

## A FIELD KEY TO THE SLUGS OF THE BRITISH ISLES

MOLLUSCA: PULMONATA

Families      Arionidae  
                  Limacidae  
                  Milacidae  
                  Testacellidae

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### ABSTRACT

Keys, notes and illustrations are provided to assist in the identification of the slugs of the British Isles in the field. External features only are used as characters, and where dissection is necessary or desirable this is clearly stated, and the user referred to other works. A systematic list and glossary are included.

### INTRODUCTION

The land molluscs of the British Isles (all Class Gastropoda) are traditionally divided into two categories, snails and slugs. Those lacking an external shell, or having one which is very small in relation to the body are called slugs. This division is arbitrary, and does not correspond to major taxonomic groupings. The categories are often used very vaguely in everyday language, and the term 'snail' is often used to include slugs (and occasionally *vice versa*).

Nevertheless, the categories are very useful in practice. In the British Isles, four families of land Gastropoda are represented exclusively by slugs, and all others exclusively by snails. The latter are usually identified by shell characters, whereas in slugs features of the soft body are necessarily the source of external identification characters.

The taxonomy of British slugs has undergone several revisions at the species level in recent years, and reliable identification has become more difficult. This is a simple field key, designed to enable the user to identify slugs as far as is possible without having to kill and dissect the specimens. Only very brief details of ecology and distribution are given, to help determine the reliability of an identification.

Apart from papers on particular groups of slugs, which are fully referred to in the text, there are a number of more general works on slug taxonomy and identification. Quick's (1949 and 1960) papers are the pioneer works, but are now rather dated. Ellis (1969) and Janus (1965) contain illustrations, descriptions and keys to genera, but are also not absolutely up to date. Kerney and Cameron (1979) contains descriptions, including details of internal anatomy, and colour plates (reproduced here) and Eversham and Jackson (1982) contains keys to species and some line diagrams. Eversham and Jackson's key has evolved in parallel with this one, and

been similarly tested in the field; it has been very heavily drawn on in the construction of this final version. Ellis (1979) gives internal and field characters. Distribution maps of all but the most recent discoveries can be found in Kerney (1976).

## IDENTIFYING SLUGS

### 1. TAXONOMY

In recent years, a number of previously well recognised British 'species' have been discovered to be aggregates of very similar, but distinct species. Others are known to contain both outcrossing and self-fertilising strains, some of which may in time be recognised as distinct species (McCracken and Selander, 1980).

These taxonomic changes make field identification to species more difficult, and in a few cases impossible without considerable experience. In any cases of doubt, the identification should be confirmed by dissection or checked by a specialist. Full details of papers giving details of internal differences and full descriptions are given in appropriate places in the text. Where these difficulties arise the main keys lead to a species aggregate. A complete check-list is given (p. 811).

### 2. IDENTIFICATION

In general, slugs may be identified by the external features of the body, using the naked eye or a  $\times 10$  hand lens. All the key features are described more fully in the glossary and accompanying illustrations (page 810).

Families of slugs are easily identified by the presence or absence and relative length of the *keel*, by the position and structure of the *mantle* and *pneumostome*, and by the presence or absence of an external *shell*.

Identification of species, or species aggregates, may involve other characters. Presence or absence, size and position of lateral pigmented *bands* on the *body* and *mantle*, presence or absence of *spotting* or *mottling*, and the colour of the *body*, *mantle*, *tentacles*, *foot fringe* and *sole* and the *keel* may also be important. Additional characters may be found in the size and shape of the *tubercles*, in the arrangement of *lateral grooves* (in *Testacella*) and in the colour and consistency of the slime or *mucus*. A few species also have diagnostic behaviour patterns and posture, which are described in the text.

There are two principal difficulties in making a correct identification in the field.

Firstly, all species show some variation in colour and pattern between individuals. In some species, this variation is very marked, both between individuals in the same population and between populations in different regions. Even where 'typical' members of two species are very different in appearance, some variants of each may closely resemble the other. Complete albinos are very rare, but can be extremely confusing. *Extra caution should be exercised when looking at slugs in an unfamiliar area.*

Secondly, adults and juveniles of the same species may differ not only in size, but also in colour and pattern. There is no easy way to tell that a slug is juvenile before it has been identified. As far as possible, the keys take account of juvenile differences. Note that *sizes given in the keys and notes refer to adults*, and that many individuals of a species will be much smaller than the maximum given. Juvenile *Arion* (key 2) in particular, are often paler and more banded than adults. Although most species have breeding seasons, these vary with weather and locality, and juvenile slugs may be found at any time of the year.

### 3. FINDING AND COLLECTING

Slugs are very dependent on moisture, and are consequently most active at night, or in rainy weather. On damp, warm nights they can be found active in large numbers, and collected by torchlight.

In daylight and dry weather, they take shelter, and may be found under logs and stones, in litter and around the base of plants. Rubbish heaps and compost heaps often carry large numbers. Some species go far underground in very dry weather, and *Testacella* and *Milax* are partly subterranean even when active.

Slugs can be collected into plastic bags or jars with damp vegetation or paper inside to prevent crushing and dehydration. They must be kept damp—but not slopping about in water—or they dry out and die very quickly. Identification is *much* easier on live than on preserved specimens, so make a provisional identification and description before killing and preserving (for later dissection or despatch to a specialist).

The nature of locality records etc. made at the time of collection will vary with the nature of the investigation, but remember that *slugs eat paper and cardboard*: labels should be on the *outside* of any container.

Slugs are easily kept in captivity in plastic lunch-boxes or similar containers, and if kept damp and free of fungus can be reared on porridge oats, carrots or lettuce. This enables behaviour to be studied, and can also be used to rear unidentifiable juveniles to adulthood.

### GLOSSARY

**BANDS**—Bands of darker pigment, sometimes fringed by very pale areas, running lengthwise on either side of the body, the mantle, or both (Figure 1C). On the mantle, the band on the right side may pass over, or under, or split round the pneumostome.

**BODY**—Sometimes the whole body is meant, *but in the keys* it refers to that part of the body behind the mantle.

**FOOT FRINGE**—The upper edge of the foot, circling the whole body, and marked off from it by a continuous groove (Figure 1A).

**FOOT SOLE**—The underside of the foot.

**KEEL**—A raised ridge on the midline of the body ending in the tail, where it is most prominent (Figure 1A).

**LATERAL GROOVES**—In *Testacella*, the two grooves running forward from the shell towards the head (see Fig. 1D and Plate 4).

**MANTLE**—A flap of skin and tissue covering part of the body, and enclosing the lung. In all slugs except *Testacella* (in which it is under the shell) it is on the anterior part of the body just behind the head. The pneumostome opens on the right side of the mantle (Figure 1A).

**MOTTLING**—A pattern of light and dark blotches covering the body or mantle or both (e.g. Plate 3: 4).

**MUCUS**—The slime exuded by slugs both on the foot-sole and on the body. Foot-sole and body mucus may differ in colour and consistency.

**PNEUMOSTOME**—The external opening of the lung on the right side of the mantle (Figure 1A). In very rare “sinistral” or “mirror image” specimens, it is on the left.

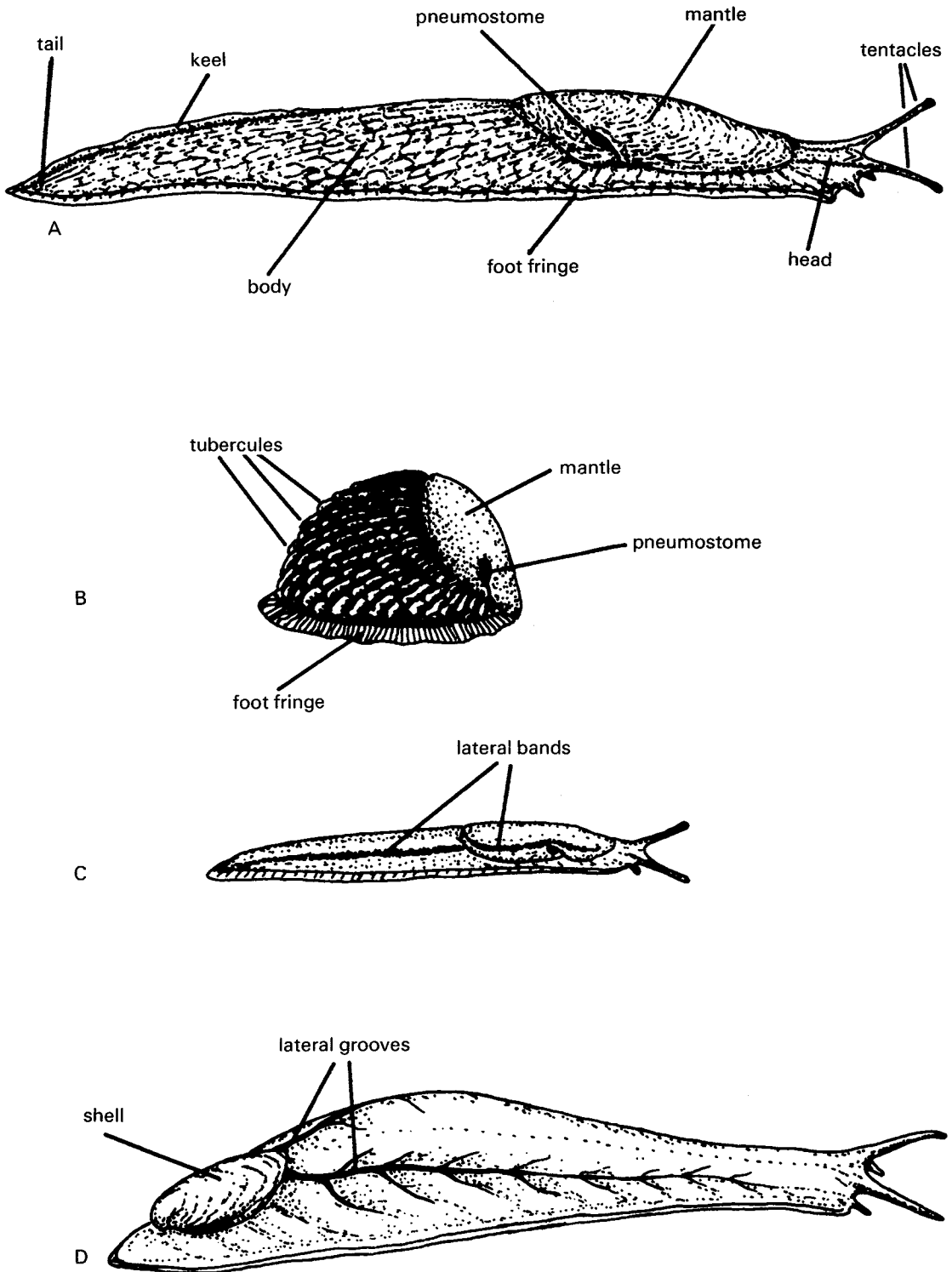


FIG. 1

Characters used in identification of slugs. A is an extended Limacid slug, B and C are Arionids, and D is a *Testacella*.

**SHELL** (Figure 1D)—An external shell is present only in *Testacella*. Many other slugs have a small shell *inside* the mantle, which can sometimes be seen through the skin of the mantle.

**SPOTTING**—Pattern of light or dark spots overlying the general colour of the slug. *Bands* are sometimes broken up into rows of spots.

**TENTACLES** (Figure 1A)—Slugs have four tentacles on the head; the upper pair are larger, and have eyespots at the tip.

**TUBERCULES** (Figure 1B)—Raised portions of the body-surface separated by grooves. Size and shape of tubercules is sometimes diagnostic.

### SYSTEMATIC LIST

This list includes all slugs native or naturalised in the British Isles, but not species restricted to greenhouses. Nomenclature follows Kerney and Cameron (1979) modified by Davies (1979) and Wiktor and Norris (1982); common synonyms are given alongside in roman type.

Subclass PULMONATA

Order STYLOMMATOPHORA

Family ARIONIDAE

*Geomalacus maculosus* Allman 1843

*Arion ater* (Linné 1758)

*Arion rufus* (Linné 1758)

*Arion lusitanicus* Mabilie 1868 (includes at least 2 species)

*Arion subfuscus* (Draparnaud 1805)

*Arion fasciatus* (Nilsson 1823)

*Arion circumscriptus* Johnston 1828 *Arion fasciatus* (non Nilsson)

*Arion silvaticus* Lohmander 1937 *Arion fasciatus* (non Nilsson)

*Arion hortensis* Férussac 1819

*Arion distinctus* Mabilie 1868 *Arion hortensis* (non Férussac)

*Arion owenii* Davies 1979 *Arion hortensis* (non Férussac)

*Arion intermedius* Normand 1852

Family MILACIDAE

*Milax gagates* (Draparnaud 1801)

*Milax sowerbyi* (Férussac 1823)

*Milax budapestensis* (Hazay 1881) *Milax gracilis* (Leydig)

*Boettgerilla pallens* Simroth 1912

Family LIMACIDAE

*Limax maximus* Linné 1758

*Limax cinereoniger* Wolf 1803

*Limax tenellus* Müller 1774

*Limax flavus* Linné 1758

*Limax maculatus* (Kaleniczenko 1851) *Limax grossui* Lupu *Limax pseudoflavus* Evans

*Limax marginatus* Müller 1771 *Lehmannia marginata* (Müller)

*Deroceras laeve* (Müller 1774) *Agriolimax laevis* (Müller)

*Deroceras caruanae* (Pollonera 1891)

*Deroceras agreste* (Linné 1758) *Agriolimax agrestis* (Linné)

*Deroceras reticulatum* (Müller 1774) *Agriolimax reticulatus* (Müller)

Family TESTACELLIDAE

*Testacella maugei* Férussac 1819

*Testacella haliotidea* Draparnaud 1801

*Testacella scutulum* Sowerby 1821

## THE KEYS

There are two kinds of key used. Tabular keys (e.g. Key 1) present characters in columns. Decide which entry in each column fits your specimen best. Your entries should lie in a single row, at the end of which is the name of the family or species best matching your specimen.

Dichotomous keys work by giving you a choice between two descriptions in a numbered couplet. Read *both* descriptions, and decide which fits your specimen best. At the end of that description you will find either a species name, or the number of the next couplet to follow. Follow couplets through until you end with a species name.

Read the notes with each key before making a positive identification. Check your identification against the colour plates (remembering that they show only the typical forms and a few common variants), and if possible confirm it by reading a species description in Ellis (1969) or Kerney and Cameron (1979).

Remember the cautions given in the Identification section (page 808) about colour variants and the differences between adults and juveniles. Very small specimens are particularly difficult for the beginner, and you should not expect to be able to identify *every* specimen you find, especially if you are a beginner, or are operating in an unfamiliar area.


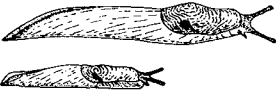

**START AT KEY 1 AND PROCEED THROUGH THE SUBSEQUENT KEYS AS INDICATED IN THE ACCOMPANYING TEXT.**

## KEY 1: FAMILIES

- A If the slug has a small external shell (at the hind end of the body), it is a member of the TESTACELLIDAE (KEY 5, page 823).



- B If the slug has no external shell, use the table below.

KEEL and TAIL	MANTLE	PNEUMOSTOME	FAMILY and KEY
No true Keel.* Blunt tail with mucus gland	Granular, no concentric rings	In front half of mantle	ARIONIDAE KEY 2 Page 814 
Keel extends from tail up to 2/3 distance to mantle. Tail pointed	Pattern of Fingerprint-like concentric ridges (USE HAND LENS)	In rear half of mantle	LIMACIDAE KEY 3 Page 819 
Keel extends from tail to mantle. Tail pointed	Mantle texture varies, but with pronounced grooves	In rear half of mantle	MILACIDAE KEY 4 Page 822 

\*Note: Some *Arion* have a "false keel" of slightly larger and paler tubercles in the mid-line. However, they have a caudal mucous gland and a rounded tail.

## KEY 2: ARIONIDAE

This family causes the greatest difficulties in field identification, and full identification to species quite often requires dissection, especially by those without previous experience. Many species have only been clearly recognised in the last ten years or so and it is certain that more will be discovered in the future. *Two important points should always be remembered.*

1. Juveniles, especially of the larger species, may be different in appearance to adults. In particular, they may be paler and show lateral bands which are obscure or absent in adults. They can be mistaken for adults of smaller species. The key allows for this as much as possible.
2. Most species have a wide range of variation in body colour and bands. Varieties common in one area may be rare or absent in another.

It may help to use the list below in conjunction with the key. In it, species are listed in order of decreasing size (extended length), and with a few taxonomic comments. Size can be used to eliminate certain species—e.g. a slug 15 cm long can only be *A. ater* or *A. rufus*, but a slug 3 cm long may be any species other than *A. intermedius*.

*List of Family Arionidae Slugs*

## Very large slugs (up to 15 cm, usually 10–12 cm)

- |                    |  |
|--------------------|--|
| <i>Arion ater</i>  | Indistinguishable without dissection. Colour not   |
| <i>Arion rufus</i> | reliable. Known together as <i>Arion ater</i> agg. |

## Large slugs (up to 12 cm, usually 8–10 cm)

- |   |  |
|---|--|
| <i>Arion lusitanicus</i>                    | Often indistinguishable from <i>Arion ater</i> agg. without dissection.  |
| <i>Arion</i> sp. 'Durham'                   | Previously confused with <i>A. lusitanicus</i> , as yet without a proper name. Can usually be distinguished from <i>A. ater</i> agg. and <i>A. lusitanicus</i> in the field. |
| <i>Geomalacus maculosus</i><br>(up to 9 cm) | In the British Isles, restricted to S.W. Ireland. Easily recognised in the field.  |

## Medium slugs (up to 7 cm)

- |  |   |
|--|---|
| <i>Arion subfuscus</i>                 | Usually identifiable in the field. It will probably turn out to be another complex of closely related species like <i>A. hortensis</i> agg. |
| <i>Arion fasciatus</i><br>(up to 5 cm) | One of three very similar species (with <i>A. circumscriptus</i> and <i>A. silvaticus</i> ) but usually identifiable in the field.          |

## Small slugs (up to 4 cm)

- |                               |  |
|-------------------------------|--|
| <i>Arion circumscriptus</i> } | Both similar to <i>A. fasciatus</i> . Usually distinguishable in the field when adult.   |
| <i>Arion silvaticus</i> }     |  |
| <i>Arion hortensis</i> }      | Very similar species, frequently requiring dissection, at least on first acquaintance. All previously included in <i>A. hortensis</i> , and referred to collectively as <i>A. hortensis</i> agg. |
| <i>Arion distinctus</i> }     |  |
| <i>Arion owenii</i> }         |  |

## Very small slug (up to 2 cm)

- |                          |   |
|--------------------------|---|
| <i>Arion intermedius</i> | Usually distinctive, but can be confused with juveniles of other species. |
|--------------------------|---|





1a



1b



2a



2b



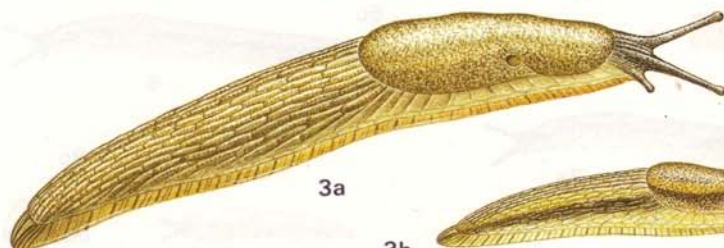
2c



2d



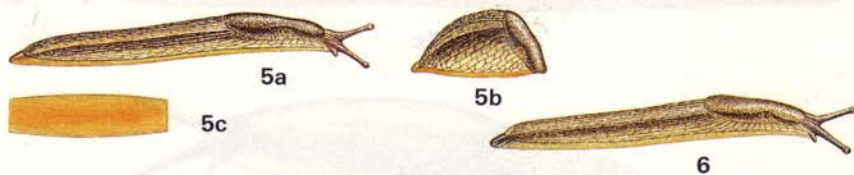
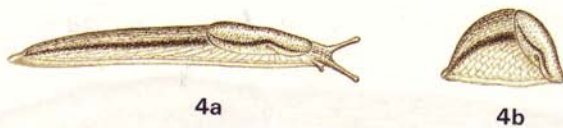
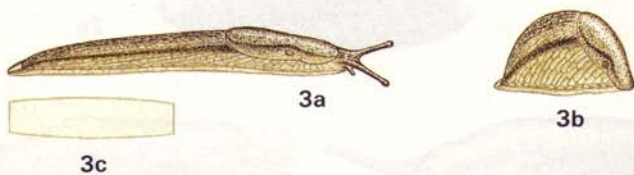
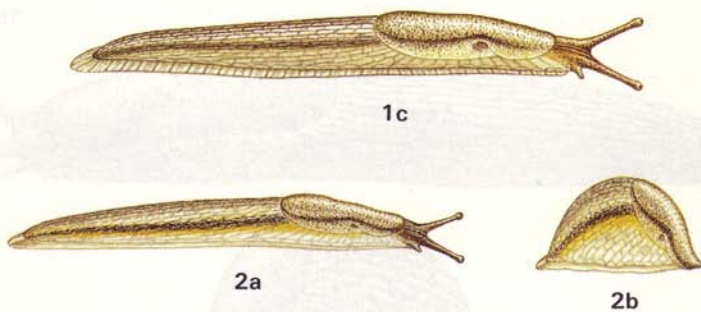
2e



3a



3b



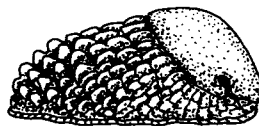
1. Body and mantle green-grey blotched with white. Contracts into ball by folding sole.

**Geomalacus maculosus**  
(Plate 1; 1)

Body and mantle not blotched with white,  
does not curl up by folding sole

—2

2. Less than 2 cm extended length. May appear prickly at rear when contracted. Usually greyish-yellow with darker head.

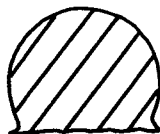


**Arion intermedius**  
(Plate 2; 8—see Note 1)

*Adults* more than 2 cm. Not prickly

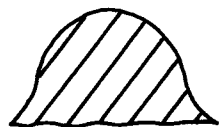
—3  
(see Note 1)

3. Less than 4 cm extended. Foot sole yellow or orange (and foot mucus likewise). Usually very dark or black above (rarely brown) with black lateral bands. Contracted body nearly circular in cross-section and not bell-shaped.



**Arion hortensis agg.**  
(Plate 2; 5, 6, 7—see Note 2)

May be larger than 4 cm. Foot sole white, pale yellow or dark, foot mucus usually colourless or pale yellow. May lack bands. Contracted body bell-shaped in cross-section.



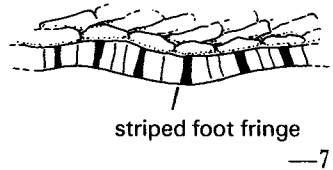
—4  
(see Note 2)

PLATE 2. 1. *Arion subfuscus*—a. Typical form, b. Contracted, c. Grey form. 2. *Arion fasciatus*—a. Extended, b. Contracted. 3. *Arion circumscriptus*—a. Extended, b. Contracted, c. Sole. 4. *Arion silvaticus*—a. Extended, b. Contracted. 5. *Arion hortensis*—a. Extended, b. Contracted, c. Sole. 6. *Arion distinctus*. 7. *Arion owenii*—a. Extended, b. Sole. 8. *Arion intermedius*—a. Extended, b. Contracted, c. Sole.

4. Up to 5 cm long. Foot sole opaque white, mucus colourless. Body grey or brownish above, with dark lateral bands, paler on flanks. "False keel" of raised pale tubercles often visible in mid-line near tail. Foot fringe pale and unmarked.

—5 (*Arion fasciatus* agg.)  
(see Note 3)

May be longer than 5 cm. Without false keel. If less than 5 cm, then with orange body mucus or with well marked dark transverse lines on foot-fringe.



—7

5. Up to 5 cm long. Body and mantle grey or brownish above, with *yellow* or *orange* flush below dark lateral band.

***Arion fasciatus***  
(Plate 2; 2—see Note 3)

Less than 4 cm long. Body and mantle dark grey above, paler on flanks below dark lateral bands. No orange or yellow flush band, but may be very weakly suffused with yellow all over.

—6

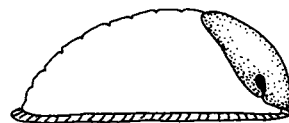
6. Grey above, with pale grey mantle without darker spotting. Flanks below well defined, lateral bands very pale.

***Arion silvaticus***  
(Plate 2; 4—see Note 3)

Grey above, but mantle with darker spotting, lateral bands less distinct, and flanks grey.

***Arion circumscriptus***  
(Plate 2; 3—see Note 3)

7. Up to 7 cm long. Body mucus very sticky and orange (smear on paper), sole mucus  $\pm$  colourless. Usually with lateral bands, and if so, then with 12+ tubercules between bands counted just behind mantle. Tubercules smooth and close set (See Fig. 2A below). Does not contract to hemisphere.



**Arion subfuscus**

(Plate 2; 1—see Note 4)

Up to 15 cm long. Body mucus colourless, greenish-yellow or very pale orange (the latter only in animals with much orange pigment in the skin). Often lacking lateral bands, and with larger and more prominent tubercules (Figure 2B and C). Can contract to hemisphere.



—8

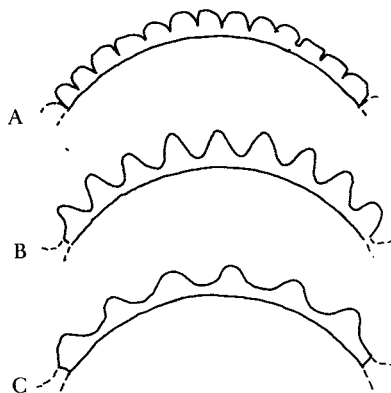


FIG. 2

Diagrammatic cross sections of the back just behind the mantle to show shape and size of tubercles in A. *Arion subfuscus*; B. *Arion ater* agg. and *A. lusitanicus*; C. *Arion* species "Durham".

8. Sole always pale. Does not rock from side to side when prodded. Usually with lateral bands. Dorsal tubercles prominent but widely spaced (with only up to 9 lying between bands behind mantle). Mucus usually with faint yellow or greenish tinge (Figure 2C).

**Arion sp. 'Durham'**

(Plate 1; 3—see Note 5)

Sole pale or dark, *may* rock when prodded, often without lateral bands. Dorsal tubercles prominent but closely spaced, with 10 + lying between bands when these are present. Mucus usually colourless, but may contain some colour in orange individuals (Figure 2B).

**Arion ater** agg.

(Plate 1; 2)

and **Arion lusitanicus**

(see Note 5)

## NOTES: ARIONIDAE SPECIES

Note 1. *Arion intermedius* is common and widespread. If the "prickles" do not show, it may be confused with juveniles of other species. In addition to characters given in the key it has yellow foot mucus, and the sole may also be yellow. Lateral bands are usually rather faint, and the anterior margin of the foot fringe is frequently spotted with black. Small juvenile *Arion ater* agg. and *A. lusitanicus* can look very like *A. intermedius*, but the foot fringe is usually well marked with dark transverse bands (see illustration accompanying couplet 4). More details on *A. intermedius* can be found in Davies (1977).

Note 2. The species in the *Arion hortensis* complex are hard to distinguish in the field without experience. In general, the features to look for are:

*Arion owenii*: Brownish above, often paling just above dark lateral bands, and with grey flanks. Tentacles pinkish-brown to purple, tail-tip with dark and light stripes. Tubercles rather sharply ridged when contracted, resembling *A. intermedius* (see illustration accompanying couplet 2). Adults most frequent in autumn. As far as is known, rather rare and local.

(Plate 2; 7)

*Arion hortensis*: Blue-black above, with much paler flanks. Lateral bands high up flanks, and on mantle, right band arches over pneumostome. Tentacles have a reddish tinge. Adults most frequent in autumn and winter. Common and widespread.

(Plate 2; 5)

*Arion distinctus*: Blue-black above, but with some overlay of yellow, giving a yellowish-grey appearance in lighter parts. Pale region of flanks much smaller and lower; lateral bands low on flanks, usually encompassing pneumostome. Tentacles grey or black. Adults most frequent in summer. Widespread and common.

(Plate 2; 6)

Since there is variation within each species, initial attempts to identify these species should be confirmed by dissection. Davies (1977 and 1979) gives full details.

Note 3. *Arion circumscriptus* and *A. silvaticus* have a characteristic "monochrome" appearance of black, neutral grey and white, the paler parts are particularly opaque. *A. fasciatus* can resemble *A. subfuscus* but does not have orange body mucus. Full accounts of internal diagnostic features can be found in Wiktor (1973) and Riedel and Wiktor (1974).

Note 4: Body colour in *A. subfuscus* varies from orange (usually with feeble darker lateral bands) to pale or dark grey, with some resembling *A. fasciatus* (see Note 3). *A. subfuscus* is common and widespread. It may turn out to be another species complex.

Note 5: *Arion lusitanicus* and *A. sp.* "Durham" have only recently been separated, and old records of *A. lusitanicus* may refer to either. (The specimen illustrated in the Field Guide (Kerney and Cameron, 1979) labelled *A. lusitanicus* is in fact *A. sp.* "Durham" and has been relabelled in the plates used in this guide.) These two species are more often banded when adult than *A. ater* agg. *A. sp.* "Durham" does not show the rocking response, and true *A. lusitanicus* very rarely does. In both species, colour varieties occur which resemble varieties of *A. ater* agg. Both are rarer and more local than *A. ater* agg. but in some places are very frequent. Details of *A. sp.* "Durham" (referred to as *A. lusitanicus*) can be found in Ellis (1964), Quick (1952) and Cain (in Conroy, 1980). Details of true *A. lusitanicus* can be found in Ellis (1965).

*Arion ater* and *A. rufus* are usually unbanded when adult. Colours range from black through dark greys to brown, orange and creamy-white. Lighter colour variants frequently have an orange-tinged foot fringe. The sole of black variants is frequently very dark. Juveniles are frequently paler than adults, and may have lateral bands, and yellowish grey juveniles with darker head and tentacles may resemble *A. intermedius* (see Note 1). Juveniles of all four large species have well marked foot fringes (couplet 4). The status of these two species is still not entirely clear, but they may be provisionally distinguished by dissection (Kerney and Cameron, 1979; Ellis, 1979). *Arion ater* agg. is very common and widespread.

**KEY 4: LIMACIDAE**

1. Less than 5 cm extended, keel truncated at tail when extended, concentric ridges on mantle centred on right side above pneumostome (see Plate 4). Not banded.

—7 (***Deroce****eras*)

(see Note 1)

Up to 20 cm extended, keel not truncated when extended, mantle ridges centred on mid-line (see Plate 3). May be banded.

—2 (***Limax***)

(see Note 1)

2. Body and mantle yellow or greenish, rarely brown, may have darker spots or blotches. Not more than 12 cm long.

—3

(see Note 2)

Body and mantle grey to black (sometimes with reddish tinge). Very rarely, keel may be yellow. Up to 20 cm long.

—5

(see Note 2)

3. Not more than 4 cm long. Body and mantle yellow, often with faint darker lateral bands but without darker blotches. Body mucus yellow or orange. Head and tentacles very dark.

***Limax tenellus***

(Plate 3; 3—see Note 3)

Up to 12 cm long. Yellow, brown or greenish, usually with darker spots or blotches but no lateral bands. Body mucus colourless or yellow.

—4

4. Usually greenish-grey, with large darker blotches on mantle and body. If keel distinctively pale then slug less than 2 cm. Dark pigment extends to foot fringe. Body mucus may be colourless or yellow.

***Limax maculatus***

(Plate 3; 4—see Note 4)

Usually yellow, with smaller dark blotches, on mantle and body. Keel may be pale in slugs more than 2 cm long. Pale zone lacking dark pigment extends above foot-fringe. Body mucus yellow.

***Limax flavus***

(Plate 3; 5—see Note 4)

5. Up to 8 cm long. Gelatinous and translucent, especially in wet weather, with copious colourless watery mucus when disturbed. Usually grey and with darker lateral bands on body *and mantle*, but these may be absent or broken up into rows of spots.

***Limax marginatus***

(Plate 3; 6—see Note 5)

Up to 20 cm long. Opaque unless very small, and with sticky mucus. May have bands on body, *but not on mantle*, which may be spotted, blotched or plain.

—6

(see Note 5)

6. Body and mantle usually grey or brownish. Usually with darker lateral bands (sometimes broken into spots) on body, and with darker spots or blotches on mantle. Tentacles pale (usually reddish-brown) without darker spots. Keel short (c.  $\frac{1}{2}$  of length between tail and mantle). Sole pale.

**Limax maximus**

(Plate 3; 2—see Note 6)

Body and mantle usually black. Tentacles grey with black spots (lens). Keel long ( $\frac{2}{3}$  or more distance from tail to mantle), and usually paler than body. Sole usually with dark strips at margins in adults.

**Limax cinereoniger**

(Plate 3; 1—see Note 6)

7. Body and mantle pale cream to dirty grey (occasionally darker), with or without darker flecking. Body mucus milky-white when disturbed. Up to 5 cm long.

—8

(See Note 7)

Body and mantle pale or dark, but usually with brown tinge (may be dark brown). Body mucus never milky white. Usually less than 3 cm long.

—9

(See Note 7)

8. Body and mantle with darker flecking and spotting, often giving the whole animal a dark appearance.

**Deroceras reticulatum**

(Plate 4; 1—see Note 8)

Body and mantle without darker flecking, pale oatmeal colour all over.

**Deroceras reticulatum**and **Deroceras agreste**

(Plate 4; 1 and 3—see Note 8)

9. Up to 2.5 cm long. Body and mantle pale chestnut to very dark brown, sole dark. Rim of pneumostome not conspicuous. Length of mantle c.  $\frac{1}{2}$  length from front of mantle to tail.

**Deroceras laeve**

(Plate 4; 2—see Note 9)

Up to 3.5 cm long. Body dark brownish grey and rather translucent, mantle usually paler brown. Sole pale. Rim of pneumostome usually conspicuously paler than rest of mantle. Mantle length c.  $\frac{1}{3}$  length from front of mantle to tail.

**Deroceras caruanae**

(Plate 4; 4—see Note 9)



NOTES: LIMACIDAE SPECIES

Note 1. *Deroceras* species can be very variable in colour, usually creamy white, grey or brown, occasionally almost black and may have darker flecks. *Limax tenellus* is only 4 cm long and is usually unbanded—it is yellow with darker tentacles, and has yellow body mucus. Mucus of *Deroceras* is colourless or white.

Note 2. Very rarely, *L. tenellus* may be brownish, and *L. marginatus* and *L. cinereoniger* may be yellowish, especially when young. Kerney and Cameron (1979) give details of anatomical differences.

Note 3. *L. tenellus* is a rare slug usually found in old woodland (including conifers where these are present in old woods).

Note 4. *L. maculatus* has only recently been distinguished from *L. flavus* in Britain, and has been recently described under the names *L. grossui* (Chatfield, 1976) and *L. pseudoflavus* (Evans 1978, a and b; 1982). Further details are given by Wiktor and Norris (1982). *L. flavus* is usually found in gardens, outhouses etc, and sometimes enters houses. *L. maculatus* lives in more natural habitats (but also in gardens). Its distribution is less well known than that of *L. flavus*, but it is widespread in Ireland, and occurs on Merseyside and elsewhere in Britain. The specimen illustrated in Plate 3 is a typical Irish specimen; specimens from England show more variation, and many require dissection to confirm their identity (Evans, 1982, who also points out defects in earlier keys based on external features). *L. flavus* sometimes lacks mottling and is plain yellow or brown.

Note 5. *L. marginatus* climbs trees very readily, and may also be found on rocks. There are frequently two darker bands on each side of the mantle. It is additionally distinguished from *L. maximus* and *L. cinereoniger* in that it cannot raise the anterior surface of the mantle away from the head.

Juvenile *L. cinereoniger* may be translucent, and may have bands on the mantle, although this is rare. Their tentacles are spotted with black (use hand lens), while those of *L. marginatus* are pale.

A number of *Limax* species accidentally introduced from abroad are naturalized in greenhouses etc (usually in Botanic Gardens). They are similar to *L. marginatus*. For further details see Kerney and Cameron (1979).

Note 6. *L. maximus* is common and widespread. There are many variations in colour and pattern, but it is rare for bands or spots and blotches to be completely absent.

*L. cinereoniger* is less common, and particularly associated with old woodland. Adults are usually unbanded, but may show paler colours than the more usual black or dark grey. Juveniles are usually lighter, may be banded, and lack the darker strips on the sole, but have dark-spotted tentacles. The dark strips on the sole may be dilute or missing in some adults. Internal diagnostic characters are given in Kerney and Cameron (1979).

Note 7. In addition to the characters mentioned in the key, the following may sometimes be useful. Individuals keying to couplet 9 tend to be more active and fast moving when disturbed and show signs of aggression towards other slugs. The larger specimens keying out to couplet 9 (more than 2.5 cm long) tend to be rather translucent.

Note 8. *D. reticulatum* is a very common and widespread species, and a notable pest of farms and gardens. *D. agreste* is very local and much rarer. It does not have darker flecks on body and mantle, but since *D. reticulatum* may also lack such flecks, dissection is required for certain identification. Details are given in Kerney and Cameron (1979).

Note 9. *D. laeve* is common and widespread in wet habitats (especially fens, water-meadows, etc.). Paler specimens often have darker flecks. The mantle has fewer and more widely spaced concentric ridges than *D. caruanae*.

*D. caruanae* is widespread in gardens, parks and waste ground, but does occur in more natural habitats, especially in the south, and near the sea. Details of internal diagnostic features are given in Kerney and Cameron (1979).

## KEY 4: MILACIDAE

1. Keel usually lighter than rest of body (may be very thin). When contracted, body in C-shape (Plate 4; 10b) or Keel crinkled (Plate 4; 8b).

—2

(See Note 1)

Keel usually same colour or darker than rest of body. Keel not crinkled in contraction, and body does not assume C-shape.

—3

(See Note 1)

2. Up to 8 cm long. Keel crinkled when contracted, outer rim of pneumostome pale, sole pale, tubercles large, humped in contraction (Plate 4; 8b) with body mucus yellow and very sticky. Usually brown-grey with darker spotting.

**Milax sowerbyi**

(Plate 4; 8—see Note 2)

Up to 6 cm usually smaller (to 4 cm). Keel not crinkled in contraction, when body frequently in C-shape (Plate 4; 10b), tubercles small. Sole dark in centre. Outer rim of pneumostome dark (pale interior may cause confusion (Plate 4; 10a and c). Usually olive-grey with darker flecks and spots.

**Milax budapestensis**

(Plate 4; 10—see Note 2)

3. Up to 6 cm extended. Smooth, grey or black, paler on flanks, keel prominent. Mantle rounded at rear.

**Milax gagates**

(Plate 4; 9—see Note 3)

Up to 4 cm, very thin and worm-like when active, body pale yellowish grey with darker keel and tentacles. Mantle pointed at rear.

**Boettgerilla pallens**

## NOTES: MILACIDAE SPECIES

Note 1. Rarely, keel colour may not correspond with this key, which can lead to confusion between *Milax* species. The other characters given are more reliable, and in cases of doubt a specimen should be tried out in couplets 2 and 3.

Note 2. *M. sowerbyi* is widespread, and the least “domestic” of the Milacidae. It can be confused with *M. gagates*, but the crinkly keel, yellow and sticky mucus, dark spotting and rough appearance are distinctive.

*M. budapestensis* is a widespread pest, especially of root crops. It does not contract into the characteristic hump of *M. gagates* and *M. sowerbyi*, and is low and slender when fully extended.

Note 3. *M. gagates* is usually found in gardens etc. It is widespread but not very common. It is smoother in appearance than *M. sowerbyi* (see Note 2).




Another species, *Milax nigricans* has been recorded once in Britain, and might be found again. It would key out as *M. gagates*, but is very dark and has coarse tubercles. Details of internal differences between *Milax* species are given in Kerney and Cameron (1979).

Note 4. *B. pallens* has only recently been discovered in Britain, but is known from many widely scattered localities, usually in parks and gardens. It is probably a recent accidental introduction.

PLATE 3. 1. *Limax cinereoniger*—a. Sole, b. Extended. 2. *Limax maximus*—a. Sole, b. Extended, c. Spotted form. 3. *Limax tenellus*. 4. *Limax maculatus*. 5. *Limax flavus*. 6. *Limax marginatus*.

## KEY 5: TESTACELLIDAE

Use the table of characters below and Illustrations in Plate 4.

SHELL	LATERAL GROOVES	BODY	SPECIES
Large and oblong 12–16×6–7 mm 	Lateral grooves far apart at junction with shell	Colours: Brown or Grey, less often rufous or black. Sole often pink or orange	<b>Testacella maugei</b> (Plate 4; 5)
Small, slightly convex and 7–8×4 mm 	Lateral grooves close together at junction with shell	Colour: Creamy white or yellow. Sole whitish	<b>Testacella haliotideae</b> (Plate 4; 6)
Small, flattened and triangular 6–7×4 mm 	Lateral grooves combine before junction with shell	Colour: Yellow speckled with black or brown. Sole orange yellow	<b>Testacella scutulum</b> Plate 4; 7)

## Notes:

1. All are large slugs when adult (6–12 cm long when extended).
2. All *Testacella* species are rare and local, commonest in the south and west. They are carnivorous, living on earthworms, and are usually subterranean. Gardens and old compost heaps are probably favoured habitats.

PLATE 4. 1. *Deroceras reticulatum*—a. Typical form, b. Pale form. 2. *Deroceras laeve*. 3. *Deroceras agreste*. 4. *Deroceras caruanae*. 5. *Testacella maugei*—a. Typical form, b and c. Shells. 6. *Testacella haliotideae*—a. Typical form, b and c. Shells. 7. *Testacella scutulum*, a. Typical form, b and c. Shells. 8. *Milax sowerbyi*—a. Extended, b. Contracted, c. Sole. 9. *Milax gagates*—a. Extended, b. Contracted. c. Sole. 10. *Milax budapestensis*—a. Extended, b. Contracted, c. Sole. 11. *Boettgerilla pallens*.

## ACKNOWLEDGEMENTS

We are indebted to the many people who used and tested earlier versions of keys to slugs, and particularly to Mrs Stella Davies, Professor A. J. Cain and Dr N. Evans for expert advice. R.A.D.C. would also like to thank Steve Tilling, the AIDGAP co-ordinator, for personally supervising and analysing the testing procedure. The AIDGAP project is grateful to Gordon Riley, the artist, and Collins, the publishers, for granting permission to reproduce the colour plates, which originally appeared in Kerney and Cameron's handbook *A Field Guide to the Land Snails of Britain and North-west Europe*.

## REFERENCES

- CHATFIELD, J. E. (1976). *Limax grossui*, a slug new to Britain. *Journal of Conchology*, London 29; 1-4 (refers to *L. maculatus*).
- CONROY, B. A. (1980). Co-existence of two closely related species of *Arion* in natural habitats. *Journal of Conchology* 30; 189-200. (Contains note by A. J. Cain: 'On the form of *Arion lusitanicus* Mabilie on the Wirral peninsula'.)
- DAVIES, S. M. (1977). The *Arion hortensis* complex, with notes on *Arion intermedius*. *Journal of Conchology* 29; 173-187.
- DAVIES, S. M. (1979). Segregates of the *Arion hortensis* complex with the description of a new species, *Arion owenii*. *Journal of Conchology* 30; 123-127.
- ELLIS, A. E. (1964). *Arion lusitanicus* Mabilie in Cornwall. *Journal of Conchology* 25; 285-287.
- ELLIS, A. E. (1965). *Arion lusitanicus* Mabilie in Devon. *Journal of Conchology* 25; 345-347.
- ELLIS, A. E. (1969). *British Snails* (2nd edition). London: O.U.P.
- ELLIS, A. E. (1979). *Key to British Slugs. Papers for students No. 12* (2nd edition). Cyclostyled publication of the Conchological Society of Great Britain and Ireland.
- EVANS, N. J. (1978a). *Limax pseudoflavus* sp. nov. A new species of slug for Ireland. *Irish Naturalist's Journal* 19; 173.
- EVANS, N. J. (1978b). *Limax pseudoflavus* Evans; a critical description and comparison with related species. *Irish Naturalist's Journal* 19; 231-236.
- EVANS, N. J. (1982). Observations on variation in body coloration and patterning in *Limax flavus* L. and *Limax pseudoflavus* Evans. *Journal of Natural History* 16; 847-857.
- EVSERHAM, B. and JACKSON, N. (1982). *Slugs: A Key for amateurs and professionals*. (Privately published by N. Jackson, ISBN: 0 9507325 1 6.)
- JANUS, H. (1965). *The young specialist looks at land and freshwater Molluscs*. London: Burke.
- KERNEY, M. P. (1976). *Atlas of the non-marine Mollusca of the British Isles*. Cambridge: I.T.E.
- KERNEY, M. P. and CAMERON, R. A. D. (1979). *A Field Guide to the Land Snails of Britain and N.W. Europe*. London: Collins.
- MCCRACKEN, G. F. and SELANDER, R. K. (1980). Self-fertilization and monogenic strains in natural populations of terrestrial slugs. *Proceedings of the National Academy of Science, U.S.A.* 77; 684-688.
- QUICK, H. E. (1949). *Slugs. (Mollusca: Testacellidae, Arionidae, Limacidae)*. *Synopses of the British Fauna No. 8*. London: Linnean Society.
- QUICK, H. E. (1952). Rediscovery of *Arion lusitanicus* in Britain. *Proceedings of the Malacological Society of London* 29; 93-101.
- QUICK, H. E. (1960). British Slugs (Pulmonata: Testacellidae, Arionidae, Limacidae). *Bulletin of the British Museum (Natural History) (Zoology)* 6; 103-226.
- RIEDEL, A. and WIKTOR, A. (1974). *Arionacea: Slimaki Krazalkowate i slinikowate*. *Fauna Polski*, Vol. 2. Warsaw: Polska Akademia nauk Instytut Zoologii. (In Polish.)
- WIKTOR, A. (1973). *Die Nachtschnecken Polens. Monographie Fauna Polski*, Vol. 1. Warsaw: Press of the Polish Academy. (In German.)
- WIKTOR, A. and NORRIS, A. (1982). The synonymy of *Limax maculatus* (Kaleniczenko 1851) with notes on its European distribution. *Journal of Conchology* 31; 75-78.