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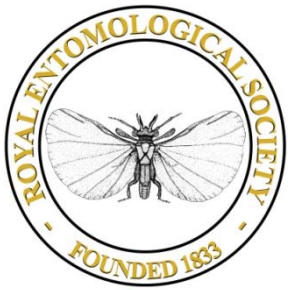

HANDBOOKS FOR

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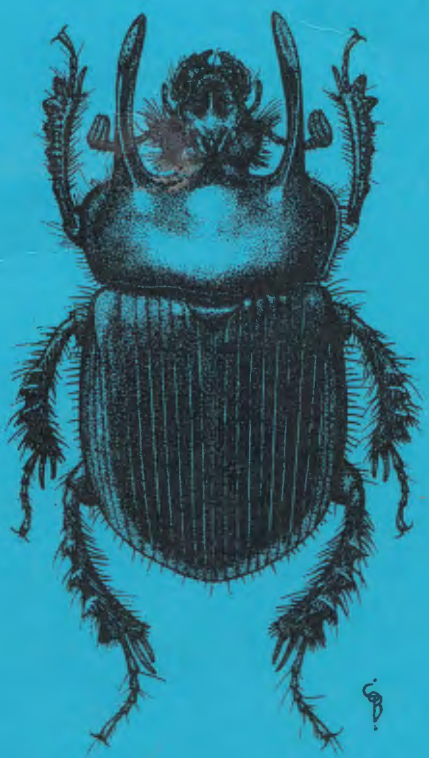
Handbooks for the Identification of British Insects
Vol. 5, Part 11

DUNG BEETLES AND CHAFERS

COLEOPTERA: SCARABAEOIDEA

New Edition

L. Jessop



ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

Handbooks for the
Identification of British Insects

Vol. 5, Part 11

Editors: P. C. Barnard & R. R. Askew

DUNG BEETLES AND CHAFERS

COLEOPTERA: SCARABAEOIDEA

New Edition

By

L. Jessop

(with nine new whole-insect figures by M.D. Kerley)

Department of Entomology
British Museum (Natural History)
London SW7 5BD

1986
ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

The aim of the *Handbooks* is to provide illustrated identification keys to the insects of Britain, together with concise morphological, biological and distributional information. The series also includes a *Check List of British Insects*.

Each handbook should serve both as an introduction to a particular group of insects and as an identification manual.

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Contents

Introduction

The superfamily Scarabaeoidea forms a clear-cut natural group within Coleoptera that has been recognized since the earliest days of systematic zoology. The large size or bright coloration of many species together with the unusual ecology of the dung feeders has attracted attention from collectors, naturalists, ecologists and taxonomists, and the European fauna in particular has been extensively studied. The distribution and natural history of the British species were already well known by the time of Fowler (1890), and the information he gave on these aspects is in many cases not substantially different from that given in the present work.

It is thirty years since E.B. Britton's handbook for the identification of British Scarabaeoidea was published, and that work has now been out of print for about ten years. There is no guide to the British members of the group currently generally available, other than the brief keys provided by Joy (1932).

Rather than re-issue Britton's work in its original edition it was decided to revise it completely. The keys have been arranged into systematic order,

and in some cases (such as that to species of *Aphodius*) they are substantially different from those given by Britton; additional keys are provided to enable larvae to be identified to genus. Much more information on the ecology of the species has been included in the present edition than was given by Britton, and this has been incorporated within the keys. Most of the figures given by Britton have been used again in this work, together with several new drawings of both whole insects and selected parts.

Natural History

Information on the natural history of the various species is given in the body of the work, but in general it can be stated that the larvae feed on roots (Melolonthinae, Hopliinae and Rutelinae) or decomposing material, either of vegetable (Lucanidae, Cetoniinae) or animal (Trogidae) origin. For dung feeders (Scarabaeinae, Aphodiinae, Geotrupidae) the dung used is mostly that of herbivores, probably because it is much more abundant than carnivore dung.

Adults also feed, generally using a similar food source to that of the larvae, except for root feeders and Cetoniinae, in which the adults feed on the upper parts of plants.

Adult Scarabaeoidea are usually well adapted for digging, the front legs are often short and stout and have lateral teeth, and the body is usually compact and heavily sclerotized. Adults are often clumsy when walking and cannot run fast, but most are capable of flight.

Scarabaeoid beetles often possess horns on the head, and these may be subject to considerable sexual dimorphism, males often having horns that are much more strongly developed than those of females. The form and function of horns was discussed extensively by Arrow (1951).

There are few pest species in this country, the most serious being *Phyllopertha horticola*, the larvae of which destroy the roots of turf. *Aphodius fimetarius* is a pest of cultivated mushrooms in Europe, so is a potential menace in this country.

Some species are commonly seen: *Melolontha melolontha* and *Amphimallon solstitialis* are very abundant in some years, and because they fly towards profiles emergent against the horizon (in their natural state, trees) will fly around houses, often entering rooms in summer evenings. For the general public this has some nuisance value.

Collecting and Preservation

Species associated with dung can be extracted by sieving dung samples through a metal gauze of about 4mm mesh on to a light-coloured tray or sheet of polythene. The beetles can then be collected from the tray or sheet by using a pooter (pooters are commercially available that operate by blowing rather than suction, for use in such situations). Another means of extracting beetles from dung is to drop pieces of dung into a bucket of water. On stirring to break up the dung the beetles will rise to the surface.

Dung beetles can also be collected by using baited traps. A pot of about 1-litre capacity is sunk into the ground up to its rim, and about 3cm of insecticidal solution (chloral hydrate solution plus a few drops of detergent

is suitable) are added. The top of the pot is covered by a metal gauze of about 2cm mesh, and from this is suspended a nylon net bag containing dung; human faeces is the most effective attractant. Such traps are very useful for studying the variation in fauna between habitats such as woodland, scrub, open ground etc.

The plant-feeding groups are not so readily captured: the density of population is not generally great enough on low vegetation to make beating and sweeping worthwhile, and these species will normally be collected as chance finds.

Adults should be pinned if possible, and stainless steel pins are preferable, as brass ones will corrode. By convention Coleoptera are pinned through the right elytron. Specimens too small to be pinned (Aphodiinae and small *Onthophagus*) should be mounted on cards. Card can be cut to size from Bristol Board or bought from entomological dealers, and a variety of water-soluble glues are satisfactory, including animal glue, gum tragacanth and even office paste.

Adult Scarabaeoidea also preserve well in 80% ethanol. The ethanol may assume a dirty yellow colour after a few months, but this does not affect the specimens. Specimens of larvae should always be stored in 80% ethanol.

For a few species it may be necessary to examine the aedeagus of male specimens in order to obtain an identification. To remove the aedeagus the abdomen should be broken off at the base (bending the tip of the abdomen downwards with a blunt needle should result in a clean break) and the aedeagus can then be taken out from the abdomen with fine forceps. The abdomen should then be glued back into its original position. If the aedeagus needs to be cleaned, it can be soaked in 5% potassium hydroxide solution for ten minutes in order to soften the matter adhering to it. After the study is completed the aedeagus should either be glued on to the same card as the specimen or on to a separate card mounted on the same pin as the specimen.

Notes on the keys

The superfamily has been divided into sections to make the keys shorter (and thus easier to use). For each of the smaller families Geotrupidae, Trogidae and Lucanidae all of the species are contained in a single key. The family Scarabaeidae has been divided into subfamilies, and there are separate keys for Aphodiinae, Scarabaeinae, Melolonthinae, Rutelinae and Cetoniinae. The genus *Aphodius*, which contains about 45% of the species of British Scarabaeoidea, is given a key apart from the rest of the Aphodiinae.

Although effort has been spent in trying to find characters that are reliable and also clearly visible, some difficulties may still be experienced with the identification of specimens of *Aphodius*. The keys given in Britton (1956) and Joy (1932) may be of some help in such cases, but there is really no adequate substitute for a well-identified synoptic reference collection.

Some species that are probably extinct in Britain or have never been established have been omitted from the keys, although they are included in the check list and are listed at the end of the appropriate key.

Some species are found only in certain months. Months of occurrence (where known) are indicated by roman numerals.

Data on natural history and distribution have been compiled mainly from Fowler (1890), Fowler & Donisthorpe (1913), Horion (1958), Britton (1956) and previously unpublished information from the extensive experience of Mr P.M. Hammond and Mr A.A. Allen.

Acknowledgements

I am extremely grateful to Mr P.M. Hammond, Mr A.A. Allen, Mr C. Johnson and Dr D. Shirt, who looked at early drafts of this work, provided additional information and commented on weaknesses in the text. My thanks go also to Dr R. Pittino, who advised on the names of Psammobiini and identified voucher specimens of the British species.

Figures 1-2 and 34-63 were drawn by Dr E.B. Britton, figures 3-11 by Mr M.D. Kerley, figures 12-33 by Mrs C. O'Brien and the remainder by myself.

Check list of British Scarabaeoidea

In principle, as few changes as possible have been made here to the list given by Pope (1977).

Dorcus parallelipipedus and *Oxyomus sylvestris*: several authors follow the usage of the *Coleopterorum Catalogus* in spelling these names as *parallelopipedus* and *silvestris* respectively. The latter are misspellings, and should not be used.

Pope (1977) followed an error in Neave (1939) in believing *Anomala* Samouelle to be a junior homonym, and therefore used the name *Euchlora* for this genus. Research undertaken in the preparation of this work has shown the senior homonym cited by Neave and Pope to be a species-group name (not a genus-group name), so it does not invalidate *Anomala* Samouelle.

Continental authors have misidentified *Hoplia philanthus*, and have applied the name *Hoplia farinosa* to the British species of *Hoplia*. The type material of *H. farinosa* has been examined in the course of preparing this work, and it is clear that the type does not represent the British species.

Paulian & Baraud (1982) use the name *Trichius rosaceus* Voet for the species known to British authors as *T. zonatus* Germar. The name *rosaceus* Voet is senior to *zonatus* Germar, but is not used here since the work in which *rosaceus* is described is mainly non-binomial so the validity of the name is open to doubt.

Where names on this list differ from those used by Pope (1977) and Britton (1956) they are indicated by **P** and **B** respectively.

SCARABAEOIDEA

LUCANIDAE

LUCANUS Scopoli, 1763
cervus (Linnaeus, 1758)

DORCUS Macleay, 1819
parallelipipedus (Linnaeus, 1758) **[B]**
parallelopipedus auct. (misspelling)

SINODENDRON Schneider, 1791
cylindricum (Linnaeus, 1758)

PLATYCERUS Müller, 1764
caraboides (Linnaeus, 1758)

TROGIDAE

TROX Fabricius, 1775
perlatus Goeze, 1777 **[B]**
hispidus auct. Brit. (misidentification)
sabulosus (Linnaeus, 1758)
scaber (Linnaeus, 1767)

GEOTRUPIDAE

ODONTEUS Samouelle, 1819 **[P, B]**
BOLBOCERAS Kirby, 1819
ODONTAEUS Dejean, 1821
armiger (Scopoli, 1772)

TYPHAEUS Leach, 1815
typhoeus (Linnaeus, 1758)

GEOTRUPES Latreille, 1796
mutator (Marsham, 1802)
pyrenaeus (Charpentier, 1825)
spiniger (Marsham, 1802)
stercorarius (Linnaeus, 1758)
stercorosus (Scriba, 1791)
vernalis (Linnaeus, 1758)

SCARABAEIDAE
APHODIINAE
AEGIALIINI

AEGIALIA Latreille, 1807
arenaria (Fabricius, 1787)
rufa (Fabricius, 1792) **[B]**
sabuleti (Panzer, 1796) **[B]**

APHODIINI

APHODIUS Illiger, 1798
COLOBOPTERUS Mulsant, 1842 **[P]**
ater (Degeer, 1774)
borealis Gyllenhal, 1827
brevis Erichson, 1848
coenosus (Panzer, 1798)
conspurcatus (Linnaeus, 1758)
consputus Creutzer, 1799
constans Duftschmidt, 1805
contaminatus (Herbst, 1783)
depressus (Kugelann, 1792)

distinctus (Müller, 1776)
equestris (Panzer, 1798)
sticticus (Panzer, 1798) nec (Linnaeus, 1758)
erraticus (Linnaeus, 1758)
fasciatus (Olivier, 1789) **[B]**
tenellus Say, 1823
fimetarius (Linnaeus, 1758)
foetens (Fabricius, 1787) **[B]**
aestivalis Stephens, 1839
foetidus (Herbst, 1783) **[B]**
scybalarius auct. nec (Fabricius, 1781)
fossor (Linnaeus, 1758)
granarius (Linnaeus, 1767)
haemorrhoidalis (Linnaeus, 1758)
ictericus (Laicharting, 1781)
lapponum Gyllenhal, 1806
lividus (Olivier, 1789)
luridus (Fabricius, 1775)
merdarius (Fabricius, 1775)
nemoralis Erichson, 1848
niger (Panzer, 1796)
obliteratus Panzer, 1823
obscurus (Fabricius, 1792)
paykulli Bedel, 1908
plagiatus (Linnaeus, 1767)
porcus (Fabricius, 1792)
prodromus (Brahm, 1790)
pusillus (Herbst, 1789)
putridus (Fourcroy, 1785)
quadrimaculatus (Linnaeus, 1761)
rufipes (Linnaeus, 1758)
rufus (Moll, 1782) nec (Degeer, 1778) **[B]**
rufescens Fabricius, 1803
satellitius (Herbst, 1789)
scrofa (Fabricius, 1787)
sordidus (Fabricius, 1775)
sphacelatus (Panzer, 1798)
sturmi Harold, 1870
subterraneus (Linnaeus, 1758)
varians Duftschmidt, 1805
zenkeri Germar, 1813

EUHEPTAULACUS Dellacasa, 1983
sus (Herbst, 1783) **[P, B]**
villosus Gyllenhal, 1806 **[P, B]**

HEPTAULACUS Mulsant, 1842
testudinarius (Fabricius, 1775) **[P]**

OXYOMUS Stephens, 1839
sylvestris (Scopoli, 1763)
silvestris auct. (misspelling)

EUPARIINI

SAPROSITES Redtenbacher, 1858
mendax Blackburn, 1892

PSAMMOBIINI
PSAMMODIINI auct. (misspelling)

PSAMMODIUS Fallén, 1807
asper (Fabricius, 1775) **[B]**
sulcicollis (Illiger, 1801)
caelatus (Leconte, 1857)

BRINDALUS Landin, 1960
porcicollis (Illiger, 1803) **[P, B]**

RHYSSEMUS Mulsant, 1842
germanus (Linnaeus, 1767)

DIASTICTUS Mulsant, 1842
vulneratus (Sturm, 1805)

PLEUROPHORUS Mulsant, 1842
caesus (Creutzer *in* Panzer, 1796)

SCARABAEINAE

COPRIS Müller, 1764
lunaris (Linnaeus, 1758)

ONTHOPHAGUS Latreille, 1802
coenobita (Herbst, 1783)
fracticornis (Preyssler, 1790)
joannae Goljan, 1953 **[B, P]**
ovatus auct. nec (Linnaeus, 1767)
nuchicornis (Linnaeus, 1758)
nutans (Fabricius, 1787)
similis (Scriba, 1790) **[B]**
fracticornis auct. Brit., nec (Preyssler, 1790)
taurus (Schreber, 1759)
vacca (Linnaeus, 1767)

HOPLIINAE

HOPLIA Illiger, 1803
philanthus (Fuessly, 1775)
farinosa auct., nec (Linnaeus, 1761)

MELOLONTHINAE

SERICA Macleay, 1819
brunnea (Linnaeus, 1758)

OMALOPLIA Schoenherr, 1817
HOMALOPLIA auct. (misspelling)
ruricola (Fabricius, 1775)

AMPHIMALLON Berthold, 1827
ochraceus (Knoch, 1801)
solstitialis (Linnaeus, 1758)

MELOLONTHA Fabricius, 1775
hippocastani Fabricius, 1801
melolontha (Linnaeus, 1758)

POLYPHYLLA Harris, 1842
fullo (Linnaeus, 1758)

RUTELINAE

PHYLLOPERTHA Stephens, 1829
horticola (Linnaeus, 1758)

ANOMALA Samouelle, 1819 **[P]**
EUCHLORA Macleay, 1819
dubia (Scopoli, 1763)

CETONIINAE
CETONIINI

CETONIA Fabricius, 1775
aurata (Linnaeus, 1761)
cuprea Fabricius, 1775

OXYTHYREA Mulsant, 1842
funesta (Poda, 1761)

TRICHIINI

GNORIMUS Lepeletier & Serville, 1828
nobilis (Linnaeus, 1758)
variabilis (Linnaeus, 1758)

TRICHIUS Fabricius, 1775
fasciatus (Linnaeus, 1758)
zonatus Germar, 1831

Identification of Larval Scarabaeoidea

The following keys are incomplete in that genera that are not commonly found have been omitted. A thorough revision of scarabaeoid larvae was given by Van Emden (1941) and a key to families and subfamilies by Crowson (1955).

Scarabaeoid larvae are readily identified as such by their C-shaped form; the body is curved downwards so that the dorsal surface forms the outside of the curve (fig. 65). The spiracles are cribriform (punctured like a sieve), and are often surrounded by a sclerotized C-shaped or kidney-shaped ring. Cerci and ocelli are never present. There is usually a patch of short stout spines (called the raster) ventrally on the last abdominal segment.

Key to families and subfamilies

1 Stridulatory file present on posterior face of mid coxae, appearing as a heavily sclerotized ridge (the roughened nature of this ridge can be felt by gently scraping a fine needle along its length). (In dead and rotten wood). ..... **Lucanidae** (p. 11)
— Stridulatory file absent from mid coxae 2
2 Tarsal claws long and acute (fig. 67). (In dry carcases, bones, hides etc.) One genus, *Trox*. ..... **Trogidae**
— Tarsal claws not long and acute (fig. 68). 3

3 Antennae with three segments. (In burrows under dung). ..... **Geotrupidae** (p. 11)
— Antennae with four or five segments. ..... **4 (Scarabaeidae)**
4 Anterior part of abdomen swollen, giving a hunchbacked appearance (fig. 64). (In burrows under dung). One common genus, *Onthophagus*. ..... **Scarabaeinae**
— Anterior part of abdomen not swollen, body uniformly curved. 5
5 Antennae with a sensillum present at apex of penultimate segment (sensillum appears as a clearly defined raised circular area). Maxillae with galea and lacinia separate. Usually associated with dung. ..... **Aphodiinae** (p. 11)
— Antennae lacking a sensillum at apex of penultimate segment. Maxillae with galea and lacinea fused. Not associated with dung. 6
6 Anus V or Y shaped. (Root feeders). ..... **Melolonthinae** and **Hopliinae** (p. 12)
— Anus transverse, not angulate. 7
7 Raster not distinct, comprised either of two median longitudinal rows of spinules, or of these two rows plus a patch of very short spinules. (In rotting wood or decomposing vegetable matter). ..... **Cetoniinae** (p. 12)
— Raster with large patches of large spinules surrounding median longitudinal rows. (Root feeders, not associated with rotting wood or decomposing vegetable matter). ..... **Rutelinae** (p. 12)

Keys to genera

Family Lucanidae

1 Raster absent. Front margin of pronotum with a blunt tubercle laterally on each side ..... **Sinodendron**
Dead or rotten wood of various trees, including ash, willow, lime, beech, apple and chestnut.
— Raster present. Pronotum lacking blunt lateral tubercles. 2
2 Tarsal claws with usually 4-6, and up to 8, setae. Mature specimens large, up to 120 mm long. ..... **Lucanus**
Dead or rotten wood of various trees, especially oak.
— Tarsal claws with two setae. Mature specimens smaller, 40-45 mm long. ..... **Dorcus**
Dead and rotten wood, mainly of ash, elm or willow.

Family Geotrupidae

1 Hind legs not reduced, same length as middle pair. ..... **Geotrupes**
In burrows, feeding on dung.
— Hind legs reduced, less than half length of middle pair. ..... **Typhaeus**
In holes in dry sandy soil, feeding on dung of sheep, rabbits or deer.

Subfamily Aphodiinae

1 Anal lobe not indented in the middle ventrally. ..... **Aegialia**
Feeds on decomposing vegetable matter, on sand dunes.
— Anal lobe indented in the middle ventrally. 2
2 Mandibles with one lateral tooth in anterior-inner region. ..... **Aphodius**
Common in dung; also found in decomposing vegetable matter.
— Mandibles with two lateral teeth in anterior-inner region. ..... **Oxyomus**
In rotten vegetation, dung and corpses.

Subfamilies Melolonthinae and Hopliinae

1 Raster with two longitudinal rows of spines medially 2
— Raster lacking longitudinal rows of spines 3
2 Anus Y-shaped, with ventral cleft short but distinct. ..... **Amphimallon**
Feeds on roots of various low-growing plants.
— Anus V-shaped, with ventral cleft absent. ..... **Melolontha**
Feeds on roots of grass, corn etc.
3 Front tarsal claws stout, long, curved and pointed; middle and hind pairs small. . **Hoplia**
Feeds on roots.
— Front tarsal claws not stout or long, curved and pointed, and not more strongly developed than middle and hind pairs. 4
4 All tarsal claws poorly developed, hind pair completely absent. ..... **Omaloplia**
Feeds on roots.
— Tarsal claws not poorly developed, hind pair present. ..... **Serica**
Feeds on roots of low-growing plants, including grass and potatoes, and young trees.

Subfamily Rutelinae

1 Raster with median longitudinal rows comprised of short spinules. ..... **Phyllopertha**
Feeds on roots; may be a pest of turf and in market gardens and nurseries.
— Raster with median longitudinal rows comprised of spinules of same size as those of remainder of raster. ..... **Anomala**
Feeds on decomposing vegetable material and roots of plants, in sandy soil.

Subfamily Cetoniinae

1 Ninth and tenth abdominal segments dorsally fused, so abdomen appears nine-segmented. Tarsal claws broad, rounded at the tip. ..... **Cetonia**
Larvae of aurata *in rotting vegetation and rotting wood of old stumps, sometimes found in association with ants; larvae of* cuprea *in lower parts of the nests of wood ants (*Formica *species).*
— Ninth and tenth abdominal segments not fused dorsally, so abdomen appears ten-segmented. Tarsal claws narrow and pointed at the tip. 2
2 Mandibles with furrow along dorsal surface. Head capsule rugose. ..... **Gnorimus**
In damp wood mould of old trees.
— Mandibles lacking dorsal furrow. Head capsule smooth. ..... **Trichius**
In rotting wood, mostly of birch stumps.

Identification of Adult Scarabaeoidea

Scarabaeoidea can usually be easily separated from other Coleoptera by the antennae which, in Scarabaeoidea, have an apical club formed of (usually) the last three segments, which are expanded laterally (lamellate). Lucanidae are an exception in that the club segments are only weakly lamellate and not closely apposed. Lucanid antennae are also distinctive in that the first segment is long and the second segment forms a right angle with the first (the antennae are said to be elbowed).

Other beetles likely to be confused with Scarabaeoidea are sphaeridiine Hydrophilidae (which can be distinguished by their very long labial palps) and Histeridae, in which the mandibles are visible in front of the head (as in Geotrupidae) but the elytra are short, exposing one abdominal tergite as well as the pygidium.

Key to families of Scarabaeoidea

1 Apical, lamellate antennal segments not forming a tight club. Antennae elbowed at the first joint (fig. 44). See also figs 3-6. ..... **Lucanidae** (p. 13)
— Apical, lamellate antennal segments closely apposed to form a tight club (these, however, are capable of being spread like a fan in life, and occasionally remain so after death). Antennae not elbowed (fig. 45). 2
2 Mandibles strongly projecting, visible when head viewed from above (figs 7, 12, 13). Antennae 11-segmented. Eyes completely divided into upper and lower halves by a bar (the eye canthus). ..... **Geotrupidae** (p. 15)
— Mandibles not projecting, not visible when head is viewed from above. Antennae 9-segmented. Eyes not divided into upper and lower halves by eye canthus. 3
3 Elytral epipleura broad, continuing to apex of elytra (fig. 46). Abdomen with five visible sternites. (Dorsal surface dull black, and elytra either with tufts of setae or with surface coarsely sculpted. Usually associated with dried animal material). . **Trogidae** (p. 14)
— Elytral epipleura narrow, not continuing to apex of elytra. Abdomen with six visible sternites. ..... **Scarabaeidae** (p. 16)

Family Lucanidae

The family Lucanidae comprises about 900 species, the greatest number of species being found in east and south-east Asia. There are only 8 species in Europe.

There is immense variation in development of the mandibles in males of many species in this family. There are often distinct major and minor forms with a discontinuous range in variation of size of mandibles and in the development of mandibular teeth, and this variation is not totally dependent on the size of the rest of the body (large specimens are not always 'major' in respect of their mandibles). This variation is probably not genetically determined, but depends on the nutritive state of the larval stages.

Key to species

1 Head with a dorsal median horn (males) or single median tubercle (females). Mandibles never produced as horns. Pronotum excavate anteriorly in males. Body strongly convex, subcylindrical (fig. 3). (Elytra, pronotum and head with coarse punctures, those on elytra more or less arranged into rows. Colour entirely shining black. Length 10-18mm). ..... **Sinodendron cylindricum** (Linnaeus)
Adults found in dead wood of various trees including ash, beech, willow, birch, apple, lime and chestnut, and are active at night. The upper side of the abdomen is red and clearly visible when the insect is in flight. The burrowing behaviour was detailed by Chapman (1868): adults burrow into rotten wood, often in pairs, but sometimes a burrow is started by one individual and completed by a mixed-sex pair. When digging as a pair, the female excavates the burrow and the male stands with his head directed towards (and closing) the entrance. The burrow is branched, and eggs are laid in these branches, which are packed with sawdust. Generally distributed but local throughout the British Isles. Found throughout the year.
— Head lacking dorsal median horn or single median tubercle. Pronotum not excavate medially. Mandibles often produced as horns (fig. 4). Body dorsally slightly compressed, never subcylindrical, and not coarsely punctured. 2
2 Dorsal surface of front tibiae with longitudinal striae. Dorsal surface of head in females with two tubercles, one on each side of the midline. Mandibles of males at most as long as head (fig. 5). Head and pronotum of males less strongly shining than elytra. Head, pronotum and elytra unicolorous. (Length 20-32mm). ..... **Dorcus parallelipipedus** (Linnaeus)

Adults occur quite often in spongy wood of willows, poplars, beech etc, and fly in the evening and at night. Common in southern England, becoming less common northwards; northern limit in Britain Cheshire-south Yorks. The histerid beetles Aeletes atomarius *and* Plegaderus dissectus *are regularly associated with wood attacked by this species. Found throughout the year.*

— Dorsal surface of front tibiae lacking longitudinal striae. Dorsal surface of head of females lacking tubercles (fig. 6). Mandibles of males at least 1.5 times length of head (fig. 4). Head and pronotum equally as shining as elytra. Head and pronotum black, elytra dark brown. (Length 28–70 mm). ..... **Lucanus cervus** (Linnaeus) *"The Stag Beetle". Develops mostly in the decayed roots of old stumps (elm, lime, beech etc.). Adults are active in the evening, males flying in search of females. Occasionally large swarms are reported. Adults feed on fruit and exudate on trees. It is commonly claimed that the males fight using the large mandibles; males are easily stimulated to fight in captivity, but fighting behaviour is rarely seen in the wild. Common in parts of south-east England, rarer in south Wales, south-west and central England, and absent from northern England and Scotland. Distribution detailed by Clark (1966) and Hall (1970). v-viii, mostly vi-vii.*

Platycerus caraboides is excluded from this key, as there have been no reports of it in Britain since 1830.

Family Trogidae

There are about 150 species of Trogidae, most of which belong to the genus *Trox*: this genus contains all of the British species of Trogidae. The greatest number of species occurs in the Afrotropical region; the European fauna comprises 16 species.

The ecology of this genus is poorly known, and the natural history of the British species has not been described in detail. Most species of *Trox* are associated with dry animal material, particularly bones.

Key to species

1 Hairs on body and first segment of antennae black. Elytral intervals with large tubercles (fig. 32) Length 8-12 mm. ..... **perlatus** Goeze *According to Paulian & Baraud (1982) this species is found under stones and in detritus of animal origin, sometimes in carcasses, in debris beneath nests of diurnal raptors, in owl pellets and in carnivore faeces. Rare, in Britain known only from Tyneham and Worbarrow Bay (Dorset), (not recorded since 1930, when it was found in lamb skins and carrion on the cliffs). iii-iv, x.*

— Hairs on body and first segment of antennae light brown or yellow. Elytral intervals lacking large tubercles. 2

2 Sutural stria broad, almost as wide as intervals one and two (fig. 31). Generally larger, length 8–10mm. ..... **sabulosus** (Linnaeus) *In dried carcasses and horns, in sandy areas. Adults stridulate by rubbing the abdomen against the elytra. Found very locally through southern and central England, and more rarely northwards to the Scottish highlands. Flies by day.*

— Sutural stria narrow, less than half as wide as intervals one and two (fig. 33). Smaller, length 5–8mm. ..... **scaber** (Linnaeus) *In birds' nests, especially in hollow trees (mostly owls' and other nests containing bones) and in detritus of animal origin. The most common British* Trox, *found locally through southern and central England and Wales, and rarely in southern Scotland. Flies to light. i-ii, v-ix.*

Not included in this key: *hispidus*, recorded in error as a British species by Britton (1956).

Family Geotrupidae

Most of the British representatives of this family belong to the genus *Geotrupes*, a taxon with about 100 species distributed through Europe, Asia and North America. Some authors, e.g. Paulian & Baraud (1982), divide the European species between several genera, placing *G. stercorosus* in the genus *Anoplotrupes*, and *G. pyrenaeus* and *G. vernalis* in *Trypocoris*. The published work on the biology of the family was reviewed extensively by Howden (1955).

Key to species

1 Elytral suture with a carina, then a punctate stria, then the first interval. Small, length 8–10mm. (Male with a median, long, recurved, movable cephalic horn). (fig. 12) ..... **Odonteus armiger** (Scopoli)
Adults fly in the evening between 20.00–21.00 hrs in hot weather, and between 14.00–17.00 hrs in cooler weather. Often found drowned in pools, and sometimes under dry cow dung, or sheep droppings, mostly in chalky areas. About 35% of specimens have been collected at light. According to Arens (1922) this species is not a dung feeder, but develops in subterranean fungi, in burrows 24-70 cm deep. Collected very sporadically through south-east England south of a line from the Wash to the Bristol Channel. vi-x, mostly mid-June to early August, females have been collected only from late June to late July.

— Elytral suture lacking a carina. Larger, length 12–25mm. 2

2 Pronotum either with three forwardly directed horns, the median horn being shorter than the lateral ones (males) or with a transverse ridge anteriorly with a spur on each side of this ridge (females) (fig. 13). Colour entirely black. (Length 12–20mm). ..... **Typhaeus typhoeus** (Linnaeus)
In burrows under dung of sheep, rabbits, horse, deer, and not infrequently cow. Both sexes collaborate in excavating and provisioning the burrow, which can reach 1.5 metres deep, and consists of a vertical tunnel with 4–5 blind-ending side branches which are provided with a mass of dung. Eggs are not laid in the dung mass, but in the soil a short distance away. Males use their thoracic horns in fighting in the burrows; the loser either leaves the burrow or is pushed out and the winner copulates with the female within a few minutes (Palmer, 1978). Local throughout England and Wales, becoming less frequent northwards; there is one record from Cumberland and three from Scotland. i-v, viii-x, most records from spring and autumn.

— Pronotum lacking forwardly directed horns, and without a transverse ridge or spurs (fig. 7). At least underside is metallic. ..... 3 (**Geotrupes**)
In all British species of this genus the female excavates a burrow directly beneath the dung source, which she provisions with dung. Eggs are laid in the dung. Adults are also sometimes found in decaying fungus and at sap exuding from trees. Adults stridulate by rubbing the hind coxae together.

3 Marginal carina of the posterior margin of the pronotum markedly narrowed on both sides of the midline (fig. 73) (Elytral striae faintly impressed, hardly visible to the naked eye.) 4

— Marginal carina of the posterior margin of the pronotum not narrowed on both sides of the midline (fig. 75) 5

4 Pronotum thickly and very distinctly punctured. Elytra with granular microsculpture (clearly visible at about × 50 magnification) Abdominal sternites with long hairs and punctures evenly distributed, not sparser medially. (Length 12–20mm). ..... **G. vernalis** (Linnaeus)
On dry and sandy soil; in Cumbria in grassy places and under dead birds. Each burrow contains one larva. Prefers dung of foxes and sheep. Once widespread but not common in England, Wales and Scotland and very rare or absent from much of east and south-east England; has become rarer in recent years and seems to have disappeared from all of its former localities near London and in west Kent. Summer and autumn.

— Pronotum finely and diffusely punctured, appearing almost smooth. Elytra smooth, not with granular microsculpture. Abdominal sternites with long hairs and punctures more sparse medially than laterally. (Length 12–20mm). ..... **G. pyrenaeus** (Charpentier) *Uses all types of dung, found once in owl pellets. Local in south-west and south-east England, on sandy heaths, also on chalk cliffs near Eastbourne (Sussex). v-vi.*

5 Elytra each with nine striae between the suture and the humeral callus. (Length 15–25 mm). ..... **G. mutator** (Marsham) *Uses mainly horse and cow dung. Local in Wales and southern England northwards to Staffs, generally less common in eastern England, appears to be scarcer now than formerly. iii-x.*

— Elytra each with seven striae between the suture and the humeral callus. 6

6 Outer face of posterior tibiae with one transverse carina (fig. 70). Form shorter and rounder. (Hairs and punctures on the abdominal sternites uniformly distributed, not sparser medially). (Length 12–19mm). ..... **G. stercorosus** (Scriba) *The typical* Geotrupes *of hillsides, mountainsides, woodland and moorland. Found in England, Wales and Scotland, but much commoner in the north and west and absent from many parts of south-east England. iii-x.*

— Outer face of posterior tibiae with two transverse carinae, the proximal carina may be incomplete. Form longer, more oblong. (Most common in pastures). 7

7 Hairs and punctures on the abdominal sternites sparser medially than laterally. Proximal transverse carina on posterior tibiae complete (fig. 72). (Length 16–26mm). ..... **G. spiniger** (Marsham) *Common in England, Wales and Scotland, becoming less common northwards.* Aphodius rufipes *was reported as being a cuckoo parasite in burrows of this species by Klemperer (1980). Mostly vii-x.*

— Hairs and punctures on abdominal sternites uniformly distributed, not becoming sparser medially. Proximal transverse carina on posterior tibiae only half complete (fig. 71). (Length 16–26mm). See also fig. 7. ..... **G. stercorarius** (Linnaeus) *"The Dor Beetle", "Dumble Dor", "Clock", or "Lousy Watchman". Uses in preference horse dung. Flies on still warm evenings in summer and autumn. Usually infested with mites.* Aphodius porcus *was reported as being a cuckoo parasite in burrows of this species by Chapman (1869). Generally common throughout the British Isles. iv-x.*

Family Scarabaeidae

Most of the extant subfamilies of Scarabaeidae are predominantly tropical in distribution and are relatively poorly represented in Britain; an exception being the subfamily Aphodiinae, which is most diverse in the north temperate zone: the British fauna is typical of north-west Europe in comprising a large numer of species of the genus *Aphodius*.

One major subfamily, Dynastinae, is completely absent from the British fauna.

As the morphology and ecology of the various subfamilies of Scarabaeidae are quite diverse they are here treated separately.

Key to subfamilies

1 Elytra long, completely covering abdomen. Elytra conceal most of pygidium (figs 15–20). (Tarsi with two equal claws that lack lateral teeth. Elongate, length up to 13mm, but usually about 3–6mm. Usually associated with dung). ..... **Aphodiinae** (p. 17)

— Elytra not covering abdomen completely. Pygidium exposed (figs 8–11). 2

2 Tarsi with two unequal claws, or with only one large claw (figs 60, 62) 3

— Tarsi with two equal claws. 4

3 Posterior tarsi with only one claw (which is split apically) (fig. 60). Head and scutellum black, elytra reddish-brown. Body covered with extremely short, scale-like pubescence above, and with bluish scales beneath. (Length 7–11mm). ..... **Hopliinae** (p. 29)

— Posterior tarsi with two claws (fig. 62). If with given colour pattern then pubescence on head, pronotum and elytra long, not scale-like, and (usually) dark. Body at least in part with metallic coloration. (Fig. 11). ..... **Rutelinae** (p. 29)

4 Each tarsal claw with one lateral tooth (fig. 59). Body lacking metallic coloration. (Fig. 9). ..... **Melolonthinae** (p. 27)

— Tarsal claws lacking lateral teeth. 5

5 Hind tibiae with one apical spur, front tibiae with three lateral teeth (fig. 10). (Usually associated with dung). ..... **Scarabaeinae** (p. 26)

— Hind tibiae with two apical spurs. Front tibiae usually with two lateral teeth, if with three then colour metallic green (Fig. 8) ..... **Cetoniinae** (p. 29)

Subfamily Aphodiinae

This subfamily contains more than half the species of British Scarabaeoidea. The largest genus, *Aphodius*, is here given a separate key for the sake of convenience.

Most species of Aphodiinae are dung feeders, but the tribes Aegialiini and Psammobiini comprise species that are usually associated not with dung but with decaying vegetable material on dry and sandy soils.

Key to tribes

1 Head viewed from directly above with labrum visible in front of clypeus (fig. 20) and eyes not visible (length 4–5mm). ..... **Aegialiini** (p. 17)

— Head viewed from above with labrum not visible in front of clypeus, and eyes usually clearly visible. 2

2 Hind tibiae lacking transverse ridges on outer edge (but may have several small tubercles). Pronotum often with transverse ridges and depressions (fig. 19). . **Psammobiini** (p. 18)

— Hind tibiae with two transverse ridges on outer edge. Pronotum never with transverse ridges and depressions. 3

3 Lateral margin of elytra sinuous (fig. 93). Longer spur at tip of hind tibiae longer than first two tarsomeres together (fig. 80). (Length 3.0–3.5mm). ..... **Eupariini** (p. 18)

— Lateral margin of elytra not sinuous (fig. 94). Longer spur at tip of hind tibiae shorter than first two tarsomeres together (fig. 78). ..... **Aphodiini** (p. 19)

Tribe Aegialiini

The tribe Aegialiini is represented in Britain by one genus, *Aegialia.*

Key to species

1 Pronotum smooth. Base of pronotum lacking a raised margin (fig. 20). (Colour reddish-brown to black). ..... **arenaria** (Fabricius)
At the foot of plants on beaches and sand dunes. Local in England, Wales and Scotland.

— Pronotum rough, or covered with coarse punctures. Base of pronotum with a raised margin. 2

2 Longer articulate spur at tip of hind tibiae narrow, pointed at tip. Colour black. Pronotum with coarse punctures. ..... **sabuleti** (Panzer)
On the sandy banks of rivers and streams. England (not south of about London to Bristol), Wales and Scotland.

— Longer articulate spur at tip of hind tibiae broad, blade-like, rounded at tip. Colour reddish-brown. Pronotum rough but lacking well-defined punctures. . **rufa** (Fabricius)
Feeds on debris in sand. Very local, on sandy coasts between Barmouth (Gwynedd) and Southport (Merseyside). v-vi.

Tribe Psammobiini

This tribe is represented in Britain by six species in five genera.

Key to species

1 Pronotum with transverse ridges and depressions (fig. 19). Lateral and basal edges of pronotum fringed with yellow bristles. 2

— Pronotum lacking transverse ridges and depressions. Lateral and basal edges of pronotum not fringed with yellow bristles. 5

2 Posterior tarsi elongate. Longest articulate spur at tip of hind tibiae slender, shorter than first two tarsomeres together. (Length 2.7–3.5mm). ..... **Rhyssemus germanus** (Linnaeus)
Known only from old records and specimens. From Bristol to Swansea. Should be looked for at the foot of plants and in decomposing material such as flood debris on dry and sandy terrain, typically beside rivers.

— Posterior tarsi short and thick. Longest articulate spur at tip of hind tibiae thick, longer than first two tarsomeres together. 3

3 Pronotum with two to three faintly impressed transverse furrows. Elytral striae narrow, one quarter to one sixth width of intervals. ..... **Psammodius caelatus** (Leconte)
An American species, which was first reported from Britain by Johnson (1976). It has been found on sand dunes at Freshfield and Formby (Merseyside).

— Pronotum with five to six strongly impressed transverse furrows. Elytral striae broad, almost as wide as intervals. 4

4 Tenth elytral interval anteriorly joining ninth interval, posteriorly extending into apical half of elytra (fig. 16). (Length 2.6–4.0 mm) ..... **Psammodius asper** (Fabricius)
In sandy coastal areas, in and on sand and under seaweed. A very local species, found in scattered localities on the east coast between Kent and Yorks, and on the west Coast from Devon to Lancs. Also reported from the banks of the Tay above Perth.

— Tenth elytral interval anteriorly not joining ninth interval, posteriorly not extending into apical half of elytra (fig. 15). (Length 3.3–4.3mm). .... **Brindalus porcicollis** (Illiger)
On sand dunes. Whitsand Bay (south-east Cornwall) and Pyle (Glamorgan). Not recorded for over 70 years.

5 Body elongate, three times as long as wide (fig. 17). Longer spur at tip of hind tibiae slender, and not as long as basal tarsomere. Hind tarsi as long as hind tibiae. (Length 2.5–3.25mm). ..... **Pleurophorus caesus** (Creutzer)
Known only from old records from the Isles of Scilly, Bristol, Cornwall and Southport (Merseyside). Should be looked for in vegetable detritus and flood debris on sandy soils.

— Body less elongate, twice as long as wide. Longer spur at tip of hind tibiae broad and as long as first two tarsomeres together. Hind tarsi half as long as hind tibiae. (Length 3.0–3.5mm). ..... **Diastictus vulneratus** (Sturm)
On sandy soil, mostly in dry, open heathy areas, in entrances to rabbit burrows, under stones, in moss and ground litter. Reported in Britain only from the Breckland area of Suffolk. Very scarce. iv-vi and xi.

Tribe Eupariini

This tribe is represented by one species in Britain. *Saprosites mendax* Blackburn.

Originally an Australian species accidentally introduced into England. Reported as being common in borings of Dorcus parallelipipedus *and* Sinodendron cylindricum *in Arundel Park (Sussex) by Tottenham (1930). Since then the species has spread, and is now found in Richmond Park (Surrey) and in West London.*

Tribe Aphodiini

This tribe is represented in Britain by 49 species in four genera.

Key to species

1 Pronotum with median groove in posterior half (fig. 18). Elytral intervals sharply carinate. (Length 2.5–3.7mm). ..... **Oxyomus sylvestris** (Scopoli)
In vegetable refuse, grass cuttings, dung heaps, corpses and mushrooms, rarely in dung that is lying in fields. Wales and England south of Lancs & Yorks; rarely found in the north of its range. iii-v, x-xi, also (in flood debris) ii and xi-xii.

— Pronotum lacking median groove. Elytral intervals flat or broadly rounded, not carinate. 2

2 Elytra with ten intervals, alternating with narrow striae (striae never broader than intervals) (fig. 24). Elytra and pronotum usually lacking hairs. ..... **Aphodius** (p. 19)

— Elytra with seven intervals, alternating with striae that are often broader than intervals (fig. 21). Each interval with two rows of long hairs, pronotum pilose 3

3 Tip of middle tibiae with one long spur (in addition to fringe of hairs). Head and pronotum black, elytra dark brown with light brown spots. (Length 3.0–3.5 mm). ..... **Heptaulacus testudinarius** (Fabricius)
In sandy areas in dry dung, rotten vegetable material and flood debris. Very local in south-east England, and there are records from York and Swansea; apparently rarer than formerly. This species was reported as overwintering in burrows of Geotrupes mutator *by Sopp (1898). Mostly early spring.*

— Tip of middle tibiae with two long spurs (in addition to fringe of hairs). Colour not as above. 4

4 Colour uniformly light brown. Shorter, length 3.5–4.5mm. ..... **Euheptaulacus villosus** Gyllenhal
In exposed and insolated areas, often in meadows near the sea, on sandy or chalky soils. In vegetable matter, in dung or under stones. Very local but widely distributed from northern Scotland to southern England, all known northern records are from sandy coastal localities and the southern records are mostly from inland sites on chalk. v-vii, mostly vi-vii. British records summarized by Welch (1979).

— Head and pronotum dark brown, elytra light brown with dark brown spots on the intervals. (Longer, length 4.5–5.0mm) (fig.21). ..... **Euheptaulacus sus** (Herbst)
Prefers dry and sandy pasture on littoral or alluvial plains. In dung. Very local in southern England as far north as Cheshire. Rarer than formerly, there are hardly any recent records.

Genus **Aphodius** Illiger

With over 1000 species worldwide, this is one of the largest animal genera. Most published work on this genus has consisted of taxonomic studies, but there is still no consensus as to the most correct division of the genus into subgenera, even for the well-studied European fauna; subgenera are therefore not included in this work.

The most interesting recent studies of *Aphodius* have concentrated not on taxonomy but on ecology. Most *Aphodius* species spend their lives in dung, although some live in vegetable refuse and at least three species are known to spend part of their lives in burrows of other Scarabaeoidea (*Geotrupes*), consuming the dung provided by the *Geotrupes* for their own offspring. Copulation takes place on the surface of the dung, or on the ground beside it. Eggs are laid singly or in small batches scattered throughout the dung or in the substrate. Unlike Geotrupidae and Scarabaeinae, aphodiine dung beetles do not bury dung.

Often several species of *Aphodius* will be found in the same cow pat or horse dropping, and in any one area at any one time there may be up to 10–15 common

species (although the species involved will be different with time and area) and several 'satellite' species that are much less common. Local extinction rates may be high for satellite species (Hanski, 1980).

Attempts have been made to discover what aspects of the food source are important in separating the species ecologically, although competition for food may not be important; one study showed that only about 0.2% of the energy available in a cow pat was consumed by *Aphodius* (Holter, 1982). Factors currently recognized include: the type of dung, age of the dung, whether conditions are shaded or exposed, whether soil is sandy, chalky or damp, and in some cases the position within the dung source (central, peripheral, top or bottom): see Hanski (1986), White (1960) and Holter (1979; 1982).

Some species of *Aphodius* overwinter as adults, being then found, not in dung, but amongst flood debris or plant litter.

Most species fly in the day time, but *A. rufipes*, which often flies to light, is a well-known exception.

The notes on ecology given here have been compiled largely from Landin (1961), Dellacasa (1983) and Paulian & Baraud (1982). It is possible that the ecological preferences of species in Britain differ from those of the same species on the European continent.

Key to species

1 Scutellum long, one-third to one-fifth length of elytral suture (fig. 23). (These four species are sometimes separated off from *Aphodius* as a distinct genus, *Colobopterus*). 2

— Scutellum short, one-eighth to one-tenth length of elytral suture (fig. 22). 5

2 Small, length 3.0–5.5mm (Black, elytra red in posterior third and with a red spot, sometimes reduced or obsolete, at each shoulder). ..... **haemorrhoidalis** (Linnaeus)
Various sorts of dung, including that of sheep, horse and cow. Common in England and Wales, becoming less common northwards, and absent from Scotland. ii (in flood debris), v-viii.

— Larger, length greater than 6mm. 3

3 Pronotum evenly covered with fine punctures. Elytral intervals finely punctate. (Length 6–9mm. Elytra dark yellow to brown with the first interval darker, head and pronotum black). ..... **erraticus** (Linnaeus)
Various sorts of dung, most often in sheep, pig or horse. Prefers open, exposed habitats. Overwinters as an adult. Common in most of England and Wales, becoming less common northwards and towards south-east England. Not common in southern Scotland. v-viii.

— Pronotum with scattered coarse punctures. Elytral intervals impunctate. 4

4 Broad, maximum width 4–6mm. Elytral striae narrow, about one-tenth as wide as intervals. Elytral intervals broad and flattened. (Uniformly shining black, elytra rarely dark red. Length 6–12mm, but not usually less than 9mm). ..... **fossor** (Linnaeus)
Usually in cow dung, often on damp soil. Prefers open pasture. Common in most of England and Wales, becoming less common northwards. Not common in southern Scotland. iv-x, also (in flood debris) xii-ii.

— Narrow, maximum width 2–3mm. Elytral striae wide, as wide as intervals. Elytral intervals narrow and strongly convex (fig. 23). (Head and pronotum black, elytra dark red to black. Length 6–7.5mm). ..... **subterraneus** (Linnaeus)
Many kinds of dung, also debris, compost and carrion. Once widely distributed but not common in most of England and Wales, becoming less common northwards. Everywhere much rarer now than formerly; not recorded for the past 30 years. v-ix.

5 Large, length 9–13 mm. Pronotum with few scattered coarse punctures as well as regularly distributed fine punctures. Head lacking transverse ridges and tubercles. (Colour dark red to pitchy black, head and pronotum slightly darker than elytra). **rufipes** (Linnaeus)
Dung of large herbivores. Often attracted to light in the evening. Reported to be a cuckoo

parasite in nests of Geotrupes spiniger *by Klemperer (1980). Common and widespread. iv-x.*

— Usually smaller, length 2.5–9.0 mm, but if as large as 9mm (some specimens of *luridus* and *depressus*), then pronotum evenly punctate, and colour either uniformly black or elytra brown with dark markings. 6

6 Head strongly convex, without tubercles, with long transverse ridge in the anterior third (fig. 28). Anterior three-quarters of head dull, impunctate, with posteriorly a shining, finely punctate band. (Length 3.5–4.5mm. Black, front of head often with a narrow red margin, antennae yellow). ..... **brevis** Erichson
Various sorts of dung, especially rabbit, usually partly dried out, on sand dunes. Excavates burrows about 4 cm deep. Found between Southport and Formby (Merseyside); previous records from other localities are misidentifications of Aegialia sabuleti.

— Head not strongly convex, not with the above combination of characters: often with three dorsal tubercles. 7

7 Ninth elytral interval carinate, posteriorly joining with seventh interval. (Length 2.5–3.5mm. Head and pronotum black, elytra dark red to black). .. **putridus** (Fourcroy)
Under vegetable debris and in dung of sheep, horse and cow, in dry, sandy and chalky areas, in open habitats. Local (formerly often abundant) in Kent, Surrey, Sussex and Suffolk. Also recorded from Swansea (West Glamorgan).

— If ninth and seventh elytral intervals join, then they are not carinate. 8

8 Colour black with two sharply defined red spots on each elytron, a large one near the apex and a much smaller one near the shoulder. (Length 3–3.5 mm).
..... **quadrimaculatus** (Linnaeus)
Sheep droppings on dry pastures. Very local and rarely found, in England (mainly in east Kent); there are old records from Wales and southern Scotland. iv-v.

— Elytra not each with two red spots. 9

9 First tarsomere of hind legs expanded apically (fig. 79). Hind tibiae in males expanded, blade-like in posterior half and fringed on lower edge with long hairs. Fourth elytral interval sometimes with a faint dark yellow or red patch in the posterior third. (Head and pronotum black, elytra black to dark red. Length 3.5–4.5mm). . **coenosus** (Panzer)
Various sorts of dung, mainly that of sheep, cow and rabbit, on sandy soil. Prefers dry, exposed and sunny areas. Very local in south and central England, and Wales. iii-iv.

— First tarsomere of hind legs not expanded apically. Hind tibiae not blade-like in males. Fourth elytral interval lacking dark yellow patch in posterior third. 10

10 Surface of pronotum and elytra covered with short, backwardly directed pale hairs. (Black. Length 4mm). ..... **scrofa** (Fabricius)
Very rare in Britain, recorded in the 19th century from Pentire Point (Cornwall), Southport (Merseyside) and Paisley (Strathclyde). Should be looked for in dry exposed areas on sandy ground, especially in dung of sheep, horse and cow.

— Surface of pronotum lacking hairs (but pronotum may have fringe of hairs laterally). Surface of elytra may have short, pale hairs 11

11 Posterolateral angles of pronotum sinuous (fig. 92). (Head and pronotum black, lateral edges of pronotum broadly yellow in anterior half. Elytra orange to brownish red without dark markings). 12

— Posterolateral angles of pronotum not (fig. 89) or only slightly sinuous (if so, then colour not as above). 13

12 Abdominal sternites black or dark brown. Lateral raised border of pronotum not continuing on to anterior margin. Pronotum with median indentation in anterior half in males. (Fig 30. Length 5–8mm). ..... **fimetarius** (Linnaeus)
Dung of various sorts and decomposing vegetable material. Has been known to be a pest on potatoes and cultivated mushrooms in Europe. Common and widespread. ii-x (also in flood debris, xii), common iii-iv.

— Abdominal sternites reddish yellow to light brown. Lateral raised border of pronotum continuing on to anterior margin. Pronotum lacking median indentation in males. (Length 6–9mm). ..... **foetens** (Fabricius)
Various sorts of dung, especially cow. Local but widespread in England, Wales and Scotland. vi, viii-ix.

13 Elytra yellow or light red, much lighter than head and pronotum, often with dark spots or with sutural interval darker than rest of elytra (this character best seen with the naked eye). 14

— Elytra dark red or black, not or only slightly lighter than head and pronotum (if elytra black with a red streak see couplet 37). 31

(Some species are keyed out on both sides of this couplet).

14 Pronotum unicolorous, not at all lighter laterally. 15

— Pronotum lighter laterally. 17

15 Sides of head sinuous, and scarcely angled in front of eye (fig. 81). Punctures on pronotum scattered irregularly. (Elytra lacking discrete markings, colour light yellow-brown, often with a dark cloud or band at sides, but varying to (rarely) all black. (Length 5–8mm). ..... **foetidus** (Herbst)
Dung and decomposing vegetable material on light soils; more often near the coast than inland. Common in England and Wales, becoming less common northwards, and rarely found in Scotland; rarer now than formerly. vi, viii-ix.

— Sides of head evenly rounded, strongly angled in front of eye (fig. 84). Punctures on pronotum evenly distributed. 16

16 Disc of pronotum finely and evenly punctured. Elytra without dark spots, colour dark brown, rarely bright red. (Length 6–9mm). ..... **depressus** (Kugelann)
Dung of various sorts. Widespread in England, Wales and Scotland, becoming more common northwards. One of the commonest Aphodius *species in Scotland. v-ix.*

— Disc of pronotum with both coarse and fine punctures. Elytra usually with discrete dark markings (fig. 91). (Length 6–9mm). ..... **luridus** (Fabricius)
Dung of sheep and cows in exposed habitats. Locally common in England, Wales and Scotland. v-vi, x.

17 Elytra with large patches of darker colour or with first interval darker than remaining intervals (fig. 26). 18

— Elytra with dark colour present as discrete dashes on elytral intervals (figs 24,25). First interval not darker than remaining intervals. 25

18 Elytra pilose, at least in posterior half. (Elytral pattern as in fig. 26). 19

— Elytra not pilose. 20

19 Frontoclypeal suture visible as an impressed line. Elytra with the 8th stria continuing almost to the base, where it nearly joins the 7th, or joins it by a few punctures. Pronotum bordered posteriorly with yellow, except (often) medially. Spur at apex of anterior tibiae tapered to a point in males. (Length 4–6mm). . **sphacelatus** (Panzer)
Dung of various kinds, and vegetable material. Often found together with A. prodromus. *Common in England, Wales and Scotland. iv-vii. Mostly found in spring, sometimes in great profusion; also in autumn, but less commonly so; also (in food debris) xi-i.*

— Frontoclypeal suture not visible. Elytra with the 8th stria ending abruptly about two scutellum lengths from the base. Pronotum continuing dark to base. Spur at apex of anterior tibiae truncate in males. (Length 4–7mm). ..... **prodromus** (Brahm)
Dung of various kinds, but rarely found in cow dung. Also found in decomposing vegetable material. Common in England, Wales and Scotland. Mostly found in spring. iv-vii, also (in flood debris) xi-i and iii.

20 Elytra yellow, with first interval dark, and a dark band (often faint), leaving the apical area, sides, and whole of second interval clear yellow; pronotum dark with base and sides broadly yellow. 21

— Elytra lacking a dark band; second interval, apical area and sides not lighter than remainder of elytra. 22

21 Dark area on head and pronotum red. Pronotum with fine, evenly distributed punctures and very irregularly scattered coarse punctures. Scutellum constricted in basal half. Maxillary palps light brown. (Length 3–6mm). ..... **lividus** (Olivier)
Various sorts of dung, including that of horse and sheep and also in manure heaps. Formerly local in Kent, south-east London, Herts, Lincs and Northumberland, but apparently has not occurred in the last half-century.

— Dark area on head and pronotum black. Pronotum with evenly distributed fine punctures, becoming coarser laterally, lacking irregularly scattered coarse punctures. Scutellum triangular, not constricted basally. Maxillary palps usually dark brown, but light brown in some specimens. (Length 3.5–5.5mm). ..... **consputus** Creutzer
In dung. Very local but frequently abundant in some east Kent localities. Restricted to south-east England. Early spring.

22 Maxillary palps, antennae and legs black or dark brown, tip of second and third palpal segments may be lighter. Head black. (Elytra ochreous-yellow, suture abruptly black. Sides of pronotum yellow, at least in front. Length 3.5–5.5mm). **merdarius** (Fabricius)
Various sorts of dung, often found in fresh dung together with Cercyon *species. Prefers exposed conditions. England, Wales and Scotland, apparently less common than formerly. iv-v, viii, x, also (in flood debris) xii.*

— Maxillary palps, antennae and legs light brown. Head red, at least in anterior half. 23

23 Smaller, length 3.5–5.5mm. Aedeagus of males with parameres short (fig. 88). ..... **ictericus** (Laicharting)
Various sorts of dung, often in horse dung that is a little dry; mostly on paths and other open areas, not in dung that is lying on grass. Local in England and Wales, becoming less frequent northwards. Also recorded from Scotland. Most common on and near the coast. Mostly vii-ix.

— Larger, length 5–8mm. Aedeagus of males with parameres long (figs 86,87). 24

24 Apex of elytra dull, duller than rest of elytra, and also impunctate. Aedeagus with parameres hooked at the tip (fig. 87). (Length 5.5–8mm). ..... **sordidus** (Fabricius)
Various sorts of dung in dry, sandy or chalky areas, often near the coast. Prefers exposed habitats. Formerly very local in England and Wales and rarely found in southern Scotland. Much rarer now than formerly. vi, viii-ix.

— Apex of elytra shining, and with fine punctures. Aedeagus with parameres not hooked at tip (fig. 86). (Colour of elytra varying from brownish-yellow to black. Length 5–7mm). ..... **rufus** (Moll)
Various sorts of dung. Locally common in England, Wales and Scotland. vii-x.

25 Elytra with pale pilosity, at least in apical half. Front angles of clypeus with long hairs. 26

— Elytra lacking pilosity. Front angles of clypeus lacking long hairs. 27

26 Pronotum fringed with long hairs. Elytra pubescent to base. Dark spots on elytra well defined, clearly demarcated from ground colour of elytra. (Length 5–7mm). ..... **contaminatus** (Herbst)
Various sorts of dung, especially horse. Common and widespread in England, Wales and Scotland, often very abundant. An autumn species. viii-xi.

— Pronotum not fringed with long hairs. Elytra not pubescent basally. Dark spots on elytra not well defined, poorly demarcated from ground colour of elytra. (Length 4.5–7mm). ..... **obliteratus** Panzer
Prefers horse dung, but can abound in deer, sheep or cow dung, especially in wooded areas. Very local (sometimes abundant) in England and southern Scotland. An autumn species. ix-x.

27 Sides of head not projecting laterally in front of eyes. Puncturation of clypeus fine, the surface smooth. (Length 4–5.5mm. Clypeus black with yellow patch in front of eye on each side. Pattern on elytra as in fig. 24). ..... **equestris** (Panzer)
Various types of dung, in shaded places. Locally common in southern England becoming less frequent northwards to as far north as Yorkshire. iv-v, vii-x, also (in flood debris) xii.

— Sides of head projecting laterally in front of eyes. Clypeus coarsely punctured, the surface rough. 28

28 Colour pattern of elytra comprising few poorly defined dark marks, none in anterior third. Elytral striae each with a row of punctures on each side. Pronotum densely covered with coarse punctures. (Length 4.5–5.5mm). ..... **zenkeri** Germar
Deer dung (also other dung, but mostly where there are deer present) in wooded areas and deer parks. Very local in south and central England, north to Yorks and Cheshire, and Wales. vii-x.

— Colour pattern of elytra including dark marking in anterior third. Elytral striae not with a row of punctures on each side. Pronotum less densely covered with punctures. . 29

29 Clypeus with red patch in front of eye on each side. Yellow pronotal side margins complete (fig. 25). (Elytra with a characteristic pattern of small, isolated rectangular marks. Length 4–5mm). ..... **conspurcatus** (Linnaeus)
In dung, especially horse, mainly in woodland, rarely in exposed habitats. Very local in England and Wales, rarer in Scotland and southern England. ii, iv-v, viii-x, xii.

— Clypeus black, lacking red patch in front of eye. Yellow colour on pronotum restricted to anterolateral margin. 30

30 Dark pattern on elytra extends to base of intervals four and five. Basal tarsomere of middle legs short, as long as next two segments together. (Length 3–4.5mm). ..... **paykulli** Bedel
Various sorts of dung. Very local in England, Wales and Scotland. ii-iii.

— Dark pattern on elytra includes base of interval five only, and pattern generally less extensive. Basal tarsomere of middle legs longer, as long as next three segments together. (Length 3.5–5.5mm). ..... **distinctus** (Müller)
Dung of various sorts, and decomposing vegetable material. Local in England, rare in southern Scotland. Seems to have periods of local abundance and scarcity, and to have been rare in the last few decades. iv-vi, ix-x.

31 Large size, length 6–9mm. Sides of head with an angle in front of eyes, then broadly rounded, not sinuous (fig. 84). 32

— Smaller, if as long as 6mm then either sides of heads not produced laterally in front of eyes, or sides sinuous with obtuse anterior angles (fig. 85). 33

32 Apical third of elytra with sparse pubescence, intervals matt. ..... **luridus** (Fabricius)

— Apical third of elytra lacking pubescence, intervals shining. ..... **depressus** (Kugelann)
(see also couplet 16).

33 Clypeus with obtuse anterior angles (fig. 85). (Pronotum black, lighter anteriorly and laterally, elytra dark red. Length 4.5–5.5mm). ..... **zenkeri** Germar
(see also couplet 28).

— Clypeus with anterior angles not obtuse. 34

34 Elytral striae broad, often as broad as intervals. Intervals concave, bounded laterally on each side by a carina. (Length 4–6mm. Head and pronotum black, elytra dark red, and because of their microsculpture appearing very dull to the naked eye). ..... **porcus** (Fabricius)
This species has been shown to be a cuckoo parasite in burrows of Geotrupes stercorarius *(Chapman, 1869), but is also quite often found above ground in dung. Very local and scarce in England, Wales and Scotland. Autumn.*

— Elytral striae narrow, one-tenth to one-fifth as broad as intervals. Intervals not concave or bounded laterally by carinae. 35

35 Raised margin of apex of elytra about twice as wide as second elytral stria (*not* interval) near its apex (fig. 29). (Head and pronotum black, elytra dark red or black, becoming gradually lighter apicaly. Pronotum very finely and sparsely punctate. Head of male as in fig. 27. Length 3–5mm). ..... **granarius** (Linnaeus)
Various sorts of dung (most often in cow dung) and decomposing vegetable material. Often in dung that is not lying on grass but on paths etc. Sometimes in muddy places under stones. Common in southern England, becoming less common in central and northern England, absent from Scotland. i, iii-v, also (in flood debris) xii-i.

— Raised margin of apex of elytra narrow, narrower than the second elytral stria near its apex. 36

36 Scutellum incurved basally (fig. 43). (Colour uniformly black, no contrast in colour between pronotum and elytra). 37

— Scutellum triangular in shape, regularly narrowed from base to apex (fig. 42). 38

37 First tarsomere on hind legs long, as long as next three segments together (fig. 83). Elytral striae strongly punctate. (Length 4–5mm). ..... **niger** (Panzer)
Feeds on decaying matter in damp soil at the side of ditches and ponds rich with decomposing leaves or frequented by cattle or horses. Local in the New Forest (Hants), mostly about one pond at Brockenhurst.

— First tarsomere on hind legs shorter, as long as next two segments together (fig. 82). Elytral striae less strongly punctate. (Exists in two colour varieties, one all-black, the other with a long red streak centrally on each elytron (fig. 90). (Length 4–5mm). ..... **plagiatus** (Linnaeus)
Not associated with dung, but with small fungi growing in damp hollows in sandhills, also found in flood debris and burrowing under stones in damp areas near the coast. Very local in southern and central England, and Wales.

38 Apical angle of elytra with surface matt. Elytral striae strongly shining (more so than intervals, at least in apical third). 39

— Apical angle of elytra with surface shining. Elytral striae not more strongly shining than intervals. 40

39 Mesosternum with a fine, sharp median carina between middle coxae. Broader, width 2–2.5mm. Elytra usually black, concolorous with head and pronotum, rarely dark red. Elytra duller than pronotum (cf. *constans*). Anterolateral angles of pronotum not red. (Length 4–6mm). ..... **ater** (Degeer)
Various sorts of dung, and decaying vegetable material. Prefers exposed habitats. Common and widespread in England, Wales and Scotland. iii-x, also (in flood debris) xii-i.

— Mesosternum lacking median carina between middle coxae. Narrower, width 1.5–1.7 mm. Elytra dark red with obscure red marks near apex and basally. Pronotum black with anterolateral angles red. (Length 3.5–5mm). ..... **borealis** Gyllenhal
Various sorts of dung, including deer and sheep. Prefers wooded areas, but also found in exposed habitats, including sand dunes. Locally common in England and Scotland. vi-vii, ix.

40 Clypeus with a transverse ridge (fig. 41). Anterior margin of head with distinct angles. (Head, pronotum and elytra shining black, pronotum with faint red marking anterolaterally. Length 4–5.5mm). ..... **nemoralis** Erichson
Dung, especially of deer and sometimes sheep, in shaded localities in woodland. Very local: Lakeside (Cumbria), Cors y Gedol (Gwynedd), Braemar (Grampian), Aviemore (Highland), 'Perthshire' and 'Morayshire'. Spring and autumn.

— Clypeus usually lacking a transverse ridge. Anterior margin of head broadly rounded, lacking distinct angles. 41

41 Antennae light brown. Maxillary palps light brown. (Head and pronotum dark brown, elytra lighter brown. Length 5–7mm).
(see also couplet 24) ..... **rufus** (Moll)

— Antennae with club dark brown to black, remaining antennomeres dark brown. Maxillary palps dark brown. 42

42 First segment of hind tarsi as long as segments two and three together, and about 0.7 times length of segments two to four together (fig. 77). 43

— First segment of hind tarsi longer, about 1.3 times length of segments two and three together, and about 0.9 times length of segments two to four together (fig. 78). . 44

43 Smaller, length 3–4.5mm. (Pronotum black with faint red marking anterolaterally. Elytral colour variable, black to dark red, usually paler apically). ..... **pusillus** (Herbst)
Various sorts of dung, and vegetable refuse. Somewhat local in England, Wales and Scotland. iv-vii, ix, x, also (in flood debris) xii-i.

— Larger, length 5–6mm. (Pronotum black, with faint red marking anterolaterally in some specimens. Elytra black to dark red, sometimes paler apically. Can be distinguished from *ater* by its uniformly shining surface). ..... **constans** Duftschmidt
In dung. Somewhat local in England, Wales and Scotland. iii-v, also (in flood debris) xii-i.

44 Head with three dorsal tubercles (fig. 40). Generally larger, length 4-6mm. Head and pronotum black, pronotum sometimes with yellow marking anterolaterally. Elytra dark red to entirely black. ..... **lapponum** Gyllenhal
In dung, especially that of sheep. A boreo-montane species. Common in Scotland, less common in Wales and northern England, absent from central and southern England. Occurs as far south as the Brecon Beacons (probably the southernmost record of this species in Europe). v-ix.

— Head lacking dorsal tubercles. Generally smaller, length 3.5–4.5mm. Head and pronotum black, pronotum with anterolateral angles red. Elytra dark red, each elytron with a cloudy dark patch behind middle. ..... **fasciatus** (Olivier)
Various sorts of dung, in shaded habitats and on moorland. Very local, from Hereford & Worcs to northern Scotland; probably in north Wales, but absent from southern England except Gloucs. iv-x, also (in flood debris) xi; most common in autumn.

Aphodius species omitted from this key, because they are doubtfully British (See Allen, 1967): *obscurus* (Fabricius), *satellitius* (Herbst), *sturmi* Harold, *varians* Duftschmidt.

Subfamily Scarabaeinae

The subfamily Scarabaeinae comprises about 4500 species, mostly distributed in the tropics. The subfamily is replaced at higher latitudes in the northern hemisphere by Aphodiinae and Geotrupidae; in Europe the number of species of Scarabaeinae declines sharply north of the mediterranean basin: there are 46 species found in France, in Britain only 9 species, most of which are either local, rare or probably extinct. The British species are typical of northern Europe in favouring open, insolated habitats.

Included in this subfamily are the well-known 'scarab' beetles, which fashion balls of dung and roll them using their long hind legs. The sacred scarab of the ancient Egyptians (*Scarabaeus sacer* among other species) belongs to this group. The British members of this subfamily do not roll dung, but dig burrows directly beneath the dung source, and these are provisioned with dung. Each burrow usually consists of a vertical shaft which ramifies at the base into a series of blind-ending sacs, each of which receives a ball of dung and an egg. There are differences in the shape of the burrow constructed by different species. *Onthophagus coenobita* differs from other British species in that the burrow is vertical with no diverticula, and the brood balls are put in one above the other.

The nest-building behaviour of Scarabaeinae was reviewed by Halffter & Edmonds (1982).

Key to species

1 Head broad, transverse (fig. 14). Large size, length 16–21mm. Hind tibiae with one large lateral tooth. Entirely shining black. ..... **Copris lunaris** (Linnaeus)
In dung, in sandy or chalky soil. Makes voluminous casts at the sides of cow pats (unlike Geotrupes*). Now rarely found in Britain, there are old records from Kent, Surrey, Hants, Sussex, Somerset, Suffolk and Staffs, and relatively recent ones from Box Hill (Surrey) in 1948 and 1955, and Frilford Heath (Oxon) in 1942 (see Allen, 1956). The behaviour of this species was described in detail by Klemperer (1982; 1982a).*

— Head narrow (fig. 10). Smaller, length not exceeding 11mm. Hind tibiae either lacking lateral teeth or with several small teeth. Upperside, if black, never shining. ..... 2 **(Onthophagus)**

2 Colour uniformly dull black. 3

— Elytra brownish ochreous, with or without black markings. Pronotum and underside black, copper coloured or metallic green. 5

3 Lateral margins of pronotum sinuous behind anterior angles (fig. 53). (Males with posterior margin of the head produced backwards as a horn and lacking transverse ridges, head of females with two transverse ridges. Length 6–11mm).
O. nutans (Fabricius)
Probably extinct in Britain, the last record being in 1926 (in Dorset). Older records are from the south of England and south Wales.

— Lateral margins of pronotum not sinuous behind anterior angles (fig. 51). 4

4 Pronotum and elytra uniformly covered with erect pale hairs. Smaller, length 4–6mm. Head either with one transverse ridge (males) or with two transverse ridges (females). ..... **O. joannae** Goljan
(O. ovatus *of previous British authors, see Goljan, 1953). Found especially on chalky and sandy soils, in horse or sheep dung, often with* O. similis. *Distinctly local in southern England, becoming less common in central England, Wales and southern Scotland.*

— Pronotum and elytra lacking erect pale hairs. Larger, length 8–10mm. Head either with two backwardly-directed horns (males) or with two transverse ridges (females). ..... **O. taurus** (Schreber)
Known only from old records, from Brockenhurst and Lyndhurst in the New Forest (pre-1839), Exmouth (pre-1867), and Oxford (pre-1841). Not uncommon in the Channel Islands.

5 Lateral margin of pronotum sinuous behind anterior angles. 6
— Lateral margin of pronotum not sinuous behind anterior angles. 8
6 Elytral epipleura ochreous (viewed from the side to eliminate shadow that would otherwise cause the carina to appear black). Pronotum metallic, colour varying from green to red. (Pattern on elytra inconspicuous, often almost absent. Length 6–9mm). ..... **O. coenobita** (Herbst)
Feeds on corpses and mushrooms in addition to dung. Local but fairly common in southern England, becoming less common in central England and Wales, and absent from northern England and Scotland. v-vi.
— Elytral epipleura black, or at least with the epipleural carina black. Pronotum less strongly metallic, colour varying from green to black. 7
7 Base of cephalic horn in males broad and with a definite angle (fig. 74). Posterior transverse ridge on head of females long, so lines connecting ends of this ridge to ends of anterior ridge are parallel. Third segment of maxillary palps as long as second segment. Larger, length 7–9.5mm. ..... **O. fracticornis** (Preyssler)
Known only from a few British specimens, the only known locality being Matley Bog, New Forest (Hants). All remaining specimens previously known as fracticornis, *except for a few old ones without data, are misidentifications of* similis *(see Johnson, 1967).*
— Base of cephalic horn in males narrow and without a distinct angle (fig. 76). Posterior transverse ridge on head of females shorter, so lines connecting this ridge to the anterior one converge posteriorly. Third segment of maxillary palps two thirds length of second segment. Smaller, length 4.5–7.0mm. ..... **O. similis** (Scriba)
Favours horse or sheep dung on chalky and sandy soils. Widespread but local in southern and central England and Wales, becoming scarce further north. Often occurs together with O. joannae *in southern England. Found especially near the coast rather than inland.*
8 Pronotum black. Elytra with dark markings extending to base of fifth interval. Smaller, length 6–9mm. ..... **O. nuchicornis** (Linnaeus)
In the past much confused with O. similis, *to which many older records apply. Now chiefly found about the Deal (Kent) and Camber (Sussex) sandhills under dog (? and other) dung. Also found in the Suffolk Breck.*
— Pronotum metallic green, seldom blackish. Elytra with dark markings not extending to base (fig. 10). Larger, length 7–11mm. ..... **O. vacca** (Linnaeus)
Found usually on green pastures, associated with cow dung, horse dung and sheep droppings. South-west and south-east England (south of a line from about London to Bristol). Seems to favour low-lying areas on alluvial soils, such as the Thames Estuary. v-vi.

Subfamily Melolonthinae

There are over 10,000 species of this subfamily worldwide, and many of the species resemble one another sufficiently to make identification of many tropical forms difficult even to the level of genus. The British fauna is very poor, but difficulties may still be encountered in identifying *Melolontha* or *Amphimallon* to species.

Melolonthine larvae are root feeders, and in some species the larvae occur locally in large numbers; the subfamily contains several important pests of cultivated plants.

Key to species

1 The two apical spurs of hind tibiae widely separated (fig. 66). Small, length not exceeding 10mm (Length 6–10mm). 2
— The two apical spurs of hind tibiae close together (fig. 69). Large, length not less than 14mm (Length 14–30mm). 3

2 Colour uniformly light brown. Length 8–10mm (Antennal club very long in males, small in females). ..... **Serica brunnea** (Linnaeus)
In sandy and chalky areas, sometimes under moss on downs, or sheltering in rotten stumps. Locally common in England, Wales and up to the Scottish highlands. Flies at dusk, and is often attracted to light. Also found at exuding sap. vii-viii.

— Head, pronotum and scutellum black, elytra reddish-brown with black borders (rarely elytra completely black). Length 6–7mm (Antennal club small in both sexes).
..... **Omaloplia ruricola** (Fabricius)
In dry and calcareous areas. Adults fly in the morning between 11.00–12.00 hrs, and also in the evening. Possibly myrmecophilous. Rare and local. Kent, Surrey, Hants, Gloucs, Cambs, Sussex and Norfolk, perhaps most frequent on the South Downs in Sussex. vi-vii.

3 Antennal club with three segments. Generally smaller, length 14–20mm. (Abdominal sternites pilose, but not with well defined patches of white hairs laterally).
..... 4 **(Amphimallon)**

— Antennal club with more than three (4–7) segments. Generally larger, length 20–35 mm.
..... 5

4 Elytra sparsely covered with long hairs (as long as hairs on pronotum). Antennal club 2–3mm long in males, about 1mm long in females. Aedeagus as in figs 55 & 57. When alive colour greenish-brown. (Length 15–20mm). ..... **A. solstitialis** (Linnaeus)
"The Summer Chafer". The behaviour of this species (and of the following one) was described in detail by Lamb (1917). Adults fly in the evening, circling in large numbers around the branches of high trees, also around the tops of buildings. There may also be a lesser flight activity before sunrise. Adults rest on low bushes during the day. Comes to light. Locally abundant, mainly in coastal areas. Southern England and Wales. vi-viii.

— Elytra very sparsely covered with short hairs (about half as long as hairs on pronotum). Antennal club about 1.5mm long in males, about 1.2mm long in females. Aedeagus as in figs 56 & 58. When alive colour light brown. (Length 14–17mm).
..... **A. ochraceus** (Knoch)
Described by Lamb (1917) as living in colonies on cliff borders where the turf has been undisturbed for many years. Flies for about two hours at mid-day with a rapid, mazing flight above and among herbage. Joy (1905) gave an account of an inland colony. Mainly coastal; north Cornwall, Wales (Tenby and Holyhead), but also Aldworth and Streatley (Berks.), Ditchling Downs (Sussex) and Coleford (Gloucs). July to early August (see Allen, 1978).

5 Abdominal sternites with a uniform covering of white scales. Elytra dark brown with patches of white scales, giving a mottled appearance. (Length 30–35mm).
..... **Polyphylla fullo** (Linnaeus)
A number of specimens were collected on the Kent coast before about 1850, mostly on the dunes around Deal and Sandwich, and one was reported as being caught at St Leonard's (Sussex) in 1902.

— Abdominal sternites with well defined patches of white scales laterally. Elytra light brown with an even covering of scales, except for four raised lines, which are glabrous (fig. 9). ..... 6 **(Melolontha)**

6 Pygidium elongate (figs. 47, 48). Third segment of antennae in males lacking an anteriorly directed spur. Antennal club lamellae about 3.5mm long in males, about 1.5mm long in females. Aedeagus as in fig. 63. (Length 20–30mm). See also fig. 9.
..... **M. melolontha** (Linnaeus)
"The May Bug or The Cockchafer". After adults emerge from the pupa they fly towards trees. After 2–3 days of feeding on leaves, and copulation, the females fly to the treeless areas where they emerged, and lay eggs. About 25–40 eggs are laid at a depth of between 15–25cm. After 3–4 days the females return to the trees for a second period of feeding and copulation lasting 2–3 weeks. Then there is a second period of egg-laying, followed by a third feeding period and a third egg-laying period. Development, from egg to adult, lasts 3 to 4 years. Adults are very common in some years because of the relatively fixed duration of larval development. Common in southern England and Wales, less common from central England northwards to southern Scotland. Markedly less abundant than formerly in many districts. v-vi.

— Pygidium short (figs. 49, 50). Third segment of antennae in males with an anteriorly

directed spur. Antennal club lamellae about 4 mm long in males, about 1.5mm long in females. Aedeagus as in fig. 61 (Length 22–27mm). ... **M. hippocastani** Fabricius
A woodland species. Flies at sunset in spring. Very local in Scotland and northern England, not found south of the Lake District, although there are old records from Malvern (Hereford & Worcs) and Harlech (Gwynedd).

Subfamily Hopliinae

One species in Britain. *Hoplia philanthus* (Fuessly).
Males fly actively in search of females. Adults found on flowering shrubs and plants. Locally common in England and Wales, becoming less common northwards, and rarely reported from Scotland. v-vii.

Subfamily Rutelinae

The subfamily Rutelinae is predominantly distributed in the tropics, and poorly represented in the temperate zone. There are 16 species in Europe, of which only two are found in Britain.

Key to species

1 Sides of pronotum straight or slightly concave in posterior half (fig. 54). Pronotum with sparse long hairs. Smaller, length 7–12mm. (Colour of head and pronotum black or metallic green, elytra light- to dark brown). ..... **Phyllopertha horticola** (Linnaeus)
"The Fernshaw Beetle, Chovey, June Bug, Field Chafer, Garden Chafer, Bracken Clock or Fernweb". A detailed account of the biology of this species in Britain, including pest control aspects, was given by Raw (1951). Larvae feed on the roots of turf, and there may be up to 1,000,000 larvae per acre. The species usually infests poor quality pasture on light soil, often on slopes of hilly areas where there is relatively high rainfall. Adults often come out of the pupal stage in a mass emergence, beginning about 10.00hrs. Birds are the most important predators, and often tear up turf in search of larvae. Infested turf becomes soft and spongy. Seems to prefer chalky ground in south-east England. Less common than previously, now very local in many parts of Britain. Occasionally occurs in huge numbers in Cumbria. v-vi.

— Side of pronotum convex in posterior half (figs 11, 52). Pronotum lacking long hairs. Larger, length 11–15mm. (Colour of head and pronotum metallic green, red or blue, sides of pronotum brown in some specimens, elytra brown, red, green or purple).
..... **Anomala dubia** (Scopoli)
In sandy areas at the foot of plants and on leaves, or buried in sand. Flies in the afternoon. Very local, found mainly on the coast in England and Wales, becoming less common northwards and rare in Scotland, occasionally found inland in southern England. v-vii.

Subfamily Cetoniinae

The subfamily Cetoniinae comprises about 2,500 species, most of which are distributed in the tropics. There are about 20 species in Europe.

Many members of this subfamily possess bright and distinctive colour patterns, and it is often possible to identify specimens to species by colour alone. Unfortunately some taxonomists have felt it necessary to give names to colour morphs. The European fauna in particular has suffered from a proliferation of names: thus in France there are recognised 5 named morphs of *Trichius fasciatus*, 13 of *Trichius*

zonatus, 36 of *Cetonia aurata* and 4 of *Cetonia cuprea*. Collectors wishing to name their specimens to the level of morph should refer to Paulian & Baraud (1982).

Adult Cetoniinae are diurnal, and are usually seen flying in bright sunshine. The emargination of the elytra is to enable the hind wings to be rapidly extended for a quick take-off.

Key to species

1 Lateral margin of elytra notched in anterior third. Mesothoracic epimera visible from above, projecting between the anterolateral margin of elytra and the pronotum (fig. 8). 2

— Lateral margin of elytra not notched. Mesothoracic epimera not visible from above. . 4

2 Colour black with white spots, including white marking on pygidium. Smaller size, length 7–12mm. ..... **Oxythyrea funesta** (Poda)
Doubtfully British; there have been several records from Lancs (see Allen, 1967).

— Colour metallic green (very rarely black), if with transverse white markings in posterior half of elytra, then these not extending on to pygidium. Larger, length 14–22mm. ..... 3 **(Cetonia)**

3 Elytra with apical margin sinuate (fig. 37). Process projecting between middle coxae shaped as in fig. 35. See also fig. 8. (Length 14–21mm). ..... **C. aurata** (Linnaeus)
"The Rose Chafer". Adults are fully formed by August and overwinter in soil rich in decomposing vegetable matter, leaving the pupal cells when the temperature is above 15°C. They fly in the early afternoon, and are afterwards inactive on flowers. They feed on pollen, nectar and fruits. A southern species, becoming less common in central England and Wales, rare in northern England, very rare in southern Scotland. More local and rarer than formerly in many parts of the country. Like Melolontha, *numbers tend to fluctuate; often scarce for a series of years, then more plentiful for a season or two. Formerly often destructive to cultivated roses. A black form is confined in Britain to the Scilly Isles and West Cornwall. v-viii.*

— Elytra with apical margin not sinuate (fig. 36). Process projecting between middle coxae shaped as in fig. 34. (Length 16–22 mm) ..... **C. cuprea** Fabricius
*Early stages appear to be associated with the wood ant (*Formica *species). Adults feed on exuding sap, and fruit. Found in late spring and early summer. Local in Scotland, not found south of Northumberland and Cumbria except three records from the New Forest (Hants).*

4 Elytra orange or straw yellow with 2–3 black patches on each elytron. Head, pronotum and underside of body black with a dense covering of long pale hairs. .. 5 **(Trichius)**

— Head, pronotum and elytra either black or metallic green, with small scattered white spots. Body lacking a dense covering of long pale hairs. ..... 6 **(Gnorimus)**

5 Middle tibiae with lateral projection weak, not tooth-like (fig. 39). (Length 11–14mm). ..... **T. zonatus** Germar
Doubtfully British; known from old records, also one specimen caught in 1959 in Marlow (Bucks) and specimens from Sheppey (Kent) and Tilbury (Essex) caught in 1946.

— Middle tibiae with lateral projection strongly developed, tooth-like (fig. 38). (Length 12-26mm). ..... **T. fasciatus** (Linnaeus)
Develops in large birch stumps containing wood mould. In Wales prefers mixed, largely deciduous woodland in river valleys. Flies freely in warm sunshine and congregates on flowers particularly of Heracleum *and* Rubus *(Miles, 1982). Found locally in Scotland and Wales, also more recently found in England: Hereford & Worcs. (several records), Forest of Dean and Cotswolds (Gloucs), Holme Fen (Cambs). v-viii.*

6 Colour metallic green. (Length 15–20mm). ..... **G. nobilis** (Linnaeus)
Rare. Associated with fruit trees or willows in south-west and south-east England, also Wyre Forest and Pershore (Hereford & Worcs.). Adults active on flowers. vi-viii.

— Colour black. (Length 17–22mm). ..... **G. variabilis** (Linnaeus)
Very rare, recorded only from suburban Surrey and Kent (Purley, Tooting, Penge, Balham, Lee; last at Purley Oaks in the 1900s), and Windsor Forest (Berks.). Still occurs in the latter locality, where it is widely dispersed but not common (larvae are

occasionally numerous in a particular tree). In the damp wood mould of old oaks, seldom found resting on trunks or flying. vi-vii, rarely viii (see Allen, 1960).

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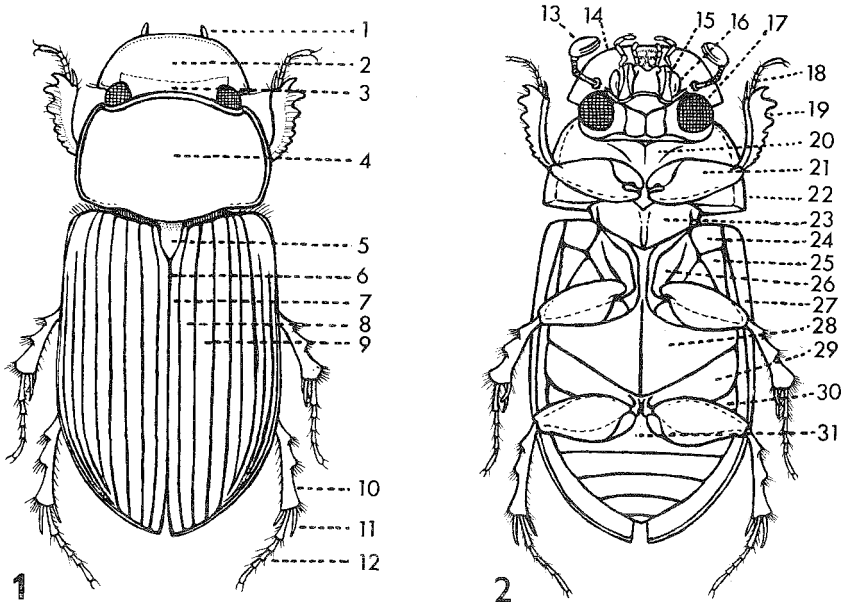

Figs 1–2. *Aphodius rufipes*. 1, Dorsal view. 2, Ventral view.

1 Maxillary palp
2 Clypeus
3 Frons
4 Pronotum
5 Scutellum
6 Elytral suture
7 Sutural, or first interval of elytron
8 Second interval
9 Third interval
10 Hind tibia
11 Tibial spur
12 Hind tarsus
13 Antenna
14 Clypeus
15 Maxilla
16 Mandible
17 Eye
18 Front tarsus
19 Front tibia
20 Prosternum
21 Front femur
22 Pronotum
23 Mesosternum
24 Mesepimeron
25 Metepisternum
26 Middle coxa
27 Elytral epipleuron
28 Metasternum
29 Hind coxa
30 First visible abdominal segment
31 Second visible abdominal segment

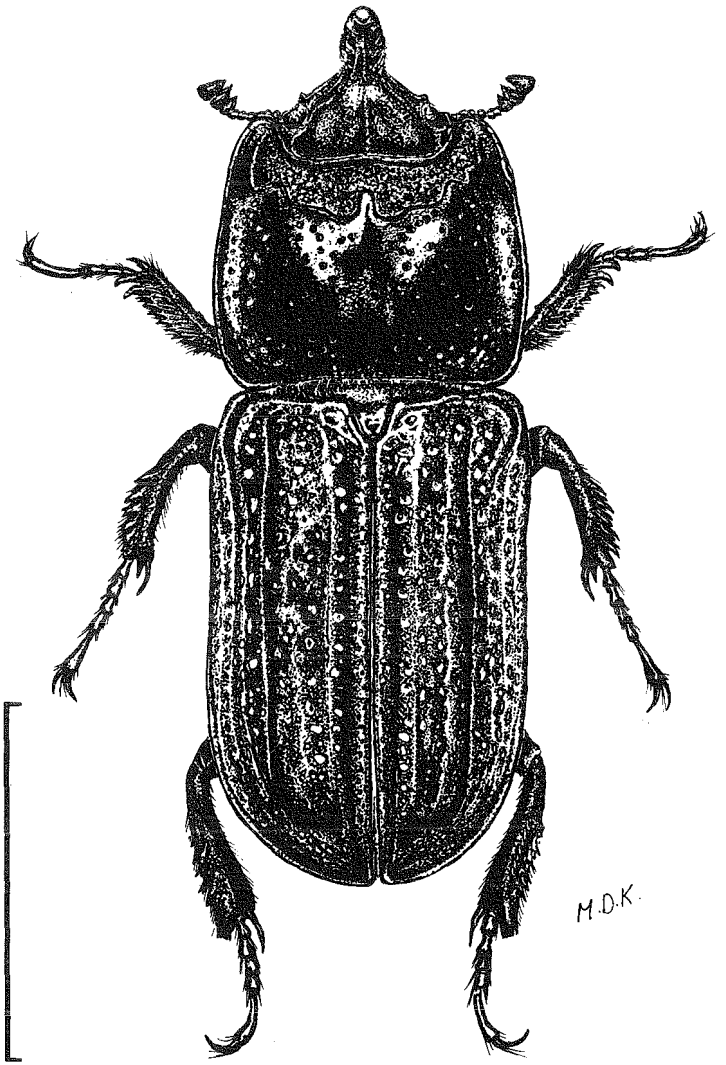

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Fig. 3. *Sinodendron cylindricum* male. Scale bar represents 5 mm.

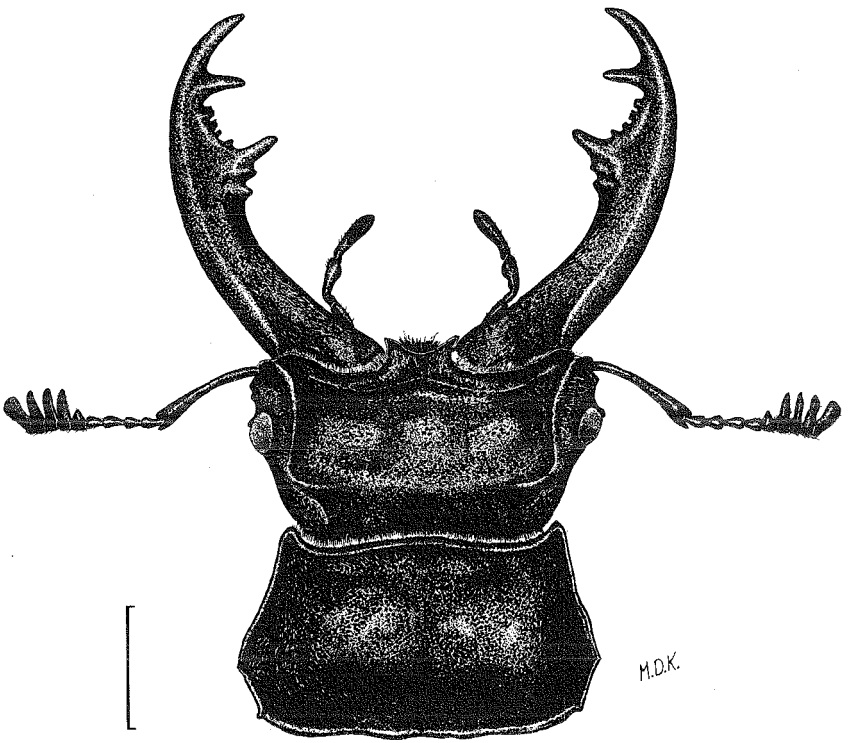

Fig. 4. *Lucanus cervus* head and thorax of male. Scale bar represents 5 mm.

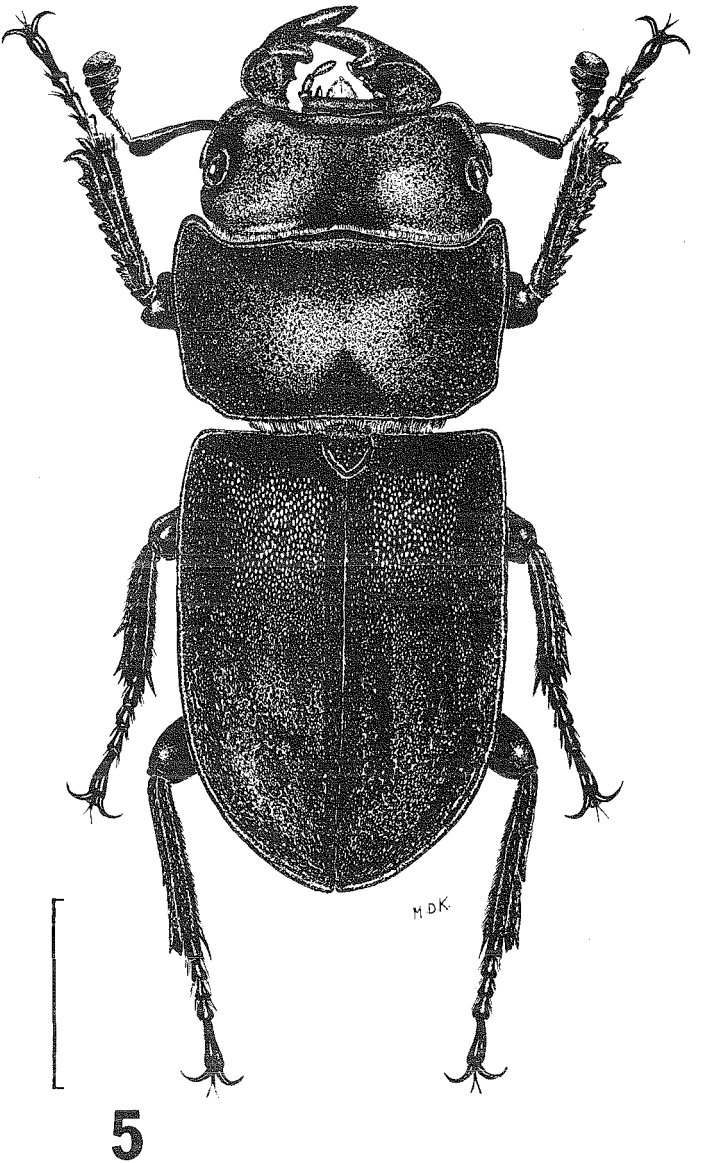

Fig. 5. *Dorcus parallelipipedus* male. Scale bar represents 5 mm.

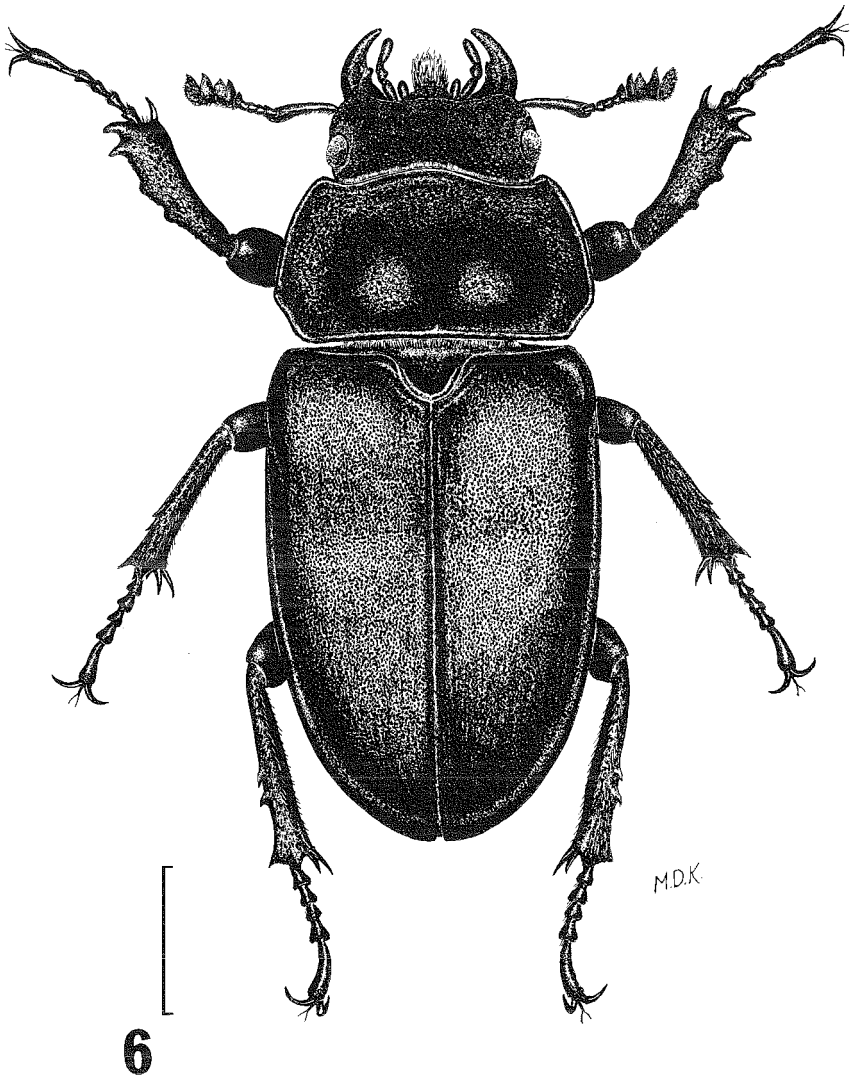

Fig. 6. *Lucanus cervus* female. Scale bar represents 5 mm.

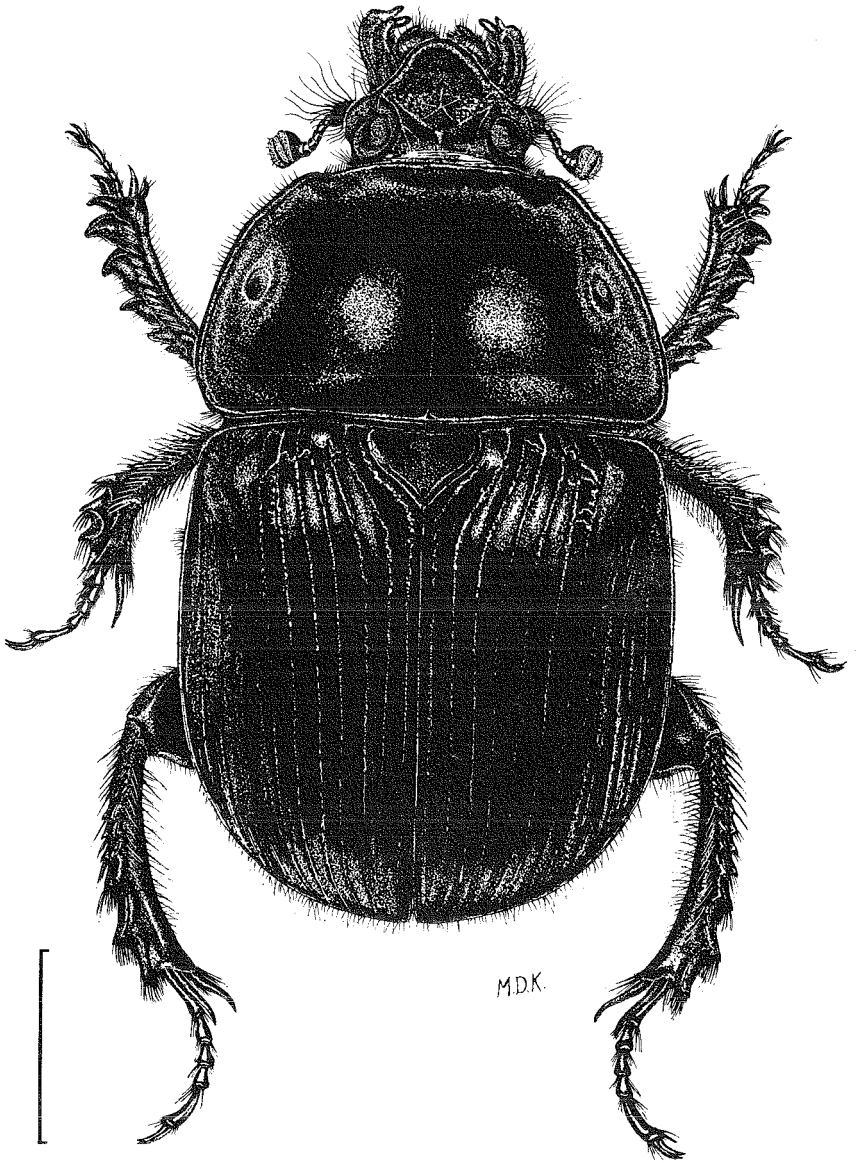

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Fig. 7. *Geotrupes stercorarius*. Scale bar represents 5 mm.

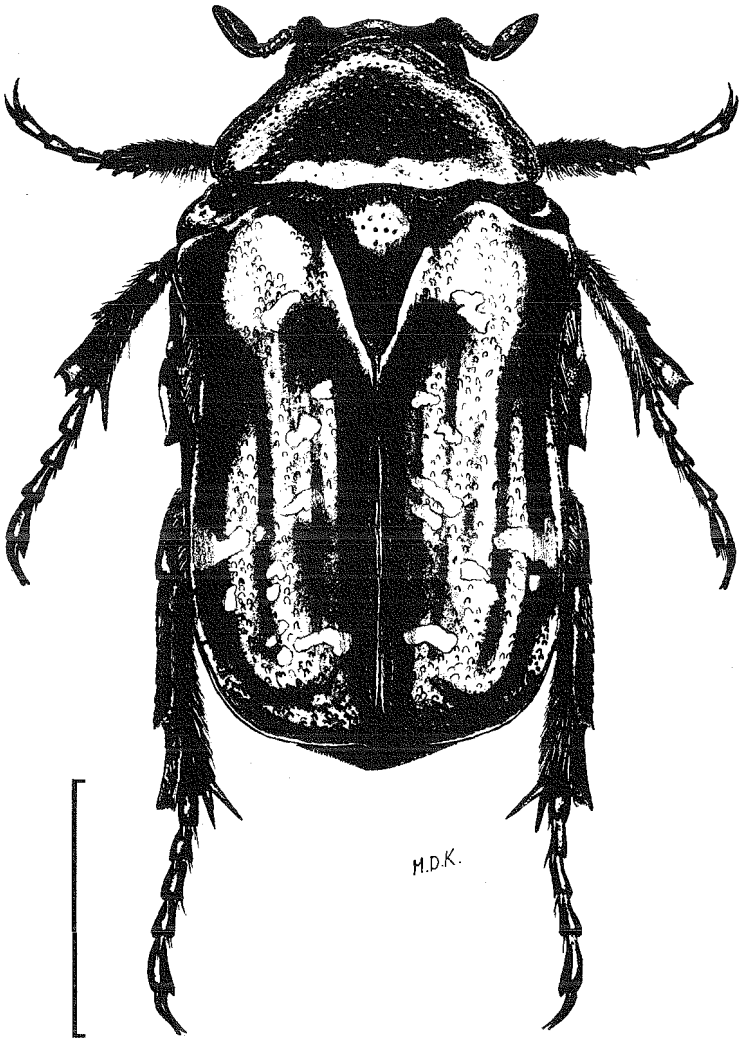

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Fig. 8. *Cetonia aurata.* Scale bar represents 5 mm.

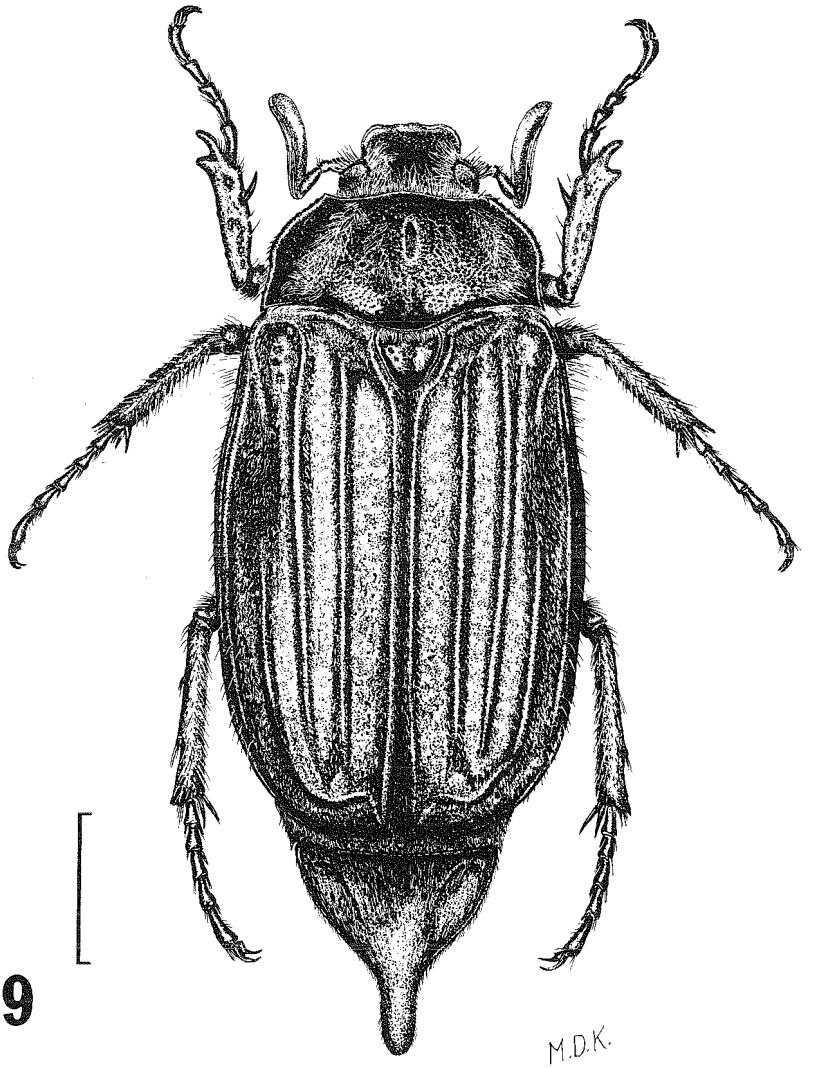
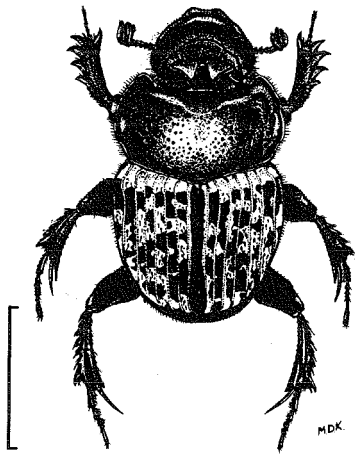


Fig. 9. *Melolontha melolontha.* Scale bar represents 5 mm.



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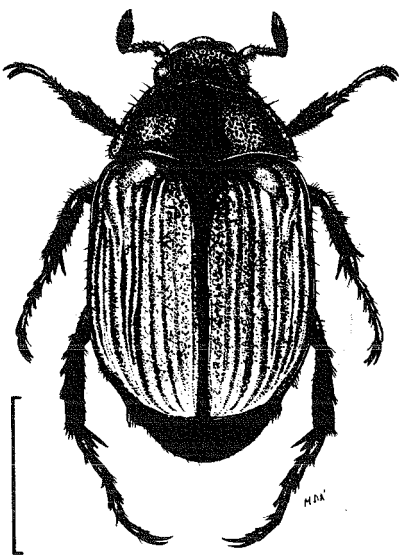

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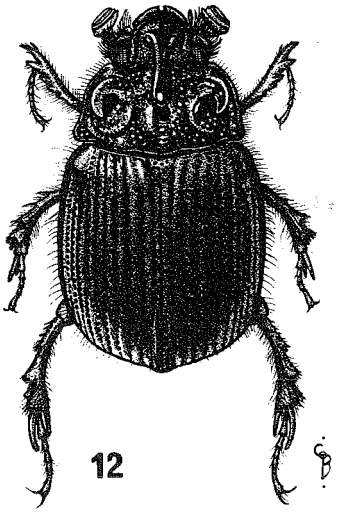
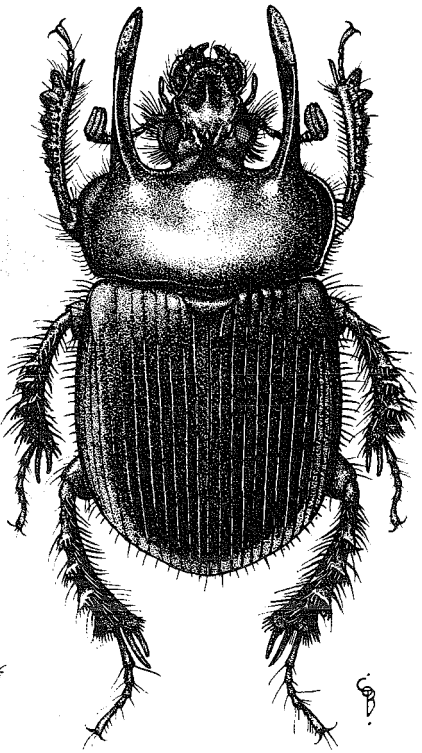
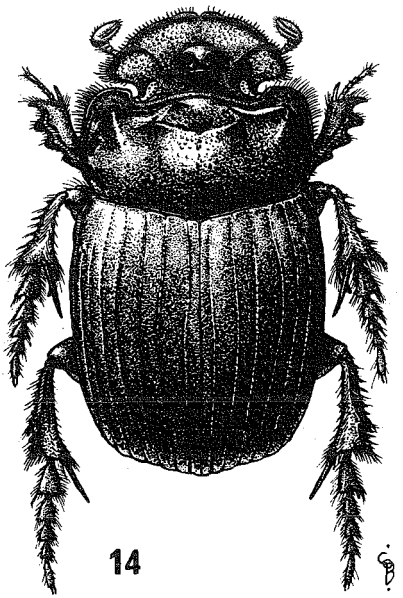
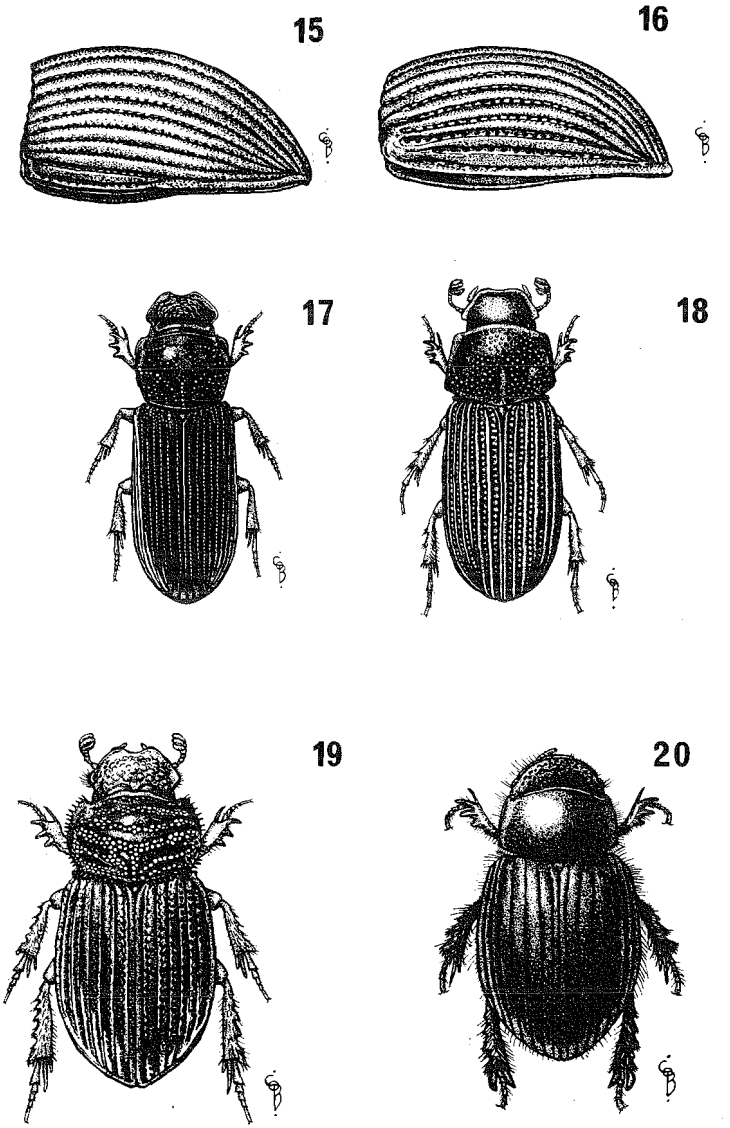
Figs 10–11. 10, *Onthophagus vacca.* 11, *Anomala dubia.* Scale bar represents 5 mm.



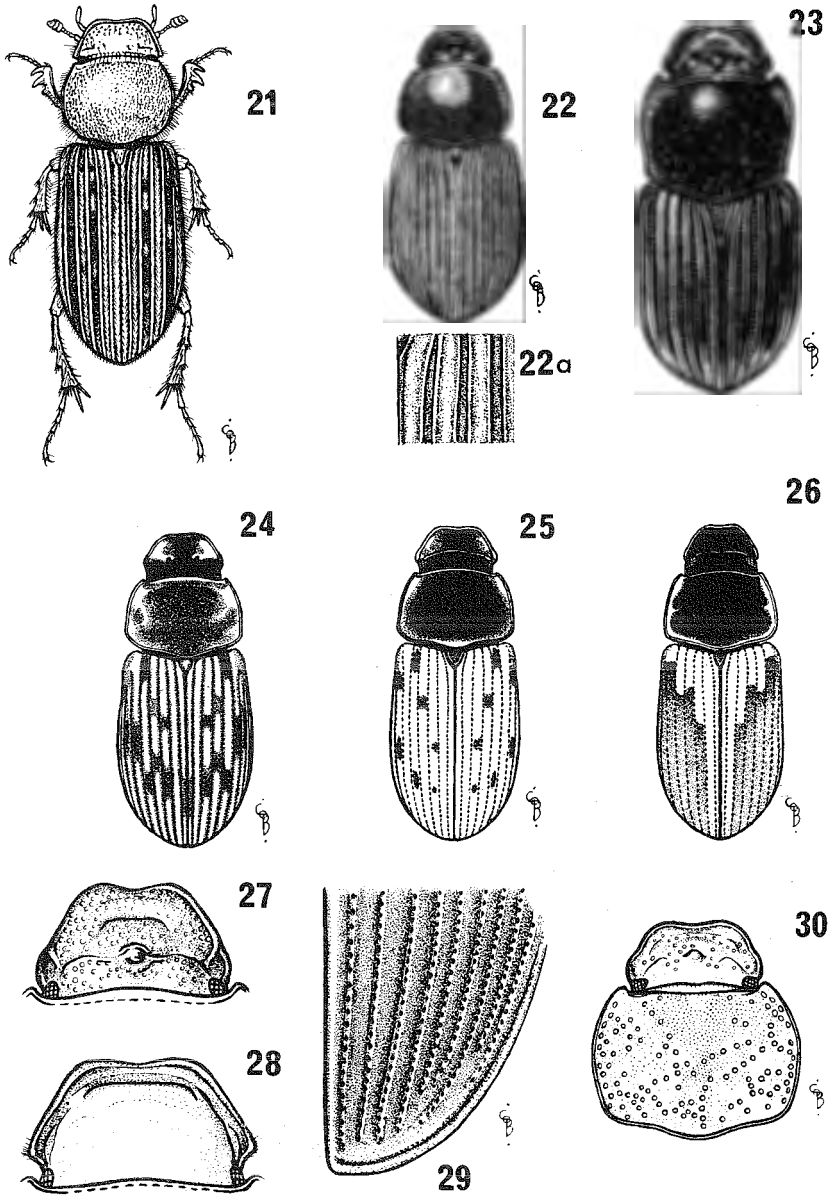




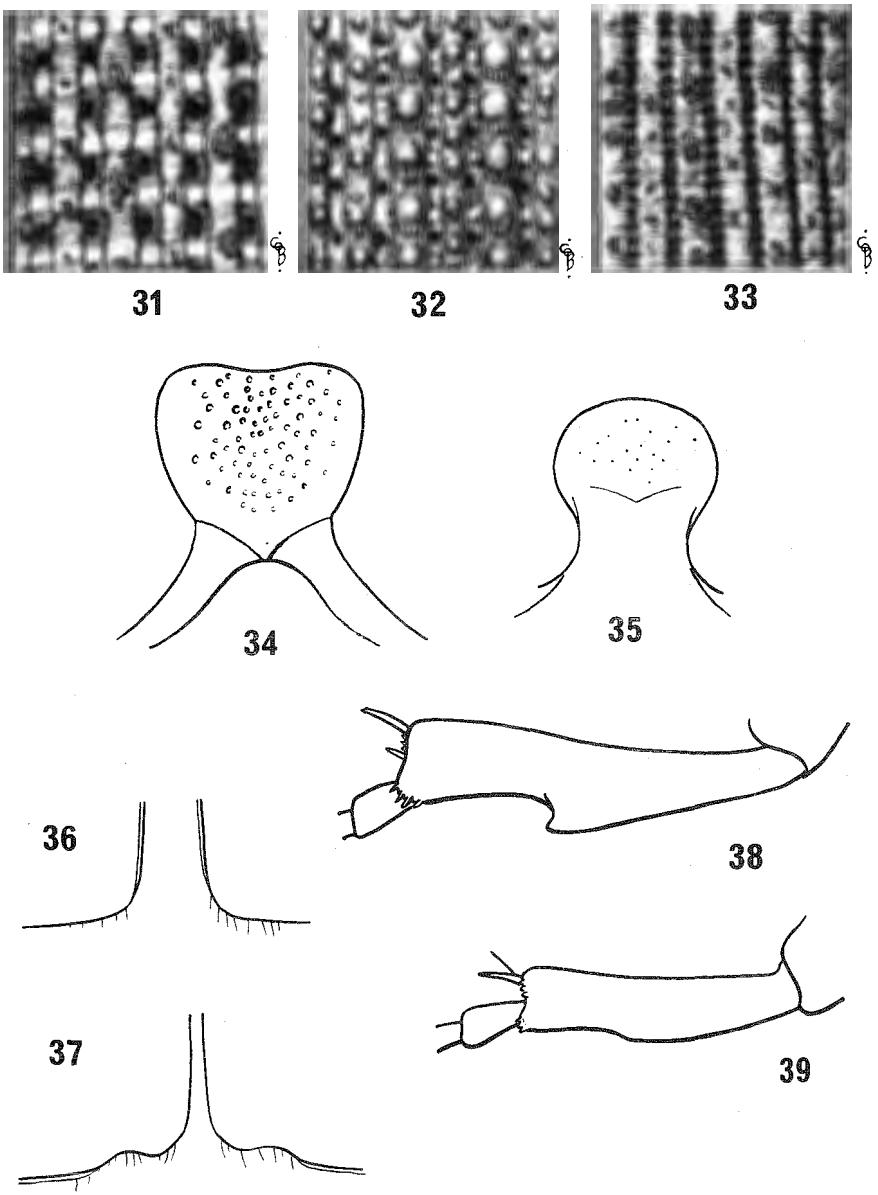
Figs 12–14. 12, *Odonteus armiger* male. 13, *Typhaeus typhoeus* male. 14, *Copris lunaris* male.



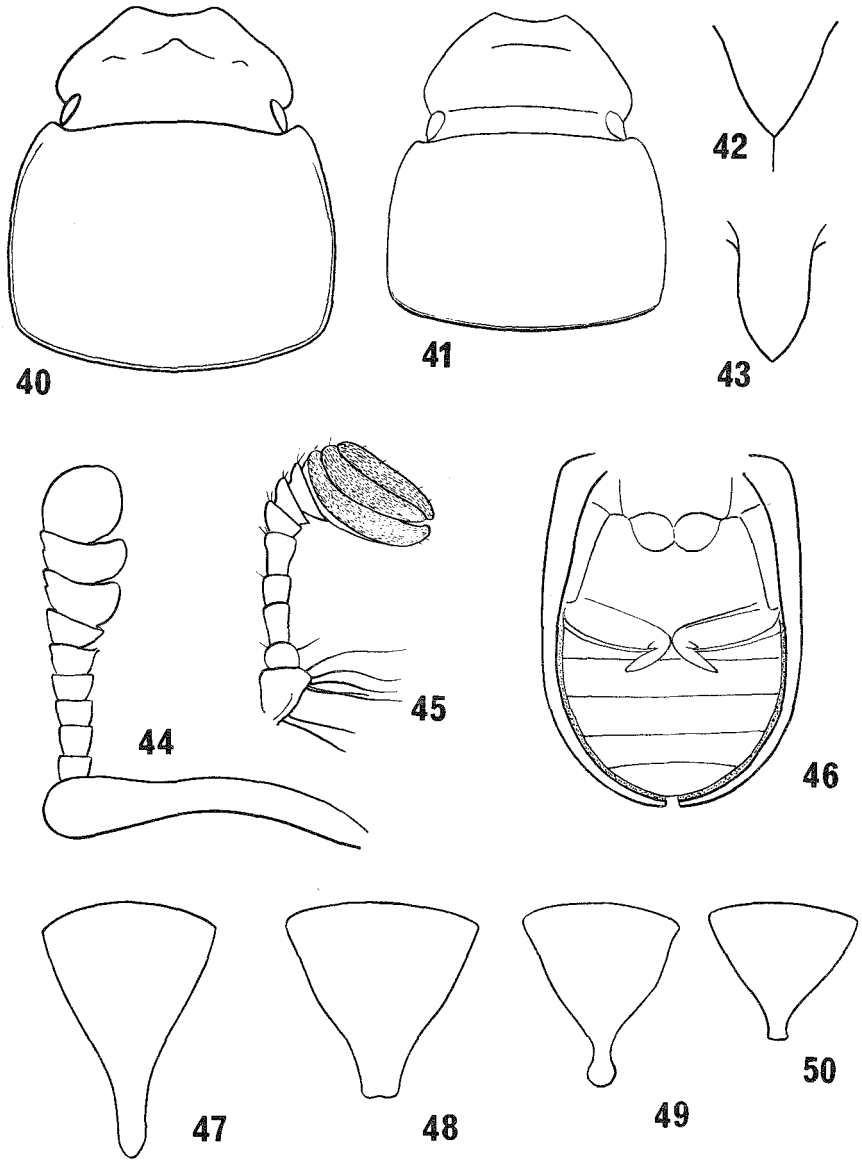
Figs 15–20. 15, *Brindalus porcicollis* lateral view of left elytron. 16, *Psammodius asper* lateral view of left elytron. 17, *Pleurophorus caesus*. 18, *Oxyomus sylvestris*. 19, *Brindalus porcicollis*. 20, *Aegialia arenaria*.



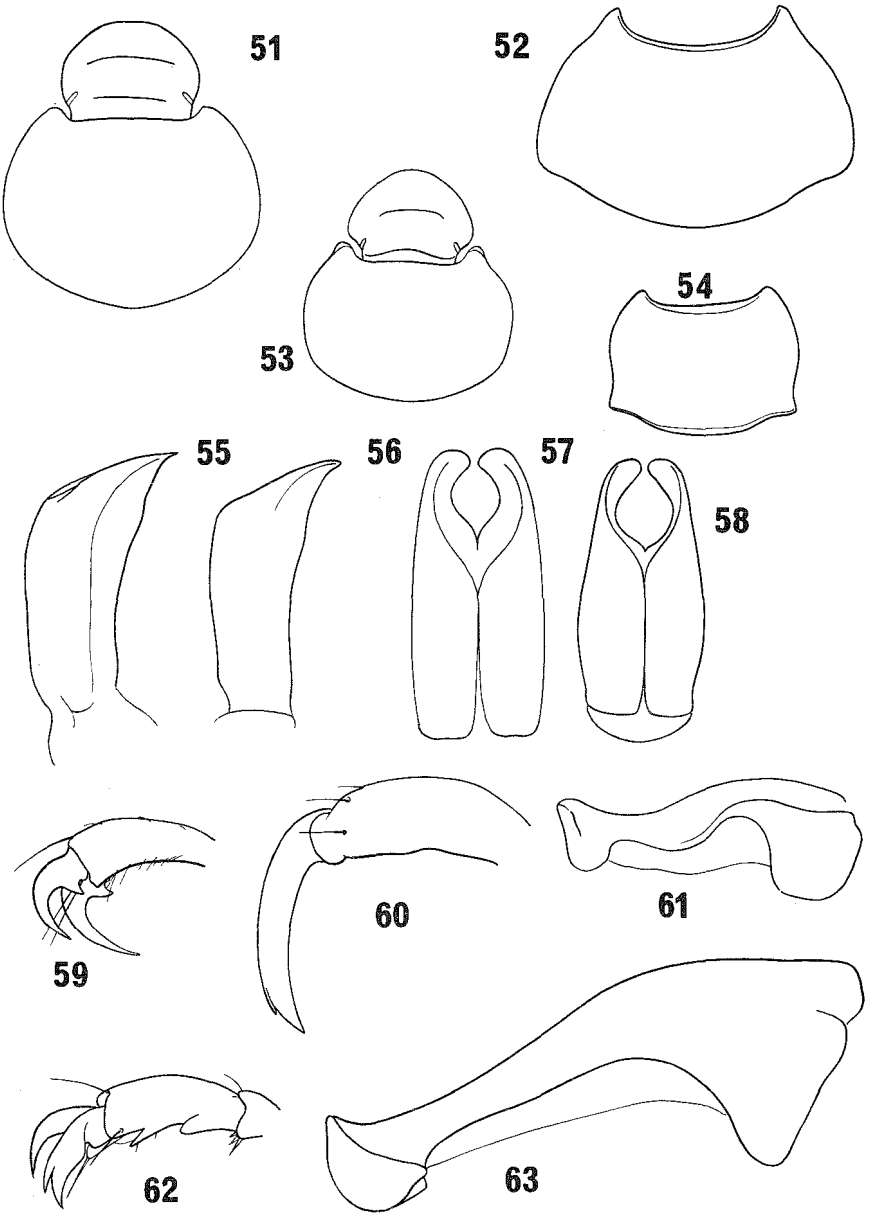
Figs 21–30. 21, *Euheptaulacus sus*. 22, *Aphodius porcus*. 22a, *Aphodius porcus* enlarged section of elytral intervals 1–4. 23, *Aphodius subterraneus*. 24, *Aphodius equestris*. 25, *Aphodius conspurcatus*. 26, *Aphodius sphacelatus*. 27, *Aphodius granarius* head of male. 28, *Aphodius brevis* head. 29, *Aphodius granarius* apex of right elytron. 30, *Aphodius fimetarius* head and pronotum.



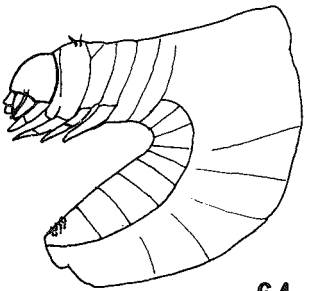
Figs 31–39. 31–33. Median portion of right elytron: 31, *Trox sabulosus,* 32, *Trox perlatus,* 33, *Trox scaber.* 34, *Cetonia cuprea* mesosternal process. 35, *Cetonia aurata* mesosternal process. 36, *Cetonia cuprea* apical angle of elytral. 37, *Cetonia aurata* apical angle of elytra. 38, *Trichius fasciatus* anterior face of middle tibia. 39, *Trichius zonatus* anterior face of middle tibia.



Figs 40–50. 40, *Aphodius lapponum* head. 41, *Aphodius nemoralis* head. 42, *Aphodius rufus* scutellum. 43, *Aphodius plagiatus* scutellum. 44, *Dorcus parallelipipedus* antenna. 45, *Geotrupes spiniger* antenna. 46, *Trox scaber* underside of mesothorax, metathorax and abdomen. 47, *Melolontha melolontha* pygidium of male. 48, *Melolontha melolontha* pygidium of female. 49, *Melolontha hippocastani* pygidium of male. 50, *Melolontha hippocastani* pygidium of female.



Figs 51–63. 51, *Onthophagus taurus* head and pronotum of female. 52, *Anomala dubia* pronotum. 53, *Onthophagus nutans* head and pronotum of female. 54, *Phyllopertha horticola* pronotum. 55, *Amphimallon solstitialis* aedeagus in lateral view. 56, *Amphimallon ochraceus* aedeagus in lateral view. 57, *Amphimallon solstitialis* aedeagus in dorsal view. 58, *Amphimallon ochraceus* aedeagus in dorsal view. 59, *Melolontha melolontha* posterior tarsal claws. 60, *Hoplia philanthus* posterior tarsal claw. 61, *Melolontha hippocastani* aedeagus in lateral view. 62, *Anomala dubia* hind tarsal claws. 63, *Melolontha melolontha* aedeagus in lateral view.



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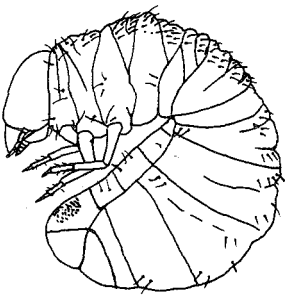

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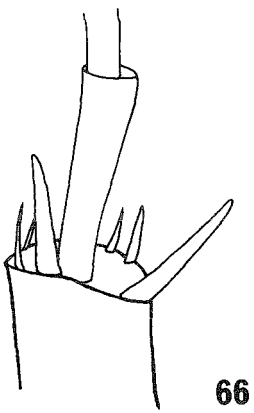

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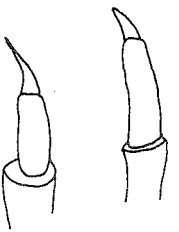

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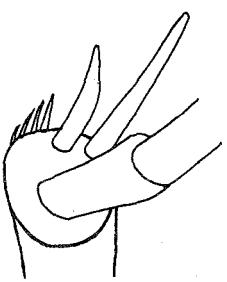

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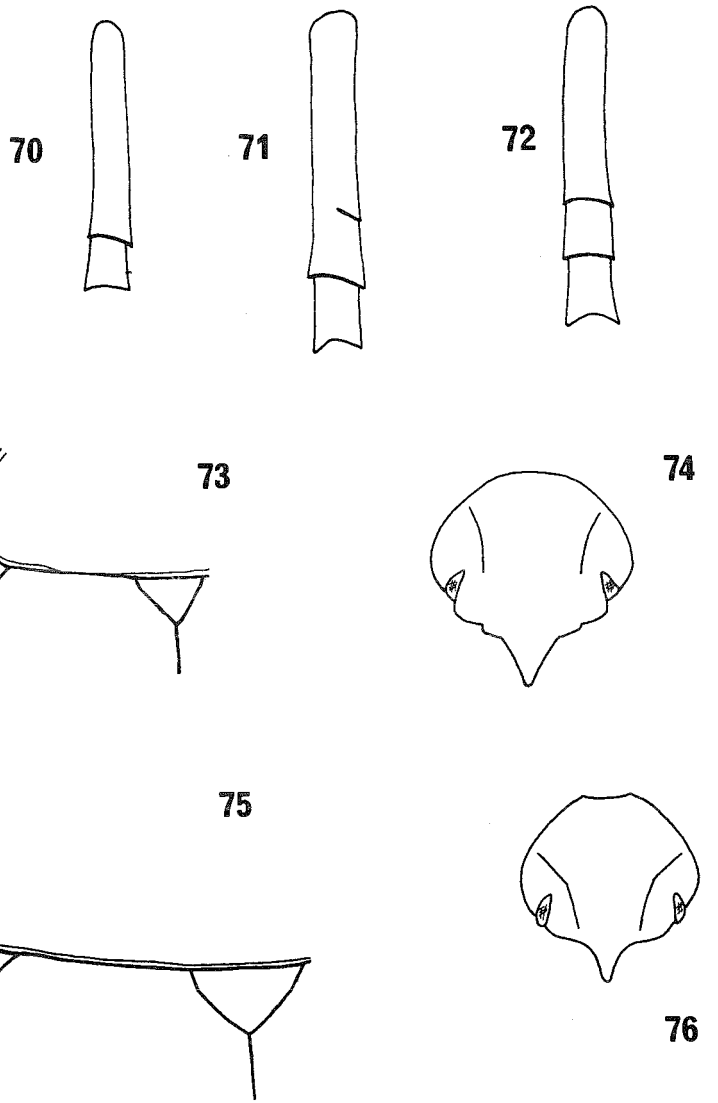
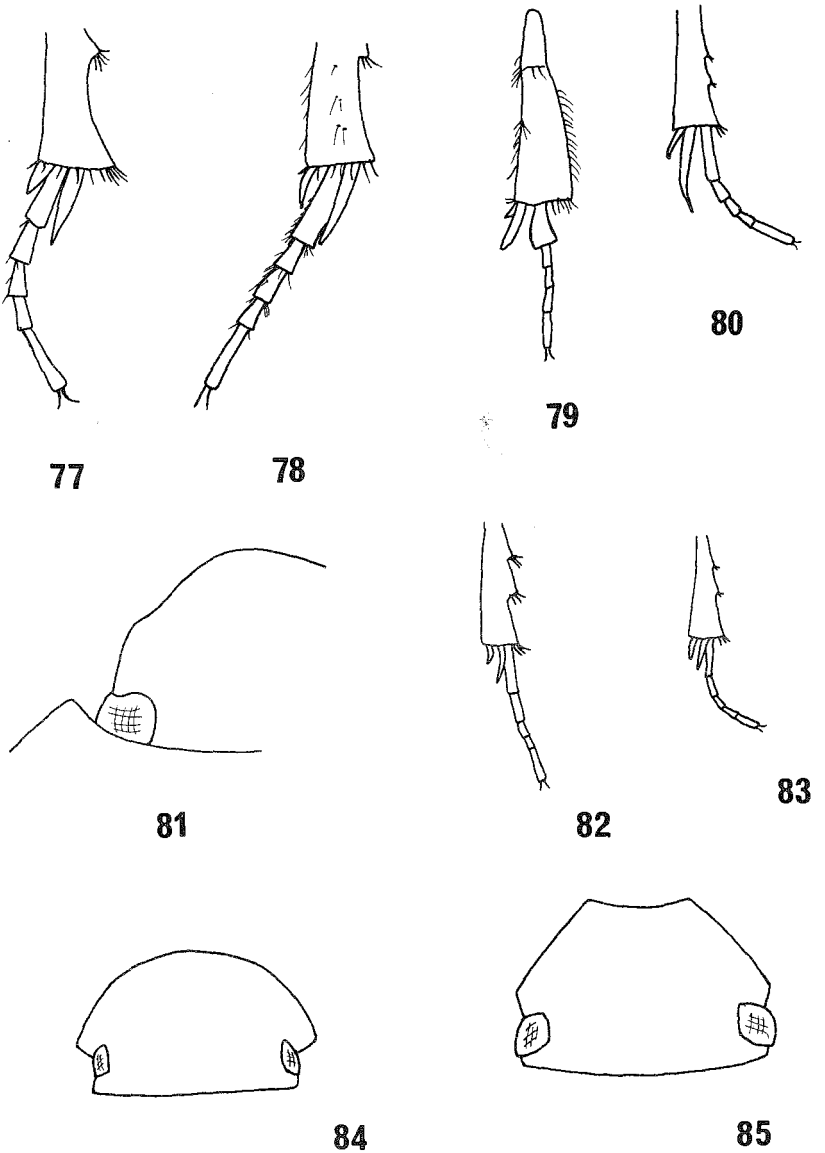
Figs 64–69. 64, *Onthophagus vacca* larva. 65, *Aphodius fossor* larva. 66, *Serica brunnea* tip of hind tibia. 67, *Trox scaber* tarsal claw of larva. 68, *Aphodius fossor* tarsal claw of larva. 69, *Amphimallon solstitialis* tip of hind tibia.



Figs 70–76. 70, *Geotrupes stercorosus* hind tibia. 71, *Geotrupes stercorarius* hind tibia. 72, *Geotrupes spiniger* hind tibia. 73, *Geotrupes vernalis* hind part of pronotum. 74, *Onthophagus fracticornis* head of male. 75, *Geotrupes stercorarius* hind part of pronotum. 76, *Onthophagus similis* head of male.



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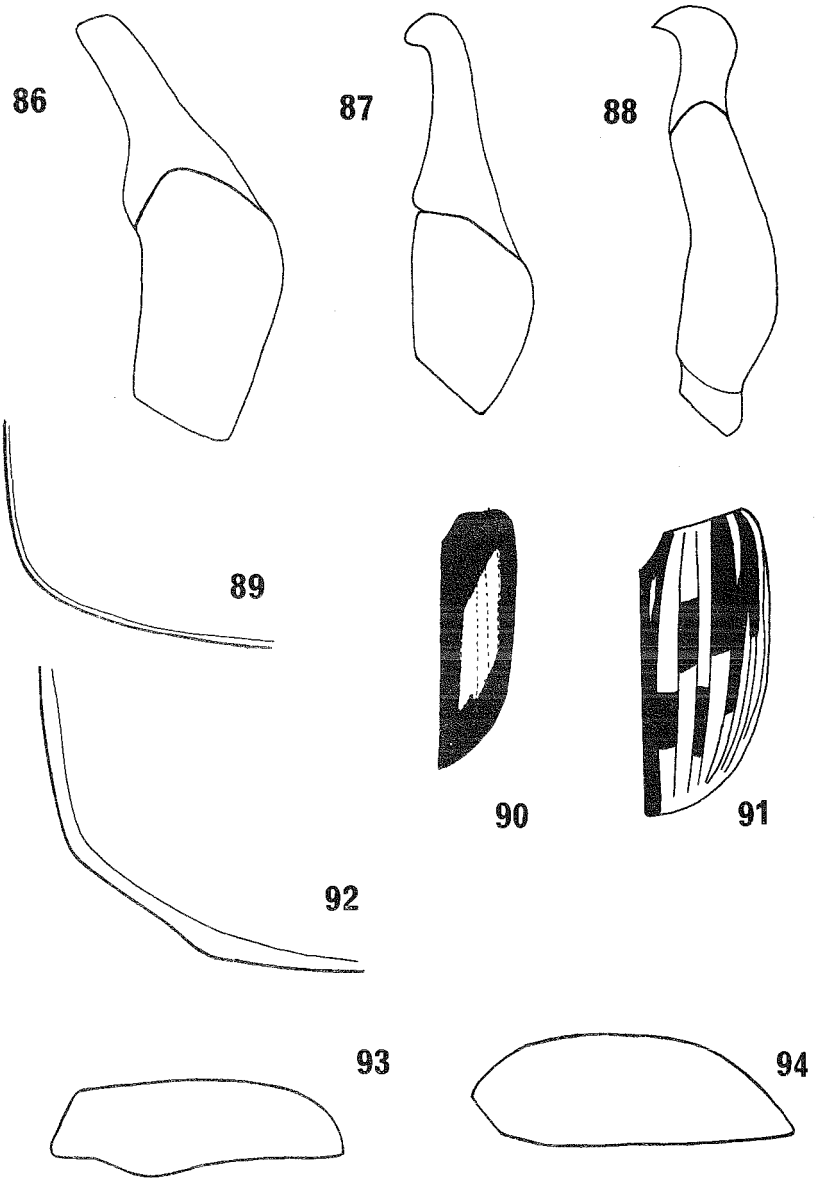

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