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The distribution, habitat, diet and forensic significance of the scarab *Frankenbergerius forcipatus* (Harold, 1881) (Coleoptera: Scarabaeidae)

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ABSTRACT

Records of African beetles feeding on carrion are scattered and incomplete, but important to forensic entomology. Thirty-three specimens of *Frankenbergerius forcipatus* (Harold, 1881) were found on carrion near Grahamstown, Eastern Cape, South Africa, providing new insight into the distribution (hills and mountains), habitat (fynbos and forest), biology (generalist on decaying material) and forensic significance (wet-decay, late opportunist) of the species.

KEY WORDS: Scarabaeidae, *Frankenbergerius*, South Africa, carcass ecology, forensic entomology.

INTRODUCTION

Many insects are known to feed on carrion or its associated stomach contents (Villet 2011). The occurrence of various flies, often identified to species level, on dead bodies is well documented but records of beetles are less well reported (e.g. Braack 1981, 1986; Midgley *et al.* 2010). However, such details are sometimes recorded on the labels of museum specimens. Information about African arthropod species is gradually being synthesised by forensic entomologists (Williams & Villet 2006; Villet 2011), because the use of arthropods in legal investigations relies on good knowledge of the likelihood of a species being found on a body. When species feeding in carcasses are identified, that information should be made as accessible as possible to assist in future forensic investigations. This is the reason for the present report.

Dung beetles are sometimes recorded from carrion in Africa (Braack 1981, 1986; Midgley *et al.* 2010; Villet 2011), the significance of which is not fully understood. The following observations concerning *Frankenbergerius forcipatus* are a contribution to knowledge in this regard. Nothing has been published about the biology of this species, and the little that is known about the biology of the genus has been inferred from museum specimen labels (Frolov & Scholtz 2005; Davis, pers. comm.). Other beetles are known to feed on carrion (Silphidae and Dermestidae), fly larvae or pupae (Staphylinidae), stomach contents (some Scarabaeidae) or hair (Trogidae), and can be present from the early wet phase of decay (Silphidae and Staphylinidae) through to advanced decay (Dermestidae) and even occur on very dry remains (Trogidae and Ptinidae) (Villet 2011).

MATERIAL AND METHODS

The carcasses of three small dogs (*Canis lupus familiaris* L.) that had been already dead were donated to us in slightly bloated condition. We relocated them to two sites near Grahamstown in the Eastern Cape on 21 February 2011 (one near Jameson Dam: 33°19'49"S 26°26'16"E and two, lying together, near Waainek: 33°18'48"S 26°31'07"E).

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The carcasses were placed on the crests of hills, to negate slope or aspect effects. The beetle community on the carcasses was sampled once three weeks later, and voucher specimens preserved in 90% ethanol. The dung beetle specimens were identified by JMM using a dissecting microscope and the key by Frolov and Scholtz (2005). Where necessary, genitalia dissections were performed to confirm species determinations. The identification as *F. forcipatus* was confirmed by Riaan Stals at the South African National Collection of Insects.

The samples contained specimens of *Frankenbergerius forcipatus* (Harold, 1881), and tissue from some of these specimens was used to obtain nucleotide sequences of the mitochondrial cytochrome oxidase I (COI) gene. DNA was extracted using standard techniques with the primers LCO1490 and HCO2198 (Folmer *et al*. 1994). The extraction and amplification protocol was as follows. The PCR reaction mixture was composed of 12.5 µl of the PCR master mix (buffer, 3 mM $MgCl_2$, *Taq* polymerase and 0.2 mM of each dNTP), 1 µl at 10 µM concentration of both primers, 2 µl $MgCl_2$ and 4.5 µl nuclease-free water added to 4 µl of template DNA, bringing the total volume of each sample to 25 µl. The PCR cycling conditions were: denaturation for 5 minutes at 94 °C, followed by 40 cycles at 94 °C for 30 seconds, an annealing temperature of 48 °C for 1 minute and 72 °C for 1.5 minutes. A final extension period of 5 minutes at 72 °C was used followed by holding at 4 °C. After electrophoresis at 100 V for 20 minutes using a 1% agarose gel stained with SYBR Green, the DNA was visualised on a UV Transilluminator. Sequences were edited and aligned on GeneStudio with ClustalW 1.6 (Thompson *et al.* 1997) to verify accuracy, and analysed using MEGA 5.05. Gut content was extracted from dissected beetles and examined under a light microscope. Aniline blue was used to stain any chitin in the gut contents because chitin is present in fungal cell walls.

The insect collections at the Albany Museum (AMGT, Grahamstown), Ditsong National Museum of Natural History (TMSA, Pretoria), and the South African National Collection of Insects (SANC, Pretoria) were checked for more specimens of *Frankenbergerius* Balthasar, 1938. No specimens additional to those mentioned by Frolov and Scholtz (2005) were found in the above collections.

RESULTS

Eleven male and 11 female adults of *Frankenbergerius forcipatus* (Harold, 1881) were collected at Jameson Dam and four males and seven females at Waainek. The specimens were easy to identify using the published key (Frolov & Scholtz 2005) and closely matched the illustrations (habitus and aedeagus) in that publication. Five voucher specimens (three males and two females) were deposited at the AMGT (specimen numbers: 59483, 59484, 59485, 59486 and 59487) and five (two males and three females) in the SANC (series numbers: COLS12360 and COLS12361).

The beetles were found in the decomposing stomach region and in the soil beneath the carcasses that had been loosened by the activity of insects and which appeared to be associated with the stomach contents rather than tissue. No mating pairs or nesting activities were noticed. No blowfly maggots were present on the carrion, but numerous adult histerids, trogids and staphylinids of various species, some adult silphids (*Thanatophilus mutilatus*), clerids (*Necrobia rufipes*) and dermestids (*Dermestes*

Fig. 1. Habitat of *Frankenbergerius forcipatus* near Waainek (a) and Jameson Dam (b). The carcasses were located on the ground amongst vegetation. (Photographs by JMM)

maculatus), and a few larval muscids (*Hydrotaea* sp.) were present, mainly in the soil beneath the carcass. The carcasses were in somewhat shaded positions among low-shrubbery (<30 cm) fynbos plants and sparse grass cover. There were no signs of mushrooms or moulds in or around the carcasses.

Less than 5% of the gut contents stained for chitin, suggesting that very little fungus was present. The stained material was not shaped like hyphae.

Twelve partial sequences of the COI gene were added to GenBank (specimens at the National Collection: JN817504, JN817505, JN817508, JN817509; other specimens: JN817506, JN817507, JN817510, JN817511, JN817512, JN817513, JN817514, JN817515). The COI sequences were easily amplified and showed 0.19% variation. They could not be compared with the three partial COI sequences (GQ290031, GQ290032 and GQ290033) of *Frankenbergerius armatus* (Boheman, 1857) published by Sole and Scholtz (2010), because they do not overlap.

DISCUSSION

Before the material documented here was collected, the most south-westerly capture site known for *Frankenbergerius forcipatus* was Pirie Forest (32°45'S 27°14'E; two males in the Natural History Museum, London). The new locality data represent a range extension of close to 100 km south-westward. The species is also known in South Africa from Rustenburg, Cathedral Peak, and Giant's Castle in January, March and December, respectively (Frolov & Scholtz 2005). It seems likely that the species is active at least throughout summer. The suggested habitat of *F. forcipatus* is "forests" (Frolov & Scholtz 2005; Davis *et al.* 2008). The habitat at both of the Grahamstown sites was a mixture of fynbos and grassland elements (Fig. 1) (Suurberg Quartzite Fynbos: Mucina & Rutherford 2006), which implies that this species is not associated only with forests. It might also occur in moist, hilly or montane habitats, which is a common feature of all five of its known occurrences.

Frolov and Scholtz (2005) stated that there is no direct evidence of any species of *Frankenbergerius* associating with carrion, but Davis *et al.* (2008) suggested, perhaps on the basis of Frolov and Scholtz's (2005) apparently successful use of meat as bait, that *F. gomesi* (Ferreira, 1954) has been attracted to carrion. The suggestion might alternatively have arisen from details on a museum label (A. Davis pers. comm. 2011), but we were unable to source this label. Our observations represent the first confirmed collection of *F. forcipatus*, and only the fourth confirmed collection of any species of *Frankenbergerius*, from any potential food source (Frolov & Scholtz 2005; Stals pers. comm. 2012). According to museum labels at the SANC, *F. armatus* and *F. gomesi* have been collected from fungus (Stals pers. comm. 2012) and *F. armatus* has been found on rotting *Cussonia* fruit (Frolov & Scholtz 2005). The Grahamstown specimens were apparently not feeding on decaying flesh, but associated with the stomach contents of a dog, suggesting that *F. forcipatus* is a generalist feeder on decaying material and will facultatively use carrion. No moulds or fungi were obvious at the sites and very little chitin (diagnostic of fungi) was present in the gut contents, so earlier speculations that *F. forcipatus* might also feed on mushrooms (Frolov & Scholtz 2005) are not validated at present.

About 45 other African dung beetle species are often associated with dead vertebrates (Braack 1986). The majority appear to be attracted to the rumen contents of artiodactyls, but meat baits can attract some species (Tshikae *et al.* 2008), notably *Anachalcos convexus* (Boheman, 1857) (Braack 1986). *F. forcipatus* is a member of the insect community that inhabits carrion during the wet phase of decay (phases described by Villet 2011).

Although it possibly feeds on material in the stomach, it might use decaying resources other than carrion too (Frolov & Scholtz 2005), and therefore belongs either to the guild of obligate necrophages or opportunistic saprophages (Villet 2011). It is also likely that it is attracted to carrion only once the tissue has started to decay extensively, making the beetle a late coloniser. Consequently, it is of significance to forensic entomology when estimates of the post-mortem interval are being made, based on the progress of ecological succession (Villet 2011) in what are likely to be montane parts of eastern South Africa.

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