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HUMAN INFLUENCE ON THE DUNG FAUNA IN AFROTROPICAL GRASSLANDS (INSECTA: COLEOPTERA)

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Abstract: Dung beetles are the main dung recyclers in most Afrotropical environments. We compare dung beetle abundance in herbivore dung in West and East African grasslands that are subject to various anthropogenic disturbances. Dung beetles are similarly abundant in grasslands with indigenous wild herbivores and with extensive cattle farming. However, if herbivore dung is regularly removed (i.e. collected by local people for domestic and agricultural use) or not present locally at all, the abundance of dung beetles decreases. The lowest numbers were found in an urban settlement.

Key words: Dung beetles; West Africa; East Africa; savanna; disturbance; land use

1. INTRODUCTION

Afrotropical grasslands form the basis of many African economies, because they are used for the majority of agricultural, horticultural and stock farming activities. Thus, with a growing population, their indigenous fauna and flora are under enormous threat. Coprophagous scarab beetles play a decisive role in tropical grasslands in maintaining soil fertility by returning nitrogen, phosphorus and other nutrients from faeces on the soil surface into the soil and by increasing soil aeration and water capacity (Hanski and Cambefort, 1991). With this study, we present a preliminary view of the overall abundance of dung beetles and other coprophilous beetles of coprocenoses in several Afrotropical grasslands affected by various levels of anthropogenic disturbance.

2. MATERIAL AND METHODS

To obtain comparable quantitative data on dung beetle assemblages we deposited standardized portions (ca. 900 ml, i.e. 1 kg) of fresh cattle or buffalo dung on the ground and flooded them after half a day in a bucket of water together with the populated soil below. Because of fundamental diel differences (Krell et al., 2003), day and night assemblages were sampled separately. In each site, ten night and ten day samples were taken, randomly distributed over the experimental period. The method is described and discussed in detail by Krell et al. (2003). All samples were collected in the first half of the main rainy season to reduce seasonal effects.

The following sites were sampled. They can be ordered along a disturbance gradient with the most natural condition boasting a constant supply of faeces of native large mammals (‘Comoé’), intermediate conditions showing a replacement of the native mammal faeces by livestock faeces (‘Bringakro P’, ‘Shiveye’) and the most disturbed condition without constant herbivore dung supply (though human faeces are regularly present) (‘Bringakro I’, ‘Buyangu’, ‘Youpogon’).

a) ‘Comoé’: Northeastern Côte d’Ivoire, southern Parc National de la Comoé, 8°45’02”N, 3°48’58”W (09.vii.-25.vii.1997), see figures 1 and 4 in Krell et al. (2003); savanna parkland (‘savane arbustive’) with indigenous large herbivore fauna, not used for agriculture or farming, but annually burned and regularly poached;

b) ‘Bringakro P’: Central Côte d’Ivoire, V-Baoulé, Bringakro, 6°25’07”N, 5°04’01”W (27.vi.-2.vii.2003); savanna parkland used for extensive cattle farming, annually burned, native large mammals almost extinct;

c) 'Shiveye': Western Kenya, outside Kakamega Forest, Shiveye village, 0º09'52" N, 34º48'04"E (6-23.iv.2003); grassland of a small farm, used as cattle pasture, dung not used by humans, native large mammals extinct;

d) 'Bringakro I': Central Côte d'Ivoire, V-Baoulé, Bringakro, 6°25'00"N, 5°05'31"W (27.vi.-2.vii.2003); grassland near village (mainly *Imperata* sp.), not used for cattle farming, annually burned, native large mammals extinct;

e) 'Buyangu': Western Kenya, Kakamega Forest, Buyangu, 0º21'13"N, 34º51'49"E (9-19.iv.2003); grassland not used for cattle farming, but surrounded by farms, in which 80% of the fresh cattle dung is regularly and all year round collected by farmers for various purposes (survey with 40 farmers in the area), native large mammals extinct;

f) 'Youpogon': Southern Côte d'Ivoire, Abidjan-Youpogon, 5°19'26"N, 4°04'58"W (16-29.vii.2002); strip of grass and herbaceous vegetation in urbanized residential area between tarmac street and housing, no cattle or other herbivores present.

The material is deposited in The Natural History Museum London except for the samples from Bringakro, which were destroyed by airport authorities in Brussels despite valid export papers. A part of the Kenyan material will be deposited in the National Museums of Kenya after species identification.

We present the data as pooled absolute abundance of individuals at family level. For this brief overview, we refrain from presenting means with standard deviation because the generally high standard deviations we find with dung beetle assemblages mainly reflect the trivial weather fluctuations during the sampling period since dung beetle abundance is strongly influenced by weather conditions (Davis, 1995). We also refrain from presenting medians because outlying activity peaks of abundant species are regular and significant events in dung beetle assemblages and would be neglected if considering medians and quartiles only.

We present the most abundant taxa Scarabaeoidea (proper dung beetles, coprophagous), Histeridae (clown beetles, predators), Hydrophilidae (water beetles, predators and coprophagous), and Staphylinidae (rove beetles, predators and coprophagous) and pool the remaining taxa ('rest', mainly Carabidae, predators).

3. RESULTS AND DISCUSSION

Although disturbed by poaching and affected by bush fires, the site in the Parc National de la Comoé is the most natural reference site. Anthropogenic bush fires have been an integral component of the West African savanna ecosystems for several hundred to 50,000 years (Meurer et al., 1994). Thus,

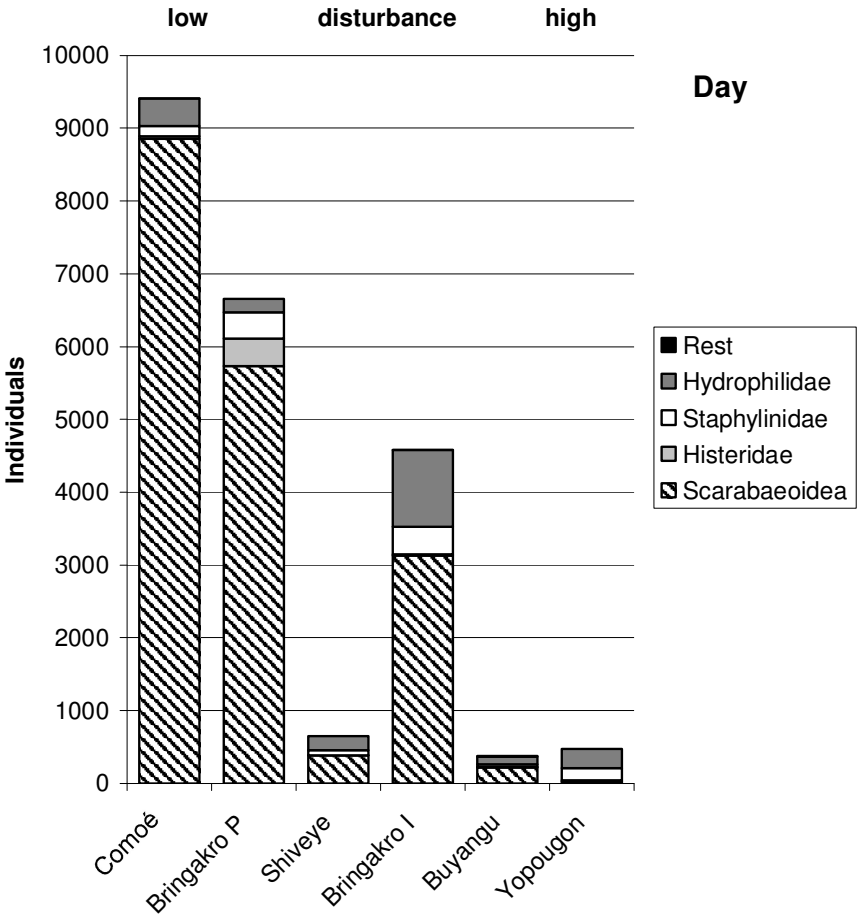

Figure 1. Abundance of beetles inhabiting ten 1 kg portions of bovid dung per site, exposed from 6:00 h to 16:00 h (diurnal beetles).

we do not consider fire as a disturbance for the purpose of this study. Savannas with constant dung supply ('Comoé' with native herbivores, 'Bringakro P' with livestock) show the highest abundance of coprophagous beetles both during the day and the night (Figs 1-2). Although the dung in the savanna of Bringakro is supplied by livestock and not by the original fauna, dung beetle abundance during the day does not differ significantly from the Comoé site ($p=0.169$; exact permutation test, SsS 1.1g, Rubisoft Software GmbH; Crowley, 1992) and is even significantly higher at night ($p=0.009$).

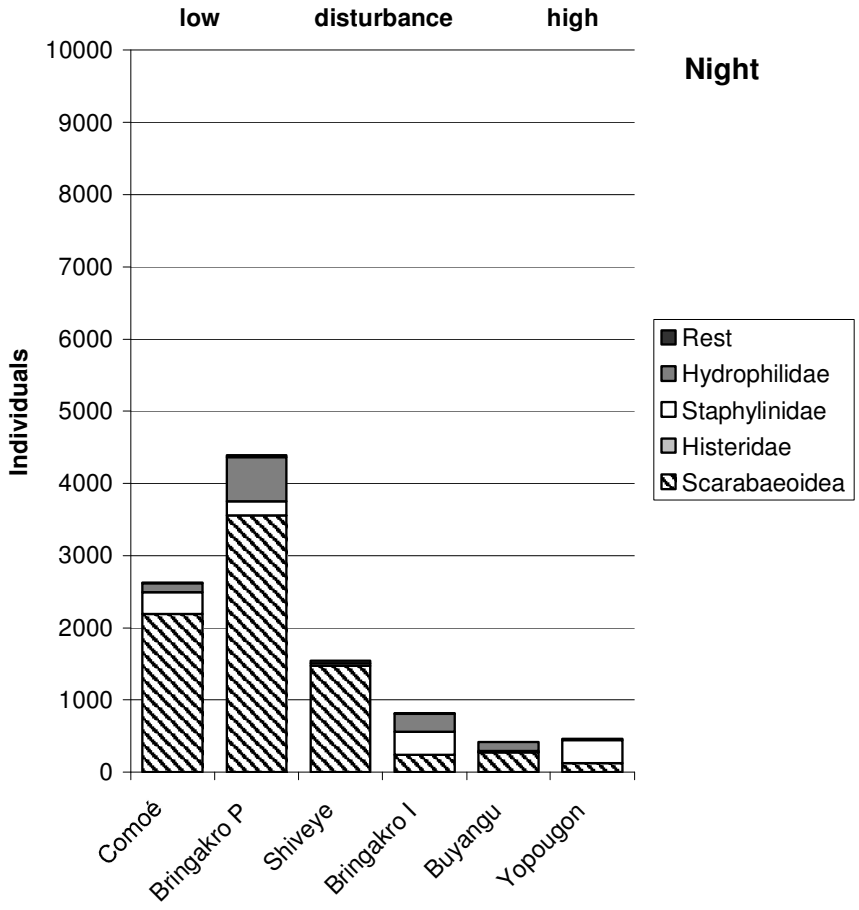

Figure 2. Abundance of beetles inhabiting ten 1 kg portions of bovid dung per site, exposed from 18:00 h to 6:00 h (nocturnal beetles).

Dung beetle abundance on the farm with constant dung supply (Shiveye) is much higher at night than during the day. This meadow surrounded by fields and gardens might be either too derived from natural grasslands (causing a different microclimate particularly during the day) or simply too small to support large dung beetle populations. However, compared to an area without constant dung supply 17 km away (Buyangu), the proper dung beetles are significantly more abundant (p_{day}=0.020; p_{night}=0.005).

'Buyangu' and 'Yopougon' are the most disturbed sites since in the whole area herbivore dung is not regularly available, either because most of

the cattle dung is removed by farmers or large herbivores are lacking. The urban site at Youpogon, which additionally suffers from pedestrian and nearby vehicle traffic, shows the lowest dung beetle abundance. Although the pooled number of beetles is higher than in rural Buyangu, this difference is not significant (p_{day}=0.504; p_{night}=0.859).

The other rural site without herbivore dung supply is an *Imperata* grassland 'Bringakro I'. *Imperata* grass is not a palatable food-source for the local cattle, but pasturelands are within a distance of 0.9 km (well within flight range of dung beetles). Compared with the grazed savanna 'Bringakro P' (which is at a distance of 2.8 km), the dung beetle abundance is, however, significantly lower (p_{day}=0.012; p_{night}=0.002).

4. CONCLUSION

Despite the high mobility and dispersal power of dung beetles, local dung supply seems to influence their abundance. Although omnipresent human faeces are attractive to most dung beetle species (Walter, 1978), for maintaining high abundance of herbivore-dung beetles the presence of herbivore dung is needed.

For sheer abundance, livestock faeces are suitable to replace the droppings of indigenous wild herbivores, however, this does not necessarily extend to diversity and dominance structure of the beetles. Removing dung from farmland apparently decreases the dung beetle fauna, and although the usage of dung as fertilizer or building material means an economic advantage for the local farmers, possible consequences of a diminished dung recycler fauna for local hygiene and soil fertility, albeit unknown so far, might be worth investigation.

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