Chapter 10

Molluscan analyses

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INTRODUCTION

The preliminary report on the Southfleet Road site, Swanscombe, recorded the discovery of a deep sequence of Pleistocene deposits with various faunal, floral and archaeological remains (Wenban-Smith *et al.* 2006). These included an elephant skeleton and a substantial Clactonian lithic assemblage from Phase 6 of the site's stratigraphical sequence, as presented in this volume (Chapter 4). Amongst the faunal remains, molluscan remains were identified in Phase 6b of the sequence, the 'tufaceous channel-fill' that occurred towards the base of the grey clay in the centre of the main east-facing section (Fig. 4.29). These deposits were also rich in small vertebrate (Chapter 7) and (in some horizons) ostracod remains (Chapter 11). Therefore, various series of samples were taken from these deposits for subsequent analysis. By far the richest samples for molluscan (as well as small vertebrate) remains were from sediments attributed to 40070, the main (and basal) tufaceous deposit of Phase 6b. The deposition of the main body of the clay is thought to have been in a lacustrine or backwater environment, with colluvial/sheetwash overbank input and periodic desiccation. The 'tufaceous channel-fill' probably represents a small, fast-flowing stream which cut into the clay when it was exposed as a short-lived land-surface during one these periods of desiccation. Although not a true *in situ* tufa, the high carbonate content suggests this stream was possibly spring-fed, and includes micritic tufaceous particles, reworked from true tufaceous sediments in the close vicinity. The calcareous nature of 40070 has clearly been important for the preservation of molluscan remains, since few Pleistocene shells have been recovered from other sediments.

In the preliminary site report, molluscs from a single sample from the middle of context 40070 were analysed to provide an impression of the climate and local environment (Wenban-Smith *et al.* 2006). For this more detailed report, columns of samples through the tufaceous channel-fill sequences have been analysed in order to investigate changes in the composition of the molluscan faunas through 40070 and into the overlying contexts 40143 and 40144, which also contain (albeit much sparser) molluscan remains.

Two columns of 20-30L bulk samples (Columns 1 and 2) were taken at different points along the longitudinal section 40075 of the tufaceous channel (Fig. 10.1a). These were sub-sampled for ostracods and molluscs before the remainder was processed for small vertebrate recovery, leading to complementary molluscan and small vertebrate records from the same sample series (see Chapter 7). A vertical series of sub-samples from two monoliths parallel to Column 1, <40321> and <40326>, were also analysed. Between them, these samples covered the thickest parts of the tufaceous channel-fill, and went well into the underlying Phase 6a deposits (40039 and 40103). At Column 1, the top of 40070 was directly overlain by context 40144, lacking the intervening (and intermittently occurring) context 40143. Therefore a vertical series of sub-samples was also examined from monolith <40282>, from Trench XIII (Fig. 10.1b), which contained both 40143 and 40144 in sequence above the top of 40070. Finally, a third column of bulk samples with molluscan and ostracod sub-sampling (Column 3) was constructed from the east-west transverse section 40079 across the east side of the tufaceous channel (Fig. 10.1c). This was taken to assess palaeo-environmental differences between the channel-edge and the channel-centre. In many cases shells from contexts adjacent to 40070 have probably been derived from that context or, in the case of underlying deposits, the result of sampling across stratigraphical boundaries, where sediment contortions and intrusions made collection of absolutely stratigraphically pure samples impossible.

Many samples from other sediments were also assessed for molluscan remains (Appendix 1) but none were found, apart from in one deposit (Phase 3, 40062). Here, numerous *Bithynia* opercula but no other molluscan remains (apart from derived Tertiary fragments) were recovered in conjunction with a relatively rich ostracod fauna (see Chapter 11). Although this assemblage does not make a particularly informative contribution to the general palaeoenvironmental reconstruction, these Phase 3 *Bithynia* were submitted for amino acid dating (Chapter 13); the significance of the results depends on careful consideration of their taphonomic history, and the possibility of derivation.

Several samples intended primarily for recovery of small vertebrate remains were also scanned for fossil molluscs. Most of these contained large quantities of reworked Tertiary shell, with only a trace of Pleistocene material. Two rich Pleistocene faunas were picked from samples <40295> (40144) and <40284> (40143). The former duplicates the mollusc sub-sample of the same number in Column 1, although the additional material

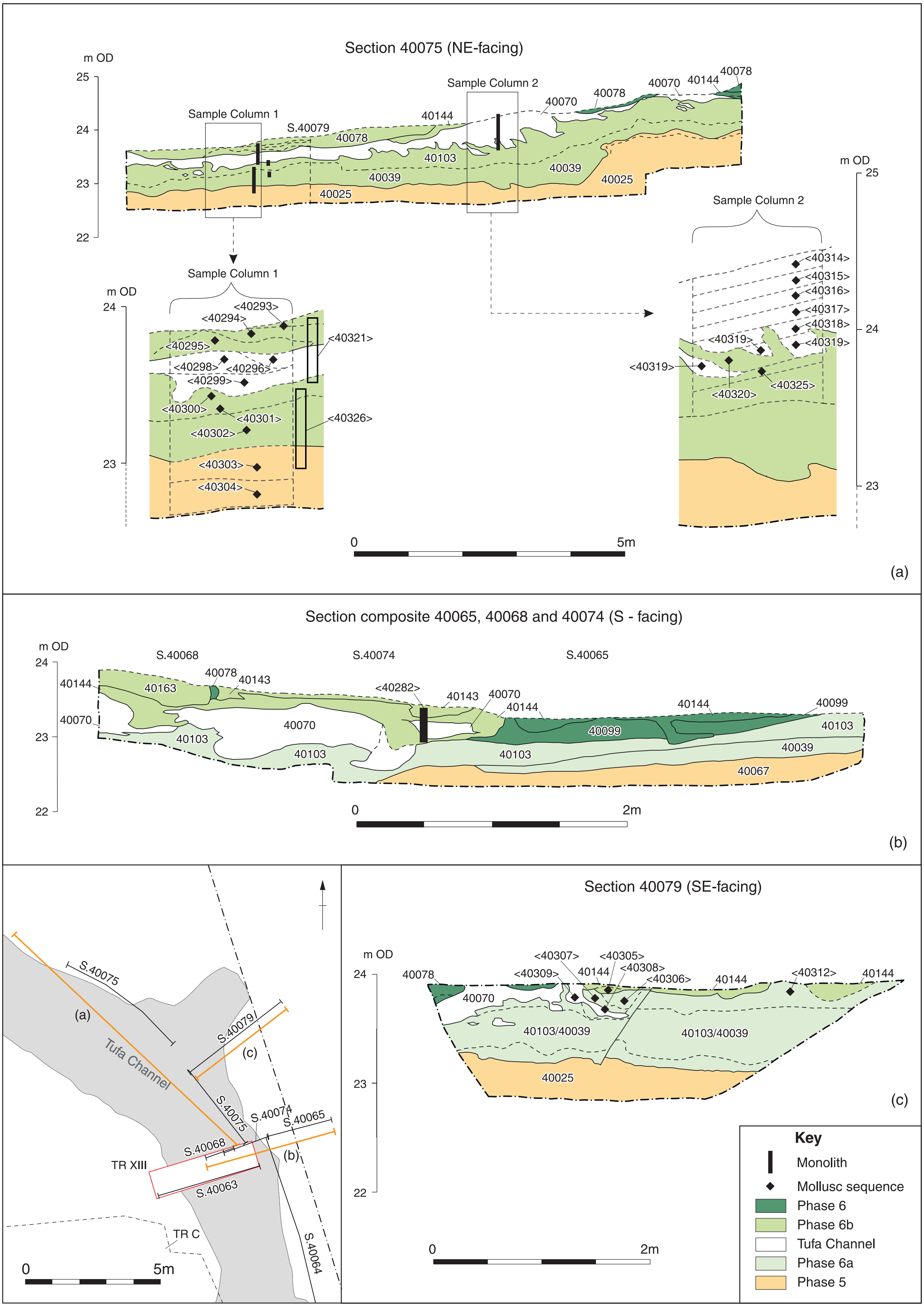

Figure 10.1 Locations of mollusc sequences through tufaceous channel fill, Phase 6b: (a) longitudinal Section 40075, showing Column 1, Column 2, monolith <40321> and monolith <40326>; (b) east-west composite section across tufaceous channel showing monolith <40282> from Trench XIII; (c) east-west Section 40079 across east side of tufaceous channel showing sample Column 3

provides a more statistically viable record of the proportions of different species at this level. The latter was of uncertain location in relation to the column samples, but the material recovered broadly duplicates the other data from context 40143, and likewise provides a more complete record.

METHODS AND TAPHONOMIC BIASES

Samples were weighed before being wet-sieved. For some samples it was necessary to use small quantities of dilute hydrogen peroxide to break up the clayey matrix before sieving. Residues above 500 µm were picked for mollusc shell fragments. Small vertebrate remains, including fish otoliths, were retained and passed on to the faunal specialist, Simon Parfitt (see Chapter 7). Residues below 500 µm were retained but were not requested for ostracod analysis as dedicated samples were available.

In many samples, the mollusc shells have been badly crushed and are represented only as fragments of body whorl. The absence of apical and apertural fragments means that it is impossible to provide a minimum number of individuals for some species. This problem particularly affects the land taxa *Discus ruderatus* and the Clausiliidae. When apical or apertural fragments are preserved they are often of juvenile individuals, suggesting that post-depositional processes have preferentially fragmented large shells. This preservational bias means that although many of the samples are rich in shell fragments, the number of quantifiable individuals is low.

Some shells were heavily encrusted with carbonate and could not be satisfactorily identified. All of the samples discussed below for which countable molluscan remains were present came from the tufaceous channel-fill sequence (Phase 6b), which without doubt represents a single short-lived stream development and channel-fill event in MIS 11. They can thus be considered both *en masse* as a representative assemblage from the part of MIS 11 represented (with due consideration of their landscape context) (see below). They can also be considered in terms of the changing local environment represented by variations in the proportions and ecological preferences of species at different levels through the sequences investigated (see below).

SPECIES LIST AND NOTES ON SIGNIFICANT SPECIES

The full list of species from the tufaceous channel-fill sequence, Phase 6b, is given at the end of this chapter (Table 10.7) compiled from all samples and all the three constituent contexts 40070, 40143 and 40144. In total 49 species were recognised, with 24 of them aquatic and 25 primarily terrestrial (including Succineidae). The ecological tolerances of some of the more interesting occurrences are given below:

Ena montana. Species of old woodland with a modern distribution mainly in Central Europe and Alpine areas, although pockets remain in SW England (Kerney and Cameron 1979). Requires warm summer temperatures.

Clausilia pumila. Species of damp woods now extinct in Britain, Central and Eastern European distribution (Kerney and Cameron 1979).

Arianta arbustorum. Widespread species, found in meadows, woods and hedgerows, but always in damp places – restricted in areas with dry climate and good drainage.

Azeca goodalli. Found in moss and ground litter in open woods, often in rocky places. Prefers light shade, avoiding both the extremes of open ground and dense woodland (Kerney 1999); the mossy edges of woodlands are often its preferred habitat (Paul 1974).

Vertigo angustior. Restricted to moist places affected neither by periodic dessication nor by flooding (Kerney 1999). Requires warm places vegetated by grasses, mosses or low herbs. This species is currently in decline, having been common at the beginning of the postglacial period after which suitable habitats were replaced by forest. This might also have been the case at Southfleet Road, as several woodland indicators are present in the assemblage; the lack of the more shade-demanding species evident at Hitchin suggests that woodland was not sufficiently well-developed for these taxa, allowing some more open species like *V. angustior* to remain.

SEQUENCE INTERPRETATIONS

Sample <40035> (context 40070)

This sample was scanned for a preliminary assessment of the molluscan remains by R. Preece; results are published in Wenban-Smith *et al.* (2006). Although doubling the number of species known from the site, subsequent analyses have not significantly altered the climatic and local environment interpretations offered by Preece in that publication. Residues from this initial assessment sample contained 26 taxa, 13 aquatic and 13 terrestrial, although quantitatively the aquatics are dominant (Table 10.1). The most common species were *Valvata piscinalis*, *Bithynia tentaculata* and bivalves of the genus *Pisidium*. This suite is typical of small hard-water streams, supported by the presence of the river limpet, *Ancylus fluviatilis*, which favours fast-flowing water and stony substrates. Many specimens were encrusted in carbonate. Marshland environments are indicated by the presence of *Vertigo antivertigo*, *Zonitoides nitidus* and indeterminate Succineidae. *Arianta arbustorum*, a large species, is common as fragments and more abundant than *Cepaea* sp. Fully temperate conditions are reflected by the presence of *Ena montana*, the modern range of which is thought to be limited by lack of summer warmth

Table 10.1 Molluscan remains from assessment sample <40035> (context 40070)

Southfleet Road Assessment Sample		
Sample	*<40035>*	*Notes*
Context	*40070*	
Dry weight	*Not rec.*	
Valvata piscinalis Müller	14	
Bithynia tentaculata L. opercula	44	
Stagnicola palustris agg.	4	
Radix balthica Müller	1	
Anisus leucostoma (Millet)	2	
Gyraulus sp.	1	
Ancylus fluviatilis (Müller)	1	
Pisidium amnicum (Müller)	9	
Pisidium moitessierianum Paladilhe	1	
Pisidium nitidum Jenyns	11	
Pisidium subtruncatum Malm	12	
Pisidium tenuilineatum Stelfox	11	
Total aquatic taxa	67	
Succineidae	3	
Cochlicopa lubrica	1	
Vertigo antivertigo (Drapernaud)	1	
Vallonia costata (Müller)	1	
Ena montana (Drapernaud)	5	
Discus ruderatus (Férusac)	+	Fragments only
Zonitoides nitidus (Müller)	2	
Deroceras / *Limax* spp.	4	
Clausiliidae	17	
Trochulus hispidus (L.)	1	
Arianta arbustorum (L.)	+	
Cepaea sp.	+	
Total land taxa	35	
Total shells	102	
Tertiary shells	+	

(Kerney 1968). The Clausiliidae are well represented but highly fragmented; these including *Clausilia pumila*, a central European forest species no longer living in Britain (Kerney and Cameron 1979). *Discus ruderatus*, another species now extinct in Britain, was also present; its congener, *D. rotundatus*, which replaces *D. ruderatus* later in the interglacial, was not recorded.

Column 1

The lowermost samples in this sequence, from contexts 40025 and 40103, were devoid of Pleistocene shells. Sample <40300> incorporated material from contexts 40103 and 40070, suggesting that the shells were derived from the latter. Above 40070, some shells were obtained from the basal sample <40295> from 40144; however, the fact that the overlying samples from this context were devoid of Pleistocene shell remains suggests that the material from the base of context 40144 was probably derived from 40070.

The species represented are detailed in Table 10.2, and represented as a histogram in Figure 10.2a. The aquatic taxa are, like the assessment sample, dominated by *Valvata piscinalis* and members of the *Pisidium*. *Bithynia tentaculata* is also well represented, predominantly by opercula. Land taxa include a large number of fragments of *Discus ruderatus*, although none of these were apices. The terrestrial assemblage is very similar to that of sample <40035> with the notable addition of *Helicella itala*, a species of dry calcareous grassland.

The range of aquatic species indicates deposition of context 40070 in an aqueous environment, probably a small stream. The terrestrial species indicate a surrounding damp woodland environment, but relatively open rather than densely wooded. Figure 10.2a does not illustrate any significant changes in the fauna or environmental conditions through the Column 1 sequence; some of the apparent increases in species such as *Valvata piscinalis* are a function of the better recovery of shells from these levels.

Column 2

Unlike Column 1, this sample column does not go into contexts above 40070, which were truncated by machine excavation, but provides the deepest record of recovery (and possible change) within 40070. Again, Pleistocene shell was only recovered from samples within context 40070, the basal two samples from context 40103 being barren. The samples from this column were much richer in countable individuals and the shells were generally less fragmented. The species represented are detailed in Table 10.3 and represented as a histogram in Fig. 10.2b. This sequence is almost identical to Column 1. The general interpretation of both the aquatic and terrestrial taxa is the same as for Column 1, being a small fast-flowing stream with nearby woodland. Traces of dry grassland species, such as *H. itala*, are again present.

Again, the impression of increasing abundance in Fig. 10.2b is somewhat artificial due to the low recovery of shells from the basal samples. The fauna does not change significantly through this sequence, although the appearance of *Valvata cristata* in the uppermost sample might suggest shallowing waters and more weedy conditions (mirrored in Column 3, see below). The consistency of the mollusc fauna through the sequence suggests that the local environment was relatively stable during the deposition of 40070, lending further support to the hypothesis that the tufaceous channel was a relatively short-lived feature

Column 3, Section 40079

The basal samples from this sequence, from context 40103, yielded no Pleistocene shells. Four samples from 40070 and a single sample from context 40144 contained a molluscan assemblage (Table 10.4; Fig. 10.2c). The assemblages from context 40070 were of

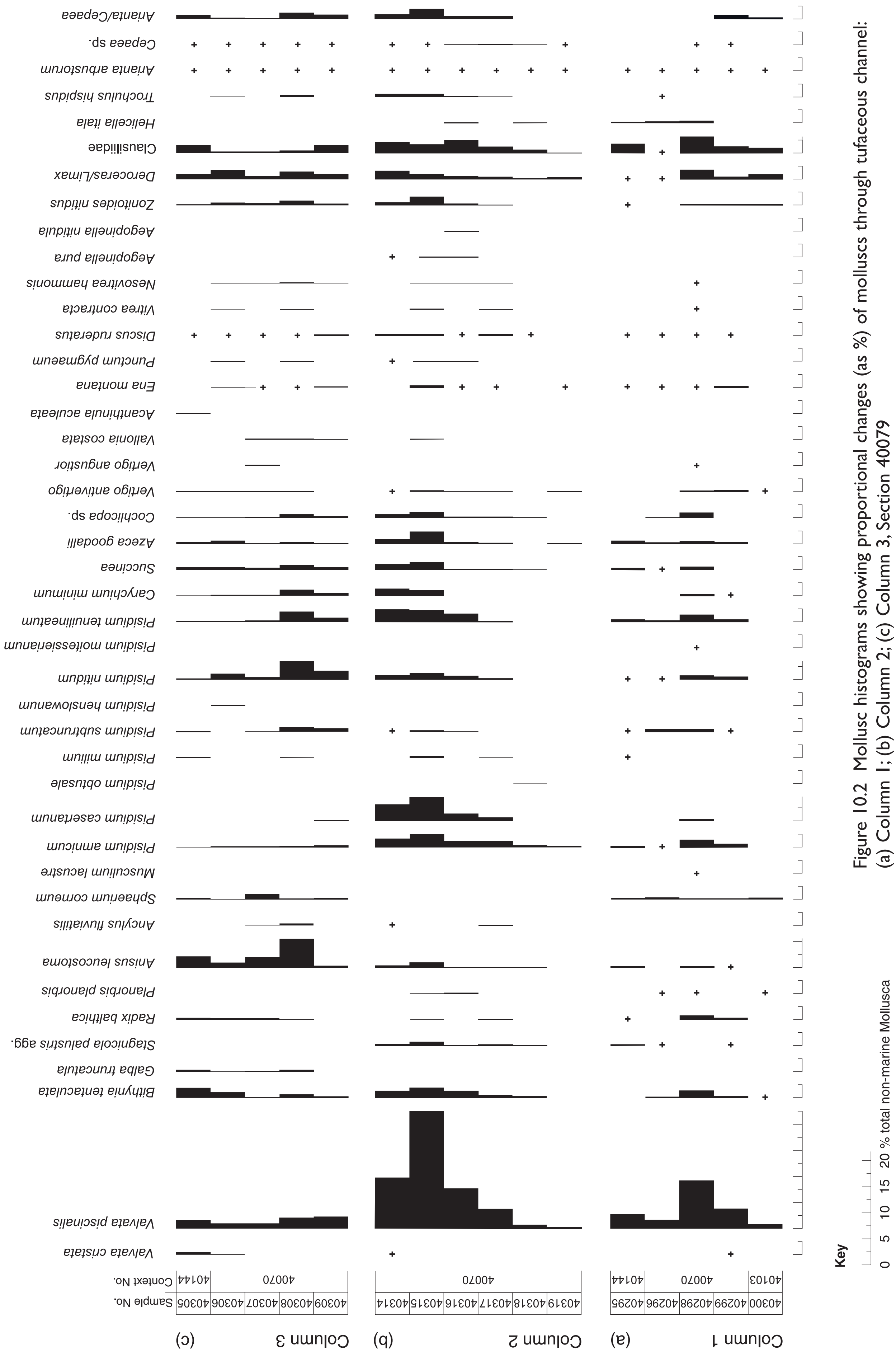

Figure 10.2 Mollusc histograms showing proportional changes (as %) of molluscs through tufaceous channel: (a) Column 1; (b) Column 2; (c) Column 3, Section 40079

Table 10.2 Molluscan remains from Column 1

Column 1					*Monolith*	*Bulk sample*
Sample	*<40300>*	*<40299>*	*<40298>*	*<40296>*	*<40295>*	*<40295>*
Context	*40070/ 40103*	*40070*	*40070*	*40070*	*40144*	*40144*
Dry weight (g)	*1061.5*	*997.5*	*1301.1*	*797.8*	*1272.7*	*c 20 kg*
Aquatic taxa						
Valvata cristata Müller	-	1	-	-	-	-
Valvata piscinalis (Müller)	9	38	93	17	28	12
Bithynia tentaculata (L.)	1	3	14	2	-	1
Bithynia opercula	12	25	49	12	3	12
Stagnicola palustris (Müller) agg.	-	1	-	1	3	4
Radix balthica (Müller)	-	3	9	-	1	4
Planorbis planorbis (L.)	1	-	1	1	-	-
Anisus leucostoma (Millet)	-	1	2	-	3	4
Sphaerium corneum (L.)	3	2	2	4	3	-
Musculium lacustre (Müller)	-	-	1	-	-	-
Pisidium amnicum (Müller)	-	6	15	1	2	+
Pisidium casertanum (Poli)	-	-	4	-	-	-
Pisidium milium Held	-	-	-	-	1	-
Pisidium nitidum Jenyns	-	6	9	1	1	1
Pisidium subtruncatum Malm	-	1	6	6	1	-
Pisidium moitessierianum Paladilhe	-	-	1	-	-	-
Pisidium tenuilineatum Stelfox	-	5	14	3	6	3
Total aquatic (minus opercula)	14	67	171	36	49	41
Terrestrial taxa						
Carychium minimum Müller	-	2	3	-	-	-
Succineidae	-	-	6	2	4	-
Azeca goodalli (Férusac)	-	4	5	3	6	7
Cochlicopa sp.	-	-	10	1	-	-
Vertigo antivertigo (Draparnaud)	1	3	2	-	-	-
Vertigo angustior Jeffreys	-	-	1	-	-	-
Ena montana (Draparnaud)	-	3	1	1	+	-
Discus ruderatus (Férusac)	-	+	+	+	+	+
Vitrea contracta Westerlund	-	-	1	-	-	-
Nesovitrea hammonis (Ström)	-	-	1	-	-	-
Zonitoides nitidus (Müller)	2	2	2	-	1	-
Deroceras / Limax spp.	10	5	18	2	1	1
Clausiliidae	10	13	32	1	18	17
Helicella itala (L.)	-	-	4	3	2	-
Trochulus hispidus (L.)	-	-	-	1	-	-
Arianta arbustorum (L.)	3	7	+	+	+	+
Cepaea / Arianta	-	1	+	-	-	-
Total terrestrial	26	40	86	14	32	25
Total Mollusca	40	107	257	50	65	66

similar character to those from the same context in Columns 1 and 2. The transition from 40070 to 40144 is marked by the appearance of *Valvata cristata* (Fig. 10.2c), which suggests increasingly shallow and weedy environments towards the top of the sequence (also noted, albeit less convincingly, at the top of Column 2). A single shell of *Acanthinula aculeata* was recovered from the uppermost sample. This species is characteristic of deciduous woodland environments. Fewer grassland taxa were recorded from this sequence, with only *V. angustior* being notable. Otherwise, this sequence shows very little change in the terrestrial and aquatic faunas.

Monoliths <40321> and <40326 >

As with other sequences, the only samples which contained Pleistocene shells from the deposit sequence represented in these monoliths relate to context 40070, all from the upper monolith <40321>. Shells were picked from 5 samples (Table 10.5) but were not very numerous by comparison with the three main sequences detailed

Table 10.3 Molluscan remains from Column 2

Column Sample 2						
Sample	*<40319/C>*	*<40318/C>*	*<40317/C>*	*<40316/C>*	*<40315/C>*	*<40314/C>*
Context	*40070*	*40070*	*40070*	*40070*	*40070*	*40070*
Dry weight (g)	*928.1*	*1142.7*	*955.6*	*1051*	*964.1*	*880*
Aquatic taxa						
Valvata cristata Müller	-	-	-	-	-	2
Valvata piscinalis (Müller)	3	8	38	77	226	99
Bithynia tentaculata (L.)	-	2	5	13	20	14
Bithynia opercula	11	9	24	36	52	37
Stagnicola palustris (Müller) agg.	-	1	3	2	8	4
Radix balthica (Müller)	-	-	1	-	1	-
Planorbis planorbis (L.)	-	-	-	2	1	-
Anisus leucostoma (Millet)	-	1	1	1	10	4
Gyraulus laevis (Alder)	-	-	-	-	3	-
Ancylus fluviatilis (Müller)	-	-	1	-	-	1
Pisidium amnicum (Müller)	3	4	13	13	26	17
Pisidium casertanum (Poli)	-	-	7	14	46	32
Pisidium obtusale (Lamarck)	-	1	-	-	-	-
Pisidium milium Held	-	-	1	-	3	-
Pisidium nitidum Jenyns	-	-	3	8	13	9
Pisidium subtruncatum Malm	-	-	-	1	3	2
Pisidium tenuilineatum Stelfox	2	-	2	16	23	24
Pisidium spp.	-	1	-	-	-	-
Total aquatic (minus opercula)	8	18	75	147	383	208
Terrestrial taxa						
Carychium minimum Müller	-	-	-	-	11	14
Succineidae	-	1	2	2	15	11
Azeca goodalli (Férusac)	1	-	2	4	24	9
Cochlicopa sp.	-	1	2	2	11	7
Vertigo antivertigo (Draparnaud)	1	-	1	1	3	2
Vertigo angustior Jeffreys	-	-	-	1	1	-
Vallonia costata (Müller)	-	-	-	-	2	-
Ena montana (Draparnaud)	+	-	+	+	4	-
Punctum pygmaeum (Draparnaud)	-	-	-	1	1	1
Discus ruderatus (Férusac)	-	+	3	+	3	3
Aegopinella pura (Alder)	-	-	-	1	1	1
Aegopinella nitidula (Draparnaud)	-	-	-	1	-	-
Vitrea contracta Westerlund	-	-	1	-	2	-
Nesovitrea hammonis (Ström)	-	-	1	1	1	-
Zonitoides nitidus (Müller)	1	-	1	3	17	6
Deroceras / Limax spp.	4	2	5	6	10	16
Clausiliidae	1	7	13	25	17	22
Helicigona lapicida (L.)	-	-	-	1	1	1
Helicella itala (L.)	-	1	-	1	-	-
Trochulus hispidus (L.)	-	-	1	2	6	6
Arianta arbustorum (L.)	+	+	+	+	+	+
Cepaea sp.	+	1	2	1	+	+
Cepaea / Arianta	-	-	6	6	19	9
Total terrestrial	8	13	40	59	149	108
Total Mollusca	16	31	115	206	564	316

above. The general environmental interpretation is the same as for other samples. The lowermost sample from which Pleistocene shell fragments were recovered (360–390mm) was notably iron-stained and contained a significant quantity of worn Tertiary shell fragments. *Bithynia* opercula were most common, together with a single fragment of *Sphaerium corneum* and an apex of a clausiliid. An additional aquatic species in this monolith was *Gyraulus crista*, from context 40070, which has a preference for weedy environments and is intolerant of desiccation, further reinforcing that the stream was a permanent waterbody during deposition of 40070.

Table 10.4 Molluscan remains from Column 3 (Section 40079)

Column 3, Section 40079					
Sample	*<40309>*	*<40308>*	*<40307>*	*<40306>*	*<40305>*
Context	*40070*	*40070*	*40070*	*40070*	*40144*
Dry weight (g)	*1018*	*1123.8*	*1125.6*	*1024.9*	*1088.7*
Aquatic taxa					
Valvata cristata Müller	-	-	-	1	5
Valvata piscinalis (Müller)	23	21	10	10	16
Bithynia tentaculata (L.)	3	7	2	11	20
Bithynia opercula	14	27	15	18	58
Galba truncatula (Müller)	-	4	2	1	4
Radix balthica (Müller)	-	1	3	3	4
Anisus leucostoma (Millet)	4	56	20	10	22
Ancylus fluviatilis (Müller)	-	4	1	-	-
Sphaerium corneum (L.)	4	2	10	1	3
Pisidium amnicum (Müller)	4	3	2	2	1
Pisidium casertanum (Poli)	2	-	-	-	-
Pisidium milium Held	-	2	-	-	1
Pisidium subtruncatum Malm	7	9	1	-	-
Pisidium henslowanum (Sheppard)	-	-	1	-	-
Pisidium nitidum Jenyns	17	36	5	12	3
Pisidium tenuilineatum Stelfox	8	20	3	2	2
Total aquatic (minus opercula)	72	165	59	54	82
Terrestrial taxa					
Carychium minimum Müller	6	12	2	2	1
Succineidae	5	10	4	5	5
Azeca goodalli (Férusac)	2	4	1	6	4
Cochlicopa sp.	3	7	2	1	1
Vertigo antivertigo (Draparnaud)	1	2	2	-	-
Vertigo angustior Jeffreys	-	1	1	1	1
Vallonia costata (Müller)	-	-	2	-	-
Ena montana (Draparnaud)	2	+	+	1	-
Acanthinula aculeata (Müller)	-	-	-	-	1
Punctum pygmaeum (Draparnaud)	-	1	-	1	-
Discus ruderatus (Férusac)	2	+	+	+	+
Vitrea contracta Westerlund	-	1	-	1	-
Nesovitrea hammonis (Ström)	1	2	1	1	-
Zonitoides nitidus (Müller)	3	9	4	5	2
Deroceras / *Limax* spp.	10	15	6	18	10
Clausiliidae	15	5	3	3	16
Arianta arbustorum (L.)	8	12	+	2	8
Trochulus hispidus (L.)	-	4	-	1	-
Total terrestrial	58	85	28	48	49
Total Mollusca	130	250	87	102	131

Monolith <40282 >

The sequence from this sample was unique in containing both contexts 40143 and 40144 overlying context 40070. It also provided an (albeit sparse) ostracod sequence to complement the molluscan record. Four relatively small samples contained Pleistocene shells. Additional molluscan material from 40143 also came from bulk sample <40284>, which also provided a complementary small vertebrate fauna from the same horizon. The species represented are detailed in Table 10.6, but there are insufficient shells from most of the samples in this monolith to make a histogram worthwhile.

The assemblages from contexts 40070 and 40144 are very similar in composition to those discussed above, showing minimal change upwards through the sequence. Those from the uppermost context (40143) show little difference in the range of aquatic species, but a marked reduction in the quantity and diversity of terrestrial species, perhaps reflecting a quiet episode of relatively still water.

Additional species in the sequence from this monolith include, from 40070, the aquatic *Bathyomphalus contortus*, a fairly catholic planorbid, which has a preference for weedy environments and is intolerant of desiccation, further reinforcing that the stream was a

Table 10.5 Molluscan remains from monolith <40321>

Sample	*40321/C*	*40321/C*	*40321/C*	*40321/C*	*40321/C*
Context	*40070*	*40070*	*40070*	*40070*	*40144?*
Depth	*39-36cm*	*36-33cm*	*33-31cm*	*31-29cm*	*27-18cm*
Dry weight (g)	*170*	*145*	*100*	*150*	*555*
Aquatic taxa					
Valvata piscinalis (Müller)		2		13	6
Bithynia tentaculata (L.)		1	1	+	1
Bithynia tentaculata (opercula)	5	9	2	18	5
Galba truncatula (Müller)					
Gyraulus crista (L.)				1	
Sphaerium corneum (L.)	1			1	1
Pisidium amnicum (Müller)				1	
Pisidium nitidum Jenyns		2		3	1
Pisidium subtruncatum Malm				2	2
Pisidium moitessierianum Paladilhe				+	1
Pisidium tenuilineatum Stelfox				3	2
Pisidium spp.			1		1
Total aquatic (minus opercula)	1	5	2	24	15
Terrestrial taxa					
Carychium minimum Müller				1	
Azeca goodalli (Férusac)				4	3
Cochlicopa sp.				1	1
Vertigo antivertigo (Draparnaud)				1	
Ena montana (Draparnaud)		+		+	+
Discus ruderatus (Férusac)		+	+	+	+
Vitrea contracta Westerlund					1
Zonitoides nitidus (Müller)				1	
Deroceras / Limax		1	1		
Clausiliidae	1	+	1	+	+
Arianta arbustorum (L.)		+			+
Cepaea / Arianta					2
Total terrestrial	1	1	2	8	7
Total Mollusca	2	6	4	32	22
Vertebrates	+	+	+	+	+
Tertiary shell fragments	+	+			

permanent waterbody. A single fragment of *Helicigona lapicida*, a calciphile landsnail characteristic of rocky environments and deciduous woodland, also from 40070, is the only additional terrestrial taxon.

CLIMATE AND ENVIRONMENT THROUGH THE SEQUENCE

The molluscan faunas from Southfleet Road have been recovered from relatively short sequences through context 40070 of the tufaceous channel-fill, and provide few indications of significant environmental changes. This is partly due to preservation, the highly fragmented nature of the material preventing accurate quantification of many species. It is probably also a reflection of the relatively short time span represented by the tufaceous channel deposits. The quantity and diversity of aquatic species through the tufaceous channel-fill sequence (40070, 40144 and 40143) indicates an aqueous depositional environment, and there are faint indications in the sequences of Column 2 and 3 (duplicated in the small vertebrate record (Chapter 7) of shallower and more weedy conditions at the top of 40070 and associated with deposition of 40144. The assemblage contains many species indicative of fully-temperate conditions, and a damp local woodland environment seems to have prevailed throughout the period of time represented, although there are sparse indications of drier and more open grassland in the vicinity.

CORRELATIONS WITH OTHER SITES

Preece (in Wenban-Smith *et al.* 2006) compared the fauna with that from the Lower Loam at Barnfield Pit, Swanscombe, where *Ena montana* is also a common constituent (Kerney 1971). The Lower Loam fauna represents a floodplain environment of a much larger river; it was therefore considered possible on purely molluscan

Table 10.6 Molluscan remains from monolith <40282> and bulk sample <40284>

Sample	*<40282/C>*	*<40282/C>*	*<40282/C>*	*<40282/C>*	*<40284>*
Context	*40070*	*40070*	*40144*	*40143*	*40143*
Depth	*22-15cm*	*15-8cm*	*8-2cm*	*2-0cm*	-
Dry weight (g)	*305.3*	*211.9*	*393.8*	*74.2*	*c 750*
Aquatic taxa					
Valvata piscinalis (Müller)	36	64	10	-	6
Bithynia tentaculata (L.)	4	18	6	5	40
Bithynia tentaculata (opercula)	12	35	26	5	177
Galba truncatula (Müller)	2	4	3	-	-
Stagnicola palustris (Müller) agg.	2	-	1	-	3
Radix balthica (Müller)	4	1	3	3	32
Lymnaea stagnalis (L.)	-	-	-	-	1
Gyraulus crista (L.)	-	1	2	1	1
Planorbis planorbis (L.)	+	+	2	7	
Anisus leucostoma (Millet)	2	4	15	-	
Planorbarius corneus (L.)	-	-	1	1	
Bathyomphalus contortus (L.)	2	-	3	-	
Ancylus fluviatilis (Müller)	1	-	-	-	
Acroloxus lacustris (L.)	-	-	-	1	
Sphaerium corneum (L.)	6	7	5	1	3
Pisidium amnicum (Müller)	-	+	-	-	
Pisidium nitidum Jenyns	3	8	1	1	1
Pisidium subtruncatum Malm	-	+	2	2	
Pisidium henslowanum (Sheppard)	-	-	1	-	
Pisidium moitessierianum Paladilhe	1	+	-	-	
Pisidium tenuilineatum Stelfox	7	11	3	-	1
Pisidium spp.	-	-	-	-	
Total aquatic (minus opercula)	70	118	58	22	88
Terrestrial taxa					
Carychium minimum Müller	2	2	3	-	-
Carychium tridentatum Risso	-	5	-	-	-
Succineidae	2	9	2	-	-
Azeca goodalli (Férusac)	3	12	4	-	1
Cochlicopa sp.	4	3	2	-	-
Vallonia costata (Müller)	2	1	-	-	-
Ena montana (Draparnaud)	+	+	+	-	-
Discus ruderatus (Férusac)	1	1	+	1	+
Vitrea contracta Westerlund	2	-	-	-	-
Nesovitrea hammonis (Ström)	1	-	-	1	-
Zonitoides nitidus (Müller)	8	-	1	-	-
Deroceras / Limax	9	11	7	-	1
Clausilia pumila Pfeiffer	1	-	-	-	-
Clausiliidae	7	4	1	-	-
Helicigona lapicida (L.)	-	+	-	-	-
Trochulus hispidus (L.)	+	2	1	1	-
Cepaea sp.	+	-	-	-	-
Arianta arbustorum (L.)	1	2	+	-	7
Total terrestrial	43	52	21	3	9
Total Mollusca	113	170	79	25	97
Ostracods	+	+	+	+	-
Otoliths	-	+	+	+	-
Tertiary shell fragments	-	-	1	-	-

grounds that the Southfleet Road tufaceous channel-fill was deposited by a small tributary of this river. Comparison can also be drawn with Hitchin, a MIS 11 tufa site in Hertfordshire (Kerney 1959). Here, *Ena montana* and *Azeca goodalli* are both common. The Southfleet Road assemblages lack the more exotic elements of the Hitchin tufa, perhaps suggesting they represent a slightly earlier part of the interglacial before characteristic woodland species such as *Platyla polita* had colonised Britain. The Southfleet Road material also shows similarities with the assemblage from Bed 3b at Beeches Pit, which is also considered to be a correlative of the Lower Loam (Preece *et al.* 2007). The most important taxa present at both sites are *Discus ruderatus*, which is replaced in later parts of the Beeches Pit sequence by *D. rotundatus*, and *Vitrea contracta*, which occurs only in Beds 3a and 3b of the Beeches Pit sequence (Preece *et al.* 2007).

CONCLUSIONS

The 'tufaceous channel-fill' at Southfleet Road appears to represent a right-bank tributary of the MIS 11 Thames and may well be a correlative of the Lower Loam deposits at Barnfield Pit, Swanscombe. Pollen evidence indicates that the Phase 6 grey clay belongs to the early-temperate phase of the Hoxnian (Chapter 12). This is supported by the molluscan evidence (Table 10.7), which indicates a local terrestrial environment of temperate woodland with areas of swamp and dry grassland nearby. The damp grassland environment, characterised by species such as *Vertigo angustior*, might be receding as the woodland develops; certainly the most shade-demanding taxa evident at sites such as Hitchin are not present at Southfleet Road.

The most common aquatic constituent of the Southfleet Road assemblage is *Valvata piscinalis*, although none of the specimens approach the *antiqua* form that first appears at the top of the Lower Loam at Barnfield Pit (Kerney 1971) and continues through the Lower Middle Gravels at Dierden's Pit (White *et al.* 2013). This lends further support to the Southfleet Road deposits being contemporary with an earlier part of the Barnfield Pit sequence, namely the lower/middle part of the Lower Loam, or the Lower Gravel. Similarly, *Ena montana*, presently a rare species in Britain that predominantly lives in old woodland, is only known from the Lower Gravel and Lower Loam at Barnfield Pit and *Vertigo angustior* is not known from Middle Gravels and above.

The proportion of land snails is high, attaining levels of around 50% in some samples. This is in keeping with the tufaceous nature of the mollusc-bearing channel deposits, which suggests that the water body was a small spring-like stream with woodland environments located nearby. The stream was a permanent water-body, however, as several aquatic taxa that require fast-flowing water, such as *Ancylus fluviatilis*, are present, as well as some intolerant of desiccation (eg *Gyraulus crista* and *Bathyomphalus contortus*).

The assemblages are very consistent, which suggests that the molluscan evidence from the tufaceous channel-fill records a relatively short time interval during which the local environment did not change significantly. There is also little variation in the proportions of species represented through the channel-fill sequences (see Figs 10.2a,b,c) through this unit, although the low countable numbers of shells from some contexts might be masking this information. It has therefore not been possible to do much more than characterise the environments represented mainly by context 40070, since there are no dynamic environmental changes recorded in the molluscan fauna.

Table 10.7 Full list of species from tufaceous channel fill sequence, Phase 6b

Aquatic taxa:	
Valvata cristata	*Valvata piscinalis*
Bithynia tentaculata	*Galba truncatula*
Stagnicola palustris	*Radix balthica*
Planorbis planorbis	*Anisus leucostoma*
Bathyomphalus contortus	*Gyraulus laevis*
Gyraulus crista	*Planorbarius corneus*
Ancylus fluviatilis	*Acroloxus lacustris*
Sphaerium corneum	*Musculium lacustre*
Pisidium amnicum	*Pisidium casertanum*
Pisidium obtusale	*Pisidium milium*
Pisidum subtruncatum	*Pisidium nitidum*
Pisidium moitessierianum	*Pisidium tenuilineatum*
Land taxa:	
Carychium minimum	*Carychium tridentatum*
Succineidae	*Azeca goodalli*
Cochlicopa lubrica	*Vertigo antivertigo*
Vertigo angustior	*Vallonia costata*
Acanthinula aculeata	*Ena montana*
Punctum pygmaeum	*Discus ruderatus*
Vitrea crystallina	*Nesovitrea hammonis*
Zonitoides nitidus	*Deroceras / Limax*
Clausilia pumila	*Clausilia* cf. *bidentata*
Aegopinella nitidula	*Aegopinella pura*
Helicella itala	*Trochulus hispidus*
Arianta arbustorum	*Helicigona lapicida*
Cepaea cf. *nemoralis*	