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## **EAST AFRICAN DUNG BEETLES (SCARABAEIDAE) ATTRACTED BY DEFENSIVE SECRETIONS OF MILLIPEDES**

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### **ABSTRACT**

Dung beetles of six species of the genus *Onthophagus* (Scarabaeidae) were attracted by millipede carcasses in Laikipia, Central Kenya. One of these species (*Onthophagus gibbus*) was lured by the quinonoid defensive secretions of the millipedes. The attractive effect of quinonoid millipede secretions to necrophagous dung beetles was previously recorded from West and Southern Africa and from tropical Asia and may also be found in other regions where large millipedes occur.

### **INTRODUCTION**

Millipedes (Diplopoda) of the orders Spirostreptida, Spirobolida and Iulida produce yellow defensive secretions consisting mainly or exclusively of quinones (Blum, 1981; Huth, 2000). Quinones, easily recognizable by their typical smell, are effective repellents for both invertebrate and vertebrate predators (Eisner *et al.*, 1978). A few years ago in Côte d'Ivoire, we found that these secretions attract several necrophagous species of dung beetles of the genus *Onthophagus* Latreille that are specialist scavengers of freshly dead millipedes (Krell *et al.*, 1997). Later, the same attraction was discovered in Southern Africa (Krell, 1999) and Borneo (Brühl & Krell, 2003) indicating that it is a common phenomenon in regions where large millipedes and dung beetles coexist. Furthermore, in field tests in Côte d'Ivoire we proved that the quinones in the defensive secretions are actually the attractants (Schmitt *et al.*, 2004). Here the first record of dung beetle attraction by quinonoid defensive secretions from East Africa is presented.

At the Mpala Research Centre in Laikipia District of Kenya, on two occasions I observed dung beetles burying millipede carcasses. At the first carcass, they all belonged to the species *Onthophagus gibbus* d'Orbigny, 1913 (4 ♀♀, 1 ♂; 6 May 2003; figure 1.1). The second carcass, found the next day, was populated by *O. graphicus* Wallengren, 1881 (1 ♀, 1 ♂; figure 1.4), *O. bellus* d'Orbigny, 1905 (1 ♀; figure 1.2), and *O. foraminosus* d'Orbigny, 1902 (1 ♂). With trapping experiments, I tested whether the quinonoid defensive secretions of the millipedes are responsible for the attraction of these necrophagous beetles.

MATERIAL AND METHODS

To obtain the defensive secretions millipedes were handled with unperfumed toilet paper (Velvex white, Chandaria Industries, Nairobi, Kenya) until yellow drops of fluid were seen and a quinonoid smell was prevalent. The toilet paper was then wrapped around a small twig and placed over a pitfall trap, composed of a transparent plastic funnel (about 10 cm diameter; polyethylene) placed on the top of a plastic cup. For each experiment I used one baited pitfall trap and one control trap. The traps were filled with water without adding any chemical to ensure that only the secretion acted as an attractant, and were exposed for one evening (since all known millipede feeding Scarabaeidae have their flight activity peak at dusk).

A further pitfall trap baited with dead millipedes was exposed from 10–11 May 2003 near and parallel to the trap with the defensive secretions. These millipedes had been dead for one day and their defensive secretions were taken with toilet paper before. Therefore, the concentration of quinones in their carcasses was much lower than in freshly dead millipedes. The millipedes used for the experiment belonged to the genus *Odontopyge* sensu Kraus (1960) (Spirostreptida, Odontopygidae) (det. R. Hoffman).

The trapping site (0°17'40"N, 36°53'57"E) was on the grounds of Mpala Research Centre in the semi-arid savanna on the Laikipia plateau (Central Kenya). A description of the area is given by, e.g., Young *et al.* (1998) and Keesing (2000), however, the trapping site was on red lateritic soil.

RESULTS

Beetles were only caught in the pitfall traps with defensive secretions and with millipede carcasses; none were caught in the control traps. The trapping result for the defensive secretion traps is shown in table 1.

Table 1: Captured specimens of *Onthophagus gibbus* d’Orbigny in a pitfall trap baited with diplopod defensive secretions at Mpala Research Centre, Laikipia, Kenya. The results of the control trap are in parentheses.

Time/date	9 May 2003	10 May 2003
06:15–20:00 h	2♀♀ (0)	5♀♀, 3♂♂ (0)
20:00–23:00 h	- <sup>1</sup>	2♀♀, 1♂ (0)
total	2 (0)	11 (0)

<sup>1</sup>Dik-diks dug out the traps before 20:30 h.

The trap with the old millipede carcasses attracted only other species: *O. bellus* (2 ♀♀, 1 ♂; figure 1.2), *O. teitanicus* d’Orbigny, 1902 (2 ♀♀; figure 1.3), and *O. quadrimaculatus* Raffray, 1877 (1 ♂).

The beetles are deposited in the National Museums of Kenya, Nairobi, and in The Natural History Museum, London.

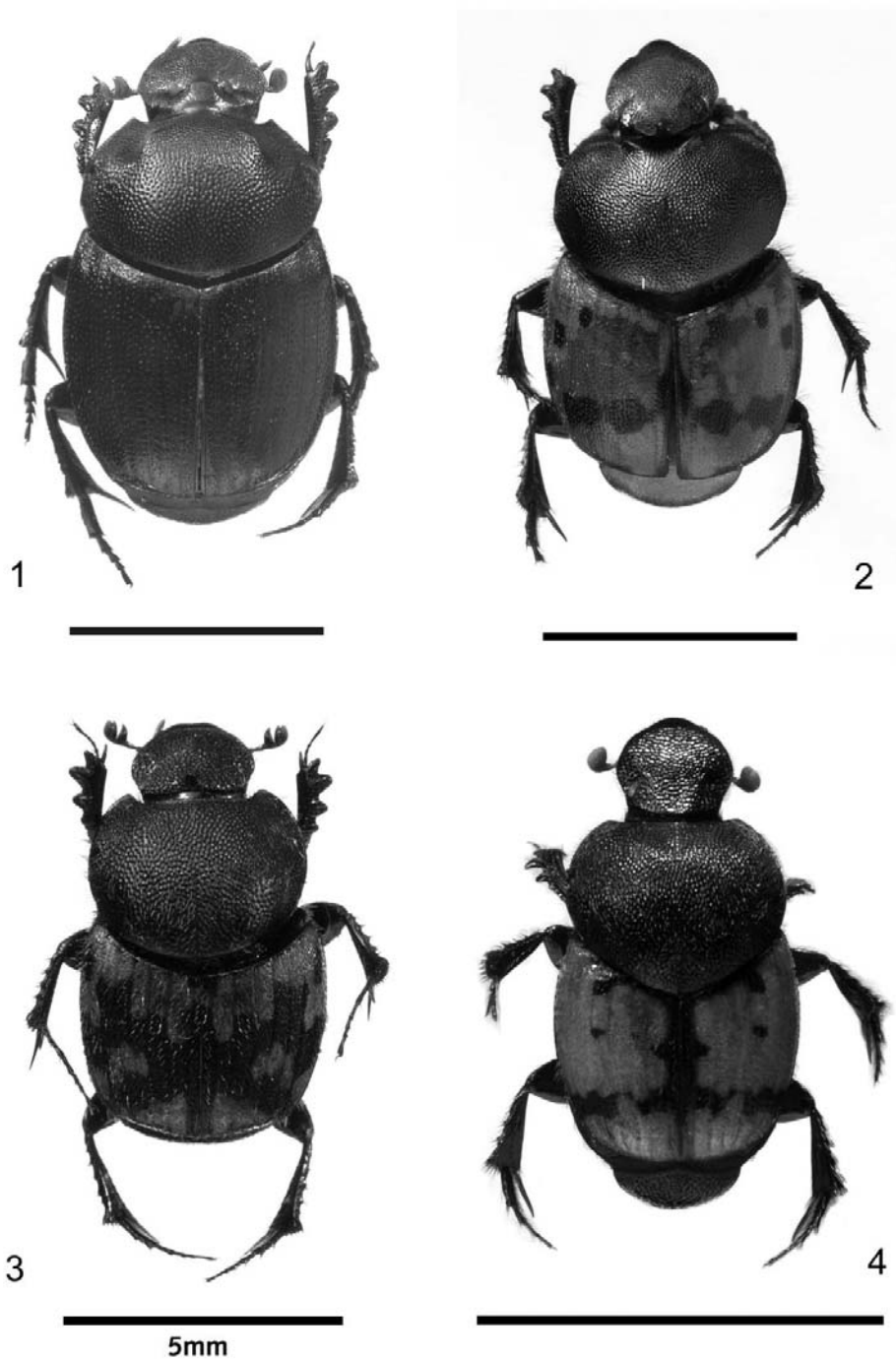


Figure 1: *Onthophagus* species attracted by millipede carcasses at Mpala Research Centre, Laikipia, Kenya. 1.1: *O. gibbus* d'Orbigny; 1.2: *O. bellus* d'Orbigny; 1.3: *O. teitanicus* d'Orbigny; 1.4: *O. graphicus* Wallengren. All scales represent 5mm.

## DISCUSSION

Very little is known about the trophic preferences of the species I collected on dead millipedes and millipede defensive secretions. The species from these baits differed. Only one species (*O. gibbus*; figure 1.1) was attracted to quinonoid secretions whereas five additional species were found on carcasses.

Several specimens of *Onthophagus graphicus* (cf. figure 1.4) which I initially found on a millipede carcass had been collected by G. Bernon in pitfall traps baited with dead millipedes in South Africa (Boekenhoutskloof, 30 km NE Pretoria, 17 December 1976, 27 January 1977; material in Canadian Museum of Nature and in coll. B. Gill, Ottawa; unpublished). Hence, this species is likely to use this resource commonly. One specimen of *O. teitanicus* (cf. figure 1.3), the species I found on old millipede carcasses (with a lower concentration of quinonoid secretions), had been collected from elephant dung by Foster (1993: 95f) in the Ngorongoro Crater. It has been also recorded “from the dung of large herbivores” in Kenya or northern Tanzania by Davis & Dewhurst (1993: 305) and is probably a generalist using both faeces and carrion.

Nothing was known about the feeding preferences of *Onthophagus gibbus* (figure 1.1), the species attracted to millipede defensive secretions in our experiment, but not to old millipede carcasses. Since *O. gibbus* did not approach old carcasses or at least preferred defensive secretions to old carcasses, it is likely to use freshly dead millipedes only. *O. gibbus* belongs to the 18<sup>th</sup> group of d’Orbigny’s (1913) classification which is defined by a combination of lateral depressions of the pronotum forming a median often edged hump, and the mostly simple punctures of the pronotum. Most of those species which are attracted to quinonoid millipede defensive secretions in high abundance in Côte d’Ivoire and South Africa belong to this group (*O. latigibber* d’Orbigny, 1902, *O. bartosi* Balthasar, 1966, *O. trinominatus* Goidanich, 1926, and *O. bicavifrons* d’Orbigny, 1902). If d’Orbigny’s 18<sup>th</sup> group (or at least a part of it) is monophyletic with the lateral depression of the pronotum as an autapomorphy, or the group is at least paraphyletic, specialization on freshly dead millipede carcasses might be another character of this taxon and we may expect to find other species of the 18<sup>th</sup> group using this unusual resource.

The attractive effect of quinonoid millipede secretions to necrophagous dung beetles has now been recorded from West, South and East Africa and from South East Asia. It is worth checking whether other regions where large juliform millipedes occur have similar specialist species which have developed the same olfactory mechanism to locate their resource.

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## REFERENCES

- Blum, M.S. (1981). *Chemical Defenses of Arthropods*. Academic Press, New York.
- Brühl, C. & F.-T. Krell (2003). Finding a rare resource: Bornean Scarabaeoidea (Coleoptera) attracted by defensive secretions of diplopoda. *Coleopterists Bulletin* **57**: 51–55.
- Davis, A.L.V. & C.F. Dewhurst (1993). Climatic and biogeographical associations of Kenyan and northern Tanzanian dung beetles (Coleoptera: Scarabaeidae). *African Journal of Ecology* **31**: 290–305.
- d'Orbigny, H. (1913). Synopsis des Onthophagides d'Afrique. *Annales de la Société Entomologique de France* **82**: 1–742.
- Eisner, T., D. Alsop, K. Hicks & J. Meinwald (1978). Defensive Secretions of Millipeds. In S. Bettini (ed.), *Arthropod Venoms*. Springer, Berlin, Heidelberg and New York. Pp. 41–72.
- Foster, R. (1993) Dung beetle community ecology and dung removal in the Serengeti. Unpublished PhD thesis, Oxford University.
- Huth, A. (2000). Defensive secretions of millipedes: more than just a product of melting point decrease? *Fragmenta Faunistica* **43**, Suppl.: 191–200.
- Keesing, F. (2000). Cryptic consumers and the ecology of an African savanna. *BioScience* **50**: 205–215.
- Kraus, O. (1960). Äthiopische Diplopoden 1. Monographie der Odontopygidae-Odontopyginae (Diplopoda, Spirostreptoidea). *Annales du Musée Royal du Congo Belge (Série in 8°), Sciences Zoologiques* **82**: 1–207.
- Krell, F.-T. (1999). Southern African dung beetles attracted by diplopod defensive secretions (Coleoptera: Scarabaeidae). *African Entomology* **7**: 287–288.
- Krell, F.-T., T. Schmitt & K.E. Linsenmair (1997). Diplopod defensive secretions as attractants for necrophagous scarab beetles (Diplopoda; Insecta, Coleoptera: Scarabaeidae). *Entomologica Scandinavica Supplementum* **51**: 281–285.
- Schmitt, T., F.-T. Krell & K.E. Linsenmair (2004). Quinone mixture as attractant for necrophagous dung beetles specialized on dead millipedes. *Journal of Chemical Ecology* **30**: 731–740.
- Young, T.P., B.D. Okello, D. Kinuya & T.M. Palmer (1998). KLEE: a long-term multi-species herbivore exclusion experiment in Laikipia, Kenya. *African Journal of Range & Forage Science* **14**: 94–102.