwe. Species lists are given, the differences between the beetle communities of boar dung and mufflon dung are considered, and the changes in the relative abundance over the year of the dung species are described.

Methods

Dung beetles were collected in the period from October 1983 to October 1984, using two collecting methods. Dung-baited pitfall traps were used from 15.x.1983 until 26.iv.1984, and were emptied at 22.x.1983, 16.xi.1983, 18.xii.1983 and 26.iv.1983. The trapping site was situated in the National Park De Hoge Veluwe. Thirty traps were placed in the heath vegetation near a game meadow and were spaced at least 5 m from each other. The traps, 8 cm in diameter, were provided with formalin (4%) to preserve the beetles. Wild boar and mufflon droppings were collected on the game meadow and placed on a small piece of wire netting on top of the pitfall traps. The drop-

pings were replaced by fresh ones at irregular time intervals. The droppings remained intact for a very long time, due to both the relatively low temperatures and to the fact that the attracted beetles fall through the netting into the pitfall trap, soon after their arrival without having attacked the dung.

On 26.iv.1984, 31.v.1984, 8.vii.1984, 25.viii.-1984 and on 14.x.1984, boar and mufflon droppings were collected on the game meadow and taken to the laboratory where the beetles were extracted by use of a Tullgren funnel.

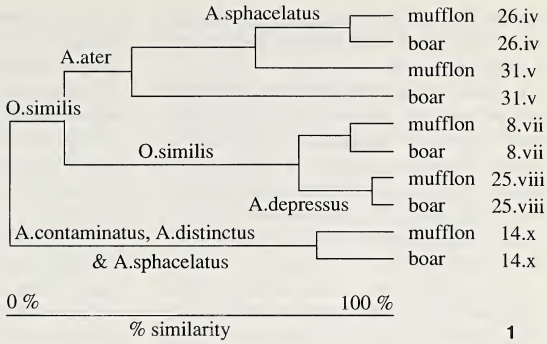
Results and discussion

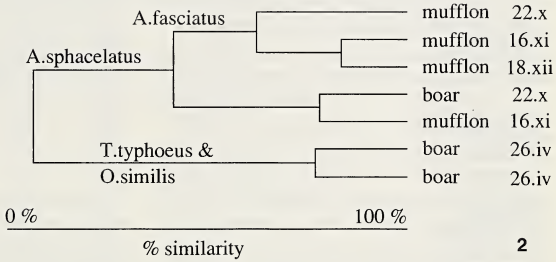
Faunistics

A total of 8092 specimens were caught belonging to 30 species which are listed in table 1. 24 of these species belong to the genus *Aphodius*. This is a very large number compared to the total number of Dutch species, considering that the samples originated from a very small area (about 200 × 200 m^2) and the baited traps were all placed within a few hundred meters from the same game meadow.

Table 1. Species of dung beetles caught in pitfall traps and extracted from droppings for mufflon and wild boar, and their relative abundances (%) (+ = < 1%).

Collecting method	Tullgren		Pitfalls	
Droppings from	mufflon	boar	mufflon	boar
Species	%	%	%	%
SCARABAEIDAE				
Onthophagus similis (Scriba)	49	45	2	1
APHODIIDAE				
Aphodius sphacelatus (Panzer)	14	16	35	58
A. distinctus (O. F. Müller)	6	7	14	18
A. contaminatus (Herbst)	5	12	4	3
A. ater (De Geer)	13	8	+	+
A. fasciatus (Fabricius)	+	+	29	6
A. paykulli Bedel	+	+	4	6
A. tristis Zenk	2	+	+	1
A. fimetarius (Linnaeus)	+	+	+	+
A. rufipes (Linnaeus)	+	+	+	+
A. prodromus (Brahm)	+	+	+	1
A. luridus (Fabricius)	1	+	–	–
A. pussilus (Herbst)	3	4	–	–
A. granarius (Linnaeus)	1	1	–	–
A. haemorrhoidales (Linnaeus)	+	1	–	–
A. depressus (Kugelanni)	4	3	–	–
A. erraticus (Linnaeus)	+	2	–	–
A. fossor (Linnaeus)	+	+	–	–
A. foetens (Stephens)	+	+	–	–
A. rufus (Moll)	+	–	–	–
A. obliteratus Panzer	+	–	+	+
A. brevis Erichson	–	–	+	+
A. corvinus Erichson	–	–	+	–
A. pictus Sturm	–	–	+	–
A. conspurcatus (Linnaeus)	–	–	1	–
GEOTRUPIDAE				
Typhoeus typhoeus (Linnaeus)	–	–	8	3
Geotrupes stercorosus (Scriba)	–	+	1	1
G. spiniger (Marsham)	+	–	+	+
G. stercorarius (Linnaeus)	+	–	+	–
G. vernalis (Linnaeus)	+	–	–	–
Total %	100	100	100	100
Total number of specimens	3163	2226	1355	1348





Figs. 1-2. UPGMA clustering of samples based on a matrix of percentages similarity between samples. If clusters can be characterized by one or a few species, these are indicated along the axes leading to the relevant clusters. 1, Tullgren samples; 2, pitfall samples.

From earlier collecting trips to the National Park I can report two additional *Aphodius* species (*A. scybalarius* (Fabricius) (19.x.1978) and *A. zenkeri* Germar (20.vii.1973)), adding up the number of *Aphodius* species to a total of 26, which is 60% of the total number of *Aphodius* species occurring in The Netherlands! Krikken (1978) found 23 *Aphodius* species, also in a very restricted area, just outside the National Park De Hoge Veluwe.

Although a large number of species was collected, only a few of them did appear in large numbers: *Onthophagus similis, Aphodius sphacelatus, A. fasciatus, A. contaminatus, A. ater*, and *A. distinctus* are the most dominant species. The first four species mentioned are also the most abundant species caught by Krikken (1978). All of these species, apart from *A. fasciatus*, are common in The Netherlands, eurytopic and feeding on dung of all kinds of animals. Brakman (1966) reports *A. fasciatus* from the province of Noord Brabant only, but since then this species was also collected in other provinces, inclusive of Gelderland (see Krikken, 1978).

Among the less abundant species several can be listed as rare for The Netherlands; *A conspurcatus* and *A. corvinus* were not mentioned by Brakman (1966) as occurring in the province of Gelderland. These two species, and also *A. pictus*, can be considered rare species (Everts, 1903, 1922). *A. zenkeri* was sampled in 1973 by me in De Hoge Veluwe and Het Deelerwoud, and also by Krikken (1978).

Ecology

One should of course be very careful in drawing conclusions from relative abundance data as to the preference for a specific kind of drop-

ping or about the phenology of a species. But the data presented here certainly permit some general conclusions.

A cluster analysis (% similarity, UPGMA) was performed to find out whether the differences among the samples are the result of a seasonal succession of the dung beetle fauna or whether they can be related to the different kind of droppings. The analysis was performed on the Tullgren data and the pitfall data separately.

In fig. 1 the dendrogram is given for the Tullgren data. On the segments the names of those species are indicated which contribute most to the similarity among the members of the cluster concerned. We can see that the mufflon and wild boar samples that were taken on the same date, are always grouped together, with the exception however of the samples taken on 31.v.1984.

In fig. 2 the results for the pitfall data are given. The wild boar sample from 18.xii.1984 was omitted because of the relative low number of specimens (n = 28) taken on this date. With exception of the samples taken on 6.iv.1983, the three remaining mufflon samples are grouped together in one cluster and the two wild boar samples in another. This indicates that there exists a preference of some species for either kind of droppings. *A. fasciatus* in-

Table 2. Relative abundances of the most dominant scarab beetles collected by means of a Tullgren funnel. A "+" indicates a relative abundance less than 1%.

Sampling date	26.iv	31.v	8.vii	25.viii	14.x
Species	percent frequency				
Onthophagus similis	42	36	77	82	11
Aphodius ater	18	34	10	1	–
A. sphacelatus	32	4	–	–	34
A. pussilus	+	17	3	–	–
A. depressus	–	2	1	12	+
A. distinctus	–	1	+	–	23
A. contaminatus	–	–	–	–	29
Other species	7	5	7	4	2
Total number of species	11	13	13	11	13
Total %	100	100	100	100	100
Total number of specimens	888	872	923	1240	1466

Table 3. Relative abundances of the most dominant scarab beetles collected by means of pitfalls. A "+" indicates a relative abundance less than 1%.

Sampling date	22.x	16.xi	18.xii	6.iv
Species	percent frequency			
Typhoeus typhoeus	6	2	7	51
Onthophagus similis	5	+	–	17
Aphodius contaminatus	13	3	4	–
A. sphacelatus	46	52	28	2
A. fasciatus	14	16	32	11
A. distinctus	9	19	11	–
A. paykulli	1	5	12	3
Other species	6	2	6	16
Total number of species	11	16	12	10
Total %	100	100	100	100
Total number of specimens	111	2156	275	161

deed seems to be more abundant in mufflon droppings. This preference, however, is not supported by data from the literature. Lumaret (1978) reports a preference of this species for cow droppings. Landin (1961) concludes that in general dung beetles do occur in all kinds of droppings and summarizes one of his main conclusions as follows: "It was clear from observations in the field as well as from laboratory experiments that dung beetles feed on dung substratum independent of the kind of dropping." Inspection of Krikken's (1978) data also indicates that no clear preferences exist for either dung of wild boar or red deer for most of the species. However, *A. contaminatus* was collected in relatively high numbers in droppings of red deer and *O. similis* seemed to prefer wild boar dung. These 'preferences', again, are not supported by data from the literature.

In conclusion, the dung beetles collected do not show a preference for either wild boar or mufflon droppings.

Phenology

To describe the seasonal pattern the data for the mufflon and the wild boar dung were taken together. This is a valid procedure since only in the case of *A. fasciatus* there might be some preference for one kind of dropping above the other. In table 2 and 3 the relative abundances are given for the most dominant species (percent frequency $> 10\%$) per collecting date, for the Tullgren catches and the pitfall catches respectively.

From these tables it appears the *O. similis* is present in large numbers from April onward, and that it's relative frequency increases until the end of August. During the winter period the species is still present but does not belong to the most dominant ones. In the beginning of April 17% of the pitfall catches consist of specimens of this species. All other dung species collected were present for a much shorter time period compared to *O. similis*.

From tables 2 and 3 one may conclude that *A. ater* is an univoltine spring species with a peak occurrence in May, and this is very well in agreement with data from England and Denmark as presented by White (1960) and Holter (1982) respectively. During the winter period only a single specimen was collected. However, according to Landing (1961) the adults of this species occur in the late summer and autumn, and again in April/May, after hibernation.

Also *A. sphacelatus* is reported by Landin (1961) to hibernate in the adult stage, and to occur in late autumn and early spring. This seems well to agree with the data presented in tables 2 and 3.

A. pusillus was collected in high numbers only in the end of May. This is not in agreement with e.g. Landin (1961) who states that the adults occur in July/August, the hibernating generation occurs in the late autumn, and they appear again in April/June.

A. depressus was present during the greater part of the summer, but was most abundant at the end of August which is not in contradiction with the literature.

Both *A. distinctus* and *A. contaminatus* were extracted in large numbers from droppings collected in October. *A. contaminatus* was present during the winter period, but unlike *A. distinctus*, not in large numbers. Both species are known to occur in autumn, but *A. distinctus* is also reported to appear in early spring (Landin, 1961). White (1960) reports the adults of *A. contaminatus* from late summer and he also found that the species overwinters in the egg stage. Also Holter (1982) found the peak occurences of both species to fall in autumn.

A. fasciatus and *A. paykulli* were mainly collected during the winter period. The latter species is reported by Landin (1961) to be an autumn species, which appears in October/November (December), and adults may hibernate and occur again in March/April. *A. fasciatus* is reported to occur from September to May.

Finally, *Typhoeus typhoeus*, a species not collected by means of the extraction method, was caught in the pitfall traps throughout the winter period, with a peak in early April. *T. typhoeus* is indeed known to be rare in summer (e.g. Paulian and Baraud, 1982).

The remaining, less abundant species from table 1 will not be discussed separately, but some of them were collected in numbers that were sufficiently large to permit some simple conclusions as to their phenology. *A. luridus* and *A. tristis* were present in the spring period, and *A. granarius, A. haemorrhoidales* and *A. erraticus* may be classified summer species.

Tables 2 and 3 clearly indicate that *O. similis* is the most dominant species in dung from April until the end of August, and is almost totally absent in the winter period. The number of abundant *Aphodius* species seems to be negatively correlated with the % frequency of occurence of *O. similis*. In spring, when the relative abundance of *O. similis* amounts 42% (26.iv) and 36% (31.v), two *Aphodius* species became very abundant. During summer and autumn when *O. similis* became very dominant (> 70%!) only one *Aphodius* species was relatively abundant. In late autumn and in the winter period, three *Aphodius* species did coexist in high numbers. Furthermore we can see from both tables that the combination of dominant species was never the same throughout the season; on each sampling date, especially in the summer period, we found another combination of (*Aphodius*) species to be abundant, indicating that the species are more or less seasonally separated.

Conclusions

As a general conclusion one may state that a) the dung beetle species studied do not show a preference for either mufflon or wild boar droppings and b) there is a specific pattern of seasonal succession. It would surely be interesting to know whether this pattern is the same from year tot year. Landin (1961) concludes from his field and experimental studies that the fluctuations in natural populations of dung beetles depend on abiotic environmental factors. Also Holter (1982) did not find evidence for competition and his data suggest that species are well separated seasonally. White (1960) found similar patterns of succession in two successive years in the same area, and he suggests that the patterns of succession may well be typical for the area. Comparing the Tullgren species list (see table 1) with the species list presented by Krikken (1978) for Hoenderloo we can see that there is a rather large agreement between the two (about 50% similarity). Therefore it may well be that the pattern of succession of scarab beetles in droppings of wild boar and mufflon, as described in this paper, is typical for the area of De Hoge Veluwe.

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