THE GEOLOGICAL ENVIRONMENT OF THE DUG-OUT CANOES FROM HOLME PIERREPONT, NOTTINGHAMSHIRE

by

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Summary

Three Iron Age or Roman dug-out canoes were found at the base of a gravel deposit at Holme Pierrepont. A study of sedimentary structures shows that the gravel accumulated by lateral point bar growth on the inside of a meander (since abandoned) of the River Trent. The river channel was about ten feet deep and two hundred feet wide. The sedimentological conclusions are supported by a detailed faunal analysis of three associated shell beds. The boats sank in the deepest part of the channel and were rapidly buried beneath the growing bed of gravel.

Introduction

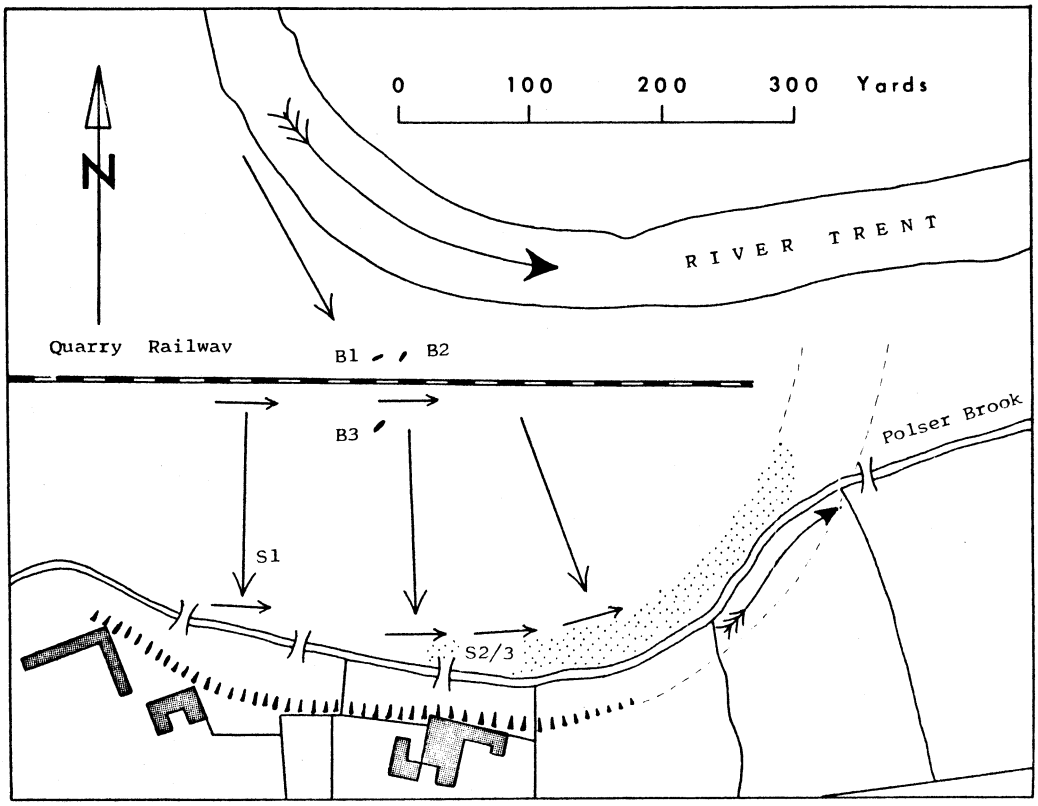
Three dug-out canoes were discovered in December 1967 at Holme Pierrepont, in Hoveringham's Nottingham Gravel Quarry (SK. 629395). Associated with them were a twelve-spoked wheel and a large wooden beam. The archaeological dating of these finds, all of which are roughly contemporary, is Iron Age or Roman (MacCormick, 1969). All the finds were from the bottom of the gravel, resting more or less directly on the underlying Keuper Marl bed-rock.

The gravel workings at this point are bounded to the north by the River Trent and to the south by a small tributary stream, the Polser Brook. The east-west quarry railway divides the workings into two parts (Text-fig. 1). At the time of the discovery, work north of the railway was nearing completion and gravel was being extracted in north-south strips between the railway and Polser Brook. As the gravel in this quarry is extracted dry, it was possible to examine a series of long north-south sections through the deposits, as well as shorter east-west sections at the ends of the excavations.

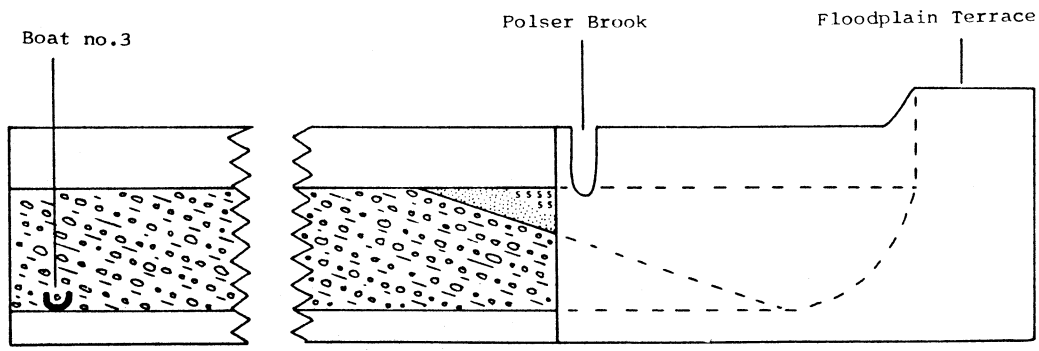
The deposits exposed in this quarry are those which form the present flood plain of the River Trent. The overburden, which is removed before the gravel is dug, consists of up to six feet of loam. The gravel, which is about ten feet thick, rests on an uneven eroded surface of Keuper Marl. At the southern end of the quarry, near Polser Brook, the gravel thins to about six feet and is separated from the overlying loam by a bed of sand followed by two shell beds (Text- fig. 2).

The loam

The loam is a uniform unstratified deposit, resting sharply on the underlying gravel and sand and passing up without a break to the present ground surface - the flood plain of the



Text-figure 1. Map showing position of Boats (B1, B2 and B3) and Shell bed samples (S1, S2 and S3). Stippled area indicates distribution of sand and shell bed deposits; hachures - edge of Floodplain Terrace; long arrows - dip of cross-strata in gravel; short arrows - current directions, from imbricate structure in gravel and from cross bedding in sand; feathered arrows - modern stream flow directions.



Text-figure 2. Diagrammatic section (enlarged) from quarry railway to Floodplain Terrace. Vertical scale about five times horizontal.

River Trent. Deposition of suspended sediment on the flood plain takes place whenever the flood-waters spread out beyond the banks of the river. Any stratification which might have been formed at the time of deposition of the sediment was quickly destroyed by the burrowing of earthworms and the roots of the plants which flourish in this environment.

The loam deposit can thus be interpreted as an accumulation of sediment on the flood plain of the River Trent. If this began here some time during the Roman period, then the average rate of deposition on this part of the flood plain would have been about one inch every twenty five years (about one millimetre per year).

The gravel

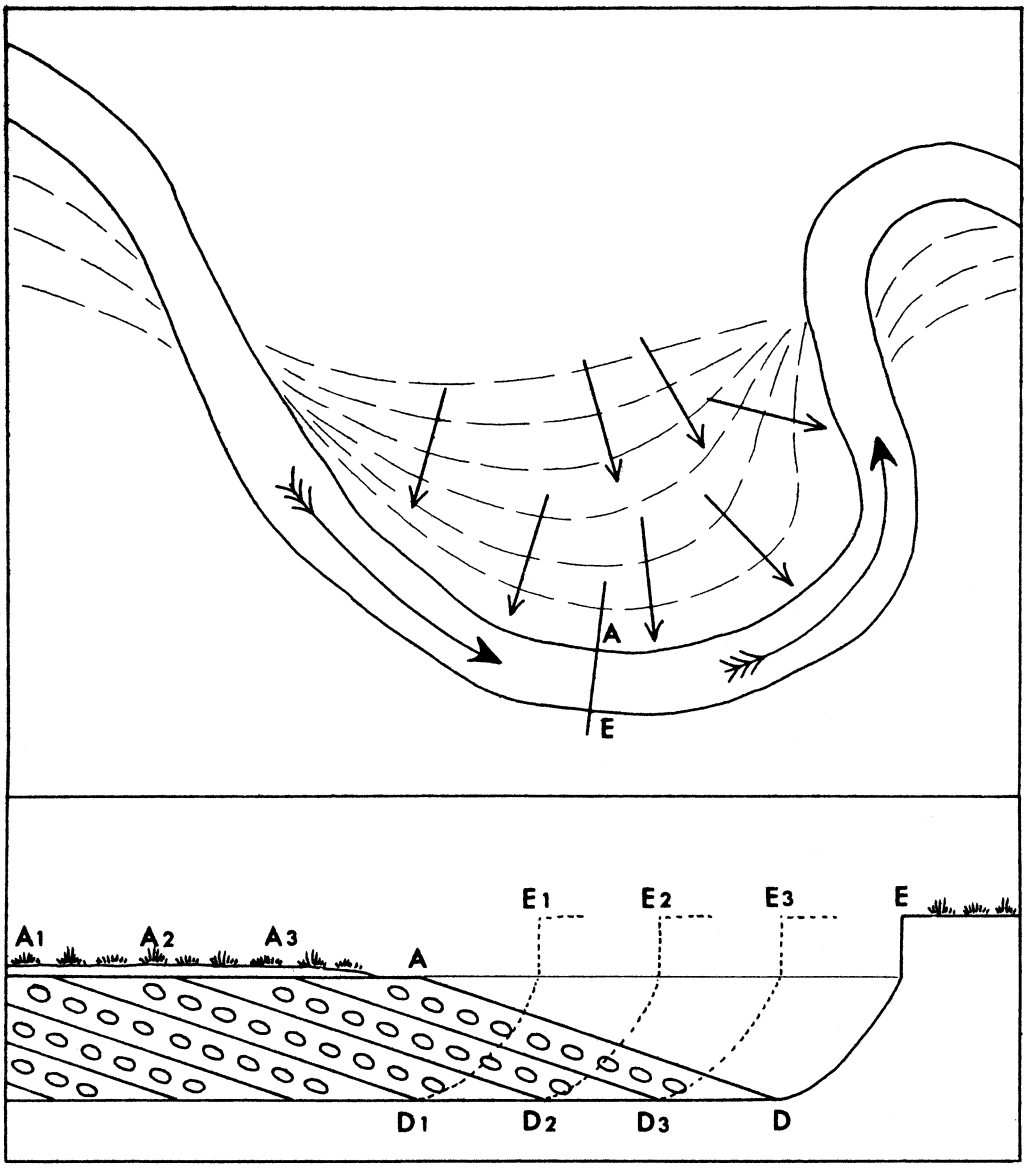
The most prominent feature of the gravel in the long north-south sections is the large scale cross bedding. The cross strata dip at a low angle to the south and are terminated abruptly at the base of the overlying bed of loam. They are slightly convex upwards, dips of 2^{o} or 3^{o} being general in the upper part of the bed and dips of 5^{o} or 6^{o} in the lower part. In the short east-west sections, the layering in the gravel appears horizontal and the arrangement of the pebbles shows a well developed imbricate structure, indicating a uni-directional current flowing from west to east, at right angles to the dip direction of the cross strata (Text-fig. 1).

The upper surface of the gravel is generally fairly flat, but at the southern end of the quarry it slopes down towards the south, parallel to the underlying cross strata (Text-fig. 2). Here the gravel is overlain by a bed of sand, up to four feet thick, coarse and somewhat pebbly at the base and getting finer upwards. The sand is cross bedded, the cross strata being arranged in grouped sets which are each two to three inches thick. The current direction indicated by this cross bedding is from west to east, in agreement with the pebble imbrication in the gravels and with the flow direction of the adjacent Polser Brook (Text-fig. 1).

Lumps of grey sticky loam are locally abundant near the base of the gravel. These were particularly noticed in the vicinity of Boat no. 1 (Text-fig. 1), during the excavations in December 1967. These lumps varied in size from a few inches across up to over a foot long and six inches high. They contain plant remains (p.185) but careful search failed to reveal any shells or shell fragments. In one small area, near the southern end of the quarry, a shell bed (Shell bed 1; Text-fig. 1) was found beneath the gravel. Mr. R.C.Alvey saw this shell bed in place, resting directly on the Keuper Marl, which was stained black beneath it. Tree trunks and branches of trees are also found at the base of the gravel.

The gravel accumulated by lateral accretion on a point bar on the inside (north bank) of a meander of the River Trent, while the outside (south bank) of the meander was being eroded (Text-fig. 3). The cross strata represent the successive surfaces of the point bar, which sloped gently southwards in a direction at right angles to the flow of the river (cf.Wright, 1959). The lumps of loam are interpreted as blocks of flood plain sediment which fell into the river and were rolled to the deepest part of the channel, as the south bank was undercut by erosion. Their preservation indicates rapid burial beneath the growing bed of gravel and, therefore, rapid lateral migration of the river meander, a conclusion further supported by the excellent state of preservation of the boats themselves (MacCormick, 1969).

The dimensions of the former river channel can be estimated on the basis of the observations made above. The thickness of the gravel bed approximates to the depth of water in the deepest part of the channel, which would therefore have been about ten feet deep. The distance across from the deepest part of the channel to the north bank (inside of the meander) can be determined directly from the dip of the cross strata. The corresponding distance from the



Text-figure 3. Diagrammatic plan and section of a river meander. On the plan, 'A' is the advancing (inner) bank and 'E' the eroding (outer) bank. The broken lines represent successive positions of the advancing bank. The arrows point in the direction of slope of successive depositional surfaces and in the direction of lateral migration of the meander. On the section, 'ADE' represents the transverse profile of the river, with 'D' the deepest part of the channel and 'AD' the surface of the growing point bar on the inside of the meander. Successive earlier river profiles are indicated by 'AI DI EI', 'A2 D2 E2' and 'A3 D3 E3'. Vertical scale of the section is about five times horizontal.

deepest part to the south bank would have been only a fraction of this, probably between a half and a quarter, because of the asymmetrical cross section characteristic of meandering rivers. Thus it can be estimated that the width of the former river channel was between 180 and 220 feet. These estimates for the depth and width of the river at the time of deposition of the gravels are close to the dimensions of the present River Trent in this vicinity.

The abandoned meander

It has been shown above that the gravels under consideration were deposited on the north bank of the former River Trent. However, the River Trent today flows to the north of these deposits; therefore, the meander in which they accumulated must have been abandoned.

The southward slope of the upper surface of the gravel bed at the southern end of the quarry (Text-fig. 2), parallel to the underlying cross strata, records the end of the lateral accretion of gravel on the point bar. This means that the main flow of the river had been transferred elsewhere. The overlying bed of sand indicates the persistence, over a period, of a somewhat weaker flow in the same direction as before. The sand is overlain by two shell beds, separated by a bed of laminated sand (Shell beds 2 and 3). The fauna of these shell beds is discussed in the next section.

South of the quarry, beyond Polser Brook, a stretch of flat ground is bounded to the south by a degraded cliff, the edge of the Floodplain Terrace (Text-fig. 1). This cliff formed the south bank of the River Trent at the time when the meander was just about to be abandoned. The width of the former river channel here, from the point where the surface of the gravel begins to slope towards the south (north bank) to the old cliff (south bank), is about 200 feet. This agrees with the estimates made above, using the cross bedding in the gravel, and with the width of the modern River Trent nearby.

The shell beds

The shell beds are dark grey sandy clays and muddy sands with abundant shells showing up white on the surface. They are poorly sorted and generally unstratified. The amount of clay and fine plant debris in these beds would suggest deposition in relatively slow moving water as compared with that in which the associated sands and gravels were deposited. Shell bed 1, from its position beneath the gravel, must have accumulated on the bed of the River Trent before the meander was abandoned. Shell beds 2 and 3, on the other hand, accumulated in the meander channel near the north bank, after the main flow of the river had been diverted elsewhere.

Samples of each of these shell beds were collected by Mr. R.C.Alvey, who carefully dissected out all the molluscs, including shell fragments, down to 30 mesh, and sent them to one of us (A.J.R.) for examination. Each of these mollusc samples contained several thousand individuals and all of these were identified and counted. The results of this faunal analysis are presented in Table 1. Five points of detail concerning the production of this table are given below.

1. Only the apical portions of gastropods and the hinges of bivalves were counted and, although the bivalves were counted as single valves, this number was halved to represent the number of individuals.

2. Juvenile specimens of Carychium and Succinea, which are not specifically determinate, were allocated proportionately to the species present in each sample as determined from adult shells.

TABLE 1

Frequency of Molluscs in the three shell beds

Species / Shell beds:	Percentages of specimens per sample		
	1	2	3
Theodoxus fluviatilis (Linné)	-	P	-
Valvata cristata Müller	18.5	6.3	9.8
V. piscinalis (Müller)	10.5	24.4	12.6
Potamopyrgus jenkinsi (Smith)	-	0.4	-
Bithynia tentaculata (Linné)	22.7	28.4	20.7
B. leachi (Sheppard)	21.2	15.1	19.4
Carychium minimum Müller	0.4	P	0.1
C. tridentatum (Risso)	0.1	-	P
Lymnaea truncatula (Müller)	0.1	0.2	-
L. stagnalis (Linné)	0.2	0.2	0.1
L. auricularia (Linné)	-	0.1	0.3
L. peregra (Müller)	1.8	1.6	2.0
Aplexa hypnorum (Linné)	-	P	-
Physa fontinalis (Linné)	0.1	0.4	0.4
Planorbarius corneus (Linné)	-	0.1	0.1
Planorbis carinatus Müller	-	1.2	0.6
P. planorbis (Linné)	-	3.0	0.6
P. vortex (Linné)	1.7	0.2	1.6
P. leucostoma Millet	-	P	P
P. albus Müller	7.0	3.4	3.2
P. crista (Linné)	8.3	2.8	17.3
P. contortus (Linné)	0.5	0.1	0.2
Segmentina complanata (Linné)	3.9	0.2	0.5
Acroloxus lacustris (Linné)	0.6	0.1	P
Ancylus fluviatilis Müller	-	P	-
Succinea putris (Linné)	0.2	0.1	-
S. pfeifferi Rossmässler	-	1.6	2.5
Cochlicopa lubrica (Müller)	0.2	P	-
Columella edentula (Draparnaud)	P	-	-
Vertigo antivertigo (Draparnaud)	-	P	-
V. pygmaea (Draparnaud)	P	P	-
Vallonia pulchella (Müller)	-	P	-
V. excentrica Sterki	-	P	-
Clausilia bidentata (Ström)	P	-	-
Hygromia liberta (Westerlund)	0.1	0.2	0.1
Arionid slug granules	-	P	P
Euconulus fulvus (Müller)	P	P	-
Vitrea contracta (Westerlund)	0.1	P	-
Retinella radiatula (Alder)	0.1	-	-
Zonitoides nitidus (Müller)	0.1	P	-
Unio tumidus Philipsson	-	0.1	P
Anodonta cygnea (Linné)	-	-	P
Sphaerium corneum (Linné)	0.3	0.6	0.6
Pisidium amnicum (Müller)	-	P	-
P. casertanum (Poli) var. ponderosa Stelfox	-	P	-
P. milium Held	0.3	0.4	0.3
P. subtruncatum Malm	0.5	0.7	0.9
P. henslowanum (Sheppard)	P	P	0.3
P. nitidum Jenyns	0.5	8.1	5.8
Total number of specimens per sample	3,060	5,431	2,986
Weights of samples	not known	2.5 kg	1.4 kg

3. In Shell bed 1, all the specimens of Pisidium were specifically determined. However in Shell beds 2 and 3, Pisidium was so abundant as to make specific determination of every specimen impracticable. Twenty five random specimens from each of these samples were identified and the total number of specimens allocated proportionately. The figures thus obtained were slightly modified by separating, identifying and counting the rarer more distinctive species (P.amnicum, P.casertanum and P.henslowanum) and including them in the table.

4. Further samples were collected from Shell beds 2 and 3, processed and the sieved concentrates subjected to a rapid examination without counting. The objects of this further work were (i) to collect the non-molluscan fauna, (ii) to extend the molluscan faunal list, and (iii) to select any particularly good specimens for illustration. Further material was no longer available from Shell bed 1 at this stage. Thus the faunal lists from Shell beds 2 and 3 are considered to be complete and comparable, whereas the list for Shell bed 1 could be extended by further collecting.

5. The presence of species which form less than 0.1% of a sample is indicated by the letter 'P'. This includes all the species which were only discovered as a result of the further sampling noted above.

6. The nomenclature used in Table 1 is that used by Ellis (1951).

The molluscan faunas of the three shell beds are all broadly similar, but differ from one another in detail. In considering these faunas, it should be borne in mind that the shell beds represent areas of shell accumulation as well as environments in which molluscs were living. The faunas are therefore broadly characteristic of the river environment as a whole, changes in the local environment being reflected in relatively small variations between the faunas of the shell beds.

The fauna of Shell bed 1 is dominated by operculate gastropods (Theodoxus to Bithynia in Table 1), four species of which make up nearly three quarters of the total. Next in abundance are the planorbid gastropods (Planorbarius to Segmentina in Table 1). Terrestrial gastropods (Carychium, and Succinea to Zonitoides in Table 1) are represented by twelve species, but only a very small number of individuals. The environment indicated by this fauna is a large body of clear, hard water (more than 20 mg. of calcium per litre). The molluscs inhabited a relatively slow-moving part of the river, with a mud bottom supporting a good weed growth. The terrestrial species in the list represent shells which fell into the river, probably during erosion of the banks.

The fauna of Shell bed 2 differs from that of Shell bed 1 in several respects. There is a marked increase in the abundance of Succinea, a terrestrial gastropod which lives high on plants overhanging water, and a corresponding decrease in the abundance of the other terrestrial gastropods (Carychium, and Cochlicopa to Zonitoides in Table 1). This implies the growth of marginal reed beds and a reduction in erosion of the river banks. Amongst the aquatic species, Valvata piscinalis has increased in abundance at the expense of Valvata cristata, and there is a notable increase in the abundance of Pisidium, particularly P.nitidum. These changes can be interpreted in terms of decreased flow of the river.

The fauna of Shell bed 3 shows a continuation of the trends noted above. There is a further increase in the abundance of Succinea, while the number of other terrestrial species recorded is significantly reduced. The dominance of the operculate gastropods is somewhat reduced and the abundance of the planorbids increased, particularly Planorbis crista. These changes are consistent with relatively still water conditions as compared with Shell bed 2.

EXPLANATION OF PLATE 13

Fig. 1 Planorbarius corneus (Linné). Apical view. (23.1 x 28.2 mm.)

Fig. 2 Planorbis planorbis (Linné). Apical view. (11.3 x 12.9 mm.)

Fig. 3 P. carinatus Müller. Apical view. (11.0 x 13.4 mm.)

Fig. 4 Same specimen as Fig. 1. Apertural view. (6.3 x 28.2 mm.)

Fig. 5 Same specimen as Fig. 2. Apertural view. (3.1 x 12.9 mm.)

Fig. 6 Same specimen as Fig. 3. Apertural view. (2.7 x 13.4 mm.)

Fig. 7 P. contortus (Linné). Apical view. (2.7 x 3.1 mm.)

Fig. 8 Segmentina complanata (Linné). Apical view. (2.7 x 3.3 mm.)

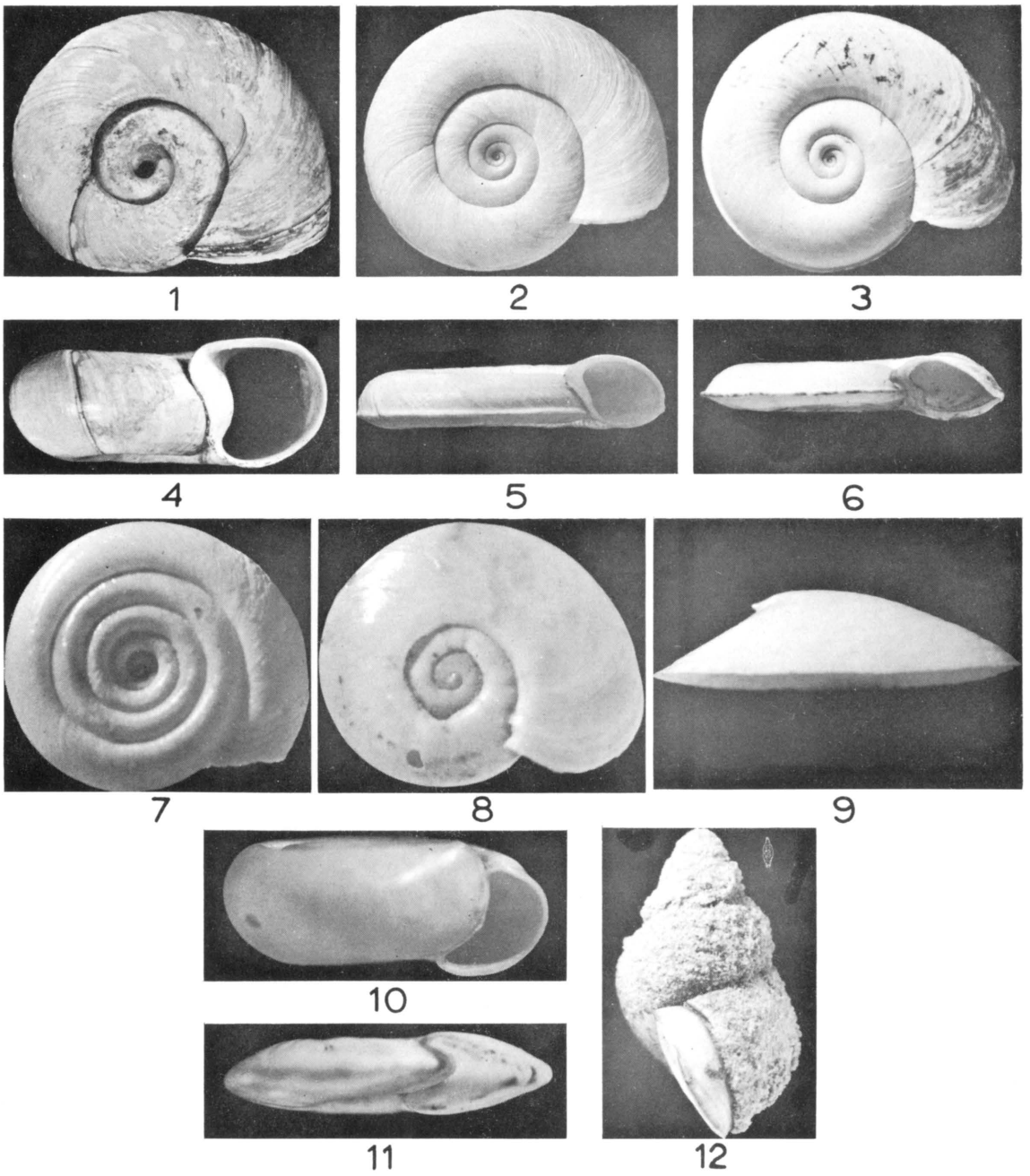
Fig. 9 Acroloxus lacustris (Linné). Lateral view. (1.7 x 5.9 mm.)

Fig. 10 Same specimen as Fig. 7. Apertural view. (1.3 x 3.1 mm.)

Fig. 11 Same specimen as Fig. 8. Apertural view. (0.9 x 3.3 mm.)

Fig. 12 Bithynia tentaculata (Linné). Specimen coated with calcareous material which ends along a growth line near the aperture. This coating was obviously deposited during the life of the snail.

All quoted measurements are of the heights and the widths respectively in each of the views given. The figured specimens have been deposited in the Department of Archaeology, University of Nottingham.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Non-molluscan fauna and flora

In addition to the molluscan fauna listed in Table 1, the following were also found:-

POLYZOA (determined by Mr. R.C.Alvey)

Cristatella sp. Many statoblasts

OSTRACODA (determined by Dr. R.H. Bate)

Candona candida (Müller)
Eucypris ornata (Müller)
Herpetocypris reptans (Baird)
} Abundant

INSECTA

Trichoptera (?Limnophilus sp.). Caddis fly. Many larval cases.
Curculionidae (2 spp. undet.). Weevils. Legs, heads, elytra.
Scarabaeidae (1 sp. undet.). Dor Beetle. 1 leg and 1 head.

ARACHNIDA

Acari (2 spp. undet.). Mites. 2 individuals.

PISCES

Esox lucius Linné. Pike. 1 tooth.

Phoxinus phoxinus (Linné). Minnow. 2 pharyngeal bones.

Undetermined teleost bones and scales. Common.

AMPHIBIA

Undetermined bones.

MAMMALIA

Many bones. Not collected.

Mr. R.C. Alvey, who has studied the plant remains from the shell beds, records that the flora is similar to that already recorded from the vicinity of Boat no. 1 (Alvey, 1969), with the addition of the following species not identified there:-

Potentilla anserina Linné. Silverweed. Twelve achenes.

Prunus spinosa Linné. Blackthorn. Two fruitstones.

Quercus sp. Oak. Two acorns.

Salix sp. Willow. Leaf impressions.

'Charophyte'. Many 'fruits'.

EXPLANATION OF PLATE 14

Fig. 1 Theodoxus fluviatilis (Linné). Apertural view. (5.5 x 6.9 mm.)

Fig. 2 Bithynia leachi (Sheppard). Apertural view. (5.7 x 4.2 mm.)

Fig. 3 Physa fontinalis (Linné). Apertural view. (6.4 x 3.7 mm.)

Figs.4-6 Bithynia tentaculata (Linné).

Fig. 4 Gerontic shell, markedly larger than the other specimens of this species recovered from these deposits. Note the well defined growth line marking cessation of growth before the final winter. Compare with the gerontic specimens of Lymnaea auricularia (Linné) and L. stagnalis (Linné) figured in Cummins & Rundle (1968, pl.20, figs.3 & 4). (13.9 x 7.2 mm.)

Fig. 5 Specimen with a strongly shouldered final whorl caused by earlier shell damage. Compare with the typical form figured in Rundle & Taylor (1967, pl.11, fig.3). (9.9 x 6.5 mm.)

Fig. 6 Specimen in which the end of the body whorl has become detached from the rest of the shell. (5.6 x 3.7 mm.)

Figs.7-8 Valvata piscinalis (Müller).

Fig.7 Specimen showing more extreme detachment of the body whorl from the rest of the shell than that shown in Fig. 6. Compare with the typical form of this species figured by Cummins & Rundle(1968, pl.19, fig. 1). (5.2 x 5.1 mm.)

Fig. 8 Scalariform individual possessing an unusually high spire. Compare with typical form of species and with Bithynia leachi shown above. (4.5 x 4.2 mm.)

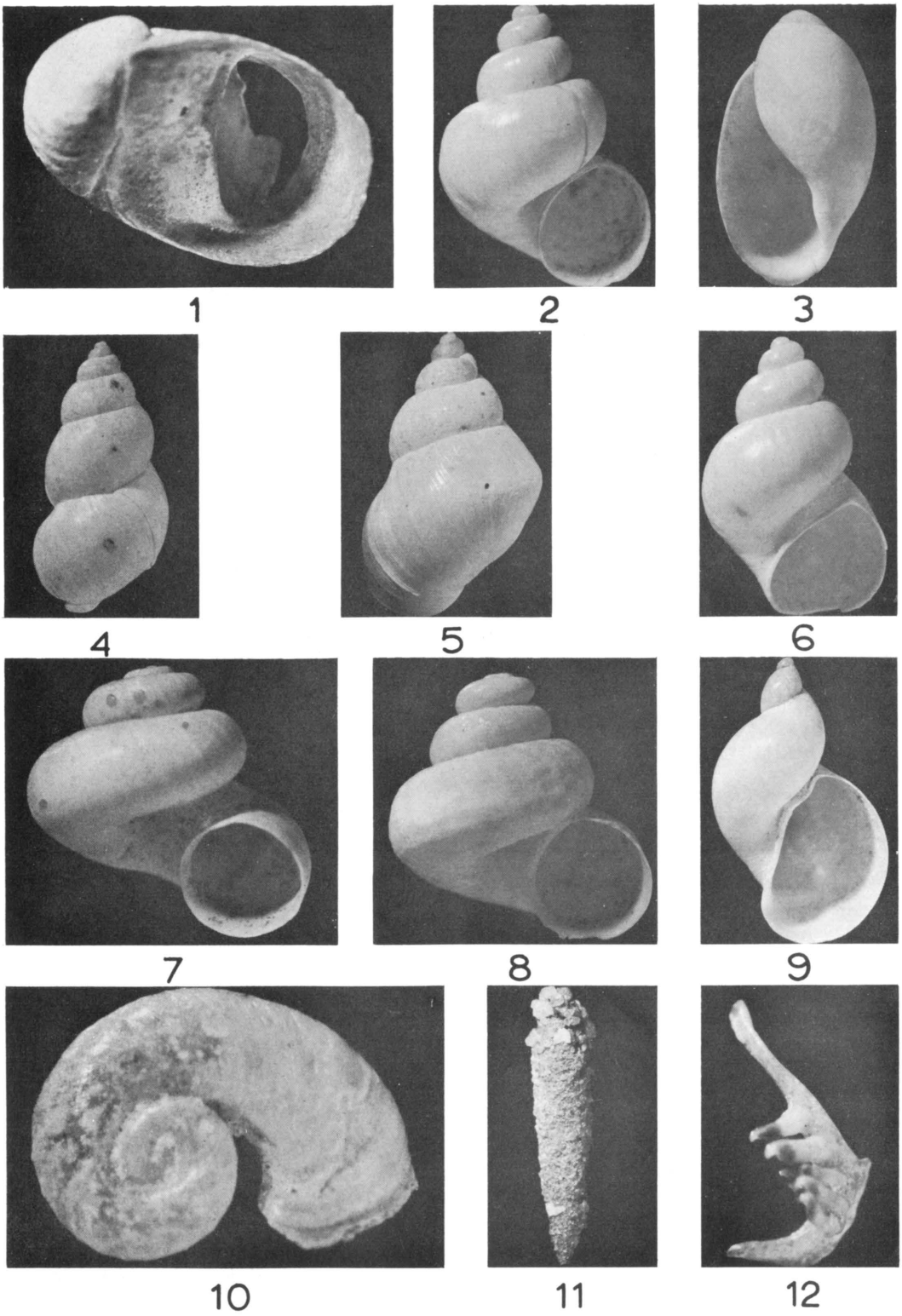
Fig. 9 Lymnaea auricularia (Linné). Specimen showing a tendency towards a scalariform type. Compare with the typical form figured in Cummins & Rundle (1968, pl. 20, fig. 3). (8.5 x 5.2 mm.)

Fig.10 Planorbis crista (Linné). Specimen in which the last third of the final whorl has become detached from the rest of the shell. Compare with the typical form figured in Rundle & Taylor (1967, pl. 12, fig. 2). (1.3 x 1.8 mm.)

Fig.11 Caddis Fly larval case (?Limnophilus sp.) made up of sand grains. (6.4 x 1.4 mm.)

Fig.12 Pharyngeal bone of Minnow (Phoxinus phoxinus (Linné)). (2.5 x 1.5 mm.)

A useful reference for identifying British Recent and Holocene Mollusca is that by McMillan (1968).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Mr. Alvey has also identified the following species from the lumps of loam at the base of the gravel (see p. 199), associated with Boat no. 3:-

Atriplex patula Linné. Common Orache. 14 achenes.

Carex spp. Sedge. 9 nutlets.

Corylus avellana Linné. Hazel. 1 nut.

Galeopsis tetrahit Linné sensu lato. Common Hemp-nettle. 1 nutlet.

Nymphaea alba Linné. White Water-lily. 24 seeds.

Oenanthe aquatica (Linné). Fine-leaved Water Dropwort. 1 fruit.

Potamogeton spp. Pondweed. 3 Fruitstones.

Ranunculus hederaceus Linné. Ivy-leaved Water-Crowfoot. 5 seeds.

Sambucus nigra Linné. Elder. 1 seed.

Stellaria media (Linné). Chickweed. 7 seeds.

This is very similar to the flora recorded from the loam above the gravel near Boat no. 1 (Clay of bank adjacent Boat no. 1; Alvey, 1969) and is thus consistent with the view expressed earlier (see p.179) that the lumps of loam are blocks of floodplain sediment, which fell into the river as the banks were undercut.

Acknowledgements

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