Emus hirtus in Niedersachsen (Germany) and Europe: contribution to the knowledge of the ecology and distribution of a locally endangered rove-beetle (Coleoptera: Staphylinidae)

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Dung, grazing, rove-beetle, site management, water buffalo

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The population development of the locally endangered rove-beetle *Emus hirtus* was monitored from 2010 to 2012. The study site is a pasture grazed by water buffalos near Oldenburg (Niedersachsen). Besides own observations, literature was reviewed to obtain more information on the ecology of this rove-beetle. *Emus hirtus* is specialized on dung of grazers in half-open landscapes on sandy soils. The dependence on carrion is discussed and it is concluded that the introduction of grazers (wild or cattle) in nature conservation or restoration areas will benefit *E. hirtus*.

Introduction

The conspicuous rove-beetle *Emus hirtus* Linnaeus (figure 1) is a psammophilic species (Curtis 1835, Horion 1965, Freude *et al.* 1971, Telnov *et al.* 2008). It is a predator of beetles of the genus *Aphodius* and their larvae (Freude *et al.* 1971), maggots (Krawczynski *et al.* 2011) and *Sphaeridium* beetles. *Emus hirtus* is a species spread throughout Europe from Spain (Champion 1902), the British Isles (Curtis 1835), France (Borges & Meriguet 2005), Central Europe (Sterrenburg & Schülke 1997, Melke & Maciejewski 1999, Staniec 2010, Krawczynski *et al.* 2011), the Alps (Schatzmayr 1908, Kofler 1980), the Baltic countries (Cibulskis 2007, Telnov *et al.* 2005, Barsevskis *et al.* 2008), Sweden (Ljundberg 2007) and Russia (Shulaev 2008) to Romania (Stan 2007) and Turkey (Kesdek *et al.* 2009). All altitudes from sea level (Rose 2010, Sterrenburg & Schülke 1997) to higher mountains (Schatzmayr 1908, Kofler 1980) are inhabited although a recent shift to higher altitudes is observed locally (Horak *et al.* 2011). The reason for this remains unclear, although changes in land-use and climate change are mentioned in literature.

After a steep decline during the 1960s, there has been an increase in observations since the 1990s in some European countries (Latvia: Cibulskis 2007, Germany: Krawczynski *et al.* 2011, Czech Republic: Horák *et al.* 2011), while it is still declining or possibly gone in other countries (The Netherlands: Sterrenburg & Schülke 1997, France: Borges & Meriguet 2005, Romania: Stan 2007, Stan 2008, Poland: Staniec 2010). The objective of this article is to contribute to the knowledge of the ecology, targeted management and population trends of this beetle.

Methods

This article is based on our observations, mainly from a water buffalo pasture in Niedersachsen and some additional observations from Brandenburg. In addition, literature from all over Europe is reviewed. Literature used gave specific details on locality and/or substrate.

The study site is a 4.6 ha pasture for water buffalos in Huntlosen (Oldenburg). The pasture is surrounded at three sites by deciduous forest, and the village of Huntlosen. The site is on a sandy soil and is part of the Hunte flood plain. In the past, the pasture has been used intensively for meat cattle production (5 livestock units per ha). Prophylactic use of dewormers and frequent use of liquid manure resulted in low diversity of plants and animals. The dominant grass species during the period with agricultural activities was perennial ryegrass (*Lolium perenne*), which was mainly accompanied by broad-leaved dock (*Rumex obtusifolius*). For historical details on land use see Lysakowski (2012). As the owner of the pasture – the forest department – was not satisfied by this intensive land-use, another farmer was asked to graze the area by his livestock. As he had used water buffalos for biodiversity conservation for many years, some of his animals were brought to the study site in April 2010. The pasture is now grazed year-round by water buffalos with varying densities between 0.5 to 2.0 livestock units per ha. Use of drugs is restricted and is never used as a preventive measure. No fertilizers or pesticides are applied. In 2012 the dominant grass was velvet grass (*Holcus lanatus*).

1. (a) *Emus hirtus* on buffalo dung with a *Lucilia* fly and (b) mating beetles in May. Photos: Peter Biel
1. (a) *Emus hirtus* op uitwerpselen van waterbuffel met een Lucilia-vlieg en (b) parende kevers in mei.

The pasture is visited almost daily by us. Since its first observation of *E. hirtus* on the study site on July 30, 2010, all new occurrences of this species were documented by making pictures or videos. No specimens were collected for this study.

Results

Substrates for feeding and wintering

Twenty-eight observations from Niedersachsen and Bremen, recorded since 1880, were reviewed. In almost all cases (96%), *E. hirtus* is found on dung or dung heaps. Of these observations nine were on cattle dung and three on horse dung, three on buffalo dung, three on unspecified dung (no animal species or condition of the dung was given) and three observations were from dung heaps. From Germany, there is just one observation from the litter under a bleeding tree. These observations were taken from Horion (1965), Schmidt (personal communication), NLWKN (personal communication), Krawczynski *et al.* (2011) and our observations.

When we include European literature, with records since 1835 (n = 97), about 70% of all observations record dung as substrate. The type of substrate and the percentages of observations per substrate type are shown in tabel 1 and figure 2. The authors from whom these data are derived, are included in table 1. Dung of grazers like cattle or horse including dung heaps make up some 80% of the total amount of records from dung. Telnov *et al.* (2006) find the litter layer under bleeding birches in two cases as substrate. Carrion as substrate is rarely specified, but Horion (1965) names a roe deer (*Capreolus capreolus*) carcass, Borges & Meriguet (2005) found *E. hirtus* on a dead hedgehog (*Erinaceus europaeus*) and we found it on a red deer (*Cervus elaphus*) carcass.

There is just one record of overwintering habitat. Krawczynski *et al.* (2011) mentioned one wintering individual on April 1, 2005 in dead wood (nature reserve Hasbruch, Oldenburg).

Phenology

On our study site, *E. hirtus* was observed from April to October (n = 49) in the years 2010 to 2012. The earliest sighting in spring was April 22 , 2011; the latest sighting in autumn was October 12, 2011. The activity was highest from May to August, with a clear maximum in July (figure 3). Mating beetles were observed on May 25, 2012 (figure 1). According to Palm (1962) and Ljundberg (2007), the larvae pupate at the beginning of July, and emerge by the end of July. We observed an 'old', almost hairless *E. hirtus* on June 30 , 2012, which might confirm Palm (1962) in his observation of a generation turnover in July.

Population development

All observations of *E. hirtus* were recorded by photos and videos without systematic monitoring. The advantage is that no specimens had to be killed. In 2010, the year of the first observations, *E. hirtus* was recorded five times in total, with never more than one specimen at the same time. In 2011, it was observed 17 times with up to three specimens at the same time. In 2012, *E. hirtus* was observed 24 times with a maximum of seven specimens at the same time (figure 4).

Discussion

Substrates for wintering and feeding

There do not seem to be any other observations of wintering *E. hirtus*, except for the one specimen found in dead wood on April 1, 2005 in the Hasbruch woodland, a former woodland pasture (Krawczynski *et al.* 2011). Our study site is also an open area surrounded by woodland. Some authors see a close relation between the species and light forests or woodland pastures. Lysakowski *et al.* (2010) also found two specimens in a single dropping of European bison in April 2009 in Döberitzer Heide near Berlin. This area is a former military training site and the woodland structure of mainly oak resembles woodland pastures. According to Horak *et al.* (2011), *E. hirtus* is an indicator for the openness of woodland pastures. Curtis (1835) gives two observations from a woodland pasture in what is now the New Forest National Park. The observations of this beetle in park-like landscapes might indicate that woodlands or light forests are suitable overwintering habitats.

Dung of large grazers seems to be the most important feeding habitat for *E. hirtus*. We observed up to seven specimens at the same time on a single buffalo dropping. Dung of browsers (in contrast to grazers) seems to be only an occasional feeding substrate. Dung of large grazers may weigh about 2 kg (Lysakowski *et al.* 2010, Floate 2011), whereas dung of sheep is just about 0.06 kg (Wassmer & Sowig 1994). Although some *Aphodius* species were found in smaller amounts of dung in that study, large numbers of more than 1,000 specimens were found in

Table 1. Records of feeding substrate of *Emus hirtus* (n = 97) and references.
Tabel 1. Waarnemingen aan voedselbron van *Emus hirtus* (n = 97), inclusief referenties.

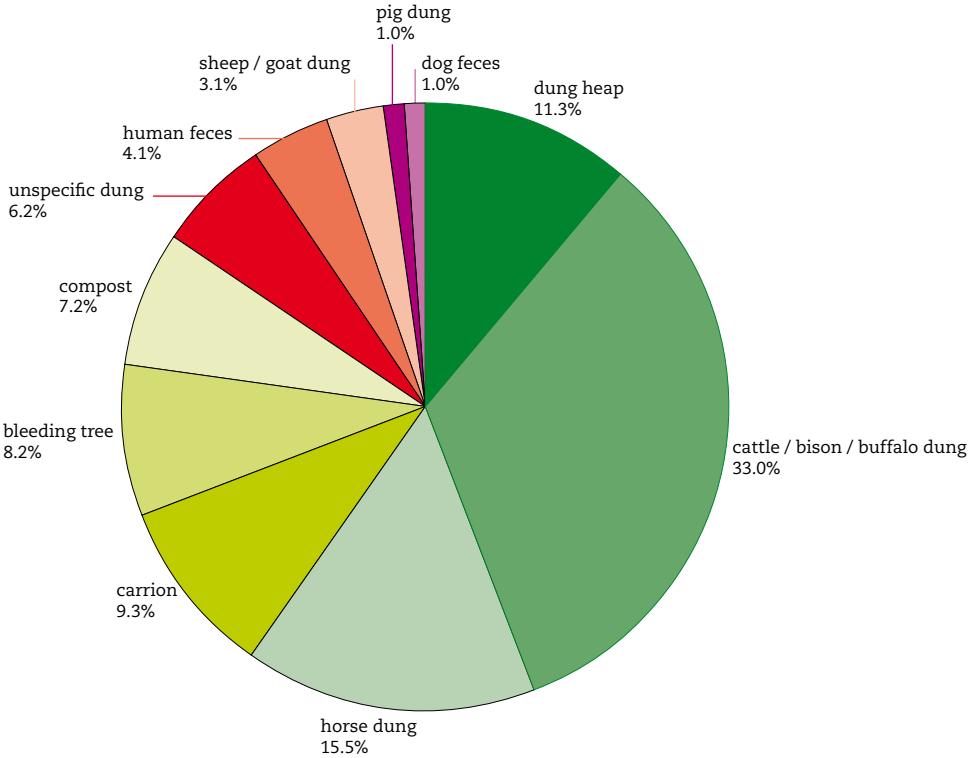
Substrate	Percentage of records	Literature cited
Cattle / bison / buffalo dung	33.0	Curtis 1835, Horion 1965, Telnov & Kalnins 2003, Telnov *et al.* 2005, Telnov *et al.* 2006, Ljundberg 2007, Krawczynski *et al.* 2011
Horse dung	15.5	Gerend & Braunert1997, Telnov & Kalnins 2003, Telnov *et al.* 2006, Ljundberg 2007, Staniec 2010
Dung heaps	11.3	Horion 1965
Carrion	9.3	Bulcock 1827,Curtis 1835, Horion1965, Borges & Meriguet 2005, Gärtig 2013
Litter under bleeding trees	8.2	Horion 1965, Telnov *et al.* 2006
Compost	7.2	Horion 1965, Krawczynski *et al.* 2011
Unspecified dung	6.2	Champion 1902, Kofler 1980, Telnov *et al.* 2006, Shulaef 2008
Human feces	4.1	Horion 1965
Sheep / goat droppings	3.1	Horion1965
Pig droppings	1.0	Telnov & Kalnins 2003
Dog droppings	1.0	Sörensson 2008

dung by Floate (2011), 1,100 beetles in a cattle dropping (Gerken *et al.* 2008), and more than 1,600 beetles in a horse dropping (Lysakowski *et al.* 2010). *Emus hirtus* hunts by checking holes in the crust of a dropping made by other dung beetles (figure 5). If successful, it drags the prey from the hole, and then turns on its back. While lying so, it holds the prey with its legs while devouring it. Such hunting scenes can be observed rarely, as *E. hirtus* stays most of the time between the dropping and the grass, where most *Aphodius* beetles can be found. Smaller droppings cannot provide these large numbers of prey.

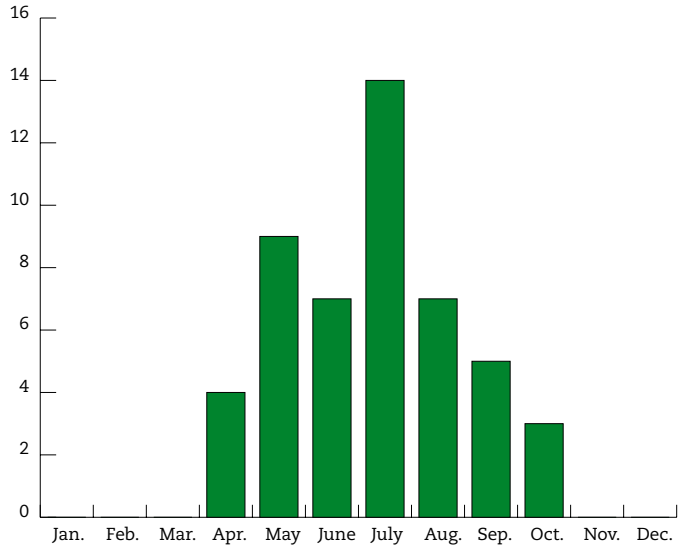
Changing agricultural practices resulted in a decrease of large grazing animals in pastures as more and more animals are kept inside large stables. This change took place in the 1960s and 70s in Western Europe and after 1990 in Eastern Europe. As a result, the availability of substrate in the agricultural landscape decreased. In addition, the use of drugs like dewormers made the remaining substrates less suitable as hunting and breeding substrate, as dewormers are known to result in a breakdown of coprophilous arthropods (Krüger & Scholtz 1998, Borges & Meriguet 2005, Floate 2011).

A development that counteracts the decrease of substrate in the agricultural landscape is the introduction of large grazers in natural areas. This grazing for biodiversity conservation has been acknowledged for a long time (e.g. Vera 2000) and is used in a large number of areas. The observations of feeding substrates from Niedersachsen and Brandenburg are from nature areas, which are either grazed (Huntlosen, Döberitzer Heide) or where large carcasses are exposed for scientific research (Lieberoser Heide). In Huntlosen and Döberitzer Heide, the use of drugs is very restricted and the animals are free to choose the diet from grasses, herbs and shrubs. A high fiber diet influences the structure of dung and seems to be more beneficial for dung fauna. We suppose that other nature reserves in the region with large grazers and sandy soils could already be inhabited by *E. hirtus*.

The role of carrion as substrate seems to be of importance as well. Horion (1965) mentions 60 specimens of *E. hirtus* on a roe deer (*Capreolus capreolus*) carcass. However, the sources which give carrion as feeding habitat are generally older than 1965. The only recent observation is by us from Lieberoser Heide. Lack of observation is most certainly due to lack of large



2. Records of feeding substrate of *Emus hirtus* in percentage (n = 97).
2. Waarnemingen aan voedselsubstraat van *Emus hirtus* in percentages (n = 97).



3. Number of all observations per month of *Emus hirtus* in Huntlosen in the period 2010-2012.
3. Aantal observaties per maand van *Emus hirtus* in Huntlosen van 2010 tot en met 2012.

animal carcasses which results from very strict hygiene regulations (Krawczynski & Wagner 2008). Although some *Aphodius* beetles can be found on large carcasses, main food source at carcasses are most certainly maggots and in some cases maybe Dermestidae, which are about the same size as the preferred *Aphodius* or *Spaeridium* species. It is not known, whether *E. hirtus* is only hunting at carcasses or also breeding.

Population development

The population of *E. hirtus* at the study-site at Huntlosen increased considerably within the three years of observation. According to Petrakis & Legakis (2005), the expansion of *E. hirtus* can be explained by global warming, which favors thermophilous species. We did find thermophilous species that have not been observed previously at certain sites, such as *Mantis religiosa* (Linnaeus) in Lieberoser Heide (Krawczynski & Wagner 2013). However, *E. hirtus* was much more common in former times. Horion (1965) quotes a source from 1862 naming *E. hirtus* an extremely common species with mass occurrences in Holstein (Schleswig-Holstein, Germany). The climate was considerably colder at that time than it is now. The species even declined most in the second half of the last century when the effects of global warming became apparent. Reichholf (2009) argues that the decline of thermophilous species is in accordance with the onset of artificial fertilizers. The denser vegetation after mass use of fertilizers changes the microclimate for soil dwelling, poikilotherm organisms negatively. Changing practices in animal husbandry with animals kept inside and production of liquid manure added to the overall negative impact. The recovery of *E. hirtus* in some European countries and decline in others might be explained by differences in development of the agricultural sector. In countries like Germany, there seems to be an increase in the population after a steep decline some decades ago. In countries like Poland or Romania a previously unknown decline can be observed. This could be due to changes in agricultural practices that Western Europe underwent already decades ago. However, detailed studies are missing. Better known is the parallel case of *Bolbelasmus unicornis* (Schrank) (Geotrupidae) which became extinct in West Germany around 1970 (Petersen *et al.* 2006), is now extinct in Poland and under heavy decline in Slovakia (Szwalko 2004). The recent increase of *E. hirtus* in Germany might be due to more grazing projects for biodiversity conservation. Occurrence of *E. hirtus* could therefore be an early and easy to measure indicator for success of restoration measures by grazing.

Conclusion

To benefit *E. hirtus*, large grazers should be brought to nature conservation or restoration areas (Reichholf 2007). It is of no importance for *E. hirtus* if these grazers are domesticated or wild animals, as long as drugs are only used restrictively or not at all for the domesticated animals. It has been shown that a whole range of drugs like dewormers, antibiotics or diclophenac will kill insects and vertebrates as side-effects (e.g. Lemus *et al.* 2008, Floate 2011, Chaudry *et al.* 2012). Moreover, the herbivores should have access to a diet rich in fibers and not be fed with silage, soya or maize. The diet influences the quality of dung which affects micro-flora and insect diversity and abundance.

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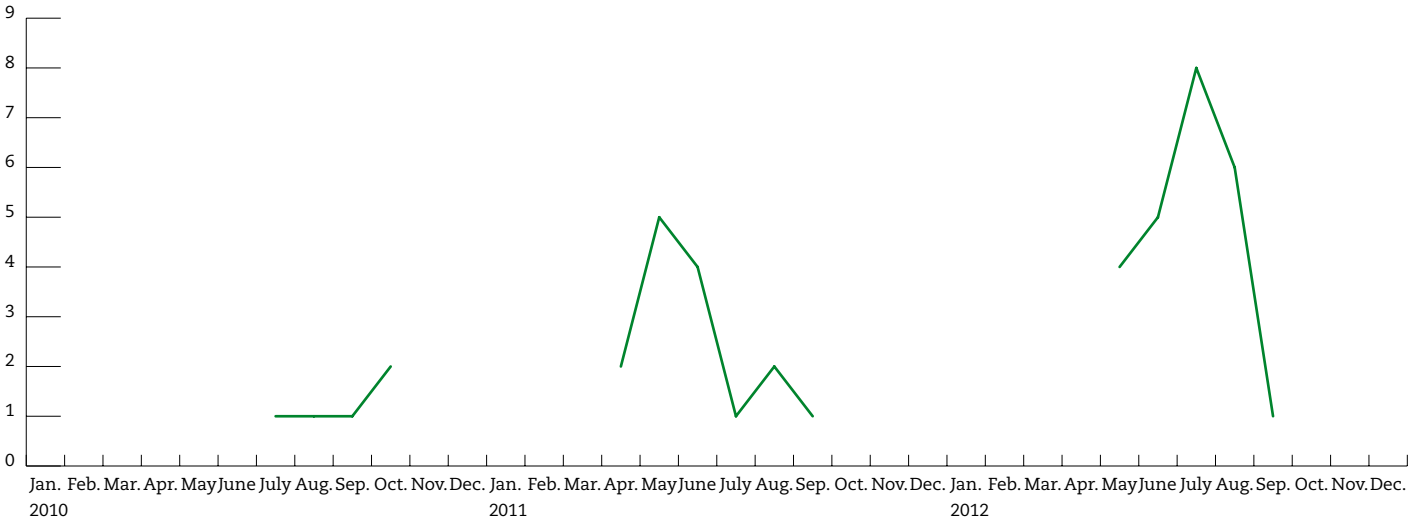

4. Population development of *Emus hirtus* in Huntlosen. The figure shows the number of observations per month for the period 2010-2012.
4. Populatie-ontwikkeling van *Emus hirtus* in Huntlosen. Het figuur laat het aantal waarnemingen zien van 2010 tot en met 2012.

5. Hunting sequence: (a) *Emus hirtus* finds a *Sphaeridium* beetle, (b) the predator caught the prey, (c) it turns on its back to devour the prey and (d) leaves the scene within few seconds. Photos: Peter Biel
5. Jaagmethode: (a) *Emus hirtus* vindt een *Sphaeridium*-kever, (b) de predator vangt de prooi, (c) draait op zijn rug en vreet de prooi op en (d) verlaat de bovenzijde van het uitwerpsel in enkele seconden.

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Samenvatting

***Emus hirtus* in Nedersaksen (Duitsland) en Europa: een bijdrage aan de kennis over ecologie en verspreiding van een lokaal bedreigde kortschildkever (Coleoptera: Staphylinidae)**

Emus hirtus is een predatoire kortschildkever (Coleoptera, Staphylinidae) met *Aphodius*-kevers en hun larven, vliegenmaden en *Sphaerium*-kevers als prooien. Het is een specialist op mest van grazers in halfopen landschappen met zandige bodem. Hoewel wijdverspreid over het hele Europese continent, is het aantal observaties van deze soort langdurig blijven dalen. Sinds de jaren 1990 stijgt dit aantal weer in sommige Europese landen, in andere landen blijft het aantal observaties echter klein of lijkt de soort uitgestorven. Sinds 1880 werden in Nedersaksen en Bremen (Duitsland) 28 observaties gemeld van *E. hirtus*. De soort werd veelal aangetroffen in mest (96%). De Europese literatuur meldt 97 observaties in totaal, waarvan 70% van mest. Populaties van *E. hirtus* werden door ons gemonitord van 2010 tot 2012 in een weide begraasd door waterbuffels in Oldenburg (Nedersaksen, Duitsland) en we deden ook enkele waarnemingen in Brandenburg (Duitsland). Alle observaties werden geregistreerd door foto's en video's. De rol van het kadaver als substraat alsook de relatie met de huidige klimaatverandering worden in dit artikel bediscussieerd. De aanwezigheid van grazers (zowel wilde als gedomesticeerde) in natuurterreinen zijn voordelig voor *E. hirtus*.

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