

**DUNG BEETLES (COLEOPTERA: SCARABAEIDAE:
SCARABAEINAE) OF THE MPALA RESEARCH CENTRE AND
ENVIRONS, LAIKIPIA DISTRICT, KENYA**

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ABSTRACT

The dung beetle fauna of the subfamily Scarabaeinae (Coleoptera: Scarabaeidae) occurring in the Laikipia District of Kenya was surveyed. A total of 79 species were found which are diagnosed, keyed, and known dung preferences discussed. Seven species are new records for Kenya, namely *Allogymnopleurus indigaceus*, *Copris denticulatus*, *Euoniticellus parvus*, *Gymnopleurus reichei*, *Oniticellus egregius*, *Oniticellus pseudoplanatus* and *Sisyphus tibialis*.

Keywords: diagnoses, keys, dung preference, mammals, herbivores

INTRODUCTION

East Africa is home to one of the largest, most spectacular concentrations of large mammals, both herbivores and their carnivore predators, in the world. Immense amounts of dung are deposited by these animals, a resource that supports great dung beetle diversity and biomass. Davis & Dewhurst (1993) describe the geographical events that created the East African highlands and the resulting climatic types. They conclude that these events and climatic changes made East Africa “an ideal area to survey for dung beetles...”. Principal large dung producers in the Laikipia area are African elephants, odd-toed ungulates such as species of zebra, and even-toed ungulates represented by hippopotamus, African buffalo, bushbuck, *etc.*

Dung beetles nearly always belong to two subfamilies of Scarabaeidae: Aphodiinae and Scarabaeinae. The Aphodiinae fauna was discussed by Gordon, *et al.* (2008), the Scarabaeinae are dealt with here.

The dung beetle fauna of Kenya is extremely rich and diverse but, as is true of most African countries, it is far from being well known. Although many specialists have dealt with the coprophagous Scarabaeidae of this region for almost two centuries, the knowledge of taxa of these two subfamilies is still largely incomplete from both systematical and

zoogeographical viewpoints. For these reasons we consider it useful to compile a check-list of taxa found recently in central Kenya, and to propose some ecological considerations.

This study was undertaken as part of a collaborative effort between the Smithsonian Institution (USNM), International Centre of Insect Physiology and Ecology (ICIPE), and National Museums of Kenya (NMK), to inventory invertebrates at Mpala Research Centre (MRC). Field investigations of dung beetle diversity and habitat preference were conducted during two visits to Mpala Research Centre by one of us (RDG) in 2001 (February) and 2002 (May), and by year round sampling conducted by Khadir Abdi, MRC staff, from April 2001 to April 2002. The area sampled consisted of MRC, the adjacent Mpala Ranch, and immediate surroundings.

Mpala Research Centre is a biological field station managed by the Kenya Wildlife Service, National Museums of Kenya, Princeton University, and the Smithsonian Institution (Miller & Lazell, 2001). It is located 50 km north of the equator (0°17'N, 37°53'E), northwest of Mount Kenya, in the semi-arid savanna of the Laikipia District of Central Kenya at 1650 m elevation. For map and further discussion see Young *et al.* (1995).

Precipitation at MRC normally consists of heavy rains from April to July and light rains in October through November (Keesing, 2000). Soil types consist of red, sandy soils; dark soils with a high clay content also called "black cotton"; and narrow riverine strips that are a mixture of the previous two types. These riverine strips are highly sandy in some places, usually moist even in periods of drought, and are utilized by many dung beetle species during dry seasons. Vegetation is dominated by species of *Acacia*, and vegetation composition is quite different between the red and dark soils. For additional information on MRC plant diversity see Young *et al.* (1998) and Keesing (2000).

A total of 79 species were found during this study. Seven of these are new records for Kenya: *Allogymnopleurus indigaceus* (Reiche), *Copris denticulatus* Nguyen-Phung, *Euoniticellus parvus* (Kraatz), *Gymnopleurus reichei* Waterhouse *Oniticellus egregius* Klug, *Oniticellus pseudoplanatus* Balthasar, and *Sisyphus tibialis* Raffray.

Biogeographical affinities of the various taxa are listed in Tables I–V in the "Ecological Considerations" section.

MATERIALS AND METHODS

Dung beetle sampling at MRC consisted primarily of three methods; 1) hand collecting individual specimens from dung pats or pellets; 2) pitfall traps baited with dung of various mammal species; and 3) nocturnal collecting for those species attracted to light. The pitfall traps consisted of small bowls (cereal bowls) placed flush with the ground with a small bait container suspended over the bowl by a wire loop. These traps were moved to new sites daily and were run for 14 hour intervals. They were set and baited early in the morning of each day and specimens and serviced again the next morning. Dung type was varied at intervals with buffalo, elephant, eland and impala most frequently utilized. Light collecting consisted of utilizing existing lights as well as UV light operated from a 12 Volt battery.

Specimens were either prepared (pinned) at MRC or layered in tissue paper for transport and subsequent preparation.

Literature references are limited to the most recent and/or most complete taxonomic treatments.

Specimens are deposited in collections of the National Museums of Kenya, Smithsonian Institution, Enrico Barbero (EB), and Mpala Research Centre. If a species is represented by a

single specimen, that specimen is placed in the NMK to assure that the NMK has a complete synoptic set of taxa included herein.

Under “Geographical distribution”, abbreviations are used for two countries. These are R.D.C. for Democratic Republic of the Congo, and R.S.A. for Republic of South Africa. Distributions are based on references cited for each species and specimens collected during this study. Temporal distributions are based on specimens collected at MRC.

Under each species heading “dung preference” is mentioned, and species are often referred to as “generalists” or “specialists.” These terms are not precise and their useage here is based almost entirely on evidence obtained from Mpala samples. For example, if a species occurs in cow, buffalo, elephant, hippopotamus, and perhaps additional types of dung, it would seem reasonable to classify it as a generalist; if a species has been taken only from elephant dung we consider it a specialist. Based on past experience with dung beetles in other parts of the world, it seems apparent that any species utilizing cow dung is a generalist, even though it may have been found in dung of only one or two other species in this limited field survey.

SYSTEMATIC TREATMENT

Key to dung beetle taxa of Mpala Research Centre

1. Middle and hind tibia arcuate, slender, widened gradually from base to apex; sexual dimorphism absent or not conspicuous 2
- 1'. Middle and hind tibia dilated at tip; sexual dimorphism often very conspicuous 14

2. Middle coxae very oblique and somewhat close to each other; metasternum narrowed between middle coxae 3
- 2'. Middle coxae parallel and widely separated from each other; metasternum very wide between middle coxae 10

3. Fore tibia without tarsi; elytra not sinuate laterally 4
- 3'. Fore tibia with tarsi; elytra deeply sinuate laterally 8

4. Middle and hind tarsi with two claws 1. *Scarabaeus isidis*
- 4'. Middle and hind tarsi with one claw 5

5. Antero-inferior edge of fore femur bearing medially an evident, tooth-like tubercle; scutellum well-developed, evident 4. *Kheper platynotus*
- 5'. Antero-inferior edge of fore femur lacking the tooth-like tubercle; scutellum not or very barely evident 6

6. Upper surface of the fore tibia bearing a tooth-like tubercle at base of second external tooth 3. *Kheper aeratus*
- 6'. Upper surface of the fore tibia not bearing a tooth-like tubercle at base of second external tooth 7

7. Metasternum very prominent, angular and carinate anteriorly; upper surface shining green with golden or cupreous lustre, or dark blue or entirely cupreous red 2. *Kheper aegyptiorum*

- 7'. Metasternum not prominent, rounded and blunt anteriorly; upper surface black with a vague bronze lustre or brown-bronze.....5. *Kheper venerabilis*
8. Metasternal epimere visible from above in elytral subhumeral sinuosity; clypeus quadridentate..... 7. *Allogymnopleurus indigaceus*
- 8'. Metasternal epimere not visible from above in elytral subhumeral sinuosity; clypeus bidentate 9
9. Head bearing a medial, longitudinal smooth carina; fore angles of pronotum and pygidium clothed with dense silver setae; body colour green, golden green, cupreous red, blue or shining black 8. *Gymnopleurus sericeifrons*
- 9'. Head not bearing a medial, longitudinal smooth carina; fore angles of pronotum and pygidium lacking silver setae; body black or very dark brown, dull 9. *Gymnopleurus reichei*
10. Body not compressed laterally; pronotal sides regularly curved; antenna nine-jointed 6. *Anachalcos convexus*
- 10'. Body strongly compressed laterally; pronotal sides vertical; antenna eight-jointed..... 11
11. Pronotum separated laterally from pronotal episterna by a very distinct carina 12
- 11'. Pronotum not separated laterally from pronotal episterna by a distinct carina..... 13
12. Clypeus with two teeth 11. *Sisyphus ocellatus*
- 12'. Clypeus with four teeth..... 10. *Sisyphus crispatus*
13. Middle tibia with a tooth-shaped process on the external side..... 13. *Sisyphus tibialis*
- 13'. Middle tibia without a tooth-shaped process on the external side ... 12. *Sisyphus spinipes*
14. Second joint of labial palpi shorter than the first; third joint always distinct 15
- 14'. Second joint of labial palpi longer than the first; third joint small, subulate, often hidden .. 28
15. Hind tibia lacking transverse carina on outer side 16
- 15'. Outer side of hind tibia bearing a transverse carina anterior to apical margin..... 18
16. Fore slope of pronotum entirely glabrous 25. *Heliocopriss hamadryas*
- 16'. Fore slope of pronotum bearing long, reddish setae..... 17
17. Fore slope of pronotum bearing irregular asperities giving rise to transverse folds 27. *Heliocopriss haroldi*
- 17'. Fore slope of pronotum bearing dense and regular granules... 25. *Heliocopriss andersoni*
18. Outer stria (eighth) of elytra not carinate, often obliterated toward apex..... 19
- 18'. Outer stria (eighth) of elytra carinate from base to more than third length..... 25
19. Pronotum of major males strongly concave, concavity limited on both sides by an elevated, toothed carina 20. *Copriss vankhali*
- 19'. Pronotum of males never strongly concave 20
20. Ninth elytral stria separated from tenth at base; pronotum of males lacking typical high, medial, anterior elevation..... 15. *Copriss diversus*

20'. Ninth elytral stria never separated from tenth at base; pronotum of males showing typical <i>Copris</i> structure	21
21. Pronotum partly granular or rugose	22
21'. Pronotum punctured, without granules, asperities, nor rugosities	24
22. Apical two teeth of fore tibia obviously joined together, especially in females	18. <i>Copris integer</i>
22'. Apical two teeth of fore tibia not joined together	23
23. Males: basal tubercles of cephalic horn evident; median pronotal lobe bearing anteriorly two small teeth; females: cephalic horn strongly widened apically; anterior surface of median pronotal lobe entirely granulose	14. <i>Copris denticulatus</i>
23'. Males: basal tubercles of cephalic horn reduced; median pronotal lobe lacking anteriorly two small teeth; females: cephalic horn very feebly widened apically; anterior surface of median pronotal lobe apically smooth	16. <i>Copris fallaciosus</i>
24. Small species (13–16 mm); clypeus bidentate	19. <i>Copris orphanus</i>
24'. Large species (15–20 mm); clypeus not bidentate	17. <i>Copris harrisi</i>
25. Pronotum (at least in males) bearing four approximately equal horns	24. <i>Catharsius jacksoni</i>
25'. Pronotum not bearing four horns	26
26. Clypeus not toothed anteriorly nor obviously sinuate	21. <i>Catharsius adamastor</i>
26'. Clypeus toothed or obviously sinuate anteriorly	27
27. Clypeus strongly bidentate anteriorly	22. <i>Catharsius erechtheus</i>
27'. Clypeus very feebly bidentate anteriorly	23. <i>Catharsius furcillatus</i>
28. Antenna eight-jointed	29
28'. Antenna nine-jointed	39
29. Pygidium bearing a basal, transverse carina	30
29'. Pygidium lacking basal, transverse carina	34
30. Large species (8–13 mm)	42. <i>Cytochirus trogiformis</i>
30'. Small species (less than 7 mm)	31
31. Sides of abdomen not visible from above outside elytra; head short, obviously wider than long	32
31'. Sides of abdomen clearly visible from above outside elytra; head short, obviously longer than wide	33
32. Pronotum bearing, in both sexes, two groups of four strong, longitudinal, smooth, more or less sinuate carinae; two groups separated by a strong, shining, median depression; fifth elytral interval strongly carinate	43. <i>Drepanocerus abyssinicus</i>

- 32'. Pronotum bearing, at most, two strong, longitudinal, smooth carinae separated by a strong, longitudinal furrow; fifth elytral interval not carinate, only slightly more convex than other intervals..... 46. *Drepanocerus sulcicollis*
33. Sides of epistoma dentate or serrate before genal angles; scutellum short, hairless, or nearly so 44. *Drepanocerus kirbyi*
- 33'. Sides of epistoma bearing a strong, wide tooth before genal angles; scutellum oblong, clothed with short, thick, whitish setae 45. *Drepanocerus patrizii*
34. Sides of head very strongly sinuate between epistoma and genae..... 35
- 34'. Sides of head not or very slightly sinuate between epistoma and genae 37
35. Elytra bearing a tuft of setae at inner apical angle; small species (3–4mm) 39. *Euoniticellus parvus*
- 35'. Elytra bearing a band of setae along entire apical margin; larger species (6–12 mm) .. 36
36. Males: vertex bearing an apically truncated horn (or tubercle in small individuals); females: vertex bearing, before hind margin, a wide, strongly convex carina 41. *Euoniticellus intermedius*
- 36'. Males: vertex lacking horns or tubercles; females: vertex lacking carina but bearing a strong, transverse furrow 40. *Euoniticellus inaequalis*
37. Lateral sides of pronotum sinuate and concave before hind angles; pronotal base more or less entirely bordered 38. *Liatongus militaris*
- 37'. Lateral sides of pronotum not sinuate or concave before hind angles; pronotal base never bordered..... 38
38. Body bicolored: pronotum and elytra blue-black, more or less widely yellow at sides 36. *Oniticellus egregius*
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41. Prosternum strongly prominent behind procoxae in males, not prominent in females; hind margin of vertex strongly raised and dentate in females, weakly raised in males 29. *Heteronitis castelnaui*
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43. Body testaceous; pronotum with three longitudinal, green metallic patches: scutellum and lateral carina of elytra bronze..... 33. *Onitis picticollis*

- 43'. Body entirely bronze or with elytra and sometimes pronotal sides testaceous44
44. Metasternum with a deep, longitudinal, medial groove..... 30. *Onitis alexis*
- 44'. Metasternum slightly impressed medially 35. *Onitis viridulus*
45. Clypeal carina present32. *Onitis keniensis*
- 45'. Clypeal carina absent46
46. Body flattened; apical, tooth-like process of fore tibia bearing a brush of hairs; pronotum not bordered basally 31. *Onitis inversidens*
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47. Anterior edge of fore tibia straight, obviously perpendicular to internal edge.....48
- 47'. Anterior edge of fore tibia sinuate or depressed, clearly not perpendicular to internal edge50
48. Clypeus rounded or slightly sinuate 47. *Caccobius obtusus*
- 48'. Clypeus emarginate, anterior edge bearing two small teeth.....49
49. Elytra mostly or entirely black or brown..... 48. *Caccobius postlutatus*
- 49'. Elytra and legs entirely testaceous.....49. *Caccobius semiluteus*
50. Head bearing anteriorly two transverse carinae, distal carinae (clypeal) almost parallel to clypeal margin, and connected to posterior (frontal) carina by a median, longitudinal ridge... 51
- 50'. Head never bearing anteriorly two transverse carinae connected by a median, longitudinal ridge52
51. Elytral interstriae punctate; punctures rather large and scattered; pronotal punctures sparse.....52. *Milichus picticollis*
- 51'. Elytral interstriae granulate or asperate; granules at least partly dense; pronotal punctures very dense53. *Milichus rhodesianus*
52. Elytra bearing nine striae..... 54. *Phalops lutatus*
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53. Base of pronotum produced medially, giving rise to a pronounced angle54
- 53'. Base of pronotum straight, or regularly and gently arcuate55
54. Head entirely or mostly granulate; larger species (11–15 mm).....
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- 54'. Head entirely punctate or almost smooth; smaller species (7-9.5 mm)
.....56. *Onthophagus (Hyalonthophagus) mixtifrons*
55. Pronotum not granulate; punctures simple or umbilicate56
- 55'. Pronotum at least partially granulate or with raspose punctures67
56. Seventh elytral stria straight or almost so; base of pronotum not bordered57

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57. Carina of vertex between eyes or slightly before eyes 67. *Onthophagus masaicus*
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58. Fore half of pronotum bearing a median protuberance, or a wide median depression, or two small depressions; monochrome species, bronze or green.....58. *Onthophagus aeruginosus*
 58'. Fore half of pronotum without protuberance or depressions.....59
59. Elytra black with two large, reddish-yellow patches...71. *Onthophagus quadrimaculatus*
 59'. Elytra testaceous, with epipleura, sutural interstriae and some longitudinal, elongate patches black..... 60. *Onthophagus alternans*
60. Head totally unarmed, or bearing only a slight outline of carina, or bearing a carina and two horns or tubercles.....61
 60'. Cephalic armature differently shaped63
61. Head entirely unarmed, fore tibia in males spatulate, without teeth, in females normal.....61. *Onthophagus anomalus*
 61'. Head carinate or tuberculate62
62. Elytral pubescence conspicuous; elytra brownish-black with humeral and circumapical reddish spots 78. *Onthophagus vinctus*
 62'. Elytral pubescence very short and inconspicuous; elytra black without reddish spots 51. *Euonthophagus carbonarius*
63. Elytra black, completely lacking testaceous spots69. *Onthophagus polyodon*
 63'. Elytra entirely testaceous, or partly testaceous and partly black or brown64
64. Elytral interstriae entirely punctulate.....75. *Onthophagus tonsus*
 64'. Elytral interstriae clearly granulate.....65
65. Pubescence of pygidium long.....65. *Onthophagus jugicola*
 65'. Pubescence of pygidium short, or moderately short.....66
66. Elytra testaceous with two bands of black patches in fore third and in hind third73. *Onthophagus stigmaticus*
 66'. Elytra testaceous with a small black apical spot, striae narrowly black, and several small, round, black spots on interstriae 72. *Onthophagus raffrayi*
67. Base of pygidium not carinate64. *Onthophagus extensicollis*
 67'. Base of pygidium carinate.....68
68. Elytral intervals almost smooth, bearing only some very scattered granules 50. *Digitonthophagus gazella*
 68'. Elytral intervals very obviously granulate or punctate69
69. Base of pronotum not bordered, or bordered only at middle70

- 69'. Base of pronotum entirely bordered71
70. Upper surface of body, or at least elytra and pronotum, clothed with short, recumbent pubescence74. *Onthophagus teitanicus*
- 70'. Upper surface of body, or at least elytra and pronotum, clothed with long, erect pubescence77. *Onthophagus verrucosus*
71. Pronotum anteriorly depressed on both sides. Internal margin of depressions carinate or tuberculate.....63. *Onthophagus bicavifrons*
- 71'. Pronotum not anteriorly hollowed on both sides72
72. Elytra monochrome or with symmetrical spots; clypeus rounded or slightly sinuate; vertex never bearing two horns or a simple carina behind eyes73
- 72'. Elytra with asymmetrical spots, or clypeus obviously notched, or vertex bearing two horns or tubercles or a simple carina placed behind the eyes77
73. Pronotal disc smooth or covered by simple or raspose punctures.....74
- 73'. Pronotal disc entirely granulate75
74. Genae distinctly protruding; clypeus rounded or very slightly sinuate; punctures on pronotal disc entirely, or almost entirely simple.....66. *Onthophagus leroyi*
- 74'. Genae not or very slightly protruding; clypeus obviously sinuate; punctures of pronotal disc entirely, or almost entirely, raspose or anteriorly granulate76. *Onthophagus trapezicornis*
75. Pygidial punctures dense, even, fine; pygidial pubescence long or rather long, dense, recumbent, concealing the punctuation.....79. *Onthophagus xanthopterus*
- 75'. Pygidium granulate or with scattered, uneven punctures; pygidial pubescence short, erect or sparse76
76. Basal region of pronotum with large, deep punctures and fine granules70. *Onthophagus pugionatus*
- 76'. Basal region of pronotum granulate, as on remaining surface62. *Onthophagus atrofasciatus*
77. Pronotum and elytra testaceous with several, small, black patches; elytral striae partly blackened55. *Onthophagus (Furconthophagus) variegatus*
- 77'. Pronotum entirely black, at most with sides lighter; elytra black with or without testaceous patches78
78. Males: horns of vertex slender, scarcely arcuate, connected by a rather high lamina, which is lobed in the middle of its upper edge and often preceded by a small, transverse, arcuate, median tubercle; females: carina of vertex strong, evenly and rather strongly arcuate, placed clearly before the eyes and as long as interocular distance68. *Onthophagus omostigma*
- 78'. Males: horns of vertex slender, nearly parallel, strongly dentate at the base of inner edge; females: carina of vertex long and strong, nearly straight, placed slightly before the eyes59. *Onthophagus aethiopicus*

Tribe Scarabaeini

Subtribe Scarabaeina

1. *Scarabaeus isidis* Laporte de Castelnau, 1840

Zur Strassen, 1967: 164; Ferreira, 1968-69: 57.

Specimens examined: 3 (NMK).

Geographical distribution: central and eastern Africa, from Chad to Tanzania.

Temporal distribution, MRC: June.

Dung preference: not known.

2. *Kheper aegyptiorum* (Latreille, 1827)

Janssens, 1940a: 66; Ferreira, 1968-69: 57.

Specimens examined: 29 (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from southern Egypt to Tanzania.

Temporal distribution: January, March, April, May.

Dung preference: a generalist species, specimens found in dung of several animals ranging from cow and buffalo to impala and giraffe. This species makes very large dung balls with both sexes involved. One sex (not determined) digs the burrow, and the mate perches on top of the ball.

3. *Kheper aeratus* (Gerstaecker, 1871)

Janssens, 1940a: 70; Ferreira, 1968-69: 49.

Specimens examined: 1 (NMK).

Geographical distribution: eastern Africa, from Kenya to Tanzania.

Temporal distribution: May.

Dung preference: the single specimen was collected from impala dung along with most of the *Kheper aegyptiorum* specimens.

4. *Kheper platynotus* (Bates, 1888)

Janssens, 1940a: 72; Ferreira, 1968-69: 62.

Specimens examined: 12 (MRC) (NMK) (USNM).

Geographical distribution: eastern and southern Africa, from Kenya to Transvaal.

Temporal distribution: May.

Dung preference: all specimens were taken from elephant dung except one specimen found in zebra dung. Therefore we assume that this species is an elephant dung specialist.

5. *Kheper venerabilis* (Harold, 1871)

Janssens, 1940a: 68; Ferreira, 1968-69: 64.

Specimens examined: 1 (NMK).

Geographical distribution: eastern Africa, from Somalia to Tanzania.

Temporal distribution: May.

Dung preference: not known. The only specimen collected was in a pitfall trap baited with cow dung.

Subtribe Canthonina

6. *Anachalcos convexus* (Boheman, 1857)

Janssens, 1938: 25; Ferreira, 1968-69: 127.

Specimens examined: 4 (MRC) (NMK) (USNM).

Geographical distribution: all of tropical Africa, from Senegal and Eritrea to Cape Province.

Temporal distribution: January, February, May.

Dung preference: possibly an elephant dung specialist. Two of the specimens were collected in elephant dung, one in cow dung, and one in a pitfall baited with human dung.

Subtribe Gymnopleurina

7. *Allogymnopleurus indigaceus* (Reiche, 1847)

Janssens, 1940b: 39; Ferreira, 1968-69: 95.

Specimens examined: 7 (NMK) (USNM).

Geographical distribution: known from Ethiopia. First record for Kenya.

Temporal distribution: January, May.

Dung preference: all specimens were taken in cow dung, therefore this species is probably a generalist dung feeder.

8. *Gymnopleurus sericeifrons* Fairmaire, 1887

Janssens, 1940b: 60; Ferreira, 1968-69: 119.

Specimens examined: 119 (MRC) (NMK) (USNM).

Geographical distribution: eastern, central and southern Africa, from Somalia and R.D.C. to Namibia.

Temporal distribution: January, February, March, April, May, June, October, November.

Dung preference: this species is an extreme generalist found in dung of baboon, human, dikdik, impala, cow, etc.

9. *Gymnopleurus reichei* Waterhouse, 1890

Janssens, 1940b: 64; Ferreira, 1968-69: 118.

Specimens examined: 78 (MRC) (NMK) (USNM).

Geographical distribution: Ethiopia and Transvaal. First record for Kenya.

Temporal distribution: January, May.

Dung preference: probably a generalist. The specimens collected were found in cow and impala dung.

Tribe Sisyphini

10. *Sisyphus crispatus* Gory, 1833

Haaf, 1955: 362; Ferreira, 1968-69: 837.

Specimens examined: 48 (MRC) (NMK) (USNM).

Geographical distribution: many African countries, from Guinea to Namibia and from Ethiopia to R.S.A.

Temporal distribution: January, February, May.

Dung preference: found in a variety of dung such as elephant, eland, cow, impala, and dikdik dung. Also found at UV light. Apparently a generalist species, but with a preference for dung of even-toed ungulates.

11. *Sisyphus ocellatus* Reiche, 1847

Haaf, 1955: 356; Ferreira, 1968-69: 806.

Specimens examined: 41 (MRC) (NMK) (USNM).

Geographical distribution: Sub-Saharan Africa, from Guinea and Cameroon to Ethiopia.

Temporal distribution: January, May.

Dung preference: specimens were taken primarily from impala dung, which we consider the primary resource for this species. Specimens were also found in dung of cow, elephant, buffalo, and pitfall traps baited with cow dung.

12. *Sisyphus spinipes* Thunberg, 1818

Haaf, 1955: 368; Ferreira, 1968-69: 837.

Specimens examined: 6 (MRC) (NMK) (USNM).

Geographical distribution: many African regions south of the Sahara, from Senegal and Ethiopia to Botswana and R.S.A.

Temporal distribution: January, May.

Dung preference: not known. One specimen was taken from elephant dung, but all other specimens were taken at pitfall traps baited with human dung.

13. *Sisyphus tibialis* Raffray, 1877

Haaf, 1955: 379; Ferreira, 1968-69: 118.

Specimens examined: 6 (MRC) (NMK) (USNM).

Geographical distribution: Ethiopia and Tanzania. First record for Kenya.

Temporal distribution: January.

Dung preference: not known. Specimens taken at human dung baited pitfall traps.

Tribe Coprini

14. *Copris denticulatus* Nguyen-Phung, 1988

Nguyen-Phung, 1988b: 216.

Specimens examined: 7 (NMK) (USNM).

Geographical distribution: Tanzania to Transvaal and Natal. First record for Kenya.

Temporal distribution: February, May.

Dung preference: not known. Specimen taken from hippopotamus dung.

15. *Copris diversus* Waterhouse, 1891

Ferreira, 1961: 259; Cambefort & Nguyen-Phung, 1996: 284.

Specimens examined: 9 (NMK) (USNM).

Geographical distribution: Somalia, Kenya and Tanzania.

Temporal distribution: February.

Dung preference: specimens were taken from both elephant and cow dung, therefore this species is probably a generalist.

16. *Copris fallaciosus* Gillet, 1907

Ferreira, 1961: 102; Nguyen-Phung, 1988b: 214.

Specimens examined: 25 (MRC) (NMK) (USNM).

Geographical distribution: Ethiopia and Uganda to Transvaal.

Temporal distribution: found year around.

Dung preference: found in dung of most animals, a true generalist.

17. *Copris harrisi* Waterhouse, 1881

Ferreira, 1961: 209; Cambefort & Nguyen-Phung, 1996: 287.

Specimens examined: 238 (EB) (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from Somalia and Eritrea to Zimbabwe. Recorded also from West Africa, but probably erroneously.

Temporal distribution: collected in all months of the year.
Dung preference: a generalist species found in nearly every kind of dung.

18. *Copris integer* Reiche, 1847

Ferreira, 1961: 126; Nguyen-Phung & Cambefort, 1987: 414.

Specimens examined: 74 (EB) (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from Ethiopia and Uganda to Tanzania.

Temporal distribution: found year around.

Dung preference: all types of dung, a true generalist dung feeder.

19. *Copris orphanus* Guérin, 1847

Ferreira, 1961: 250; Cambefort & Nguyen-Phung, 1996: 287.

Specimens examined: 8 (NMK) (USNM).

Geographical distribution: west (Guinea), central (R.D.C. and Rwanda) and eastern Africa (from Ethiopia to Kenya).

Temporal distribution: January, March, May, June, July, August.

Dung preference: found in eland, elephant and impala dung, also taken at UV light. This is certainly a generalist.

20. *Copris vankhali* Nguyen-Phung, 1988

Nguyen-Phung, 1988a: 12.

Specimens examined: 1 (NMK).

Geographic distribution: Ethiopia and southern Somalia to Kenya and northern Tanzania.

Temporal distribution: July.

Dung preference: the single specimen was taken from elephant dung.

21. *Catharsius adamastor* Gillet, 1933

Ferreira, 1960: 245; Ferreira, 1968-69: 256.

Specimens examined: 1 (NMK).

Geographical distribution: endemic to Kenya.

Temporal distribution: April

Dung preference: not known, one specimen taken from hippopotamus dung.

22. *Catharsius erechtheus* Felsche, 1907

Ferreira, 1960: 181,249; Ferreira, 1968-69: 256.

Specimens examined: 19 (MRC) (NMK) (USNM).

Geographical distribution: Kenya and Tanzania.

Temporal distribution: February, April, May.

Dung preference: a generalist on many kinds of dung.

23. *Catharsius furcillatus* Guérin, 1847

Ferreira, 1960: 168,250; Ferreira, 1968-69: 256.

Specimens examined: 19 (EB) (MRC) (NMK) (USNM).

Geographical distribution: both the nominotypical subspecies and the subsp. *laeviplaga* G. Müller, 1941, were described from Ethiopia. The nominal subspecies was recorded by Ferreira (1968-69) from Kenya.

Temporal distribution: March, April, May, July, September.

Dung preference: a generalist dung feeder found in many kinds of dung.

24. *Catharsius jacksoni* Waterhouse 1891
 Ferreira, 1960: 202,251; Ferreira, 1968-69: 270.
 Specimens examined: 1 (NMK).
 Geographical distribution: endemic to Kenya.
 Temporal distribution: February.
 Dung preference: not known. One specimen collected from elephant dung.

Tribe Dichotomiini

25. *Heliocoprís andersoni* Bates, 1868
 Janssens, 1939: 97; Ferreira, 1968-69: 226
 Specimens examined: 2 (NMK) (USNM).
 Geographical distribution: tropical Africa, from Eritrea, Kenya and R.D.C. to Namibia and R.S.A.
 Temporal distribution: March, April.
 Dung preference: not known. One specimen dug out from under hippopotamus dung, the other at a human dung baited pitfall trap.

26. *Heliocoprís hamadryas* (F., 1775)
 Janssens, 1939: 89; Ferreira, 1968-69: 231.
 Specimens examined: 7 (MRC) (NMK) (USNM).
 Geographical distribution: entire tropical Africa, from the Tropic of Cancer southward to Cape Province.
 Temporal distribution: February, March, April, May, October.
 Dung preference: probably a generalist; specimens dug out from under both hippopotamus and buffalo dung.

27. *Heliocoprís haroldi* Kolbe, 1893
 Janssens, 1939: 94; Ferreira, 1968-69: 233.
 Specimens examined: 4 (NMK) (USNM).
 Geographical distribution: western, central and eastern Africa, from Guinea and R.D.C. to Kenya.
 Temporal distribution: April, May, October.
 Dung preference: probably a generalist because specimens were dug out from under cow, buffalo, and eland dung.

Tribe Onitini

28. *Aptychonitis anomalus* Gestro, 1895
 Janssens, 1937: 195; Ferreira, 1968-69: 412.
 Specimens examined: 21 (EB) (MRC) (NMK) (USNM).
 Geographical distribution: Ethiopia (Arussi Galla), Kenya and Tanzania.
 Temporal distribution: May, June.
 Dung preference: probably an elephant dung specialist as all specimens were taken from that dung.

29. *Heteronitis castelnaui* Harold, 1962
 Krikken, 1977: 165; Ferreira, 1968-69: 420.
 Specimens examined: 1 (NMK).
 Geographical distribution: from Kenya and R.D.C. to northern Namibia and Transvaal.

Temporal distribution: February.

Dung preference: not known. The single specimen was taken from elephant dung.

30. *Onitis alexis* Klug, 1835

Janssens, 1937: 59; Ferreira, 1978: 30.

Specimens examined: 136 (MRC) (NMK) (USNM).

Geographical distribution: a polytypic species, common and widely distributed. The nominotypical subspecies occurs throughout the entire Afrotropical Region. The subspecies *septentrionalis* Balthasar has a Palearctic distribution.

Temporal distribution: found year around

Dung preference: a general dung feeder found in many kinds of dung.

31. *Onitis inversidens* van Lansberge, 1875

Krikken, 1977: 159; Ferreira, 1978: 331.

Specimens examined: 11 (MRC) (NMK) (USNM).

Geographical distribution: eastern and southern Africa, from Ethiopia to Transvaal and Namibia.

Temporal distribution: May, August.

Dung preference: probably an elephant dung specialist because all specimens were taken from that resource.

32. *Onitis keniensis* Gillet, 1935

Krikken, 1977: 150; Ferreira, 1978: 187.

Specimens examined: 6 (NMK) (USNM).

Geographical distribution: Kenya and Tanzania.

Temporal distribution: May, June, July, October.

Dung preference: probably an elephant dung specialist. All specimens were taken from that resource except one specimen at a UV light trap.

33. *Onitis picticollis* Boheman, 1857

Janssens, 1937: 70; Ferreira, 1978: 64.

Specimens examined: 37 (EB) (MRC) (NMK) (USNM).

Geographic distribution: eastern and southern Africa from Kenya to Cape Province and Namibia.

Temporal distribution: found year around.

Dung preference: most specimens were taken from elephant dung with others found in cow, zebra, and hippopotamus dung. This species is quite likely an elephant dung specialist.

34. *Onitis uncinatus* Klug, 1855

Janssens, 1937: 112; Ferreira, 1978: 311.

Specimens examined: 10 (MRC) (NMK) (USNM).

Geographical distribution: widely distributed in eastern, central and southern Africa, from Ethiopia and R.D.C. to all of the R.S.A.

Temporal distribution: March, April, May, June, July, September, October

Dung preference: a generalist found in dung of cow, hippopotamus, and elephant.

35. *Onitis viridulus* Boheman, 1857

Janssens, 1937: 65; Ferreira, 1978: 104.

Specimens examined: 56 (MRC (NMK) (USNM).

Geographical distribution: widely distributed in eastern, central and southern Africa, from Ethiopia and Angola to the entire R.S.A. Also known from south of the Arabian Peninsula.

Temporal distribution: found year around.

Dung preference: a generalist found in cow, buffalo, elephant, hippopotamus dung, and taken at UV light.

Tribe Oniticellini

Subtribe Oniticellina

36. *Oniticellus egregius* Klug, 1855

Janssens, 1953: 112; Ferreira, 1968-69: 396.

Specimens examined: 2 (NMK) (USNM).

Geographical distribution: Somalia, R.D.C., Mozambique, Zimbabwe, Transvaal, N'Gami Lake. New record for Kenya.

Temporal distribution: January.

Dung preference: not known. Specimens taken at a pitfall trap baited with human dung.

37. *Oniticellus pseudoplanatus* Balthasar, 1964

Ferreira, 1968-69: 398.

Specimens examined: 8 (NMK) (USNM).

Geographical distribution: R.D.C., Rwanda, Tanzania, Natal. New record for Kenya.

Temporal distribution: January, February, March, April, May.

Dung preference: apparently a generalist, found in dung of buffalo, hippopotamus, elephant, waterbuck.

38. *Liatongus militaris* (Laporte de Castelnau, 1840)

Janssens, 1953: 97; Ferreira, 1968-69: 389.

Specimens examined: 16 (MRC) (NMK) (USNM).

Geographical distribution: wide spread: known from all of eastern Africa, from Sudan and Eritrea to Transvaal, and from central and southern Africa.

Temporal distribution: January, February, March, April, May, July.

Dung preference: apparently a generalist with an affinity for elephant dung. Taken from dung of elephant, buffalo, eland, and also at UV light.

39. *Euoniticellus parvus* (Kraatz, 1895)

Janssens, 1953: 51; Ferreira, 1968-69: 384.

Specimens examined: 4 (NMK) (USNM).

Geographical distribution: western Africa, from Guinea to R.D.C., and Tanzania. First record for Kenya.

Temporal distribution: January.

Dung preference: not known. Specimens taken from human dung baited pitfall traps.

40. *Euoniticellus inaequalis* (Reiche, 1849)

Janssens, 1953: 54; Ferreira, 1968-69: 381.

Specimens examined: 81 (MRC) (NMK) (USNM).

Geographical distribution: Ethiopia, Eritrea, Kenya, and Tanzania.

Temporal distribution: January, February, April, May, June, July, August, September, October.

Dung preference: a generalist found in dung of many animals.

41. *Euoniticellus intermedius* (Reiche, 1849)

Janssens, 1953: 53; Ferreira, 1968-69: 381.

Specimens examined: 39 (MRC) (NMK) (USNM).

Geographical distribution: widely distributed in the entire Afrotropical Region. Recorded also from the Arabian Peninsula (Paulian, 1980).

Temporal distribution: February, March, April, May, July, August, September, October.

Dung preference: a generalist dung feeder collected from dung of many animals.

Subtribe Drepanocerina

42. *Cyptochirus trogiformis* (Roth, 1851)

Simonis & Zunino, 1980: 33.

Specimens examined: 2 (NMK) (USNM).

Geographical distribution: described from Tigré (Ethiopia), known also from Uganda and northern Kenya.

Temporal distribution: January, February.

Dung preference: not known. One specimen taken from waterbuck dung, other lacking host data.

43. *Drepanocerus abyssinicus* (Roth, 1851)

Janssens, 1953: 30; Ferreira, 1968-69: 372.

Specimens examined: 7 (MRC) (NMK) (USNM).

Geographical distribution: widely distributed in tropical Africa, from Guinea to Ethiopia and Tanzania.

Temporal distribution: January, February.

Dung preference: not known. Found in eland and hippopotamus dung.

44. *Drepanocerus kirbyi* Kirby, 1828

Janssens, 1953: 35; Ferreira, 1968-69: 375.

Specimens examined: 4 (NMK) (USNM).

Geographical distribution: wide spread in central, eastern and southern Africa, from R.D.C. and Ethiopia to Cape Province.

Temporal distribution: January, February.

Dung preference: not known. Two specimens taken from waterbuck dung, the other two from human dung baited pitfall traps.

45. *Drepanocerus patrizii* (Boucomont, 1923)

Janssens, 1953: 36; Ferreira, 1968-69: 376.

Specimens examined: 17 (EB) (MRC) (NMK) (USNM).

Geographical distribution: Eastern and southern Africa, from Kenya to Cape Province.

Temporal distribution: January, February, May.

Dung preference: Probably a generalist. Specimens were taken from buffalo, cow, and impala dung.

46. *Drepanocerus sulcicollis* (Laporte de Castelnau, 1840)

Janssens, 1953: 32; Ferreira, 1968-69: 377.

Specimens examined: 1 (NMK).

Geographical distribution: widely spread through the entire Afrotropical Region, from Guinea and Ethiopia to Cape Province.

Temporal distribution: February.

Dung preference: not known. The single specimen was taken from waterbuck dung.

Tribe Onthophagini

47. *Caccobius (Caccophilus) obtusus* Fähræus, 1857

d'Orbigny, 1913: 28; Ferreira, 1968-69: 483.

Specimens examined: 9 (MRC) (NMK) (USNM).

Geographic distribution: eastern and southern Africa, from Kenya and Rwanda to Cape Province.

Temporal distribution: January, May.

Dung preference: not known. Most specimens taken from human dung baited pitfall traps, two specimens taken from impala dung.

48. *Caccobius (Caccophilus) postlutatus* d'Orbigny, 1905

d'Orbigny, 1913: 36; Ferreira, 1968-69: 484.

Specimens examined: 3 (NMK) (USNM).

Geographical distribution: eastern and southern Africa, from Kenya and R.D.C. to Natal.

Temporal distribution: January.

Dung preference: not known. Specimens taken from human dung baited pitfall traps.

49. *Caccobius (Caccophilus) semiluteus* d'Orbigny, 1905

d'Orbigny, 1913: 34; Ferreira, 1968-69: 486.

Specimens examined: 7 (NMK) (USNM).

Geographical distribution: eastern Africa, from Ethiopia to Tanzania.

Temporal distribution: January.

Dung preference: not known. Specimens taken from human dung baited pitfall traps.

50. *Digitonthophagus gazella* (F., 1787)

d'Orbigny, 1913: 249; Balthasar, 1963: 365.

Specimens examined: 109 (MRC) (NMK) (USNM).

Geographical distribution: entire Afrotropical Region, Madagascar and Comoro Islands, Saharo-sindian area and the Indian subcontinent to Sri Lanka. Introduced in Australia, North and South America, Japan and several Atlantic and Pacific islands (Barbero & López-Guerrero, 1992; Kohlmann, 1994).

Temporal distribution: found year around.

Dung preference: this species is the quintessential generalist found in nearly every imaginable kind of dung.

51. *Euonthophagus carbonarius* (Klug, 1855)

d'Orbigny, 1913: 159; Zunino, 1981: 413.

Specimens examined: 39 (MRC) (NMK) (USNM).

Geographical distribution: not well defined: multiple taxa are probably recorded under this name. The species, *sensu lato*, is present in all of the Afrotropical Region.

Temporal distribution: January, February, April, May, June, July, August, October.

Dung preference: a generalist found in dung of many animals.

52. *Milichus picticollis* Gerstaecker, 1871

Janssens, 1954: 397; Cambefort, 1996: 168.

Specimens examined: 30 (EB) (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from Ethiopia to Tanzania and the R.D.C.

Temporal distribution: January, February, April, May, June, July, August.

Dung preference: a generalist, but most specimens were taken from elephant or hippopotamus dung.

53. *Milichus rhodesianus* Péringuey, 1904

Janssens, 1954: 396; Cambefort, 1996: 168.

Specimens examined: 1 (NMK).

Geographical distribution: eastern Africa, from Ethiopia to Transvaal, and R.D.C. (Katanga).

Temporal distribution: January.

Dung preference: not known. The single specimen was taken from a human dung baited pitfall trap.

54. *Phalops lutatus* (d'Orbigny, 1902)

d'Orbigny, 1913: 481; Barbero *et al.*, 2003: 213.

Specimens examined: 44 (EB) (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa from Uganda and Kenya to north central Tanzania.

Known also from southern Mozambique.

Temporal distribution: found year around.

Dung preference: found in dung of several animals, but with some apparent preference for elephant dung.

55. *Onthophagus (Furconthophagus) variegatus* (F., 1798)

d'Orbigny, 1913: 452; Zunino, 1981: 410.

Specimens examined: 172 (MRC) (NMK) (USNM).

Geographical distribution: the entire Afrotropical Region, Arabian Peninsula, Mesopotamia, Sind, Pakistan and the Indian subcontinent.

Temporal distribution: January, February, May.

Dung preference: a generalist species utilizing nearly any kind of dung.

56. *Onthophagus (Hyalonthophagus) mixtifrons* d'Orbigny, 1910

d'Orbigny, 1913: 552; Palestrini & Giacone, 1989: 89.

Specimens examined: 17 (MRC) (NMK) (USNM).

Geographical distribution: southern Ethiopia to Tanzania.

Temporal distribution: January, March, April, May, July.

Dung preference: found in dung of several animals, but a preference for elephant dung is apparent.

57. *Onthophagus (Proagoderus) nigricornis* Fairmaire, 1887

d'Orbigny, 1913: 525; Palestrini, 1992: 155.

Specimens examined: 80 (EB) (MRC) (NMK) (USNM).

Geographical distribution: Somalia and Ethiopia to Tanzania.

Temporal distribution: found year around.

Dung preference: this species is a specialist on elephant dung.

58. *Onthophagus (s. l.) aeruginosus* Roth, 1851

d'Orbigny, 1913: 99; Ferreira, 1968-69: 558.

Specimens examined: 50 (MRC) (NMK) (USNM).

Geographical distribution: present in the entire Afrotropical Region, but the distribution becomes sporadic on the western areas.

Temporal distribution: January, February, May, July, December.

Dung preference: a generalist dung feeder found in dung of elephant, eland, impala, cow, giraffe, etc.

59. *Onthophagus (s. l.) aethiopicus* d'Orbigny, 1902

d'Orbigny, 1913: 460; Ferreira, 1968-69: 560.

Specimens examined: 130 (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from Somalia to Kenya.

Temporal distribution: found year around.

Dung preference: this species is a complete generalist found in nearly every kind of dung examined.

60. *Onthophagus (s. l.) alternans* Raffray, 1877

d'Orbigny, 1913: 94 ; Ferreira, 1968-69: 563.

Specimens examined: 2 (NMK) (USNM).

Geographical distribution: eastern Africa, from Nubia and Eritrea to Kenya.

Temporal distribution: May.

Dung preference: not known. Both specimens were taken in a cow dung baited pitfall.

61. *Onthophagus (s. l.) anomalus* Klug, 1855

d'Orbigny, 1913: 43; Zunino, 1978: 9.

Specimens examined: 2 (NMK) (USNM).

Geographic distribution: Kenya to Cape Province.

Temporal distribution: January, February.

Dung preference: not known. One specimen taken in cow dung, the other specimen from a human dung baited pitfall trap.

62. *Onthophagus (s. l.) atrofasciatus* d'Orbigny, 1905

d'Orbigny, 1913: 409 ; Ferreira, 1968-69: 570.

Specimens examined: 13 (MRC) (NMK) (USN).

Geographical distribution: Kenya and Tanzania.

Temporal distribution: February, April, May, December.

Dung preference: a generalist taken from buffalo, cow, elephant, hippopotamus, and impala dung.

63. *Onthophagus (s. l.) bicavifrons* d'Orbigny, 1902

d'Orbigny, 1913: 323 ; Ferreira, 1968-69: 574.

Specimens examined: 1 (NMK).

Geographical distribution: eastern and southern Africa, from Kenya to Angola and Cape Province.

Temporal distribution: May.

Dung preference: not known. The single specimen was taken at a UV light.

64. *Onthophagus (s. l.) extensicollis* d'Orbigny, 1907

d'Orbigny, 1913: 224; Ferreira, 1968-69: 621.

Specimens examined: 4 (NMK) (USNM).

Geographical distribution: southern Ethiopia and Kenya.

Temporal distribution: February, May, June.

Dung preference: a generalist species found in dung of buffalo, elephant, hippopotamus, and waterbuck.

65. *Onthophagus (s. l.) jugicola* d'Orbigny, 1902

d'Orbigny, 1913: 187; Ferreira, 1968-69: 660.

Specimens examined: 69 (MRC) (NMK) (USNM).

Geographical distribution: Angola, R.D.C., and eastern Africa, from Ethiopia to Tanzania.

Temporal distribution: January, February, April, March, May, June, July, August.

Dung preference: a generalist dung feeder found in many kinds of dung.

66. *Onthophagus (s. l.) leroyi* d'Orbigny, 1902

d'Orbigny, 1913: 371; Ferreira, 1968-69: 675.

Specimens examined: 5 (NMK) (USNM).

Geographical distribution: Kenya and Tanzania.

Temporal distribution: January.

Dung preference: not known. Specimens taken from human dung baited pitfall traps.

67. *Onthophagus (s. l.) masaicus* d'Orbigny, 1905

d'Orbigny, 1913: 76 ; Ferreira, 1968-69: 683.

Specimens examined: 4 (NMK) (USNM).

Geographical distribution: southern Ethiopia, R.D.C. and Kenya.

Temporal distribution: May.

Dung preference: not known. Specimens taken from both cow and impala dung.

68. *Onthophagus (s. l.) omostigma* d'Orbigny, 1902

d'Orbigny, 1913: 462 ; Ferreira, 1968-69: 701.

Specimens examined: 124 (MRC) (NMK) (MRC).

Geographical distribution: Kenya and Tanzania.

Temporal distribution: found year around.

Dung preference: a generalist feeder found in dung of every kind of animal.

69. *Onthophagus (s. l.) polyodon* d'Orbigny, 1913

d'Orbigny, 1913: 182; Ferreira, 1968-69: 713.

Specimens examined: 13 (EB) (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from southern Ethiopia to Tanzania.

Temporal distribution: January, February, May.

Dung preference: a generalist species taken from dung of buffalo, cow, waterbuck, zebra, and at UV light.

70. *Onthophagus (s. l.) pugionatus* Fåhraeus, 1857

d'Orbigny, 1913: 399 ; Ferreira, 1968-69: 717.

Specimens examined: 10 (MRC) (NMK) (USNM).

Geographical distribution. southern Ethiopia and R.D.C. to Angola and R.S.A.

Temporal distribution: January, February.

Dung preference: probably a generalist species. Specimens were taken from dung of cow, elephant, and waterbuck; also collected at UV light.

71. *Onthophagus (s. l.) quadrimaculatus* Raffray, 1877
d'Orbigny, 1913: 93; Ferreira, 1968-69: 722.
Specimens examined: 2 (NMK).
Geographical distribution: eastern Africa, from Kenya to Zimbabwe and Mozambique.
Temporal distribution: January, May.
Dung preference: not known. One specimen was taken at UV light, the other specimen from a human dung baited pitfall trap.
72. *Onthophagus (s. l.) raffrayi* Harold, 1886
d'Orbigny, 1913: 193 ; Ferreira, 1968-69: 624.
Specimens examined: 15 (MRC (NMK) (USNM)).
Geographical distribution: Cameroon, R.D.C., and southern Ethiopia, southward to Zimbabwe.
Temporal distribution: January, February, May.
Dung preference: probably a generalist. Specimens were found in cow, impala, and waterbuck dung, and also at UV light.
73. *Onthophagus (s. l.) stigmosus* d'Orbigny, 1902
d'Orbigny, 1913: 189; Ferreira, 1968-69: 749.
Specimens examined: 27 (MRC) (NMK) (USNM).
Geographical distribution: Kenya and Tanzania.
Temporal distribution: January, February, May, August.
Dung preference: a generalist feeder found in many kinds of dung.
74. *Onthophagus (s. l.) teitanicus* d'Orbigny, 1902
d'Orbigny, 1913: 285; Ferreira, 1968-69: 756.
Specimens examined: 14 (MRC (NMK) (USNM)).
Geographical distribution: eastern Africa, from southern Ethiopia to Mozambique.
Temporal distribution: January, February, April, May.
Dung preference: a generalist feeder found in dung of buffalo, cow, hippopotamus, and impala. Also recorded from dead millipeds at MRC by Krell (2004).
75. *Onthophagus (s. l.) tonsus* d'Orbigny, 1902
d'Orbigny, 1913: 203; Ferreira, 1968-69: 758.
Specimens examined: 8 (MRC) (NMK) (USNM).
Geographical distribution: eastern Africa, from Eritrea and R.D.C. to Mozambique.
Temporal distribution: January.
Dung preference: not known. Specimens taken from human dung baited pitfall traps.
76. *Onthophagus (s. l.) trapezicornis* d'Orbigny, 1902
d'Orbigny, 1913: 375; Ferreira, 1968-69: 759.
Specimens examined: 39 (MRC) (NMK) (USNM).
Geographical distribution: central (R.D.C.) and eastern Africa, from Eritrea to Kenya, and the Arabian Peninsula.
Temporal distribution: January, February, May, July, August.
Dung preference: a generalist feeder found in dung of many animals.
77. *Onthophagus (s. l.) verrucosus* d'Orbigny, 1902
d'Orbigny, 1913: 289; Ferreira, 1968-69: 770.

Specimens examined: 8 (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa (Kenya and Tanzania).

Temporal distribution: January, April, May, June.

Dung preference: taken in elephant and hippopotamus dung, and cow dung baited pitfall.

Probably a generalist.

78. *Onthophagus (s. l.) vincetus* Erichson, 1843

d'Orbigny, 1913: 130 ; Ferreira, 1968-69: 773.

Specimens examined: 38 (MRC) (NMK) (USNM).

Geographical distribution: entire Afrotropical Region.

Temporal distribution: January, February, April, May, June.

Dung preference: a generalist feeder in dung of buffalo, cow, elephant, hippopotamus, also taken at UV light.

79. *Onthophagus (s. l.) xanthopterus* d'Orbigny, 1908

d'Orbigny, 1913: 392; Ferreira, 1968-69: 777.

Specimens examined: 11 (MRC) (NMK) (USNM).

Geographical distribution: eastern Africa, from Eritrea to Kenya.

Temporal distribution: January, May, June.

Dung preference: probably a generalist, taken from dung of elephant, giraffe, and impala dung.

Ecological considerations

Dung beetles are almost invariably members of the family Scarabaeidae, therefore all comments and discussion herein refer to scarabs, specifically members of the Scarabaeinae.

Animal dung comes in many shapes, sizes, and degrees of moisture, one or all of which may dictate what species utilize it. Dung of herbivores is normally a wide niche "plenty for all" resource because deposits are usually large, moist, and abundant, leading to development of three basic utilization strategies; a) feed on site; b) bury pieces of dung on site; and c) form dung into balls and roll these balls away from the resource (Gordon, 1983). Doube (1990) developed a system of dung-use strategies and that publication should be consulted for detailed information. Hanski & Cambefort (1991) also discussed dung beetle ecology and that work should also be consulted. Feeding in place is done by small species, usually members of Aphodiinae, that complete a life cycle in a brief period of time, allowing them to complete the cycle before dung desiccation occurs. On site burial is usually done by larger species such as members of *Copris*, and is an efficient strategy because energy is not expended in rolling a ball but moisture is effectively retained for larval development. Ball rolling is an extremely effective strategy because moisture content is ensured by burial but it also precludes other species from laying eggs in a selected piece of dung, something that commonly occurs when dung is buried in place (Halffter, 1977). Ball rollers are well known in popular circles because of the unusual and photogenic behavior, however, rollers are very much a minority in dung beetle guilds because such energy expenditure comes at a high cost. Two basic strategies of dung use are represented by nearly all species recorded here. A few are actually "dung rollers" that form discrete balls of dung and roll them some distance away from the original source where are they are then buried. Some genera utilizing this strategy are *Scarabaeus*, *Kheper*, *Anachalcos*, *Gymnopleurus*, and *Sisyphus*. The remaining genera simply carve out chunks of dung from the primary source and bury them beside or under that source.

Moisture is the single most important factor in dung beetle life and dictates when breeding takes place, what resource is favored, and percentage of larval survival (Gordon, 1983).

MRC was first sampled in February and March, 2001, at the end of an extended period of drought. No specimens were found at lights, no flight activity was observed, egg laying did not occur, larvae were not present, and dung preferences were nonexistent. During periods of drought survival is all important, therefore any type of dung containing some degree of moisture usually contained several species of beetles.

A second sampling was done in May, 2002, during the wet period, and the contrast between number of species and beetle activity was striking. In May, light trapping was highly productive, flight activity occurred both day and night, eggs and larvae were abundant, and dung preferences could be ascertained for many species.

It was assumed that distinct differences in dung beetle faunal composition between the "black cotton" and red soils would be observed. However, no significant trends emerged except that the red soils were preferred during the dry season, probably because they contained more moisture and were much easier to burrow into.

Dung beetles occur in a wide variety of animal dung. Generally speaking, in tropical regions a significant number of dung beetle species regularly, and sometimes exclusively, utilize dung of monkeys, man, warthog, pig, carnivores such as tiger, dog, hyena, etc. But dung of ungulates (Ungulata) is the most commonly used resource. There are also necrophagous carnivorous species, including some that utilize diplopods (Diplopoda) (Krell, 2004). African elephant *Loxodonta africana* (Blumenbach) (the only representative of Proboscidea) dung was utilized by several species in this study, some of which appear to be restricted to that resource. Elephant dung is usually a large mass of somewhat dry, semi-digested vegetation resembling damp, rotting straw in texture and appearance.

Odd-toed ungulates (Perissodactyla) were represented by the common zebra *Equus quagga* Boddaert, and Grevy's zebra *Equus grevyi* Oustalet. Zebra dung is composed of slightly dry, more or less rectangular pieces containing some degree of partially digested plant material. No particular beetle species preference for zebra was observed.

Even-toed ungulates (Artiodactyla) were represented by many species including hippopotamus, giraffe, African buffalo, bushbuck, eland, and the "Antelopinae" with its myriad species of antelope and related species. Hippopotamus *Hippopotamus amphibius* Linnaeus dung is wet, unformed, and is usually a thin, flat pat on the ground. Hippo dung is an excellent resource utilized by many dung beetles, some of which may exhibit a preference for it. Giraffe *Giraffa camelopardalis* (Linnaeus) dung is dry, somewhat pelletized, contains shreds of undigested *Acacia* leaves and twigs, and is not preferred by any dung beetle species. Buffalo *Syncerus caffer* (Sparrman) dung is often difficult to distinguish from that of cattle, both form a large, wet, amorphous pile utilized by many beetle species. Eland *Tragelaphus oryx* (Pallas) and bushbuck *Tragelaphus scriptus* (Pallas) dung usually consists of clumps of very moist pellets (during the wet season), these pellets are rarely dry enough to be separated. This dung is a reliable resource because the clumps are large enough to retain moisture for a long period of time, consequently it is utilized by many dung beetle species. Antelopes were represented primarily by dikdik *Madoqua* sp. and impala *Aepyceros melampus* (Lichtenstein) at the research centre. Dung of these mammals is highly pelletised, consisting of a clump of discrete, elongated pellets that are moist when fresh and highly attractive to a variety of beetles. When dry they are not utilized by any species of beetle, as was the case in February, 2001. *Sisyphus* species, in particular, appear to be impala dung specialists whose long legs enable them to easily roll small balls of dung formed from the pellets.

Animal species whose dung was examined for beetles during this survey are: impala; hartebeest *Alcelaphus buselaphus* Günther, cattle *Bos* sp., Burchell's zebra, Grevy's zebra,

giraffe, hippopotamus, waterbuck *Kobus ellipsiprymnus* (Rüppell), African elephant, dikdik, yellow baboon *Papio cynocephalus* (Linnaeus), African buffalo, eland, bushbuck.

Most beetles observed were generalist feeders utilizing a wide variety of animal dung, but some species specialised in elephant and impala dung. *Kheper platynotus*; *Onitis keniensis*; *Anachalcos convexus*; *Onitis picticollis*; *Aptychonitis anomalus*; *Onthophagus* (*P.*) *nigricornis*; and *Onitis inversidens* exhibited a distinct preference for elephant dung while *Sisyphus crispatus* and *Sisyphus ocellatus* showed a distinct preference for impala dung.

The biogeography of taxa included herein are of some interest. Tables 1–5 below and ensuing discussion deal with some biogeographical aspects.

Table 1. Species with East African distribution; 32 sp. 41.03%.

<i>Kheper aegyptiorum</i>	<i>Caccobius semiluteus</i>
<i>Kheper aeratus</i>	<i>Milichus picticollis</i>
<i>Kheper venerabilis</i>	<i>Onth. (Hyalonthophagus) mixtifrons</i>
<i>Allogymnopleurus indigaceus</i>	<i>Onth. (Proagoderus) nigricornis</i>
<i>Sisyphus tibialis</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>aethiopicus</i>
<i>Copris diversus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>alternans</i>
<i>Copris integer</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>atofasciatus</i>
<i>Copris vankhali</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>extensicollis</i>
<i>Catharsius adamastor</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>leroyi</i>
<i>Catharsius erechtheus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>masaicus</i>
<i>Catharsius fuscillatus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>omostigma</i>
<i>Catharsius jacksoni</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>polyodon</i>
<i>Aptychonitis anomalus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>stigmaticus</i>
<i>Onitis keniensis</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>trapezicornis</i>
<i>Euoniticellus inaequalis</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>verrucosus</i>
<i>Cyptochirus trogiformis</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>xanthopterus</i>

Table 2. Species with East, South-central and, usually, Southern African distribution; 29 sp. 37.19%.

<i>Kheper platynotus</i>	<i>Drepanocerus kirbyi</i>
<i>Gymnopleurus sericeus</i>	<i>Drepanocerus patrizii</i>
<i>Gymnopleurus reichei</i>	<i>Caccobius obtusus</i>
<i>Sisyphus spinipes</i>	<i>Caccobius postlutatus</i>
<i>Copris denticulatus</i>	<i>Milichus rhodesianus</i>
<i>Copris fallaciosus</i>	<i>Phalops lutatus</i>
<i>Copris harrisi</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>aeruginosus</i>
<i>Heliocopris andersoni</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>anomalus</i>
<i>Heteronitis castelnaui</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>bicavifrons</i>
<i>Onitis inversidens</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>jugicola</i>
<i>Onitis uncinatus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>pugionatus</i>
<i>Onitis viridulus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>quadrimaculatus</i>
<i>Oniticellus egregius</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>teitanicus</i>
<i>Oniticellus pseudoplanatus</i>	<i>Onthophagus</i> (<i>s.l.</i>) <i>tonsus</i>
<i>Liatongus militaris</i>	

Table 3. Species with Panafrotropical distribution. 11 sp. 14.10%

<i>Anachalcos convexus</i>	<i>Drepanocerus sulcicollis</i>
<i>Sisyphus crispatus</i>	<i>Digitonthophagus gazella</i>
<i>Heliocopris hamadryas</i>	<i>Euonthophagus carbonarius</i>
<i>Onitis alexis</i>	<i>Onth. (Furconthophagus) variegatus</i>
<i>Euoniticellus intermedius</i>	<i>Onthophagus (s.l.) vinctus</i>
<i>Drepanocerus abyssinicus</i>	

Table 4. Species with East- and West-/northern Central African distribution. 3 sp. 3.84 %

<i>Scarabaeus isidis</i>	<i>Euoniticellus parvus</i>
<i>Heliocopris haroldi</i>	

Table 5. Species with East, South-central and West-central African distribution. 3 sp. 3.84 %

<i>Sisyphus ocellatus</i>	<i>Onthophagus raffrayi</i>
<i>Copris orphanus</i>	

Total 78 sp.

Some biogeographical considerations

Dung beetles are commonly regarded as a very important element of the entomological fauna of Kenya and East Africa. Nevertheless, the East African dung beetle fauna is still relatively poorly known, both from systematic and biogeographical points of view. The current literature offers very few general contributions dealing with the biogeographical analysis of the Kenyan dung beetles. Here we refer mainly to the paper of Davis & Dewhurst (1993), in their contribution dealing with the Kenyan and northern Tanzanian dung beetle fauna. The authors suggested and utilized in the biogeographical analysis five patterns of distribution. These patterns, though perhaps too comprehensive and somewhat imprecise, seem to be useful also for a preliminary study of the biogeographical aspects of the dung beetle fauna of Laikipia region. So we assigned each species recorded in Laikipia to one of these patterns.

From this preliminary analysis of the chorologies of coprophagous Scarabaeidae of the Laikipia region at least three aspects of some interest arose. The first one is represented by predominance (41.03% of the total number) of the East African endemic species (table 1). According to Davis & Dewhurst (1993) the distribution areas of species showing an East African pattern are in the regions spreading from Somalia and Ethiopia, through Uganda and Kenya to northern Tanzania. Interestingly, the preeminence of East African endemic species in the dung beetle fauna of Laikipia is comparable with the preeminence of the same distributional pattern recorded by Davis & Dewhurst (1993) for the whole of Kenya and northern Tanzania (61.5%).

The second most common pattern of Laikipia dung beetle distribution is the pattern defined as "East, South-central and, usually, Southern Africa" (table 2). Nevertheless, while in the Laikipia region this pattern shows a per cent value only slightly less than the East African one (37.19% vs 41.03%), in the Davis & Dewhurst research the difference is much greater (18.8% vs 61.5%). It is possible to suppose that, as "East Africa" is a highly geographically and ecologically heterogeneous region, the relative number of "endemic" entities increases with increasing size of the investigated area because the number of different

environments, each with an high level of endemism, increases. However, it is worthy of mention that, in the Laikipia region, the endemic species and the East and South African species are together almost 4/5 (78.22%) of the total amount of recorded species. It is significant to note that, in the area considered in the paper of Davis & Dewhurst, even though with different single percentages, the total percentage of the species showing these two distributional patterns is almost identical (79.13%).

A third pattern of distribution, the Panafrican, is represented in Laikipia region by 14.1% of the entire fauna (table 3). This percentage is, once again, markedly similar to the percentage obtained for the entire East African region (13.1%). In other studies, dealing with the dung beetle fauna of different Afrotropical regions (*i.e.* West-central Africa, D.R.C., area around Kinshasa, *cf.* Walter, 1978 and West Africa, Ivory Coast, Lamto, *cf.* Cambefort, 1982) the Panafrican pattern of distribution is represented by 27.5% (Kinshasa) and 24.8% (Lamto) of the total amount of dung beetle species. In general terms East Africa seems to show a higher degree of endemism than western and west-central regions. Correspondingly, the Pan-african elements, though important, are relatively less abundant. This aspect is surely worthy of further research.

The remaining patterns are represented in the Laikipia region by an equivalent percentage (3.84%) (tables 4 and 5). In the study dealing with the entire East African region these two patterns are the most infrequently represented, but not in the same way. While pattern 4 (East- and West-/northern Central Africa) percentage is 6.1, pattern 5 (East, South-central and West-central Africa) percentage shows a much lower value (0.7). To explain this it is important to remember that the Laikipia region has a relatively peripheral position in the East African region, lying in the western part of it. The presence of western elements can be therefore modified with respect to that of East Africa as a whole.

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