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# COLEOPTERA 

 RHIZOPHACIDAE

# COLEOPTERA RHIZOPHAGIDAE 

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## COLEOPTERA

Family RHIZOPHAGIDAE

Enid R. Peacock

## INTRODUCTION

The family Rhizophagidae (Superfamily Cucujoidea) comprises four subfamilies (Crowson, 1955), two of which are represented in Britain: the Rhizophaginae and the Monotominae. The subfamily Rhizophaginae is founded on the holarctic genus Rhizophagus Herbst which contains 45 species, 12 of which occur in Britain. (One of these, R. aeneus (Richter), is in the subgenus Cyanostolus Ganglbauer which will be raised to generic status-Peacock in prep.) The Monotominae are almost world-wide in range and include 15 genera comprising 157 species. Nine of these, all in the genus Monotoma Herbst, occur in Britain.

Of the two subfamilies which are not found in Britain, one (containing a single species) occurs in New Zealand and the other (containing two genera) is found in tropical America and the oriental region. At present the family contains 217 species.

The British Rhizophagidae are all more or less elongate and parallel-sided. The 10th and llth segments of the antennae are fused to form a onesegmented club, which is circular in cross-section. The elytra are truncate, leaving uncovered the last abdominal tergite in the $q$ (or the last two tergites in the ${ }^{\circ}$ ). The tarsal formula is 555 (sometimes apparently 444 or 33 3) in the $q$ and 554 in the ${ }^{6}$, the third segment very slightly lobed below in both sexes. The first visible abdominal sternite is at least as long as the next two together.

Because of nomenclatural changes (see Fowler, 1889) and frequent misidentifications, many old records of Monotoma species must be regarded as unreliable. Nomenclature in the present work conforms with that of Pope, 1977, in Kloet \& Hincks' Check list (2nd edition, revised).

## BIOLOGY

It has been commonly supposed that Rhizophagus species are fungus feeders or predators, the latter because of their association with other larval and adult beetles and the larvae of other insects.

According to some European authors several species of Rhizophagus are predators of small insects living beneath bark. All species except $\boldsymbol{R}$. parallelocollis Gyllenhal, R. oblongicollis Blatch \& Horner and R. dispar (Paykull) have sometimes, although not always, been found with scolytids but this may be partly due to the fact that they occupy the same habitats. Experiments have shown that R. bipustulatus (Fabricius) is a fungus feeder and carnivore rather than a predator (Beaver, 1966). This could be so for other species. R. bipustulatus was bred from egg to adult on fungal hyphae, with no animal food. The adults lived for at least two months without animal food, apparently feeding on fungal hyphae. They would eat dead scolytid larvae but did not attack live ones. Development from egg to pupa took five to seven weeks under bark in scolytid larval galleries and the pupal
cell was hollowed out in the scolytid larval frass. The pupal phase lasted about two weeks.

The British species of Rhizophagus are found in damp conditions where there is mould or sap, either under bark or in decaying vegetable or animal matter. Horion (1960) regards most species as sap and/or mould feeders. They are mainly found under bark, except for R. cribratus which is often found in rubbish heaps, and R. parallelocollis and R. perforatus which are usually subterranean species. $R$. parallelocollis is frequently found in coffins but it is not known whether it feeds on the corpse, mould or dipterous larvae. Recent research supports the latter (Buckland, in press) but some earlier authors believed that it was feeding on mould (Horion, 1960) or on putrescent adipose matter. There are various theories as to how the beetle enters the coffin: the eggs could be laid on the corpse before burial, on the surface of the soil in the graveyard, under ground on mouldy wood, or on the coffin after burial. Horion (1960) stated that, in spring the young beetles leave the coffins and make their way to the surface to swarm and mate, feeding on moulds in rubbish heaps, which explains their copious presence in graveyards. In other situations the species is often found with Atomaria larvae which could indicate either that it is feeding on them or sharing the mould they feed on.

Cyanostolus aeneus (Richter) is found under and in crevices in bark, sometimes in scolytid beetle burrows, usually on or near water. Nothing is known about its feeding habits.

Little is known about the feeding habits of the Monotoma species, which are very slow-moving beetles, but it is generally supposed that they are mould feeders. They are quite often found in man-made habitats such as compost heaps and haystacks.

## LARVAE

The larvae of Rhizophagidae are elongate, subparallel, slightly depressed and whitish in colour. The 9th abdominal segment possesses a pair of cerci or processes together with setiferous tubercles, the shape and arrangement of which differ diagnostically between and within genera.

Keys to the subfamilies of larval Rhizophagidae are given by Böving and Craighead (1931) and van Emden (1942). These will also serve to distinguish between the genera Rhizophagus and Monotoma.

Keys, figures and descriptions of certain species of Rhizophagus larvae are given by Perris (1853) (translation in Fowler, 1889) and Blair (1922).

No descriptions of Monotoma larvae have been traced but some larvae of M. brevicollis Aube and M. picipes Herbst in the British Museum (Natural History) collection have been examined. In these the tergal plates are armed with a series of roughly fan-shaped processes. These have lobed or crenulate apices and bear long setae, but do not bear fan-shaped hairs as stated by Böving and Craighead. The cerci terminate in three setiferous processes, two upper and one lower. The head is sharply constricted posteriorly into a narrow neck.

## NOTES ON THE KEYS

Two keys have been prepared to the Rhizophaginae: a detailed one, mentioning but not relying on colour or colour-pattern, and a short one
which, if the specimens are typical and mature, should enable them to be determined quickly at low magnification. Unfortunately, many individuals do not exhibit the typical colour-pattern of the species and it is mainly for these that the longer, more detailed key has been prepared.

Characters of the ventral surface have been mentioned, when unusual, but these need only be used as a check.

The mention of spines on the outer edges of the tibiae in the Rhizophaginae does not refer to the apical spines which are present on the tibiae of all species, but to the lateral spines which are placed some distance from the apex on the outer edge. Most species have one lateral spine on the front tibia and two or more on the middle.

The key to the Monotominae relies almost completely on head and pronotal characters but others have been added to help confirm identification. Square brackets have been used for additional characters which are not key characters and for localities when specimens have not been seen by the author.

The Watson-Praeger county and vice-county divisions have been used to denote distribution (see Balfour-Browne, 1940) and an interpretation of the numbers is given in the appendix.

Characteristics of the genitalia have not been described as there are reliable diagnostic external characters.

Monotoma quadrifoveolata Aube has been transferred from the subgenus Gyrocecis Thomson to the subgenus Monotoma (see Peacock, in prep.).

## SECONDARY SEXUAL CHARACTERS

Secondary sexual characteristics are of almost general occurrence in the Rhizophaginae. In the $\delta$ two abdominal tergites are visible beyond the apices of the elytra (fig. 1) but only one in the 9 (fig. 2). Less easily seen is the tarsal formula which is 555 in the 9 and 554 in the $\delta$. Other sexually dimorphic characters are present in most species but to a varying degree. In the ${ }_{0}{ }^{\text {on }}$ of many species the head is larger and broader, the pronotum either longer or broader and the body often larger in size than in the ㅇ. The legs also frequently exhibit some sexual dimorphism; for instance, the $\delta$ of $R$. oblongicollis, $R$. parallelocollis and $R$. bipustulatus has very slightly bowed hind tibiae and the $\delta$ of $R$. perforatus has a slight bend near the apex of the fore tibia. No other species has these leg characters. In all species, except $R$. dispar and $R$. perforatus, the 5 th visible abdominal sternite is broad and semicircular in the $\delta^{2}$, but is longer and less broad in the $q$. The pronotal shape differs slightly between individuals as well as between the sexes. In most species the of and $\circ$ pronota are sufficiently alike for both to be recognizable from the figures, but in some a greater degree of dimorphism exists: the pronotum of $C$. aeneus and $R$. parvulus (Paykull) is broadest in the anterior third in the $\delta$, but broadest at the middle in the $q$; in $R$. dispar the pronota of the two sexes differ as shown in figs 25 and 44 ; in $R$. nitidulus (Fabricius) the $\delta$ pronotum is much broader anteriorly than that of the 8 , and in $\boldsymbol{R}$. parallelocollis the sides of the ơ pronotum are straighter, not bulging as they are in the 9.

Some species exhibit secondary sexual characters of the underside of the metasternum or abdomen and these are referred to in the key. $R$. ferrugineus
(Paykull) does not have modified sternites, contrary to the statements of various authors.

In the Monotominae two apical abdominal tergites are visible in the ${ }^{\prime}$ and one in the 9 and there is variation in the form of the head and pronotum between the sexes. Some secondary sexual differences are indicated in the key couplets.

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## KEY TO SUBFAMILIES

The British subfamilies of Rhizophagidae may be separated as follows:
1 Body shiny, appearing glabrous except under high magnification ( $\times 100$ or more) when minute, hair-like setae are visible; pronotum without lateral teeth, prominent anterior angles or basal foveas (figs 15-26 \& 41-45); fore coxal cavities transverse, with exposed trochantins.

RHIZOPHAGINAE (pp. 4, 11)
(Rhizophagus Herbst \& Cyanostolus Ganglbauer)
Body often dull, setae always visible under low magnification ( $\times 15$ ), often scale-like; pronotum often with lateral teeth and prominent anterior angles, always with basal foveae (figs 46-54); fore coxal cavities rounded, trochantins hidden.

MONOTOMINAE (p. 12)
(Monotoma Herbst)

## Subfamily RHIZOPHAGINAE <br> KEY TO BRITTSH GENERA AND SPECIES

1 Tibiae very slender and sinuate, without lateral spines on outer edges (fig. 7) (of all the specimens examined, one had a lateral spine on a mid tibia but this could have been an abnormality); pronotum with evenly rounded, slightly crenulate sides, usually broadest in middle (rarely anteriorly), elytra with curved sides (fig. 41), at broadest part much broader than pronotum; metepisternum wider than epipleuron and densely covered with minute whitish hairs, appearing matt. Body black or brown, elytra with a greenish or bluish reflection. [Tibiae, tarsi and antennee reddish brown, antennal club distinctly darker.] Length $2.2-3.3 \mathrm{~mm}$. $\delta^{\circ}$ and 9 pronota figs 15 \& 41.

CYANOSTOLUS Ganglbauer
Raised to generic status by Peacock (in prep.).
One known species: ( = caeruleipennis (Sablberg)) aeneus (Richter) At sap, under and in crevices in bark, often of floating or partly submerged timber, usually in damp situations. In large numbers under bark of elm (Ulmus), beech (Fagus), oak (Quercus). Less commonly and often singly in alder (Alnus), birch (Betula), sweet chestnut (Castanea sativa), pine (Pinaceae), apple (Malus). Often with scolytids. Rare. Sparse but fairly widespread distribution. England: S. Devon, S. Hampshire, [W. Sussex, W. Kent], Surrey, Worcestershire, Derbyshire, [S. Lancashire, N.E. Yorkshire, County Durham]. Scotland: [Dumfriesshire, 1 record]. Wales: Carmarthenshire, 1 record 1973.

- Tibiae not slender and mid tibiae, at least, with one or more minute spines along outer edge (figs 8-12, 35, 37); pronotum not notioeably narrower than elytra. and other characters not as above; metepisternum shiny and punctured, not appearing whiter than rest of derm, often with long setae; elytra without metallic refleations.

RHIZOPHAGUS Herbst


Fias 1-14. 1-2, Rhizophagus ferrugineus, dorsal view of apex of abdomen. 1, male. 2, female. 3-4, apical segments of left antenna. 3, R. cribratus. 4, R. ferrugineus. 5, R. depressus, part of left elytron. 6, R. picipes, dorsal view of head to show oblique depressions. 7-12, right mid tibia. 7, Cyanostolus aeneus. 8, Rhizophagus picipes. 9, R. parvulus. 10, R. ferrugineus. 11, R. oblongicollis, 12, R. nitidulus. 13-14, basal segments of left antenna. 13, R. picipes. 14, R. parvulus.

2 Antennal club truncate at apex (fig. 3); disc of pronotum flat. [Pronotum at least as broad as long (fig. 16), microsculpture not apparent, very shiny, anterior part as broad as base of elytra, body unicolorous reddish brown, disc of pronotum and elytra with very large, coarse punctures.] Length 3.0-3.8mm. (Subgenus Anomophagus Reitter)
cribratus Gyllenhal
At roots of oak (Quercus), lime (Tilia), in grass, leaf litter, fungus, dried cow dung, carrion. Occasionally under bark. Locally common but very widespread. England: $[1-3,10], 11,13,17,[18,20], 21-23,[26,27,36-40,55], 56,579,[58,59], 62,63$, $[64,66,67,69,70]$. Scotland: [72], 73, 75, [77], 83, 84, 89, [95], 1111 record, 1905. Wales: [41, 48]. Ireland: 2, [3 or 4 or 5, 15 or 16 or 17, 21, 22, 27, 30], 36, 37.

- Antennal elub rounded at apex (fig. 4) and pronotum not as in fig. 16................ 3

3 Second elytral interval punctured and noticeably widened in basal half (tilt beetle forward) (fig. 5); pronotum fig. 17. [Body unicolorous light reddish brown and lat visible abdominal sternite in of with a median, longitudinal depression.] Length


Figs 15-26. Pronotum, to show shape and punctures on disc. 15, Cyanostolus aeneus, male. 16, Rhizophagus cribratus, male. 17, R. depressus, female. 18, R. ferrugineus, male. 19, R. parallelocollis, female (dotted line, male). 20, R. perforatus, female. 21, R. oblongicollis, male. 22, R. nitidulus, male. 23, R. picipes, male. 24, R. parvulus, fernale. 25, $R$. dispar, male. 26, R. bipustulatus, male.
2.0-4.0mm. (Subgenus Eurhizophaqus Méquignon) depressus (Fabricius) At sap, most commonly under bark of oak (Quercus), spruce (Picea), pine (Pinus). Also birch (Betula) and poplar (Populus) and in fungus. F'airly common, generally distributed throughout Britain. England: [1 (Scilly Is), 3], 7, 8, [9, 10], 11, 12, 14, $16,17,[20], 22,23,[24,25], 26,[27], 28,[30], 34,[36,38,39], 40$, [53 or 54$], 55,56$, [57], 58, [59], 62-64, [66, 67, 69], 70. Scotland: 72, 73, 78, 82, 83, 88, 91, 92, 95 96, 97, [105, 106]. Wales: 41? Ireland: [1], 2, 17, [18, 21, 30], [34 or 35], 37, [39, 40].

- Second elytral interval of uniform width and without punctures (except sometimes for the occasional one or two in the basal quarter). (Subgenus Rhizophagus). . . . 4
4 Pronotum as broad as or broader than long (figs 23, 24). . . . . . . . . . . . . . . . . . . . . . . 5
- Pronotum longer than broed (figs 18-22, 25, 26). ....................................... . . 6

5 3rd antennal segment very long, about as long as combined lengths of 4th, 5th and 6th segments, much longer than 2nd (fig. 13); head with 2 oblique depressions (fig. 6); elytral punctures much fainter towards apex; body very dark, usually black, with legs, antennee and sometimes abdominal sterna reddish (antennal club may be darker); median sternal punctures slightly larger on basal segment than on apical 3. of with a median longitudinal depression on the lat visible abdominal sternite and 2 setiferous protuberances on the apical sternite (fig. 30). \% with 1 small median protuberance on apical sternite; pronotum fig. 23. Length $2.5-4.0 \mathrm{~mm}$. ( $=$ politus (Hellwig)) picipes (Olivier)
At sap, under bark of pine (Pinus), oak (Quercus), beech (Fagus), ash (Fraxinus), poplar (Populus), alder (Alnus) and other trees. Also in fungi and in numbers in rotting vegetation. Rare, but often abundant where found. England: [39, 11], 16, 17, [18, 22, 23], 35, 37, 38, [39], 56, [58], 59, 60. Scotland: 96, 1 record.

- 3rd antennal segment only as long as combined lengths of 4th and 5th (fig. 14), not longer than 2nd; no obvious oblique depressions on head; elytral punctures not much fainter towards apex; body brown with a longitudinal lighter patch on each elytron (fig. 42) which sometimes extends to cover elytron; median sternal punctures larger and denser on apical 3 than on basal 2 segments (fig. 31); 1st sternite without depressions and apical sternite without prominences in either sex; elytra with slight v -shaped depression just behind scutellum; pronotum fig. 24. Length $2.0-2.8 \mathrm{~mm}$.
parvulus (Paykull)
The occasional specimen of $R$. bipustulatus may key out here if the pronotum is unusually broad, but the colour-pattern or (if unicolorous) the shape of the pronotum should serve to distinguish it (figs. 24 \& 26).

Under bark of deciduous trees, on sappy atumps of fallen silver birch (Betula pendula Roth) and oak (Quercus) and on bracket fungi. N. Scotland: E. Invernessshire only, probably quite common in this area. A continental species, first found in Britain in 1962.
6 Anterior angles of pronotum distinct, produced slightly forward (figs 18-20); if there is difficulty in observing this character the ventral side should be examined as the sides are produced more obviously ventrally (figs 27-28); 3rd antennal segment about as long as combined lengths of 4th, 5th and 6th together (fig. 13); body unicolorous, never with light or dark patches on elytra although dise of pronotum may be darker
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

- Anterior angles of pronotum rounded, not produced forward dorsally and only slightly ventrally (figs 21, 22, 25, 26, 32); 3rd antennal segment short, about as long as the 4th and 5th together (fig. 14) (sometimes slightly longer in $R$. oblongicollis); body unicolorous or with light or dark patches on elytra and/or pronotum
7 Elytral strise well marked at sides, although not as strong as on disc; pronotum usually broedest about one-third of length from anterior end (fig. 18), sides rather rounded, disc convex, not flattened; mid tibise with 3 or more strong spines on outer edge (fig. 10); fore tibiae also with several strong spines; prosternal process between fore coxae convex. [Body unicolorous rust-red or brown; pygidium very strongly punctured, particularly at apex.] ot with a brush of long setae on each side of median longitudinal line on metasternum (fig. 29). Length $2.9-4.6 \mathrm{~mm}$, See cover-fig.
( $=$ minor Méquignon) ferrugineus (Paykull)
Under bark and at sap of 'firs', pine (Pinus), beech (Fagus) and oak (Quercus) growing, freshly cut, dead or rotten trees. On Fomes on birch (Betula), in nest of Vespa vulgaris, in wood mould, Cossus frass and vegetable debris. It swarms
frequently. Common and widespread in England, Scotland and Ireland. Aingland: [1, 2], 3, [5, 6], 9-11, 13-18, [19, 20], 21, 22, [24, 25], 26-29, [30, 31], 36,[37-39, 55], 56, [57], $58,[61], 62,[66,67,69], 70$. Scotland: 72, 73, 76, 78, 80, 81, 83, 86-88, $92,[959], 96,99,105,106$. Wales: [41, 1 record 1829]. Ireland: 2, [3 or 4 or 5], 7 or $10,17,[21,22]$, [34 or 35$]$.
- Elytral striae weak at sides but strong on disc; pronotum slightly flattened on disc, sides almost straight but diverging anteriorly so that pronotum appears broader anteriorly (figs 19, 20); middle tibiae sometimes with 3 small spines but usually with fewer; fore tibiee rarely with more than one spine on outer edge; prosternal process flat between front coxes


Fras 27-29. 27-28, ventral view of base of head and prothorax, showing tempora. 27, Rhizophagus parallelocollis. 28, R. perforatus. 29, R. ferrugineus, male, mid line of posterior part of metasternum showing setae.

8 Tempora long, sides of head nearly parallel behind eyes (usually visible from above, but if obsoured by pronotum, can be seen ventrally (fig. 27)); reticulation on elytra and pronotum strong. [Body reddish or yellowish brown.] Sometimes with dise of pronotum slightly darker; pronotum fig. 19. Length $3.0-4.3 \mathrm{~mm}$.
parallelocollts Gyllenhal
Known as the 'graveyard beetle'. Frequently swarming in graves, graveyards, tombstones, on corpses in coffins (from 10 months to 2 years old) buried at some depth below ground. Often with dipterous larvae. Also (often with Atomaria, R. perforatus or dipterous larvae) in fungi, on mould, at sap and under bark of beech (Fagus), oak (Quercus), elm (Ulmus), in Cossus (Lepidoptera: Cossidae) larval burrows, on vegetable refuse (in profusion in decayed potatoes), in soil, old bones, rabbit and moles' nests. Local but often common where it occurs. England: [2, 3], 9, [10], 11, 13-18, 20, 21, [22], 23, [24], 25, 27, [29, 31, 33, 34], 36, 37, [38, 39], 40, 56, 58, 59, [61, 62], 66, [67, 70]. Scotland: 72, [73], 82, 83, 86, [92], 96, [99]: Wales: [42, 1 record 19th century]. Ireland: 2, 3, [21, 37], 39.

- Tempora short, parallel for about length of eye behind the eyes and then constricted (this is usually visible from above but can be seen better ventrally (fig. 28)); reticulation of elytra and pronotum not very strong; unicolorous reddish or yellowish brown; elytra tapering towards pygidium which is very sparsely and finely punctured; pronotum fig. 20. Length 2.5-3.5 mm. perforatus Erichson

Often taken in company with R. parallelocollis. Rarely under bark, often. subterranean, or on soil and decaying vegetable matter (large infestation recorded in buried, decaying maize grains; about 10 beetles in each grain), in fungus, mouldy bones, moles' nests, buried mouldy carcass. Under bark of deciduous trees: e.g. oak (Quercus), beech (Fagus) but not usually in large numbers." Widely distributed throughout England and S. Scotland. England: [1 or 2], 3, [4, 6], 9, [10], 11, 13-19, [20], 21-23, [24], 25, 29, [31], 36, 37, [38, 40], 55-57, [58, 59, 62], 63, [66], 67, [70]. Scotland: 72, 73, 76-78, 81, [82], 83, 84, 87. Wales: [41, 1 record 1896].. Ireland: 2, [15 or 16 or 17], 21 [22, 30], 37, 38 .
9 Eyes small, not prominent (fig. 33), almost flush with contour of head when viewed from above in ${ }^{\text {d }}$, slightly more prominent in 9 ; pronotum almost parallel-sided, not broader anteriorly (fig. 21); punctures in middle of dise very large, about 4
times as large as those at sides of disc (not sides of pronotum). [Body reddish brown, diso of pronotum may be slightly darker; fore and mid tibiae slightly sinuate externally (fig. 11).] Length $3.7-4.0 \mathrm{~mm}$. oblongicollis Blatch \& Horner
(Not, as previously thought, a synonym of the Japanese R. simplex Reitter. (See Tozer, 1972).)

Under bark of oak (Quercus) stumps or logs or in fungi. 1 record from beech (Fagus). 2 records of single specimens in colonies of R. ferrugineus. Very rare, from 7 vice-counties in England. Surrey: Richmond, 1896, 2 examples found by the author in material from the Royal Scottish Museum, locality not previously recorded. [S. Essex: Epping Forest, 1942]. [Hertfordshire: Hatfield, 1963]. Berkshire: Windsor Forest, 1938-1953. [Oxfordshire: Blenheim, 1954). Staffordshire: Bagots Park, 1892. Nottinghamshire: Sherwood Forest, 1886 \& 9.

- Eyes fairly large and prominent (figs 34, 43-45); pronotum broader anteriorly (figs 22, 25-6); punctures at middle of pronotal disc the same size or, at the most, twice as large as those at side; tibiae either very noticeably sinuate externally or not sinuate; usually bicolorous (figa 43-45) but some specimens unicolorous. .. 10
10 Outer edge of all tibiae concave just before apex and curved outwards (fig. 12); mid tibiae with 2 or more strong spines above apex on outer edge; lst abdominal sternite of ot with median longitudinal depression, apical abdominal sternite of both sexes with median depression between two small prominences. Elytra and pronotum typically reddish brown with dark or bleck patches (fig. 43); head, legs and antennae reddish brown. ©f and 9 pronota as in figs 22 and 43. Leigth $3.0-4.7 \mathrm{~mm}$.
nitidulus (Fabrioius)
Under bark of beech (Fagus), hornbeam (Carpinus), oak (Quercus), pine (Pinus), birch (Betula); usually fallen or decaying. On fungus. Rather rare; comminest in the midlands of England and western Scotland. England: [18, 20, 31, 38], 39, 40, [55], 56, [57, 58, 62], 63, [64]. Scotland: 73, 75, 88, 96, 98, [106]. Wales: [45, 1 record, 1965)].
-Outer edge of at least mid and hind tibiee straight, not concave or curved outwards just before apex (figs 35-38); mid tibiae with small lateral spine or spines above apex; apical abdominal sternite without depressions or prominences in either sex.


Figs 30-32. 30-31, apical abdominal sternites of male. 30, R. picipes. 31, R. parvulus 32, $R$. dispar, ventral view of base of head and prothorax.

11 Head very large, eyes strongly convex (figs 32, 44); width of head acrose eyes (including eyes) about as broad as broadest part of pronotum; frons with 2 well marked oblique depressions (tilt beetle backwards to see these); elytra smoothly curved from base to apex (without $V$-shaped depression), sides tapering, very slender at apex (fig. 44); strial punctures becoming smaller in apical third; pronotum, especially in o', considerably longer than broad; of with apical abdominal sternite long (fig. 39), not twice as broad as long and hind tibiae much longer than mid tibiee (figs 35-6); colour light reddish brown with a dark patch across elytra and sometimes on disc of pronotum; pronota of $\begin{gathered} \\ \text { and }\end{gathered}+$ es in figs 25 and 44. Length $2.5-4.5 \mathrm{~mm}$.
dispar (Paykull)


Figs 33-45. 33-34, dorsal view of anterior part of head of male. 33, R. oblongicollis. 34, $R$. nitidulus. 35-36, $R$. dispar. 35, middle tibis of male. 36, hind tibia of male. 37-38, $R$. bipustulatus. 37, middle tibia of male. 38, hind tibia of male. 39-40, apjoal sternites of male. 39, R. dispar. 40, R. bipustulatus. 41-45, dorsal view of female to show colour-pattern (these are the same in the male) and form of pronotum. 41, Cyanostolus aeneus. 42, Rhizophagus parvulus. 43, R. nitidulus (arrows indicate that dark area often extends to apex of elytra). 44, R. dispar. 45, R. bipustulatus (diagonal marks indioste depressions).

Under bark and on bark fungus, often in profusion. Commonly on pine (Pinus), oak (Quercus), birch (Betula). Less commonly beech (Fagus), sycamore (Acer pseudoplatanus), elm (Ulmus) and poplar (Populus), in mouldy stumps. Common. Mainly a midland and northern species in England, but in recent years has been found as far south as S. Devon. England: 3, [4], 5, [6], 9, 11, 14, 17, 18, [20], 21, 22, 24, [25], 26, 28-30, [31, 34], 36-38, [39], 40, 55-58, [59-60], 62-64, 66, 67, 69, [70]. Scotland: 72, 73, 75-78, [80-81], 83-86, 88, 89, 92, 96, 97, 100, 103, 105, 106. Wales: [41, 42], 45, 49. Ireland: 2, 9, 17, 20, 21, [257, 28, 33, [34 or 35], 37-39, [40].
Head normal, width across eyes not as broad as broadest part of pronotum; frons with shallow oblique depressions; elytra with distinct $\mathbf{V}$-shaped depression (tilt beetle forward to see this); elytra not as strongly tapering as in R. dispar (fig. 45), strial punctures strong almost to apex; pronotum only slightly longer than broad (fig. 26); ${ }^{\text {a }}$ with apical abdominal sternite broad, about twice as broad as long (fig. 40); hind tibiae of ${ }^{1}$ not noticeably longer than mid tibiae and slightly bowed, inner edge concave (figs 37-8); colour dark brown with a light spot on the apioal quarter of each elytron and sometimes on shoulder. Legs, antennae and front of head reddish brown (fig. 45); pronota of $\delta^{\pi}$ and 9 as in figs 26 \& 45. Lergth $2.0-3.5 \mathrm{~mm}$. blpustulatus (Fabricius)

Usually under bark of deciduous trees, at sap and in fungus. Mainly beech (Fagus), oak (Quercus). Less commonly elm (Ulmus), alder (Alnus), birch (Betula), apple (Malus), poplar (Populus) and other trees. Occasionally under bark of conifers. Common throughout England (especially the south) and south-western Scotland. England: [1 or 2], 3, [4, 5, 6], 7, 9, [10], 11, [12], 13, 14, [15], 16-23, [24], 25, [26], $27-30,[31], 36,37,[38,39], 40$, [53 or 54], $55.56,[57,58], 59,[60], 62-64,[66], 67$, [69], 70. Scotland: 72, 73, 76, [77], 88, 96, [105]. Wales: [41, 43]. No confirmed records for Ireland.

## SHORT KEY TO RHIZOPHAGINAE SPECIES

1 Pronotum and elytra unicolorous. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

- Pronotum and/or elytra with distinct dark or light patches. . . . . . . . . . . . . . . . . . . . . 9

2 Upperside of body blaok, or black with metallic sheen on elytra. ...................... 3

- Upperside of body reddish brown. ........................................................ 4

3 Mid tibiee without spines on outer edge (except on apex), very slender (fig. 7); antennal club darker than rest of antenna; elytra with metallic bluish or greenish sheen; pronotum narrower than elytra and often with rounded sides (fig. 41); 3rd antennal segment short, not longer than combined length of 4th and 5th segments (fig. 14). ( = caeruleipennis Sahlberg) Cyanostolus aeneus (Richter)

- Mid tibiae with small spines on outer edge, not very slender; antennal club not usually darker; elytra without metallic sheen; pronotum about same width as elytra and broader anteriorly (fig. 23); 3rd antennal segment very long, about as long as combined length of 4th, 5th and 6th segments (fig. 13)
( $=$ politus (Hellwig)) Rhizophagus picipes (Olivier)
4 Antennal club truncate (fig. 3)
R. cribratus Gyllenhal
- Antennal club not truncate (fig. 4)

$$
.5
$$

5 2nd elytral interval wider in basal third with scattered punctures (fig. 5)
R. depressus (Fabricius)

- 2nd elytral interval neither wider in basal third nor punctured

6 Front angles of pronotum rounded; pronotum parallel-sided (fig. 21). [Temples long.]
R. oblongicollis Blatch \& Horner

- Front angles of pronotum produced slightly forward (figs. 18-20)


7 Temples long and straight, eyes appear small (fig. 27); microsculpture on elytra very strong
R. parallelocollis Gyllenhal

- Temples short, constricted not more than eye's length behind eye, eyes appearing normal (fig. 28); microsculpture present but not detracting from shine. .......... . 8
8 Elytral strize very strong at sides although not as strong as on diso; pronotum with curved sides, not distinctly broader anteriorly (fig. 18); fore and mid tibiae with strong spines on outer edge, fore with at least 2, mid with at least 3; outer edge of tibia very slightly sinuate (fig. 10)
R. ferrugineus (Paykull)
- Striae weak at sides, strong on disc; pronotum clearly broadest anteriorly (fig. 20); spines on tibiae minute, fore tibige with only 1 , mid tibiae with 1 or 2 , outer edges not sinuate
R. perforatus Erichson

9 Pronotum not longer than broad; body dark brown with longitudinal light yellowish brown patch on each elytron (fig. 42); front of head, antennae and legs yellowish brown
R. parvulus (Paykull)

- Pronotum longer than broad; colour not as above .10
10 Body dark brown, with lighter spot on each elytron, one quarter of elytral length from apex (fig. 45); legs, antennae and front of head light reddish brown


## R. bipustulatus (Fabricius)

- Colour not as above.

11 Outer edge of mid tibiae distinctly sinuate (fig. 12); body, legs, antennae and head reddish brown, with a dark patch on dise of pronotum and one on the apical two thirds of the elytra (fig. 43).
R. nitldulus (Fabricius)

- Outer edge of mid tibiae not sinuate (fig. 35); body including legs, antennae and head, reddish brown with a dark patch in the middle of elytra (fig. 44); pronotum also sometimes with a dark patch
R. dispar (Paykull)


## Subfamily MONOTOMINAE

## KEY TO SPECLES OF MONOTOMA Herbst

1 Pronotal disc with 4 deep foveae, which are joined in pairs to form 2 longitudinal furrows (fig. 46). [Pronotum almost quadrate, about as broad as long, broadening slightly anteriorly; head and pronotum scabrous with small punctures, elytral intervals smooth and shiny; strial punctures shallow; elytral setee coarse, in distinct rows, overlapping to form continuous lines; ot with distinct median depression on 1st visible abdominal sternite and epipleurae with broadened areas; unicolorous reddish brown.] Length $1.8-2.3 \mathrm{~mm}$.
(= subquadrifoveolata Fowler) quadrifoveolata Aubé
In decaying vegetable matter. Found in numbers in decayed sacks (which had oontained bones) from glue and chemical works and in granaries. Rare. Mainly S.E. England. Single records from [S. Devon]. and N.E. Yorkshire. England: $[3,14], 15,[16-18,20,21], 22,62$. Scotland: 87, 1 record. Latest record 1936 [Surrey].

- Pronotal dise with 2 foveae (often very small) in posterior half and sometimes with a trace of 2 very shallow fove日e in anterior half
.2
2 Pronotum broadest anteriorly, shield-shaped, tapering towards base (fig. 47), sides with only minute teeth, without larger tooth or teeth to mark posterior lateral angles; the 2 basal foveae are confluent. [Elytral setae fine and scattered, not in rows; ${ }^{*}$ with front tibiae very slightly bent inwards near apex.] Metasternal groove with a smooth shiny area on either side; body shining, small, very dark brown. Legs, antennae, clypeus reddish yellow. Length $1.5-2.0 \mathrm{~mm}$.
longicollis Gyllenhal
In decaying vegetable matter, birds' nests, ants' nests, under bark, in moss. Local fairly common, widespread in England and Scotland. 1 (Scilly Is), 3, 5, [6, 9, 10], 11, 14-18, 20-22, [23], 24, [25], 29, [30, 33], 34, [36, 38, 39], 54, 55, [56-59], 62, 63, $[66], 67,[70,71]$. Scotland: 72, 73, 78, 82, [83], 96, 99, 100. Wales: 41, 42 . Ireland: [3 or 4 or 5, 21, 22], 38, 40.
- Pronotum broadest in posterior half or in middle, or parallel-sided; if slightly broader anteriorly, then with distinct posterior angles; sometimes, but not always, with larger teeth to mark posterior angle. Length over 2 mm (except for some specimens of testacea Mots. \& picipes Hbst.)
3 Pronotum almost quadrate, about as broad as long, with well marked callosities (fig. 48) at the lateral posterior angle (these are cylindrical protuberances with upturned, circular, flattened apices); elytral setae coarse, in distinct rows. [ $\delta$ with front tibiae bent inwards near apex and epipleurae with broadened areas.] Head, pronotum, pygidium and underside very dark brown to black, elytra slightly lighter; legs, antennae, pronotal protuberances and front of clypeus reddish brown. Length 2.1-2.5 mm.
brevicollis Aube

In decaying vegetable matter. Also in dead jackdaw and on blossom. Common, but limited distribution, not further north than Derbyshire and Cheshire. Most common in southern and south-east England. England: [1 incl. Scilly Is], 3-5 incl. Lundy $I$., [6, 9, 10], 11, 12, 14-18, 20-26, [27 or 28], 29, [31], 37, [38, 57, 58]. Wales: 41, 1 record.

- Pronotum longer than broad and without callosities at the posterior angles, although these angles may be well marked by the general shape of the pronotum or by a larger tooth or teeth
4 Pronotum more or less parallel-sided or slightly broader anteriorly, anterior angles not produced forward
- Pronotum broadest posteriorly or in the middle, tapering to just before the anterior angles which are usually produced forward
.6
5 Pronotum with 2 distinot foveae in the posterior half and 2 very shallow, indistinct ones in the anterior half, so that disc appears slightly flattened; posterior angles of pronotum distinct, more prominent than in bicolor (fig. 49); head with shallow depressions around raised middle part. [Elytral setae fairly fine and slightly clubbed, in wavy indistinct rows, of with a very shallow depression on lat abdominal sternite and epipleurae with broadened areas]. Body, legs and antennae reddish brown, metasternum sometimes slightly darker. Length $1.6-2.1 \mathrm{~mm}$.
( = rufa Redtenbacher) testacea Motschulsky
In decaying vegetable matter, also found swarming in decayed sacks (which had contained bones) from glue and chemical works, and in granaries. Local, sometimes abundant, but often scarce. England: S.E. and midlands mainly, but also some northern counties. 14, 15, [16], 17, 20-25, [27 or 28], 29, [38, 58], 59, 62-64, [66, 67].
- Pronotum with 2 small foveae in the posterior half only, appearing strongly oonvex transversely; posterior angles present but not very distinct (fig. 50); head without depressions. [Elytral setae fairly fine, tapering, not in rows. $\delta$ with shallow depression on lst visible abdominal sternite, epipleurae with broadened areas and front tibiae bent inwards near apex (in $\uparrow$ also very slightly).] Pronotum, pygidium, posterior part of head and most of underside brown; elytra, pronotal angles, clypeus, legs and antennae lighter yellowish brown. Length $\mathbf{2 . 0}-\mathbf{2 . 4} \mathbf{~ m m}$.

$$
(=\text { quadricollis Aubé) bicolor Villa }
$$

In decaying vegetable matter. Commonest in S.E. England. England: [1 or 2], $[5,6,8,10], 11,13-25$, [27 or 28], 29, 30, [31], 36, 37, [38], 39, [57, 59], 62, 66, [70]. Scotland: 72, 77, 81-83, 95 . Wales: 41, 1 record. Ireland: 21, 38.
6 Head with deep elongate foveae extending almost to basal edge, temples very short, hind angles acute; pronotum with a larger tooth marking the posterior lateral angle (fig. 51). [Elytral setae very fine, no trace of rows. $\boldsymbol{\sigma}^{t}$ with front tibiae bent inwards near apex and with a distinct depression on Ist visible abdominal sternite.] Head, pronotum, pygidium and underside fuscous, elytra and pronotal angles very slightly lighter. Antennae and legs yellowish to reddish brown. Length 1.7-2.6 mm.
picipes Herbst
In decaying vegetable matter. Also under bark of pine (Pinus) logs, in moss, seaweed, occasionally found with ants, seen swarming. Common, generally distributed throughout Britain. 1 (Scilly Is), [2], 3-5, 9-11, 13-18, [19], 20-25, [26-28], $29,30,[31,34], 36,37,[40,54], 55,[56-61], 62,63,[64-66], 67,[70], 71$. Scotland: 72, 73, 76-78, 81-85, 88, 96, 99, 100. Wales:.41, 42, 49. Ireland: 1, 2, [6, 20], 21, [22], [34 or 35], 37-40.

- Head without deep elongate foveae, temples longer than in the preceding species, with hind angles more or less rounded; all lateral teeth on basel part of pronotum of similar size.
7 Elytra shiny, pronotum with very curved sides with no marked posterior angles, ejes large, temples not longer than diameter of eye (fig. 52). [Elytral setae fairly fine, in indistinat rows. $\hat{o}^{*}$ and $\%$ with front tibiae bent inwards near apex.] Pronotum, pygidium, most of underside and posterior part of head brown. Clypeus, antennae, legs and, at least base of elytra lighter, yellowish brown. Length $2.0-2.4 \mathrm{~mm}$.
spinicollis Aubé
In decaying vegetable matter. Also found in numbers in decayed sacks (which had contained bones) from glue and chemical worlss and in dried bracken. Often found singly with other members of genus. Not common. England: mainly south, southeast and midlands, but has been found as far north as Durham. [3, 6, 9, 10], 11, 14-18,


Figs 40-54. Head and pronotum of Monotoma speoies (shaded areas denote depressions, setae are indicated on left side only). 46, M. quadrifoveolata. 47, M. Longicollis. 48, M. brevicollis. 49, M. testacea. 50, M. bicolor. 51, M. picipes. 52, M. spinicollis. 53, M. conicicollis. 54, M. angusticollis.
[19], 20, 21, [22], 23-25, 36, 37, [38], 54, 55, 57, 61, 64, 66. Scotland: 77 (imported). $78,82,84$. Wales: 41, 1 recond. Ireland: $[5,1$ record $]$.

- Elytra dull, scabrous; pronotum with sides almost straight, tapering towards apex from lateral posterior angles; eyes small; temples behind eye longer than diameter of eye.
8 Head elongate, oblong, parallel-sided, longer than broad; pronotum with very prominent anterior angles and strong lateral teeth, very distinctly narrowed anteriorly (fig. 63); elytra strongly tapered. [Elytral setae small, wedge-shaped, about 4 times as long as broad, rows indistinat. © with a distinct depression on 1st visible abdominal sternite.] All tibiae of ó with a large apical spine; body, legs and antennae light orange to dark reddish brown, metasternum sometimes slightly darker. Length $2.5-3.0 \mathrm{~mm}$. (Subgenus Gyrocecis Thomson) conicicollis Aube Myrmecophilous in nests of Formica rufa, F. lugubris, F. aquilonia, F. pratensis. Collingwood, 1957, notes that this species exactly resembles small pieces of pine needle and is almost impossible to detect unless it moves. Generally distributed throughout England and northern Scotland. England: [1, 3, 5, 9, 10], 11-17, [18, 21], 22, [23], $27,[36-38], 55,[57], 62,63,[66,67,70]$. Scotland: [88], 89, 92, [95], 96, [105]. Wales: 42, 1 record. Ireland: [15-1st record 1964, 37].
- Head not much longer than broad, appearing triangular; pronotum with anterior angles not so prominent, lateral teeth weaker and only weakly narrowed anteriorly (fig. 54); elytra not strongly tapered. [Elytral setae very small, wedge-shaped, about 3 times as long as broad, rows indistinct, $0^{4}$ with front tibiae very slightly bent inwards near apex.] Body very dark brown, with clypeus, sides of pronotum edges of elytra, lege and antennae sometimes reddish brown. Length $2.5-2.9 \mathrm{~mm}$. (Subgenus Gyrocecis Thomson)
(=formicetorum Thomson) angusticollis Gyllenhal
Myrmecophilous in nests of: Formica rufa, F. lugubris, F. aquilonia. Often in nests with M. conicicollis but less common. England: [5, 9, 10], 11-17, 19, 20, [21], 22, [23], 27, 36, [37-40, 54, 55], 62, [66, 69, 70]. Wales: 42, 1 record. Ireland: [1, 1908, possibly now extinct in Kerry as F. lugubris, in whose nests it was found, has not been found there in recent years, 37].

All the species except the last two are in the subgenus Monotoma.

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## APPENDIX

## Counties and vice-counties of the British 1sles (after Watson and Praeger)

ENGLAND
1 Cornwall, W. (incl. Scilly Is)
2 Cornwall, E.
3 Devon, S.
4 Devon, N.
5 Somerset, S .
6 Somerset, N.
7 Wiltshire, N.
8 Wiltshire, S.
9 Dorset
10 Isle of Wight
11 Hampshire, S.
12 Hampshire, N.
13 Sussex, W.
14 Sussex, E.
15 Kent, E.
16 Kent, W.
17 Surrey
18 Essex, S .
19 Essex, N.
20 Hertfordshire
21 Middlesex (Greater London)
22 Berkshire
23 Oxfordshire
24 Buckinghamshire
25 Suffolk, E.
26 Suffolk, W.
27 Norfolk, E.
28 Norfolk, W.
29 Cambridgeshire
30 Bedfordshire
31 Huntingdon
32 Northamptonshire
33 Gloucestershire, E.
34 Gloucestershire, W.
35 Monmouthshire
36 Herefordshire
37 Worcestershire
38 Warwickshire
39 Staffordshire
40 Shropshire
41-52 (See WALES)
53 Lincolnshire, S.
54 Lincolnshire, N.
55 Leicestershire with Rutland
56 Nottinghamshire
57 Derbyshire
58 Cheshire
59 Lancashire, S.
60 Lancashire, Mid (see 69)
61 Yorkshire, S.E.
62 Yorkshire, N.E.
63 Yorkshire, S.W.

64 Yorkshire, Mid W.
65 Yorkshire, N.W.
66 Durham
67 Northumberland, S.
68 Northumberland, N. or Cheviotland
69 Westmorland with N. Lancashire
70 Cumberland
71 Isle of Man
SCOTLAND
72 Dumfriesshire
73 Kirkcudbrightshire
74 Wigtownshire
75 Ayrshire
76 Renfrewshire
77 Lanarkshire
78 Peeblesshire
79 Selkirkshire
80 Roxburghshire
81 Berwickshire
82 Haddington (East Lothian)
83 Edinburgh (Midlothian)
84 Linlithgow (West Lothian)
85 Fifeshire and Kinross-shire
86 Stirlingshire
87 Perthshire, W. (S.) and
Clackmannanshire
88 Perthshire, Mid
89 Perthshire, E.(N.)
90 Angus or Forfar
91 Kincardineshire
92 Aberdeenshire, $\mathbf{S}$.
93 Aberdeenshire, N.
94 Banffshire.
95 Moray or Elgin
96 Easterness (Inverness-shire, E. and Nairnshire)
97 Westerness (Inverness-shire, W.)
98 (Main) Argyll
99 Dunbarton
100 Clyde Isles (Bute)
101 Cantyre (Kintyre, Argyll)
102 S. Ebudes-Islay etc. (S. Inner Hebrides, Argyll)
103 Mid Ebudes-Mull etc. (Mid Inner Hebrides, Argyll)
104 N. Ebudes-Skye etc. (N. Inner Hebrides, W. Inverness)
105 Ross and Cromarty, W.
106 Ross and Cromarty, E.
107 Sutherland, E.
108 Sutherland, W.
109 Caithness

110 Outer Hebrides
111 Orkney Islands
112 Shetland Islands
WALES
41 Glamorgan
42 Brecon (Brecknock)
43 Radnor
44 Carmarthenshire
45 Pembrokeshire
46 Cardiganshire
47 Montgomeryshire
48 Merioneth
49 Caernarvonshire
50 Denbighshire
51 Flintshire
52 Anglesey
IRELAND
1 Kerry, S.
2 Kerry, N.
3 Cork, W.
4 Cork, Mid
5 Cork, E.
6 Waterford
7 S. Tipperary
8 Limerick
9 Clare with Aran Isles
10 Tipperary, N.
11 Kilkenny

12 Wexford
13 Carlow
14 Queen's County (Leix)
15 Galway, S.E.
16 Galway, W.
17 Galway, N.E.
18 King's County (Offaly)
19 Kildare
20 Wicklow
21 Dublin
22 Meath
23 Westmeath
24 Longford
25 Roscommon
26 Mayo, E.
27 Mayo, W.
28 Sligo
29 Leitrim

30 Cavan
31 Louth
32 Monaghan
33 Fermanagh
34 Donegal, E. or (S.)
35 Donegal, W. or (N.)
36 Tyrone
37 Armagh
38 Down
39 Antrim
40 Derry (Londonderry)

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