Fld Stud. (1978), 4, 671–692

VALLEY DEPOSITS AT JUNIPER HALL, DORKING: A PHYSICAL AND ECOLOGICAL ANALYSIS WITH EMPHASIS ON THE SUB-FOSSIL LAND SNAIL FAUNA

By B. W. BARRETT and J. E. CHATFIELD
Faculty of Educational Studies, Portsmouth Polytechnic and
Department of Zoology, National Museum of Wales, Cardiff

Introduction

Snail shells may be preserved in calcareous sites in considerable numbers, and can be used in the study of past environments. The use of sub-fossil snails in this way was pioneered by the teamwork of A. S. Kennard and B. B. Woodward in the late nineteenth century and in the first part of the present century, but the later work of B. W. Sparks and M. P. Kerney laid the foundations of a more quantitative approach with a finer appreciation of stratigraphy. More recently a book has been published (Evans, 1972) which gives full details of the methods used in snail analysis and in the interpretation of results.

Snail shells have been used in the study of deposits from the Pleistocene interglacials and interstadials, the Post-glacial and also of soils from archaeological sites. An attractive feature of snail analysis is the fact that most of the species are still in existence, and from knowledge of their present day ecology we can postulate fairly confidently about conditions in the past. The general principles of the more publicized pollen analysis apply also to snail analysis and the latter usefully fills a gap for calcareous sites where pollen is poorly preserved. Sub-fossil snail shells may be found in a number of different situations, but valley bottom deposits accumulated from adjacent hill-sides, as described in the present work, are particularly common.

Description of the Site

The valley deposits described in this paper were examined in two trenches excavated in the grounds of Juniper Hall Field Centre, Dorking, Surrey (TQ/173527). This Field Centre is situated in a chalkland dry valley (trending approximately NE–SW) that connects with the valley of the River Mole to the west. The Juniper Hall valley is bounded by the steep slope (27°) of White Hill to the north and less steeply (*circa* 10°) by Lodge Hill to the south. Details of the topography including the almost flat valley floor and the marked asymmetry of the valley sides are shown in Fig. 1, which is a N–S transverse section drawn across the valley along the line of the trenches. Fig. 2 shows the detailed locations of the trenches, one of which was dug near the boundary fence south of the walled garden and the other excavated some 30 m away on the north side of the walled garden. The valley floor where the samples were taken is about 55 m above sea level.

Methods

Fieldwork

Trench 1: Sections 1A and 1B

In April 1972 a trench was excavated in the garden of Juniper Hall in preparation for a soakaway drain. Advantage was taken of this to observe and record the nature

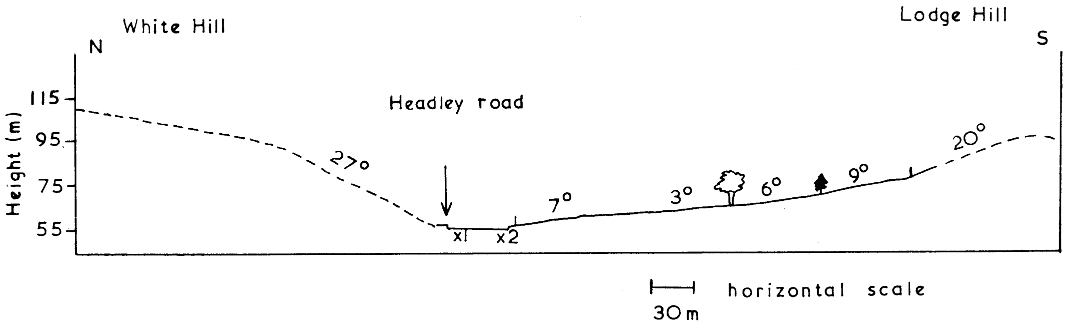


FIG. 1.

A transverse section across the valley in the line of the trenches. Angles of slope, measured with an angle meter, are shown. Dotted lines indicate an estimated profile in areas which were heavily wooded and inaccessible.

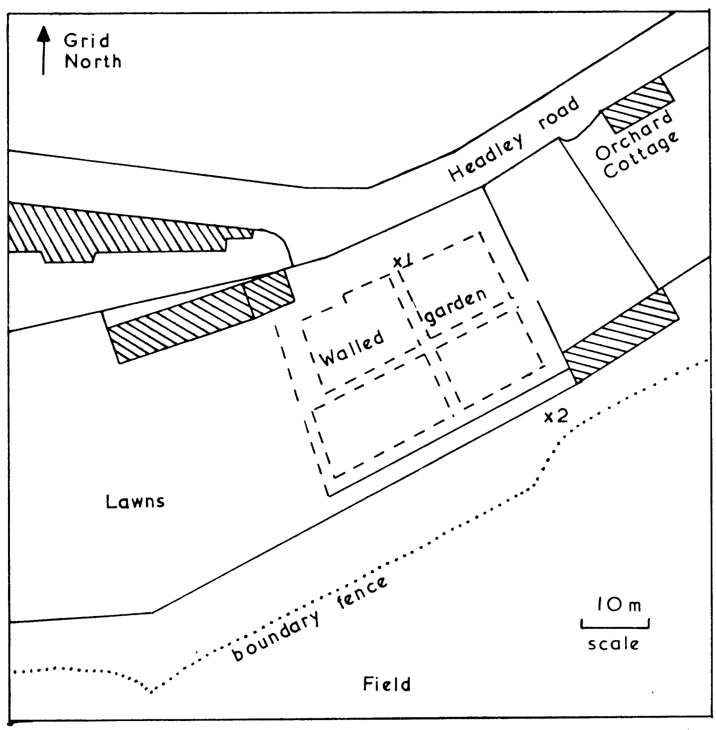


FIG. 2.

A plan of the walled garden at Juniper Hall showing the location of Trenches 1 and 2.

of the valley bottom infill on the east face of the trench and to extract a continuous column of it at 5–10 cm intervals to a depth of 2·10 m. Prior to recording, the face of the section was cleaned and the serial samples of infill material carefully dug out and placed in labelled polythene bags. Each sample weighed in excess of 1 kg. At a depth of 145 cm a sandy layer crossed the section (1B) diagonally, and additional serial samples were taken to the right (south) to obtain a more representative series; this sequence (at 135–170 cm) has been subsequently incorporated with the direct sequence from 0–135 cm and 170–210 cm and referred to as Section 1A (Fig. 3). Section 1B refers to the direct sequence only between 135 and 170 cm through the sandy layer (Fig. 3). The term "section" is used to refer specifically to the columns of serial samples.

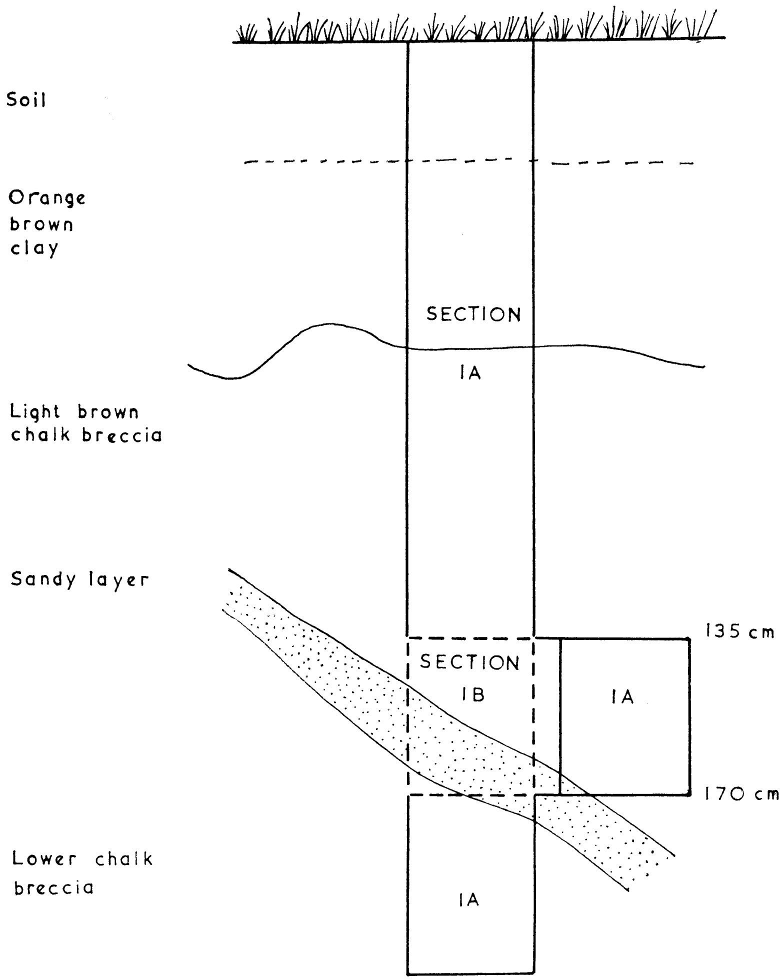


Fig. 3.
Diagram of Trench 1 showing the locations of Sections 1A and 1B.

Trench 2:

Prior to serial sampling in 1972, the project had been originally initiated in 1971 when a straight-sided trench (2·5 m × 0·75 m) was dug to a depth of 2·5 m with the assistance of students. A description was made of the west face and initial spot samples taken in different layers. Subsequently the trench was dug to a depth of 3·7 m under the direction of Mr E. Payne, the Assistant Warden. In 1973 serial samples were taken from the south face from the surface down to a depth of 1·85 m. A Fujihira Standard Soil Colour Chart was used to describe the colour and an account made of the appearance and texture of each sample. Because of the textural characteristics and cohesive nature of the infill below 167 cm, sampling ceased at a depth of 1·85 m.

Laboratory work

Each sample was air-dried and 1 kg of it oven-dried to constant weight. The oven-dried sample was divided into two parts and placed in sieves of 0·5 mm mesh, each within a plastic bowl. Water was added and any floating snail shells were collected. The sieve was taken out of the water and when the water had drained out, 100 volume hydrogen peroxide* was carefully added. This broke down the organic structure of the soil and so facilitated the subsequent sieving of each sample through a nest of sieves of 2·0, 1·0 and 0·5 mm mesh. The material was washed through with a jet of water entering the top sieve. When the sample had been divided into fractions, the residue in each sieve was dried in a warm oven. The residue retained in the 2 mm mesh was re-sieved with a 4 mm sieve thus separating the larger stones. Each dried fraction was re-weighed for comparison with the initial oven-dry weight. These weights formed the basis of the physical analysis. The shells were then extracted by eye or by scanning under a ×10 stereomicroscope, according to the grade of the sample. Notes were made on the mineral material.

An alternative method adopted for Trench 2 and some of the Trench 1 samples, was to omit the initial washing, to place the material in sieves of 0·25 mm mesh and to treat with hydrogen peroxide immediately. After washing through (with water) to remove the finer fraction (less than 0·25 mm) the samples were oven-dried and sieved as before.

With both methods the finest fraction was allowed to escape into a sump. Some of this fine material was checked and showed very few shell fragments and no apices. The separation of each sample into sieved fractions made the sub-fossil shells easier to find. The shells were then identified and the numbers of each species recorded. The counts were based on apices, but notes were made of other recognizable fragments. Further information on the methods for snail analysis, including identification, can be found in Evans (1972).

Results

1. *Description and physical analysis*

A labelled diagram showing the nature of the column of samples studied in each trench, and their various divisions, is given as parts of Figs. 6 and 7. For

* This substance is caustic and can cause blisters on the skin, so rubber gloves are a necessary protection. It is also essential to ensure that the liquid does not splash into the eyes.

each section notes were made on the visual appearance in the field; whilst the relative quantity of humic material was assessed from the reaction of the soil to 100 volume hydrogen peroxide (see opposite); the mineral composition was determined from the sieved material and the proportions of particles of various sizes were measured by weight (see opposite).

(a) Visual appearance in the field

A dark brown soil layer occurred at the top of each trench but it was deeper (30 cm)* in Trench 1 than in Trench 2 (10 cm). Trench 2 gave a colour reading of Hue 7·5 YR 3/3 (Fujihira Standard Soil Colour Chart). Below these soils both sections revealed a brownish clay layer which, in Trench 1 had an orange tinge and in Trench 2 a yellowish tinge (Hue 10 YR 3/4). These clay layers extended to 75 cm in Section 1A and to 90 cm in Section 2 and each comprised a mixture of clay, chalk chips (up to 1 cm) and flint fragments and pebbles (to 10 cm). The chalk chips and the flints were mostly sub-rounded or sub-angular. In Trench 1, apart from a stonier layer at 55–65 cm, there was a steady increase in the chalk content to 75 cm, whilst in Trench 2 the chalk chips were (in the comparable levels) smaller and less frequent. At 75 cm the clay division of Trench 1 gave way along a sharp boundary (which undulated on either side of the column of samples) to a division of chalk breccia (Fig. 6, division C). The proportion and size of the chalk chips increased with depth (1 cm at 75 cm to 3 cm at 170 cm), although at about 100 cm there was a stonier band, and at 135–155 cm a zone of marly lumps. By contrast the clay (Fig. 7 division b) in Trench 2 was separated downwards from the next extensive division (d) by a thin indurated zone (c) rather than by a sharp and undulating boundary. This zone (c) (90–110 cm) was darker, stonier and more compact than the brown clay division above and it gave a gleyed appearance. Below this (110–167 cm) Trench 2 contrasted with Trench 1 in a reversion to clay with occasional chalk chips and flints (Hue 5 YR 4/4 : 6/4). In this division (d) the flints and chalk chips were small (1–3 cm) and scattered, except at 125–130 cm where there was a band of flints (3 cm across) and below 155 cm (flints to 8 cm). Thus in Trench 2 the finer matrix was more dominant than in Trench 1 and probably accounted for the deeper colour.

Trench 1 also differed from Trench 2 in the presence of a diagonal zone of apparently sandy material described in part as Section 1B and its position illustrated in Fig. 3.

At the level of about 170 cm both trenches showed the presence of a chalk breccia which continued to the foot of Trench 1 at 215 cm and the foot of Trench 2 at 370 cm. In each case the upper boundary was marked by an increase in the amount and/or size of the chalk and flint.

The chalk lumps in Trench 1 (division d) remained at about 3 cm across but the flints measured 6 cm at 180 cm depth with tabular flints of 10 cm long at 200 cm. In Trench 2 the chalk was larger and measured 7 cm at 180 cm and 20 cm in length from 330 cm. Both breccias were cemented by a pale yellow brown material that, in Trench 2, gave a colour reading of 10 YR 3/8 to 7·5 YR 3/8 at 180 cm.

* All depths are measured *down* from present ground level.

(b) Humic content

In both trenches the dark brown soil at the top of the trench was rich in humus, but some (less vigorous) effervescence with 100 volume hydrogen peroxide was recorded in a few samples from greater depth, indicating the presence of some humic material at 145–150 cm in Sections 1A and 1B and at 105–110 cm and 160–167 cm in Section 2.

(c) Mineral composition

In both Sections 1A and 1B, the coarser material (more than 2 mm) from the upper two layers was mostly broken angular flint and sub-angular chalk. In Section 1A chalk dominated from 10 cm downwards. The finer material (less than 2 mm) from the soil layers (division a) included flint, chalk, quartz (of various colours), pyrites, charcoal and artefacts like brick, clinker, and glass. In Section 2 quartz grains were dominant in the 0·5–1·0 mm siftings in the brown clay division (b) and the indurated layer (c), but it contributed only about 50% in the succeeding chalky orange clay division (d). Conversely the proportion of chalk fragments increased and became dominant below 167 cm in the finer siftings.

In contrast, in Section 1A, the 0·5–1·0 mm siftings contained mostly chalk, while quartz contributed less than 10%, except in the soil levels and at 65–70 cm: similarly in the 1–2 mm grade. There was a slight increase in quartz in the vicinity of the sandy layer in Section 1A, but even within this layer in Section 1B, quartz comprised only about 10% of the various grades. The sandy layer of Section 1B consisted mostly of very fine chalk fragments. In both trenches chalk dominated all grades of siftings below about 170 cm (i.e. coarse chalk breccia).

In Trench 1 pseudomycelia (a filamentous form of carbonate concretion) were present at 145–150 cm (a feature also referred to by Kerney, Brown and Chandler, 1964); echinoid (sea urchin) spines at 170–190 cm and cylindrical rods (probably root casts) at 180–210 cm whilst in Trench 2 root casts occurred at 100–105 cm and 140–155 cm. At many levels in both trenches some of the quartz grains were ovoid in form and with a patterned surface.

(d) Particle sizes

The analysis of particle sizes was done by sieving and the results (Fig. 4) show that, within the size ranges chosen, Section 1A contained consistently coarser material than Section 2. In neither sequences is there any obvious difference between the soil and the brown clay layers, but in Section 1A there are breaks in the variation pattern at about 75 cm and at 175 cm. The first corresponds to the incidence of chalk breccia (c) and the second with the coarser chalk breccia (d). In Section 2 increase in the proportion of coarser grades between 95–110 cm corresponds to the stony, indurated zone (c), but the pattern reverts for the succeeding chalky orange clay division (d). The increase in coarse material from 167 cm matches the incidence of the chalk breccia (Fig. 7).

In the levels where part of Section 1A is paralleled by Section 1B (Fig. 3, Appendix 1), there was little difference at 135–140 cm but subsequently the proportion of fine material increased abruptly to dominate the section from 150–170 cm. In view of the very small proportion of material exceeding 0·25 mm it would be appropriate to describe this band as a fine sand.

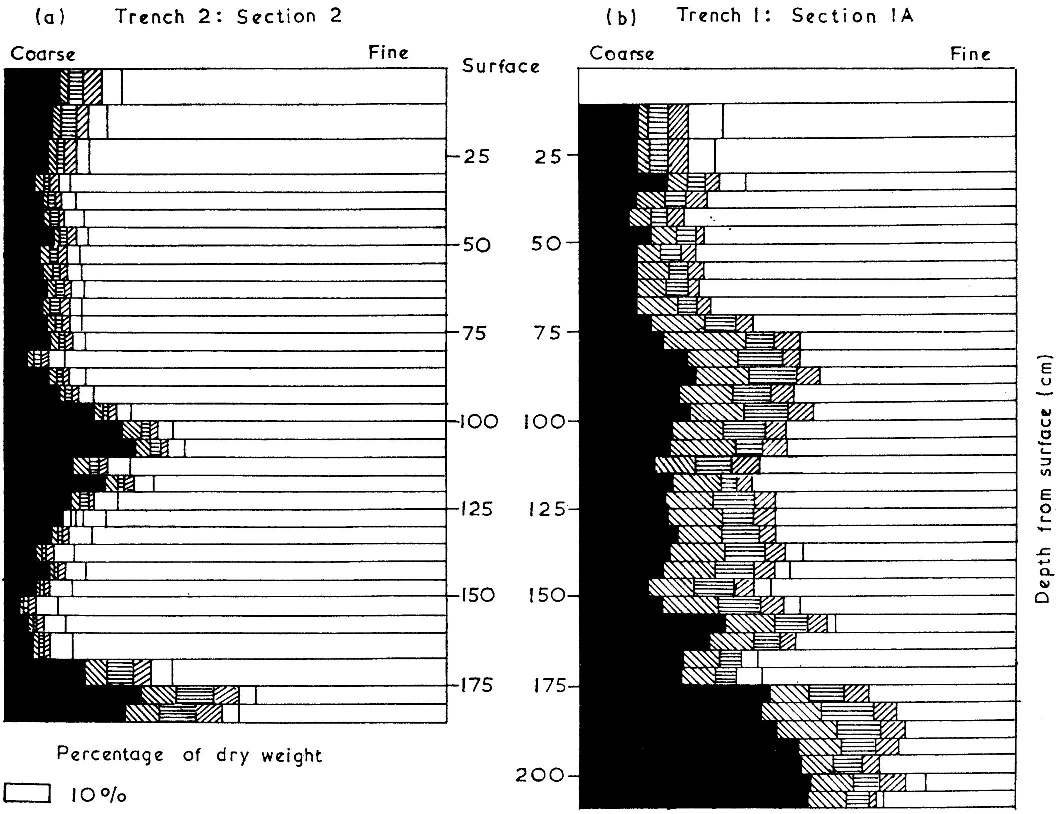


FIG. 4.

Diagram to show the relative percentages (by weight) of soil particles of different sizes in serial samples from Trenches 1 and 2. The length of the horizontal bar indicates the percentage and each size category is distinguished by shading. Results for Section 1B are shown in Appendix 1.

Key: More than 4 mm; 2–4 mm; 1–2 mm; 0·5–1 mm; less than 0·5 mm.

Where a vertical line is present this shows the percentage of particles of 0·25–0·5 mm separately from those less than 0·25 mm.

2. *Analysis of the sub-fossil snail shells*

Trench 1: Section 1A (See Appendix 1 for Section 1B)

The total numbers of snail shells and the numbers of species represented in the serial samples for Section 1A are shown in Appendix 2a. By comparison with other studies of this kind (Kerney, Brown and Chandler, 1964), the figures for the total numbers of snails from a kilogram sample are relatively small, but Kerney *et al.* (1964) found snail shells in greatest abundance in deposits of chalk mud rather than chalk rubble such as occurred at Juniper Hall. In the samples from Section 1A the maximum number of shells was 161 (at 35–40 cm) and the minimum 6 (at 180–185 cm). The maximum number of species was 21 (at 55–60 cm) and the minimum three (at 200–205 cm). Shells of the burrowing snail *Cecilioides acicula* were not counted in these totals and the occurrence of this species is described later in a separate section (p. 681). In general terms there was an increase both in the total numbers of shells and in the numbers of species of non-marine Mollusca from the foot of the trench upwards with the exception of a richer layer from 120–135 cm, but there was no corresponding increase in the species diversity at this level. At 170 cm there was an abrupt decline in the total numbers of shells and in the numbers of species present. Detailed analysis of the snail shells from samples above 35 cm was not undertaken since the trench was within a cultivated garden and the top layers must have been disturbed.

Fig. 5 shows the percentages of the total numbers of snails falling into the ecological divisions of open country, intermediate and shade-loving species. In Section 1A (Fig. 5b) open country snails were dominant from 75 cm downwards. Percentages of intermediate category snails ranged from 5·9–52·5% whilst the percentages of shade-loving snails (sometimes absent below 175 cm) ranged from 0–50%.

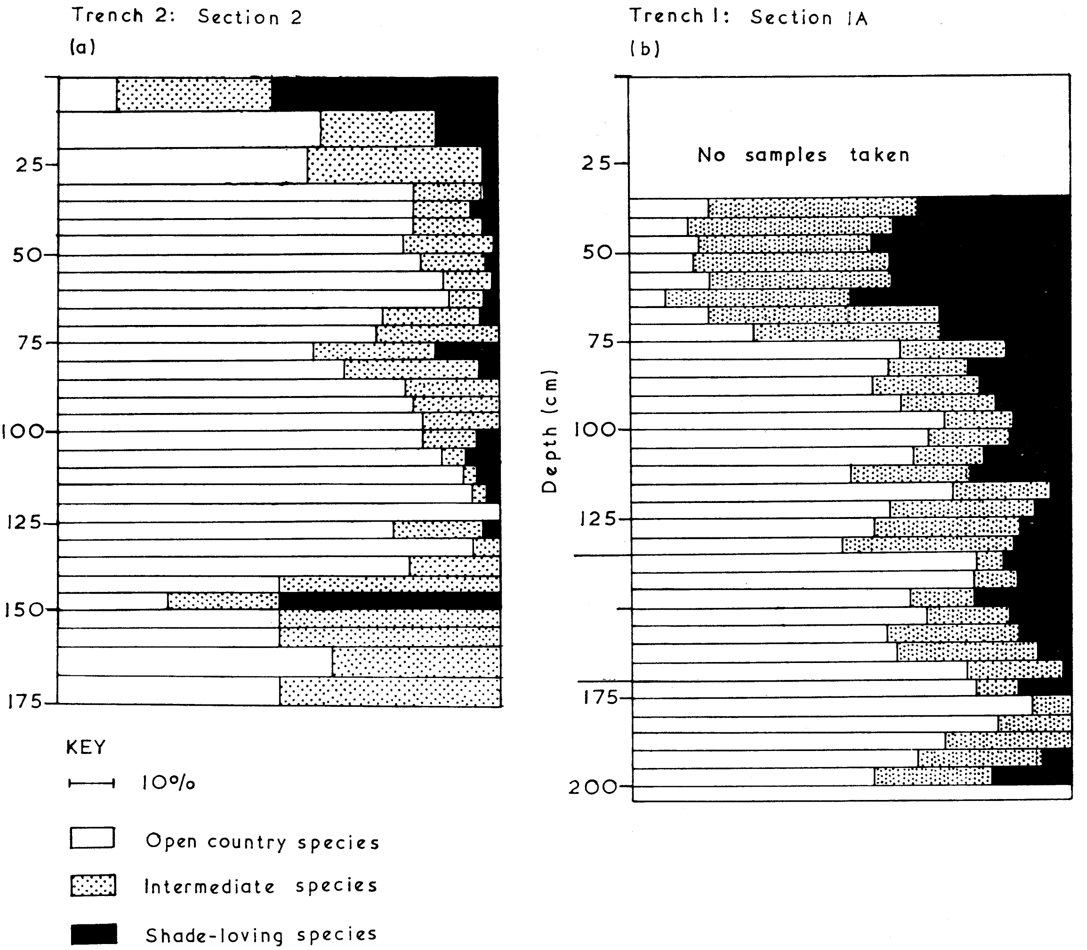


FIG. 5.

Bar diagram to show the relative percentages of snails from three ecological categories in the deposits from Trenches 1 and 2. The ecological groups are denoted by shading and the length of the horizontal of each band indicates the percentage represented by each ecological group. Results for Section 1B are shown in Appendix 1.

In the top layers (35–70 cm) intermediate and shade-loving snails dominated and they occurred in similar proportions. Below 75 cm the proportions of intermediate and shade-loving species diminished and the fauna was dominated by an open country assemblage.

Fig. 6 shows the percentage distribution of each species in Section 1A: the species are arranged in three ecological groups and within that they are mostly in taxonomic order. The names follow the recent check-list of British non-marine Mollusca (Waldén, 1976). The diagram shows the importance of *Pupilla muscorum*, *Vallonia excentrica* and *Trichia hispida* throughout the section, particularly below 75 cm, and the relative persistence of other species including *Abida secale*, *Helicella itala*, *Cochlicopa lubrica* agg., *Punctum pygmaeum*, *Vitrina pellucida* and limacid slugs. These persistent species included both abundant and less abundant species and also representatives from each habitat group. Some species were absent in the lower levels and made an appearance only in the upper layers from 80 cm to 35 cm. These included *Vertigo pygmaea*, *Pomatias elegans*, *Aegopinella nitidula*, *A. pura* *Carychium tridentatum*, *Vitrea crystallina* agg. and *Discus rotundatus;* the last being one of the most abundant species in these upper layers.

Within the open country group below 75 cm *Pupilla muscorum* and *Vallonia excentrica* were relatively abundant. *Abida secale* and *Helicella itala* were less numerous and the remaining open country snails, *Vertigo pygmaea* and *Vallonia costata*, were similarly sparse and also limited in their distribution. Below 75 cm *Trichia hispida* was the dominant member of the intermediate category and it accounted for most of the specimens at certain levels. *Cochlicopa lubrica* agg., *Oxychilus* spp. and limacid slugs were some of the other intermediate category molluscs which occurred both below and above 75 cm. The intermediate fauna also included *Pomatias elegans*, *Aegopinella nitidula*, *Cepaea* spp., *Helix aspersa* and *H. pomatia*. In the upper levels, especially, there was a range of shade-loving species including *Carychium tridentatum*, *Punctum pygmaeum*, *Discus rotundatus*, *Vitrina pellucida*, *Vitrea crystallina* agg., *Aegopinella pura*, *Euconulus fulvus*, Clausiliidae and others occurring less consistently. Some of these (*Punctum pygmaeum*, *Vitrina pellucida*, *Nesovitrea hammonis* etc.) occurred also in small numbers in the levels below 75 cm.

In comparison with Section 1A, Section 1B at 135–170 cm (Appendix 1) showed that the open country snails remained dominant between 135–145 cm (as in Section 1A). The intermediate category was of greater importance here and included up to 42% of the total. In the sandy layer (150–170 cm) there was a slightly greater proportion of open country snails compared with the data for Section 1A. In respect of individual species, Section 1B showed few differences in the general features of the distributions, the chief exception being the reversal of the relative importance of *Vallonia excentrica* and *Pupilla muscorum* between 150 and 170 cm. At these same levels there was a total absence of *Trichia hispida*. In terms of numbers of snails, Section 1B tended towards lower totals, especially in the sand band which yielded only 26 shells.

Trench 2: Section 2

In the samples from Trench 2 there were generally fewer shells than in Trench 1 and there were also fewer species (Appendix 2b). The maximum number of shells was 161 (in the topsoil at 0–10 cm); the maximum number below 30 cm was

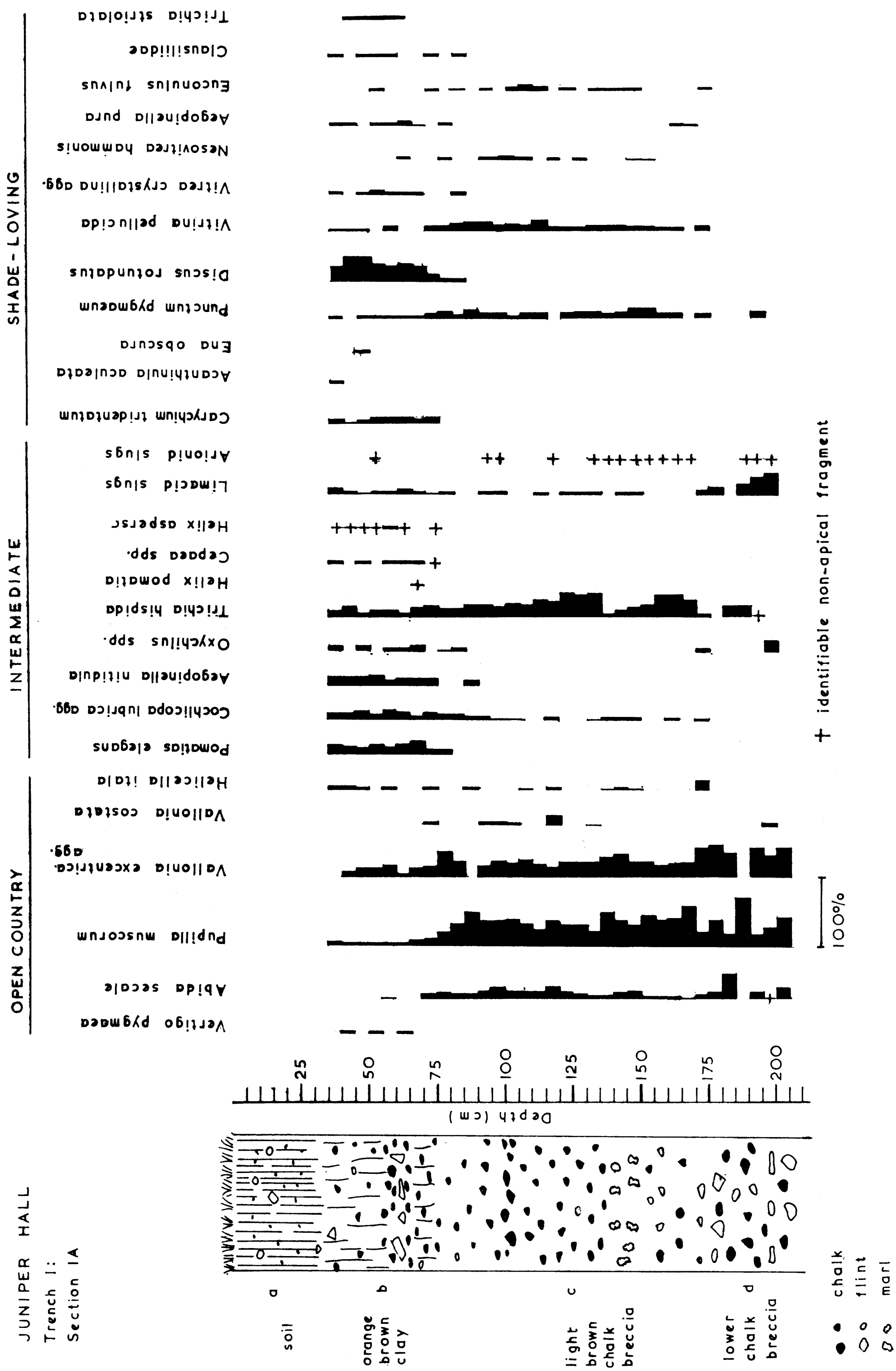


FIG. 6.
Diagram to show the percentages of the individual species of non-marine Mollusca represented in serial samples from Trench 1: Section 1A. The profile of the section with its different layers is illustrated (left).

121 at 50–55 cm. The minimum, just one, occurred at 175–180 cm, below the more productive layers. Above 70 cm there were 50 or more shells from each sample with Arionid slug granules and *Cecilioides acicula* in addition to the totals shown in Appendix 2b, but below 130 cm the total numbers of shells dropped (not counting *Cecilioides*) to below 20. In terms of species, the number varied between thirteen at 10–20 cm and two at 175–180 cm. Taking account of both numbers of shells and numbers of species the section falls into three zones: above 70 cm; 70–135 cm and below 135 cm.

Fig. 5a shows the marked dominance of open country shells, the moderate representation of the intermediate category and the minor representation (or total absence in some layers) of shade-loving snails. The open country species fell below 50% in only two samples (0–10 cm and 145–150 cm). In both of these the shade-loving group dominated but the lower sample comprised only four shells. In many samples below 30 cm the open country species accounted for 80% of the total.

Study of the distribution of the individual species (Fig. 7) reinforces the open country nature of the snail fauna in Trench 2 and also shows *Vallonia excentrica* to be the dominant species throughout almost the entire section. *V. excentrica* was also far more abundant than any of the other open country species. Of the remaining open country species, only *Helicella itala* commonly reached the 5% level whilst in the intermediate category *Pomatias elegans*, *Trichia hispida* and the limacid slugs were of similar abundance. Most of the shade-loving species occurred in small numbers and with a discontinuous distribution in the various levels of the trench.

In Trench 2 a number of species including *Vallonia excentrica*, *V. costata*, *Helicella itala*, *Pomatias elegans*, *Trichia hispida*, limacid slugs and *Discus rotundatus* were relatively persistent, although sometimes present only in small numbers. The persistent species included examples from each ecological category.

Further examination of Fig. 7 shows a slight decrease in the percentage of *Vallonia excentrica* at 65–85 cm and at the same levels a break in the continuity of *V. costata*, *Vertigo pygmaea* and *Trichia hispida* together with an increase in the percentages of *Pomatias elegans* and the slugs. Above this zone the proportion of *Vallonia* spp., *Vertigo pygmaea* and *Trichia hispida* increased with a corresponding reduction in the proportion of *Pomatias elegans* and limacid slugs.

Above 30 cm marked changes both in the percentages and the species lists reflect the increasing importance of the intermediate and shade-loving species in these upper horizons (see also Fig. 5a). The suggestion of a similar trend at the base of the section is, however, based on too few shells to be of any real significance and this constraint must be applied to the lower levels of Trench 2 (below 135 cm).

3. *Cecilioides acicula* (Müller)

Cecilioides acicula is a small blind subterranean snail with an elongate white shell up to 5 mm in length. On account of its burrowing activities it is not regarded as a useful species in the interpretation of snail faunas from fossil soils or archaeological sites and it is often ignored in reports of sub-fossil molluscan faunas. However, it is an interesting snail in its own right and one about which surprisingly little is known.

The numbers of *C. acicula* (based on counts of shell apices) in the samples from

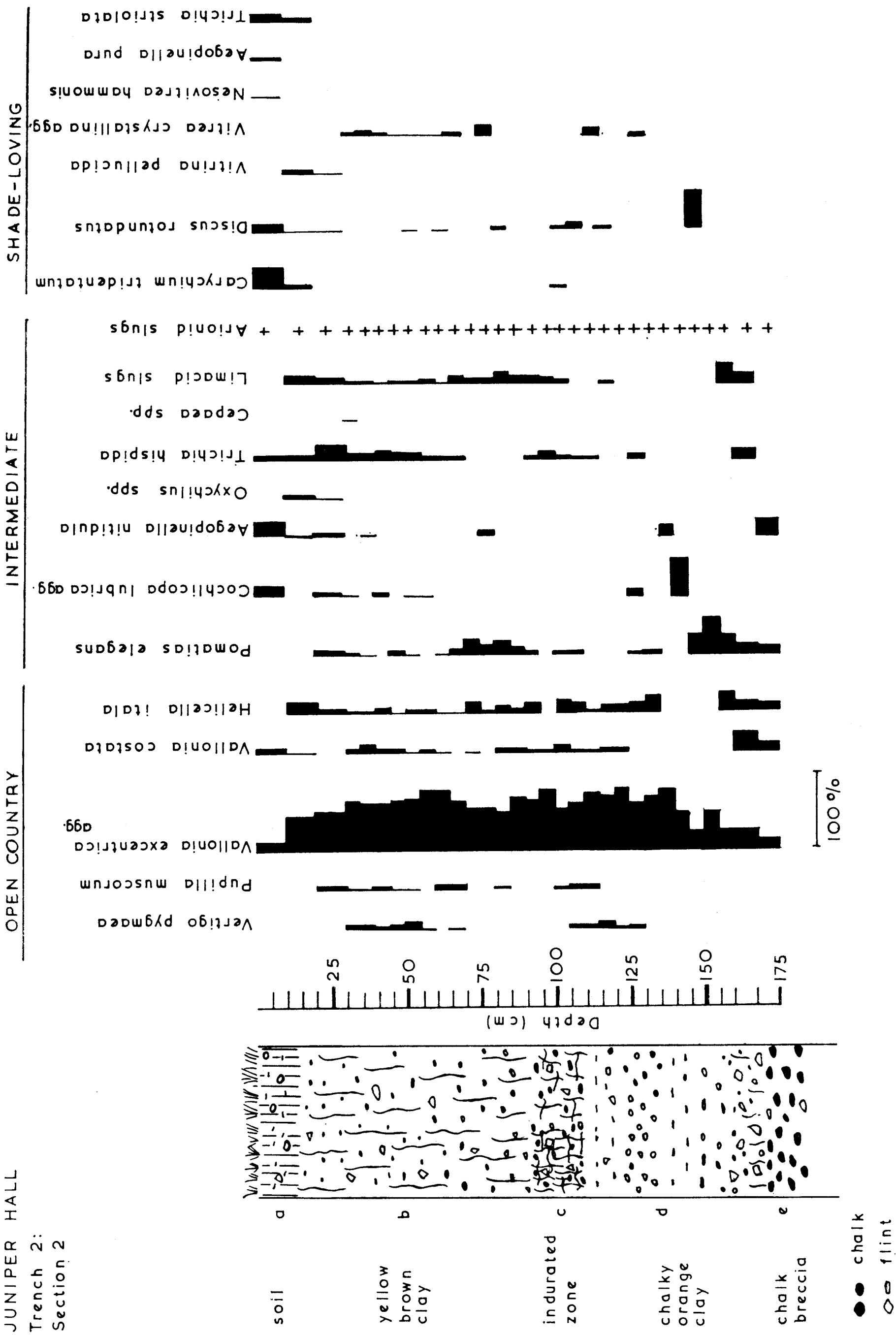


Fig. 7.

Diagram to show the percentages of the individual species of non-marine Mollusca represented in serial samples from Trench 2: Section 2. The profile of the section with its different layers is illustrated (left).

the two trenches in the grounds of Juniper Hall are shown in Fig. 8. These show interesting differences; *C. acicula* was abundant (around 50 shells per sample) in Trench 1: Section 1A reaching a peak of 102 shells from the sample taken at a depth of 55–60 cm. This was followed by a rapid decline in numbers down to a depth of 90 cm. Only one shell was recorded below 90 cm in this section. In Trench 2: Section 2, less than 36 snails were recovered from each sample in the upper layers of the soil (0–30 cm), below which the numbers of *C. acicula* in each sample oscillated from 15 to 83 down to a depth of 130–135 cm. In the samples from 30–135 cm there were three separate peaks of abundance at 75–85 cm (80–83 shells), 100–115 cm (44–50 shells) and 120–135 cm (45–52 shells).

The abrupt decline in Section 1A may be related to the presence of chalk breccia from about 80 cm downwards that would not be suitable for this snail which prefers a less stony soil. In Trench 2 the coarse chalk breccia did not appear until about 175 cm depth and the orange clay with chalk obviously proved a suitable environment.

The soil samples were dried before analysis and the *C. acicula* specimens in the sample were thus all dead. However, many of the shells recovered after treatment

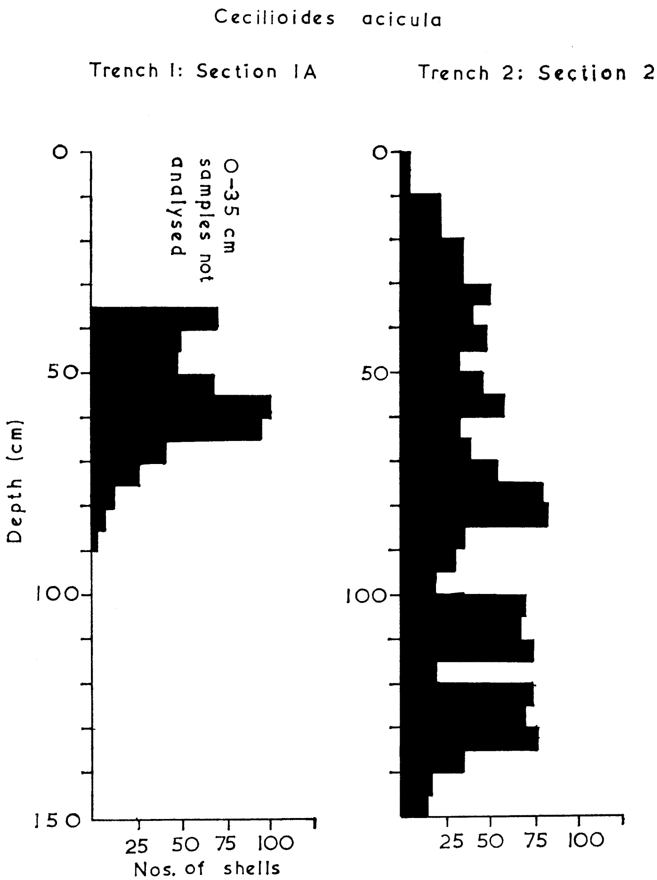


Fig. 8.

Diagram to show the numbers of shells (with apices) of the burrowing snail *Cecilioides acicula* found in the deposits from Trenches 1 (Section 1A) and 2 (Section 2).

with hydrogen peroxide (see Methods) were thin and translucent in appearance and contrasted with the opaque white of empty shells of this species found on the surface. Many of the shells of *C. acicula* from the samples at Juniper Hall can therefore be interpreted as part of a living population rather than a totally sub-fossil assemblage. *C. acicula* has been reported living at a depth of 45 cm (Emmet, 1885).

Interpretation and Discussion

Trench 1

The presence of scree-like material in this trench suggests that the bottom of the valley has been infilled by chalk debris. The dominance of shells of open country snails (Fig. 5b) from the lowest levels to within 70 cm of the surface suggests that during accumulation of the infill material, the habitat was of an open grassy nature and mostly lacking in shade. The presence of a substantial proportion (about 20–40%) of snails from the intermediate category might throw some doubt on this, but when the species were studied (Fig. 6), most of these snails were of *Trichia hispida* which occurs in a variety of habitats including open country. The relative persistence of some shade-loving species above 170 cm would suggest the presence of some shelter (possibly scrub), and since the dominant species within this relatively small group are *Punctum pygmaeum* and *Vitrina pellucida* it is possible that there might have been scattered pockets of moist fallen leaves trapped amongst the chalk scree. Evans and Jones (1973) pointed out the importance of leaf litter as a critical factor in the colonization of rock rubble habitats.

The dominance of the open country snails *Pupilla muscorum* and *Vallonia excentrica* suggests an open downland habitat with patches of unstable and broken ground, e.g. chalk rubble interspersed with areas of turf. The presence of *Abida secale* and *Helicella itala* is additional evidence for open, dry conditions with some bare chalk rubble. The occurrence of *Abida secale* is interesting as it has a very local distribution on calcareous sites in the British Isles at the present day (Kerney, 1976) and there are no confirmed live records of this snail on the North Downs. *A. secale* is known to have been common on the chalk in the south east under the open country conditions of the Late-glacial (Kerney, 1962) but its distribution became restricted with the development of extensive climax forest in the Post-glacial period. In Trench 1 *A. secale* occurred relatively persistently from 205 cm up to 55 cm: it would be interesting to know whether these shells represent the presence of this species in the open country of the post-clearance period (from the Neolithic onwards) or whether they have accummulated from the subsequent erosion of Late-glacial deposits. Of the other species present, *Trichia hispida* might have found suitable conditions amongst tussocks of grass, the limacid slugs in moist pockets of soil beneath the larger stones, and the shade-loving species in seasonal pockets of leaves blown in from nearby bushes or scrub.

In general terms these conclusions on the habitat are in keeping with the physical analysis of the infill material given earlier. This indicated the accumulation of fragmented chalk of various grades at the site of Trench 1 that would provide a stony habitat and, with the continued addition of new scree material, would give rise to relatively unstable conditions and repeated development of the early stages of chalkland vegetational succession. The evidence of Trench 1 suggests that in the earliest period (as represented by the deposits of 175–215 cm) the material was at its coarsest and its accumulation at the most rapid stage, thus creating difficult conditions for snail colonization. Kerney, Brown and Chandler (1964), working on deposits on chalk downland in Kent, also commented on the small numbers of snail shells found in coarse chalk where accumulation was rapid. There was very little evidence of any fine-grained soil at these lower levels (175–205 cm). The finer texture of the material above 175 cm and the increased numbers of both shells and species suggests the development of a more favourable and possibly more stable habitat and it is probably significant that at this level shade-loving species appear, and *Trichia hispida*, indicative of more stable grassland, becomes more abundant.

Between 135–170 cm Section 1B (Appendix 1) shows a much greater change in textural characteristics than Section 1A described previously. Both in the field and from the laboratory analysis the reduction in the percentage of coarser grades is most evident in the diagonal band of silty material that crossed Section 1B between 150 and 170 cm. However chalky material dominated in the various grades of siftings. In terms of the ecological groups of snails, the band at 150–170 cm (Section 1B) showed a pattern similar to that for Section 1A at the same levels, but there were differences in individual species.

Above 80 cm the texture of the samples from Trench 1 gradually became finer with only a small proportion of material exceeding 3 mm and also the colour of the deposit changed markedly at about 75 cm. From 70 cm upwards the open country snails lost their dominance and the intermediate and shade-loving groups became co-dominant. The change in environmental conditions is reflected both in the physical nature of the deposits and also in the sub-fossil land snail assemblage (Figs. 4 and 5). Such changes are strongly indicative of the development of a deeper and more finely textured soil, the increasing stability of both the physical and biotic habitat and the development of scrub and possibly tree vegetation with a layer of leaf litter. The small proportion of open country species and *Trichia hispida* remaining in these upper horizons suggests that pockets of more open and unstable conditions remained in the vicinity.

Trench 2

Below 167 cm the texture of the deposit was generally coarse (as in Trench 1) and would have provided difficult conditions for land snails; also, the rapid deposition would lead to a low density of preserved shells. At 167 cm the colour of the deposit changed and the texture became finer, but it was not until above 130 cm that there was an increase in the number and variety of snail shells. Slightly coarser material with an increased abundance of snails occurred from 125 to 95 cm, but above 90 cm there were marked changes in texture, colour, numbers of shells and in the relative importance of particular species. As in Trench 1 these features suggest the development of a more stable habitat with a deeper soil but with some open country. In the lower layers the evidence points towards an open scree-like situation with chalk rubble and intermittent grassy patches. The "indurated zone" (Fig. 7) at 110–90 cm may be related to some amelioration of conditions. The flints within it could have rolled down the valley sides or been brought to the surface by frost action. Under stable conditions these would accumulate and remain *in situ* on the floor of the valley.

From 20–65 cm the sub-fossil record was similar to that for 95–125 cm. As in Trench 1, *Trichia hispida* was fairly well represented and there were shells of limacid slugs which probably lived in moist conditions under stones. Such stony rock rubble habitats were probably colonized by *Discus rotundatus* which is often a scree-dweller at the present time (Barrett and Chatfield, 1972) and also *Vitrea crystallina* agg., which has been considered a member of the rock rubble fauna (Evans and Jones, 1973).

The marked changes that occurred in the snail analysis of the top 30 cm would seem to reflect the increased proportion of shelter and increasing soil stability. Such changes could be correlated with the planting of shrubs and trees associated with the previous building on the site.

Present-day land snail fauna

Field studies of the modern snail fauna around Juniper Hall provide an interesting basis for comparison with the sub-fossil assemblage. The results are summarized in Table 1 and they include three sites on chalk downland (Happy Valley, Box Hill and White Down) and also a list from the wooded slopes of White Hill on the north side of the valley. The downland sites showed the presence of *Cochlicopa lubricella*, *Vertigo pygmaea*, *Pupilla muscorum*, *Vallonia costata* and *V. excentrica* which were also represented in the sub-fossil assemblages described earlier. *Helicella itala* was present (alive) in large numbers at White Down, Ranmore in sparse grassland with chalk rubble, but only occasional empty shells of *H. itala* have been found at Box Hill. *Candidula intersecta* was present on all three downland sites and *Cernuella virgata* on two of them, but these species are post-Roman introductions to the British fauna (Kerney, 1966) and they were not represented in the Juniper Hall deposits below 20 cm. Although a few shade-loving species were listed from all sites, the majority of these were from Happy Valley (north-facing slope) where the grassland has been invaded by dogwood scrub, and also in areas shaded by the woodland fringe. In the deeply dissected dry valleys in the chalklands around Juniper Hall, there are often contrasting molluscan faunas on the opposite sides of the same valley. A small area of ground can also provide a wide variety of molluscs especially if it consists of a mosaic of different microhabitats.

Comparison of the two trenches

In spite of general similarities between the two sections, there are marked and possibly significant variations. In its physical appearance Trench 2 showed greater visual variety in the field, notwithstanding its greater depth; but it was fossiliferous to a shallower depth and showed differences in the species content of otherwise comparable zones. The depth of Trench 2 showed clearly the considerable amount of infill material that may occupy the lower parts of a dry chalkland valley and lends support to the indications at the base of Trench 1 of a period during which fairly coarse material was accumulating. Although no detailed fabric analysis was undertaken in the field, the general orientation indicated that the material might not be in an original stratified position, but might have originated from the immediate valley sides and accumulated in positions that permitted maximum subsequent consolidation. The lack of soil layers at these lower levels suggests either adverse climatic conditions or the relatively rapid accumulation of material.

Table 1. *A summary of the present-day land snail faunas (1961–1972) of four selected habitats in the vicinity of Juniper Hall. The species are grouped in ecological categories*

	Box Hill (chalk grassland) 1962–1968	Happy Valley (chalk grassland, dogwood scrub and edge of wood) 1961–1968	White Hill and Mickleham Downs (grassland and woodland) 1963	White Down Ranmore (chalk grassland) 1961–1972
OPEN COUNTRY SPECIES				
Cochlicopa lubricella (Porro)	+	+ (valley and slope)		+*
Vertigo pygmaea (Draparnaud)	+	+		+
Pupilla muscorum (L.)	+*	+		+
Vallonia costata (Müller)	+*	+ (valley)		+*
V. excentrica (Sterki)	+	+ (valley)		+
Candidula intersecta (Poiret)	+*	+ (valley)	+	+*
Cernuella virgata (Da Costa)		+		+
Helicella itala (L.)	+			+*
INTERMEDIATE SPECIES				
Pomatias elegans (Müller)	+*	+ (wood)		+*
Azeca goodalli (Férussac)				+*
Cochlicopa lubrica (Müller)	+*	+ (slope)		+
Lauria cylindracea (Da Costa)		+		
Arion intermedius Normand			+*	
Vitrea contracta (Westerlund)		+ (valley and slope)		+
Aegopinella nitidula (Draparnaud)	+	+ (all sites)	+	+
Oxychilus cellarius (Müller)		+	+	
O. helveticus (Blum)		+	+	
Deroceras reticulatum (Müller)	+*	+*		
Cecilioides acicula (Müller)	+	+ (slope)		+
Monacha cantiana (Montagu)	+*	+*		
Trichia hispida (L.)		+ (valley and slope)	+	+*
Cepaea nemoralis (L.)		+ (slope and wood)		+*
C. hortensis (Müller)	+	+		
Helix pomatia L.		+ (wood)	+	+
SHADE LOVING SPECIES				
Carychium tridentatum (Risso)		+ (slope)		+
Acanthinula aculeata (Müller)		+ (slope)		
Ena obscura (Müller)		+	+*	
Punctum pygmaeum (Draparnaud)	+			
Discus rotundatus (Müller)		+ (valley and wood)	+	+*
Vitrina pellucida (Müller)	+	+		
Vitrea crystallina (Müller)	+*	+ (valley and slope)		+*
Nesovitrea hammonis (Ström)	+	+ (valley and slope)		
Aegopinella pura (Alder)		+ (wood)		+
Limax maximus L.			+*	
Cochlodina laminata (Montagu)			+*	
Clausilia bidentata (Ström)		+		
Trichia striolata (C. Pfeiffer)		+ (wood)		
Total number of species	18	31	11	21

* Denotes a record based on a living specimen.

Local variations in the rate of accumulation or in the nature of material supplied probably accounted for some of the physical contrasts. In view of the marked asymmetry of the valley cross-profile (Fig. 1) it is possible that the infill from both trenches was derived from the steep north slope of White Hill.

There were some differences in the snails found in the two trenches. In Trench 2 (Fig. 7) *Vallonia excentrica* was the dominant open country snail and none of the other species from the same ecological group approached it in abundance. In Trench 1, however (Fig. 6), the dominant open county species was *Pupilla muscorum*, although *Vallonia excentrica* was almost of equal abundance. Other points of contrast include the presence of *Abida secale* in Trench 1 only and the very limited numbers and distributions of *Vertigo pygmaea*, *Vallonia costata* and, to a lesser extent, *Helicella itala* in Trench 1. *Pomatias elegans* was present in both trenches; its distribution was general in Trench 2 but restricted to the top 75 cm in Trench 1. The same contrast also applies to *Discus rotundatus* and *Nesovitrea hammonis* whilst *Punctum pygmaeum* and *Euconulus fulvus* were totally absent from Trench 2. Such contrasts over a short geographical distance suggests some variety of conditions within the various layers of the deposits and lends support to the concept of a mosaic of micro-habitats at any one time. A modern parallel might be found in a disused chalk quarry, (such as Brockham limeworks) in the early stages of chalkland vegetational succession.

An additional problem relates to the origin of the infill material and the assumed mobility of the physical fraction. So far the interpretation has been based on an indigenous snail fauna for each site, but it is equally possible that for certain levels, at least, the sub-fossil content is a combination of snails living *in situ* at the time of deposition with other empty shells brought down from up-slope with the chalky materials or washed down during intervening phases. The shapes of some of the shells (e.g. *Pupilla muscorum* and the tightly coiled *Vallonia* spp.) are conducive to such movement down-slope. Any variety of habitat grouping or of actual species present might be related to much wider geographical areas, although the consistency of many of the samples suggests some uniformity of conditions of the valley sides and valley floor.

In searching for a mechanism for the erosion of the valley sides, the immediate inclination is to relate the lower coarser scree-like materials with few or no shells to the gelifraction and geliturbation (slumping) processes of the Late-glacial and immediate Post-glacial phases, but there is little evidence in these valley bottom sections of the subsequent forest stages that are known to have colonized the south east of England prior to the activities of Neolithic man. There were a few shells and fragments of shade-loving species at the lowest fossiliferous levels of Trench 1, but the total numbers of shells are too small for any reliable interpretation. Furthermore, there was no substantial evidence of buried soils visible at these levels. Thus the serial samples might be an incomplete sequence with any evidence of the forest stage having been removed, so that post-clearance deposits lie directly on Late-glacial or early Post-glacial rubble. Evans (1968) recorded a similar broken sequence from Wadden Hill in the Avebury area of Wiltshire where Late-glacial deposits were followed by Romano-British plough-wash.

From the evidence available there are various possible interpretations. It is possible that the entire sequence of samples represents the post-clearance phase only (i.e. from Neolithic onwards). The coarser scree-like material at the lower levels of the trenches would then represent the effects of drastic soil erosion resulting from Neolithic clearance. However it is difficult to conceive that the simple and shallow farming techniques of the Neolithic culture (using antler picks) could have resulted in such effective erosion.

In view of the findings of other workers on southern England (Kerney, Brown and Chandler, 1964, and Evans, 1968), the former interpretation is more likely. Thus at Juniper Hall the coarse chalk breccia with few fossil shells (below 170 cm) could be a Late-glacial deposit whilst the more finely textured yellowish clays (from about 75–170 cm) could be interpreted as the products of accumulation resulting from prehistoric farming. The various changes in physical texture might reflect changing patterns of erosion, land use and development of vegetation in fallow or abandoned areas. In the asymmetrical valley at Juniper Hall there may have been a more rapid accumulation of material under the steeper northern slope which might explain the longer fossiliferous series of Section 1. Even today under woodland cover, the slope of White Hill above the Headley road is unstable and subject to soil creep and broken ground.

A late Post-glacial date for the more fossiliferous layers at Juniper Hall (above 170 cm) is indicated by the presence of *Pomatias elegans* from almost all the fossiliferous layers of Section 2. This species is one of a group that established in Britain in the late Post-glacial in response to a warmer climate at the beginning of the climatic optimum (Kerney, 1968). *Discus rotundatus* (occurring from 150 cm upwards in Trench 2) is another species which indicates a post-clearance date to much of the fossiliferous sequence since it did not occur in the Late-glacial period (Evans and Jones, 1973).

Archaeological findings in the vicinity of Juniper Hall would seem to support the proposed relationship of the mid-section deposits (*c.* 75–170 cm) to pre-Roman farming, for although little evidence of prehistoric fields is available for Surrey, an Iron Age field system has been reported on Mickleham Downs (Frere and Hogg, 1945). More recent work (Hanworth, personal communication) suggests that parts of Surrey were cultivated during these times and some new pre-Roman fields have been discovered on the line of Stane Street not far away. Arable farming could have taken place on the hill tops or on the chalk slopes (thus avoiding the clay-with-flints cappings). The use of metal on ploughs would have enabled deeper ploughing than the antler picks and stone-tipped ards used in the Neolithic and could, in combination with more advanced ploughing techniques and greater population densities, have led to soil erosion from the slopes. The eroded material would then have accumulated on the valley floors, and thus the immediate pre-Roman levels (below 75 cm in Section 1) could well be attributed to Bronze and Iron Age plough-wash. The increased rainfall at the beginning of the Sub-Atlantic period may also have been contributory. In Section 1 the presence of *Helix aspersa* from 75 cm upwards suggests a Roman or subsequent date for the upper levels since this species is thought to be a Roman introduction (Kerney, 1966). Unfortunately no artefacts like pottery were found to date any of the deposits.

There is the further possibility that some snail shells particularly those of *Pupilla muscorum* and possibly *Abida secale* found in the various levels of the trenches might have derived from eroded Late-glacial deposits and become mixed with a snail fauna of a different age. Evans (1968) described a mixture of Late-glacial and Romano-British faunas in an account of work at Wadden Hill, Wiltshire.

The presence of many sand grains and flint fragments in some of the finer grades of the physical analysis may relate to plough-wash from residual "Clay-with-flints" and other superficial deposits upslope from the site, although in the upper part of the sequence in Trench 1 the sand might be attributed to gardening activities. Other deposits that may have been the source of the more deeply placed sand grains below 75 cm include the local Headley Heath Beds or a former extension of the Netley Heath Beds (that are now confined to the chalklands of the Guildford area). Some authorities (Gallois, 1965) might consider these two coarse grained deposits to be of the same age (Plio-Pleistocene) and origin. Other possible sources from the northern part of the Juniper Hall valley catchment include remnants of the early Eocene succession situated on the chalk dipslope. But the extensive areas of superficial "Clay-with-flints" to the south must also be given due consideration since this area is so extensively dissected by south bank tributary valleys. Perhaps the higher proportions of quartz grains in the 0·5–1·0 mm siftings of Trench 2 compared with Trench 1 (further to the north) support the case for the "Clay-with-flints". Heavy mineral analysis techniques might assist further investigation.

Following forest clearance it is perhaps only since Roman times that there has been any considerable stability and maturing of the soil, changes which have been reflected by the darker colour and greater humus content of the deposit and other physical features in the upper 70 cm of Trench 1. Whilst there are similar physical trends in the upper parts of Trench 2, the more gently sloping valley side to the south might have continued in cultivation and this would have restricted plant succession towards woodland and a deeper soil. These south slopes are open fields today, whilst the steep north slope of the valley is wooded. Evans (1968) looking at Iron Age deposits at Fyfield Down, Wiltshire, also suggested that rapid accumulation ceased at the end of the Romano-British period and presumably a more stable soil condition followed.

One problem arising from this interpretation concerns the nature of the undulating junction between zones (b) and (c) in Trench 1: which has, on a small scale, some of the features of involutions (Fig. 3). Such features are normally assigned to a Late-glacial or early Post-glacial date. In cases such as this it may be possible to relate them to the much later processes believed to have operated in calcareous infill materials. These are grouped under the term "de-calcification", a term used to summarize all those leaching processes that are thought to be removing the calcareous material from the upper parts of chalky deposits, thus reducing the size of the chalk fragments, concentrating the insoluble residues and producing an ochre-coloured upper layer (Clark, Lewin and Small, 1967). Differential porosity might then result in the undulating junction observed in Trench 1 (Fig. 3). The composition of the finer grades of material in the upper part of Trench 2 which were described earlier as being rich in quartz fragments and grains, may have been concentrated by a similar process. If such a process has been in operation it has probably been much more prevalent in the polluted atmosphere of modern times and it may have "compressed" the infill material and its snail content (hence the larger numbers of snails in the upper parts of both sections). However, if this is the case it is also logical to suppose that the snail shells would be similarly eroded.

A further problem to the interpretation of the fossiliferous deposits above 170 cm of Trenches 1 and 2 proposed above as a post-Neolithic chronology, is to explain the derivation of the open-country species of snails; for these species would surely have been largely eliminated by the previous millenia of extensive forested conditions. However, such species may have spread from refuge sites such as undercut river cliffs (e.g. The Whites) and from other relatively open patches. Such an interpretation is based upon the principle of the present being the key to the past, and the value of comparisons with present snail faunas has been demonstrated in earlier parts of this paper. But it is also possible that some species may have evolved new habitat preferences rather in the way that *Deroceras caruanae* (Pollenera) and *Milax budapestensis* (Hazay) appear to have done in colonizing cultivated land, leading to a dramatic increase in their geographical distribution in the British Isles. The distribution of the woodland leaf-litter snail *Punctum pygmaeum* throughout all levels of Trench 1 appears anomalous, but perhaps this species does occur more extensively in damp pockets of leaf-litter and grass in open country than is generally realized and it is overlooked on account of its small size. Evans (1972) does refer to its presence on chalk grassland.

In summary, the lower levels of both trenches, composed of coarse chalk breccia with few or no fossil snails, probably represent the products of erosion in Late-glacial times. This could include the solifluction into the valley bottoms of chalk fragmented by frost together possibly with open country snails of Late-glacial origin. There was no positive evidence for the climax forest stage in either of the trenches and fossiliferous deposits from this period either did not accumulate, or were destroyed perhaps by the increased levels of erosion following the initial stages of prehistoric land clearance. The more finely textured deposits from about 170 cm to 75 cm are thought to be pre-Roman and the presence of Iron Age fields nearby suggests that they might be of Iron Age date, but there was no evidence from pottery or carbon dating to substantiate this. Certainly the snail fauna with *Helicella itala* and *Trichia hispida* is consistent with the Iron Age post-clearance stage. The richer deposits above 75 cm are dated as post-Roman as indicated by the presence of later introduced species (e.g. *Helix aspersa*) and they could be the result of medieval plough-wash.

Acknowledgements

We are most grateful to Mr J. H. P. Sankey, then Warden of Juniper Hall Field Centre, for his interest in this project and for help at various stages. Dr J. G. Evans of University College, Cardiff, gave much useful advice on the methods used for separating the shells from the deposits and, at a later stage, gave help with identification of some of the more problematical specimens. Laboratory facilities were provided at the City of Portsmouth College of Education (now a Faculty of Portsmouth Polytechnic).

References

Barrett, B. W., and Chatfield, J. E. (1972). *Discus rotundatus* (Müller) growing on algae. *J. Conch., Lond.*, **28,** 13–21.

Clark, M. J., Lewin, J., and Small, R. J. (1967). The sarsen stones of the Marlborough Downs and their geomorphological implications. *Southampton Research Series in Geography No.* **4,** 3–40. Southampton University.

Emmet, J. (1885). *Achatina acicula* (the needle agate snail) and its occurrence and distribution over the magnesian limestone of Yorkshire. *Naturalist*, **10,** 270–274.

Evans, J. G. (1968). Changes in the composition of land molluscan populations in North Wiltshire during the last 5,000 years. *Symp. zool. Soc. Lond.*, **22,** 293–317.

Evans, J. G. (1972). *Land snails in archaeology*. Seminar Press, London and New York.

Evans, J. G., and Jones, H. (1973). Subfossil and modern landsnail faunas from rock-rubble habitats. *J. Conch., Lond.*, **28,** 103–129.

Frere, S. S., and Hogg, A. H. A. (1945). An Iron Age and Roman site on Mickleham Downs. *Surrey Archaeological Collections*, **49,** 104–106.

Gallois, P. W. (1965). *British Regional Geology: The Wealden District*. H.M.S.O., London.

Kerney, M. P. (1962). The distribution of *Abida secale* (Draparnaud) in Britain. *J. Conch., Lond.*, **25,** 123–126.

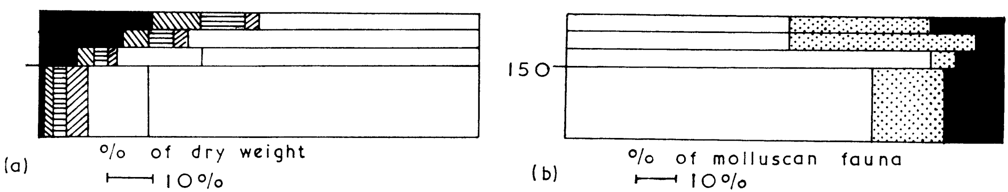
Kerney, M. P. (1966). Snails and man in Britain. *J. Conch., Lond.*, **26,** 3–14.

Kerney, M. P. (1968). Britain's fauna of land Mollusca and its relation to the Post-glacial thermal optimum. *Symp. zool. Soc. Lond.*, **22,** 273–291.

Kerney, M. P. (1976). *Atlas of the non-marine Mollusca of the British Isles*. Institute of Terrestrial Ecology, Cambridge.

Kerney, M. P., Brown, E. H., and Chandler, T. J. (1964). The Late-glacial and Post-glacial history of the chalk escarpment near Brook, Kent. *Phil. Trans. R. Soc. Series B*, No. **745,** 135–204.

Waldén, H. W. (1976). A nomenclatural list of the land Mollusca of the British Isles. *J. Conch., Lond.*, **29,** 21–25.



Appendix 1. *Trench 1: results from the straight sequence Section 1B between 135 and 170 cm depth. (a) Physical analysis based on particle size. For key to shading see Fig. 4; (b) The representatives of three ecological categories in the land snail fauna. For key to shading see Fig. 5.*

Depth of Sample (cm) Below Ground Surface

Trench 1: Section 1A

		35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	105–110	110–115	115–120	120–125	125–130	130–135	135–140	140–145	145–150	150–155	155–160	160–165	165–170	170–175	175–180	180–185	185–190	190–195	195–200	200–205	205–210
																						(135–170 cm)														
Open Country	Snails																																			
Open Country	*Vertigo pygmaea* (Draparnaud)		1		1		1																													
Open Country	*Abida secale* (Draparnaud)					1			4	8	4	3	9	15	6	4	5	11	10	7	5	3	7	9	3	2	3	1	5	1	2		+	+	1	
Open Country	*Pupilla muscorum* (L.)	9	4	5	4	3	6	6	8	17	24	30	34	39	25	14	13	29	46	36	30	40	30	26	41	39	23	26	15	4	1	5	2	2	3	
Open Country	*Vallonia excentrica* agg.	16	7	17	13	21	5	11	10	31	16		13	21	12	10	9	11	29	24	31	21	24	19	18	14	10	8	29	5	2		6	2	3	
Open Country	*Vallonia costata* (Müller)								1				3	2	1			8			2													1		
Open Country	*Helicella itala* (L.)	3	4	2		2			1			1				1		1				2	2	2					9							
Intermediate	*Pomatias elegans* (Müller)	21	12	13	18	13	18	17	5	6																										
Intermediate	*Cochlicopa lubrica* agg.	12	11	16	8	17	15	2	7	4	4	2	3	1	1			2			2	2	2				1		1							
Intermediate	*Aegopinella nitidula* (Draparnaud)	14	17	19	19	10	11	10	8			4																								
Intermediate	*Oxychilus* spp.	8		7		1	2	6		1	2																		2							
Intermediate	*Trichia hispida* (L.)	8	15	5	9	11	3	9	13	9	8	9	15	13	11	7	13	16	47	37	48	2	6	10	14	29	18	10	1		1	1	+			
Intermediate	*Cepaea* spp.	2		1		5	3	3	+																											
Intermediate	*Helix aspersa* Müller	+	+	1+	+	1	+		+																											
Intermediate	*H. pomatia* (L.)							1																												
Intermediate	Limacid slug plates	12	4	1	4	5	12	3	1	2			3	3			2		1	3	5	1		3	2				3	1		1	3	3		
Intermediate	Arionid slug granules					*							*	*				*			*	*	*	*	*	*	*	*				*	*	*		
Shade-Loving	*Carychium tridentatum* (Risso)	9	2	6	8	11	12	5	6																											
Shade-Loving	*Acanthinula aculeata* (Müller)	1																																		
Shade-Loving	*Ena obscura* (Müller)					1																														
Shade-Loving	*Punctum pygmaeum* (Draparnaud)	4		1	1	3	1	1	4	6	3	6	4	7	1	2	3		7	10	10	4	5	12	11	6	3		4				1			
Shade-Loving	*Discus rotundatus* (Müller)	34	45	54	32	29	40	20	9	2	1																									
Shade-Loving	*Vitrina pellucida* (Müller)	2	1	3		9			3	3	6	7	9	5	5	3	7	3	3	3	8	5	4	5	2	4	1		4					1		
Shade-Loving	*Vitrea crystallina* agg.	2		3	7	4	5	2			3																									
Shade-Loving	*Nesovitrea hammonis* (Ström)						1			1			2	2	2	1		1		1		3		1	1									1		
Shade-Loving	*Aegopinella pura* (Alder)	2	1		4	2	10	1		1																1										
Shade-Loving	*Euconulus fulvus* (Müller)				1				2		2		1		1	3	3		2		1	1	1	2			1	1	1							
Shade-Loving	*Clausiliidae*	1		2	2	1			1		3																									
Shade-Loving	*Trichia striolata* (C. Pfeiffer)						6																													
	Number of molluscs	161	125	156	132	150	152	97	85	91	76	62	96	108	65	45	55	82	145	121	142	84	81	89	92	95	60	46	74	11	6	7	14	11	7	
	Number of species	19	14	17	16	21	18	15	18	13	12	8	12	11	10	9	8	10	8	8	11	12	10	11	9	8	9	6	11	4	4	4	7	8	3	

	Depth of Sample (cm) Below Ground Surface	0–10	10–20	20–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	105–110	110–115	115–120	120–125	125–130	130–135	135–140	140–145	145–150	150–155	155–160	160–167	167–175	175–180	180–185
	Trench 2: Section 2																																	
	SNAILS																																	
OPEN COUNTRY	*Vertigo pygmaea* (Draparnaud)				4	6	2	3	10	2		1								2	2	3	1	1										
	Pupilla muscorum (L.)			2	1	1	2	1	2		5	4			1				1	2	2													
	Vallonia excentrica agg.	15	22	31	52	68	46	47	82	80	77	46	24	16	21	13	21	23	22	25	28	25	30	15	12	4	1	1	1	+	2	1		
	Vallonia costata (Müller)	7	1		5	10	3	4	1	1	3		1		2	1	1	1	4	1	1	2	2								2	1		
	Helicella itala (L.)		7	3	2	4	5	1	6	5	2	1	7	1	4	1	4		7	5	1	4	4	3	4					+	1			
INTERMEDIATE	*Pomatias elegans* (Müller)			3	2	1		4	+		2	6	9	4	7	2	1		+	1				+	+			+	+	+	1	+		
	Cochlicopa lubrica agg.	18		2	1		3		1	1														2			1							
	Aegopinella nitidula (Draparnaud)	28	1	2		1								2												1						2		
	Oxychilus spp.		3	1																														
	Candidula intersecta (Poiret)		1																															
	Trichia hispida (L.)	10	3	13	7	9	8	7	12	5	4	3					2	3	2	1	1			2							+			
	Cepaea spp.				+																													
	Limacid slug plates		5	4	2	4	1	3	3	5	2	6	3	2	6	2	3	2	2			1								1	1			
	Arionid slug granules	20	40	36	55	39	55	50	35	34	32	36	28	35	15	55	37	17	7	13	5	4	8	12	4	8	6	5	11	16	1	6	1	2
SHADE-LOVING	*Carychium tridentatum* (Risso)	46	2																1															
	Discus rotundatus (Müller)	13	1	1					1		+				1				+	3		1						2						
	Vitrina pellucida (Müller)		2	1																														
	Vitrea crystallina agg.				3	6	2	1	2	1	2	3		4							2			1										
	Nesovitrea hammonis (Ström)	2																															1	
	Aegopinella pura (Alder)	4																																
	Trichia striolata (C. Pfeiffer)	18	2																															
	Number of molluscs	161	50	63	80	110	72	71	121	100	98	70	44	29	42	19	32	29	41	40	37	36	37	25	17	5	2	4	2	4	8	5	1	0
	Number of species	11	13	12	12	11	10	10	12	9	10	9	6	7	8	6	7	5	10	9	8	7	5	8	4	3	3	4	3	5	7	6	2	1

Appendix 2. *Raw data giving the numbers of shells of each species recorded at the various levels and also the total numbers of shells and numbers of species present.* (*a*) *Trench 1: Section 1A;* (*b*) *Trench 2: Section 2*