QUATERNARY MOLLUSCA FROM PORT FAIRY, VICTORIA, AUSTRALIA, AND THEIR PALAEOECOLOGIC IMPLICATIONS

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Abstract

Calcareous marine Quaternary sediments from Port Fairy, Victoria have yielded over 300 species of molluscs in two assemblages. One represents a back-beach deposit assembled from a moderately exposed rocky shore with minor admixtures of shells from other near-shore environments. The other is interpreted as a shallow-water offshore sandy bottom deposit that includes shells from rocky and sandy shores, rocky, sandy and silty shallow offshore bottoms, and rarely, moderately deep offshore bottoms. A rich flora of algae and cryptogams is suggested by the molluscs.

The assemblages include a few species that live today only to the north, and several that live only to the east. The extra-limital forms are interpreted as indicating slightly warmer (1-2°C) summer temperatures than at present; perhaps the cool northward-flowing currents along W. Tasmania were formerly modified.

Introduction

Richly fossiliferous Quaternary sediments are exposed in the Borough of Port Fairy, W. Victoria. The fossils are chiefly molluscs, though Foraminifera are also abundant, and they provide what must be a fairly large sample of the former molluscan associations of the region. The purpose of this study is to record the fossil molluscan associations from two localities, to infer the former environments from which the fossils were assembled, and to assess the biogeographic significance of the fauna.

Attention has been drawn to the Port Fairy Quaternary by Gill (Gill & Fairbridge 1953; 1954), who noted the presence in these deposits of extra-limital molluscs, *Anadara trapezia* and *Ninella torquata,* interpreted as indicating warmer waters than are present today in the Port Fairy region. Radiocarbon analysis of opercula of *Ninella torquata* from one of the localities (Bank St) yielded an age estimate of 'older than 35,000 years' (Gill 1956).

Foraminifera from the Port Fairy Quaternary have been described by Collins (1953), who noted that the associations resemble recent beach and lagoonal associations in the Port Fairy region but contain a few forms that are not known to live near Port Fairy today. These have been interpreted as indicating warmer waters than at present (Collins in Jennings 1959, app. III).

Acknowledgements

Study of the Port Fairy Mollusca was suggested by E. D. Gill, National Museum of Victoria, who accompanied me in the field to many Quaternary localities and provided much data and encouragement, and to whom I am much indebted for these and numerous other courtesies. It is also a pleasure to acknowledge the aid of J. Hope Macpherson, National Museum of Victoria, who drew on her large knowledge of marine molluscs to solve many problems arising during the course of the work.

The late C. J. Gabriel aided in the identification of many of the minute forms, and Robert Burn provided identifications and ecologic data on pleurobranchids and berthelinids. Eric Wilkinson, Patricia Hoggart, and Joyce Shaw, National Museum of Victoria, and Bob Mallory, University of Missouri, aided with various phases of the work. Photographs were made by Frank Guy, Royal Melbourne Institute of Technology. The South Australian Museum, Adelaide, kindly permitted access to their molluscan collections.

Special thanks are due the Sub Aqua Group of Victoria, particularly the Geology Group and Mrs Jeannette Watson, for sampling recent offshore thanatocoenoses and for introducing me to the subtidal benthos of Victoria in its own milieu.

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FIG. 1—General tectonic setting of W. Victoria and SE. South Australia during the Cainozoic. Partly after Wilkins 1962.

Geological Setting

The general tectonic setting of the Port Fairy district during the Cainozoic is depicted in Fig. 1. Port Fairy lies within the Otway Basin (Bureau of Mineral Resources 1960), bounded to the E. by Mesozoic rocks of the Otway Ra. and to the N. by a persistent Cainozoic high, the Dundas Peninsula. To the W., where magnetic and bore data are available, several tectonic elements have been identified: the Gambier sunklands (Sprigg 1952) in the far W. of the Otway Basin, bounded to eastward by the Dartmoor Ridge (Boutakoff 1952), a tectonic swell running

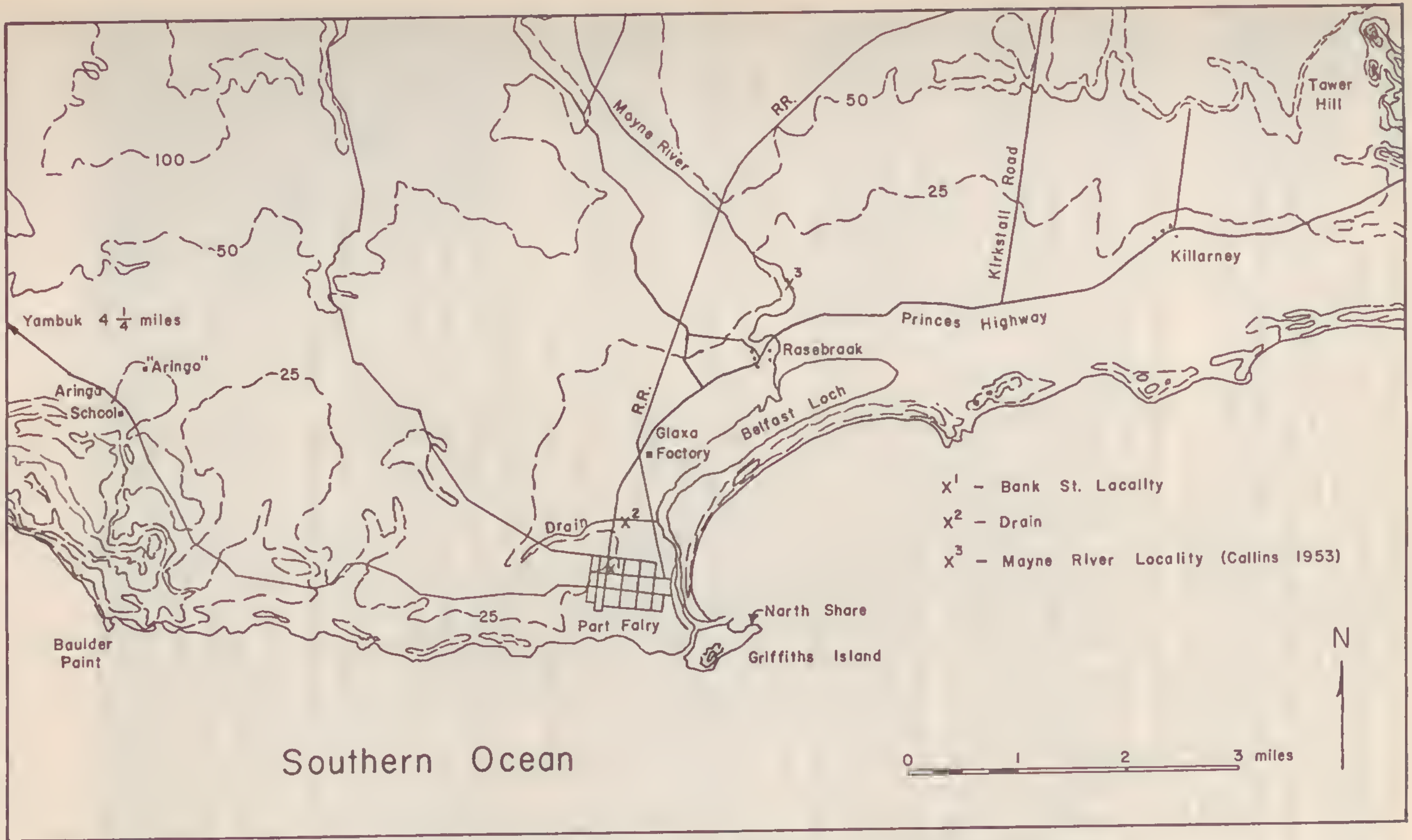

FIG. 2—Sketch map of Port Fairy and vicinity, W. Victoria, showing fossil localities and landmarks mentioned in text. Base map, Australia 1:63,360, Port Fairy sheet.

southward from the Dundas Peninsula from near Casterton to Cape Bridgewater; and the Portland sunklands (Boutakoff 1952) E. of the Ridge.

The oldest rocks outcropping or penetrated by shallow bores in the Port Fairy region are Miocene limestones and marls, evidently continuous with the upper formations of the Heytesbury Group described in the Port Campbell and Moonlight Head districts (Baker 1944, 1950, 1953). This group has not been completely penetrated by bores in the Port Fairy district for which data are available. However, a bore at the Glaxo factory (Chapman 1925, Fig. 2) proved Miocene marls at depths between 94 and 954 ft below sea level.

Overlying the Miocene sediments is a basalt assigned to the Newer Volcanics, probably of Pliocene age. Field and bore data collected by E. D. Gill demonstrate the general geometry of the basalt, which has played an important role in the distribution of marine communities along the Pleistocene shores of Port Fairy. I am indebted to Mr Gill for permission to use this unpublished information. The upper surface of the Heytesbury Group had been eroded into a topography of moderate relief before extrusion of the basalt, which occupies a channel in the Heytesbury Group that extends 94 ft below sea level (or thereabouts; Chapman 1925 does not specifically identify the top of the Miocene rocks) in the Glaxo bore (Fig. 2). The Port Campbell Limestone, the upper formation of the Heytesbury Group, outcrops to the W. of Port Fairy near Aringa and Yambuk, and to the E. near Tower Hill, but is evidently absent in the Glaxo bore, having presumably been eroded from the channel. Bores which have bottomed in volcanics have been drilled near the railway station, Port Fairy (basalt to at least 72 ft below sea level) and S. of Rosebrook (basalt to at least 80 ft below sea level).

To the E. of Port Fairy the volcanics outcrop in a drain which crosses the Princes Highway about $\frac{7}{8}$ mile W. of its intersection with Kirkstall Rd. Bores less than a mile E. of Killarney, however, failed to penetrate basalt but found sand at depths between 15 and 65 ft below sea level.

Thus the volcanics form a tongue running southward from the W. Victorian Basalt Plains proper along a channel cut in Miocene rocks. The tongue is thickest between Port Fairy and Rosebrook and thins both eastward and westward. The upper surface of the volcanics may itself be deeply channelled in the E. near Killarney, for the lateral change from basalt to sand is abrupt.

In Port Fairy proper the upper surface of the tongue of Newer Volcanics is rather irregular, and variations in its elevation have exercised some control upon the character of the shore line and the distribution of near-shore environments. A break in elevation which follows a N.-S. trend runs along the E. side of Griffith's Is. and separates a region of generally high surface elevations to the W. from one of lower elevations to the E. The coast from Griffith's Is. W. to Boulder Point forms a headland; at the island are rocky shores and offshore rocky bottoms. To the E. the basalt surface is generally well below sea level near the present shore, and the coast is embayed. Information from shallow bores and trenches between Princes Highway and the shore demonstrates a relief of from 21 ft above sea level on an uneven basalt ridge that runs E.-W. along Bank and Regent Streets, to 9 ft below sea level in depressions S. of the ridge. N. of the ridge the basalt surface drops off to unknown depths beneath a thicker blanket of sediments. This drop-off may well represent the margin of an old course of the Moyne R. which ran E.-W. near the coast.

Overlapping the Miocene sediments and Newer Volcanics is a complex of calcareous dune sands with associated marine sands and conglomerates of Quaternary age. Near Portland and in the Mt Gambier sunklands similar sedimentary complexes are mapped as a single unit, the Bridgewater Formation (Sprigg & Boutakoff 1953). The present report is concerned with fossils contained in marine and beach sediments of this complex which veneer the Newer Volcanics E. of the Princes Highway at Port Fairy. To facilitate discussion these fossiliferous sediments are hereafter called the Port Fairy beds, a term used as a sort of nomina aperta outside the formalities of stratigraphic nomenclature. Detailed mapping is required to define useful, mappable formations within the Quaternary complex.

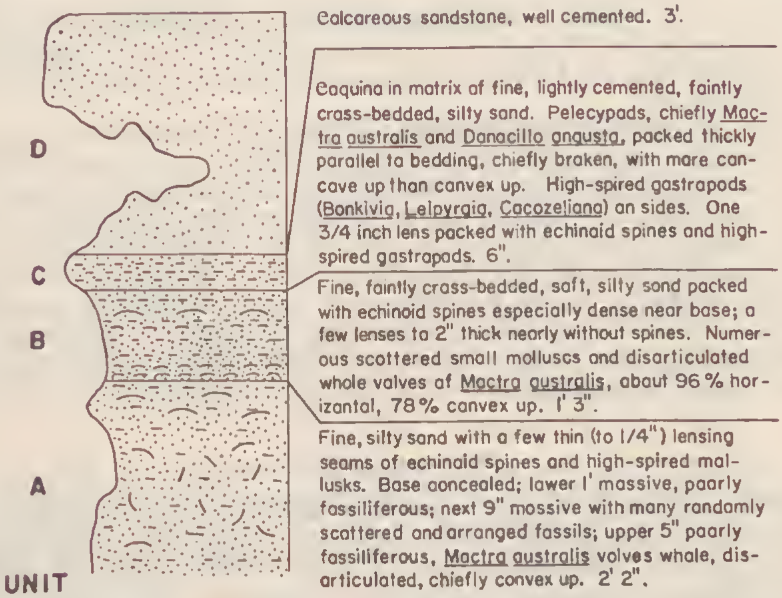

FIG. 3—Pleistocene sediments exposed at Fig. 2, locality 2, in drain 196 ft E. of Princes Highway.

Stratigraphy of the Port Fairy Beds

On the SE. corner of Bank St and Albert St (Princes Highway), Port Fairy, a 2½ ft-thick conglomerate is exposed in the street cutting. It consists of irregular basalt boulders, to at least 18 in. in long diameter, and cobbles and pebbles in a coarse sand matrix. The conglomerate is well-cemented, especially so toward the top, and lies on Newer Volcanics. Fossils are scattered among the clasts and locally concentrated in sandy pockets. Three samples were collected—a single pocket of about 100 cu. in., a 136 cu. in. sample from several pockets, and a skimmed sample from the entire outcrop.

About 725 yds N. of Bank St a drain crosses Princes Highway; 196 ft E. of the highway along the S. side of the drain a section of fossiliferous calcareous sands begins that is exposed for about 30 ft to the E. The column in Fig. 3 was measured near the W. end of the exposure. Newer Volcanics are not exposed in the bottom of the drain, which is about 8 ft above sea level at the outcrop. As is evident from Fig. 3 the sediments consist of lenses of fine silty sands that exhibit differences in texture and sedimentary structures. Some of the chief textural differences are owing to the fossils—whether they are chiefly small and minute or include large shells, and whether they are scattered or are gathered into pockets or lenses.

Lens A was sampled 10 times to gather data on the heterogeneity of species' abundances and on the reproducibility of abundance figures, lenses B and C were sampled once each, and the well-cemented lens D was not sampled. All these samples were of 136 cu. in. However, in preparation they were sieved and approximately 100 gm of the fraction coarser than 1 mm was investigated for each sample. In addition to these quantitative samples, fossils were collected from the outcrop by skimming.

Traced to the E., lens A becomes massive and less fossiliferous, lens B changes aspect as echinoid spines become rare so that it resembles lens C, while lens C becomes crossbedded and the fossils become comminuted so that it is relatively barren of identifiable shells.

E. of this exposure the Quaternary sediments are concealed by slumping for about 71 ft, where they reappear in a poor exposure approximately 38 ft long. Here, lenses exhibit the same range of lithologies as at the westerly outcrop, though not in the same order. A single sample was skimmed from this exposure.

For the purposes of this paper all the samples from Bank St have been pooled and all the samples from the drain have been pooled, so that only two localities are discussed. Statistical assessment of species' abundances within sampled units is incomplete. It will bear on the detailed depositional history of the lenses sampled but should not affect the general environmental and biogeographic conclusions of the present paper, which indeed form a necessary background for the detailed study.

Palaeogeography

The locality at Bank St (Fig. 2) contains a molluscan association that includes many littoral and supra-littoral rocky-shore forms and was probably deposited between the upper littoral zone and the rear of the former beach (see 'Palaeoecology' later). Mean sea level was thus evidently somewhat lower than the exposure when the fossils were accumulating. The locality lies on the nose of a rise of about 6 ft. Perhaps this represents the former beach slope. It is closely comparable to the present slope of the boulder beach at Griffith's Is. By analogy with this recent beach the base of the littoral zone at Bank St may have been about 6 ft below the Bank St conglomerate, or at about 18 ft above present mean sea level. The horizons sampled at the drain lie between 12 and 16 ft above present sea level. If the sands at the drain are associated with the same depositional episode as the conglomerate at Bank St, which is very likely though not proved beyond all doubt, then they were all deposited in waters shallower than 6 ft below about the mean low tide level.

The E.-W. trending basalt ridge on which the conglomerate at Bank St rests formed a peninsula when washed by the sea, or possibly was broken partly into islands. It was at any rate rather analogous topographically to the present Griffith's Is. The conglomerate accumulated on the E. shore of the former point. To the W. the trace of the old shore line must run nearly E.-W. to NW.-SE. To the E. of the former point the sea flooded inland over the lower basalt surface for over a mile and perhaps for a few miles in some areas, forming a more pronounced embayment than the present Port Fairy Bay (Fig. 2). Gill has found marine sediments about 1¾ miles inland from the present coast along the Moyne R. (Fig. 2). Foraminifera from this locality suggest a lagoonal environment (Collins 1953, sample 3). Fossils at the drain were thus deposited in the lee of a headland on a bottom of silty sand, about 725 yds N. of a rocky shore, and may have accumulated on a broad sand flat in shallow water or on a beach.

The Molluscan Fauna

The invertebrate fauna of the Port Fairy beds is rich and diverse, with representatives of numerous phyla. Foraminifera, Porifera (as spicules), Bryozoa, Annelida, Brachiopoda, Mollusca, Cirrepedia, Ostracoda, Decapoda, and Echinoidea are the groups most abundantly represented. Coralline algal fragments are also present. Only the Mollusca are studied in this report.

TABLE 1

Number of species in Pleistocene molluscan collections from Port Fairy, by classes

CLASS	DRAIN	BANK ST	TOTAL
Polyplacophora	15	2	17
Gastropoda	181	54	193
Scaphopoda	1	0	1
Pelecypoda	80	23	97
Cephalopoda	1	1	1
Total	278	80	309

Table 1 gives the composition of the molluscan fauna by classes at the two localities. Table 2 lists all the molluscan forms collected that are well enough preserved to merit study, with their relative abundances at each locality and their approximate geographic ranges at present. Over 300 species of Mollusca were found in the collections.

The abundance data are based on approximately 500 shells from Bank St and 12,600 from the drain. Much of the material is badly broken, so that in tallying species' abundances an operating definition of what comprises the remains of an individual organism has been necessary for many forms. Among gastropods, a shell or fragment of a shell that includes the apex has usually been counted as a single individual. Other fragments have been noted but are not ordinarily included in the specimen tally, unless only single non-apical fragments, or a few non-apical fragments that could not possibly have come from the same individual, are present. For pelecypods, the possession of a hinge or the presence of hinge fragments has ordinarily been used to tally numbers of valves, unless single non-hinge fragments or a few fragments clearly from different valves are present. As the bivalved pelecypods have two chances per individual to contribute to the fossil record, and as in about half the samples the number of valves of a given species will on the average be odd, the number of individual pelecypods represented by valves of a given species in several samples is computed as $Nv/2 + S/2$, half the number of valves in the collection plus half the number of samples in which the species is found. For polyplacophorans a more direct procedure was followed: in each sample head valves, tail valves, and every multiple of 6 median valves are counted separately for a given species, and whichever count gives the largest result is taken as the number of individuals present.

TABLE 2

List of Pleistocene Mollusca from Port Fairy with relative abundance at each locality and present living distribution

Species abundance symbols are: V (very rare), less than 0·2%; R (rare), from 0·2-0·8%; C (common), 0·8-12·8%; and A (abundant), more than 12·8% of the specimens in the collection. Range symbols are: P, Peronian-ranging; M, Maugean; F, Flindersian-ranging; U, ubiquitous; and D, disjunct. An asterisk following the range symbol indicates that the form is not known to be living at present in the Port Fairy region. Parentheses enclosing the range symbol indicates that the identity of the fossil with the living form is not secure, and the form cannot be given biogeographic weight. For further explanation of range data, see text.

Species	Locality		
	Drain 1	Bank St 2	Present Range 3
POLYPLACOPHORA			
Paricoplax crocinus (Reeve)	V	—	U
Poneroplax albida (Blainville)	—	C	F
Bassethullia matthewsi Pilsbry	V	—	F
Acanthochiton coxi lachrymosus May & Torr	V	—	F
A. gatliffi Ashby	V	—	F
A. kimberi Torr	V	—	U
Autochiton torri (Iredale & May)	V	—	F
Heterozona cariosa Carpenter	V	—	F
H. subviridis Iredale & May	V	—	M*
Haplophax cf. *H. thomasi* Bednall	V	—	(F)
Stenochiton cymodocealis Ashby	R	—	F
Callistelasma meridionalis Ashby	V	—	F
Callistassecla mawleyi (Iredale & May)	V	—	F
Rhyssoplax diaphora (Iredale & May)	V	—	F
R. exoptanda (Bednall)	V	—	F
R. tricostalis (Pilsbry)	V	—	F
Clavarizona hirtosa Blainville	—	C	F*
GASTROPODA			
Schismope pulchra Petterd	V	—	F
Scutus? cf. *S. antipodes* Montfort	V	—	(U)
Notomella candida (A. Adams)	R	—	F
N. dilecta (A. Adams)	V	—	F
Montfortula rugosa (Quoy & Gaimard)	—	R	F
Amblychilepas javanicensis (Lamarck)	R	R	U
A. crucis (Beddome)	R	—	P*
A. oblonga (Menke)	V	—	F
Schismotis laevigata (Donovan)	V	R	F
Marinauris cf. *M. emmae* (Reeve)	V	—	(F)
Notohaliotis cf. *N. ruber* (Leach)	V	—	(U)
Haliotid sp.	V	—	—
Cellana tramoserica (Sowerby)	V	C	U
Patellanax chapmani (Tenison Woods)	R	—	U
P. cf. *P. peroni* (Blainville)	V	—	(U)
Patelloida alticostata (Angas)	V	C	U

Species	Locality: Drain 1	Bank St 2	Present Range 3
P. latistrigata (Angas)	R	C	F
Notoacmea granulosa Macpherson	V	—	M
N. scabrilirata Angas	V	—	F
Asteracmea crebristriata (Verco)	R	—	F
A. stowae (Verco)	A	C	F
Naccula? sp.	V	—	—
Clanculus limbatus (Quoy & Gaimard)	V	—	F
C. ochroleucus (Philippi)	V	—	F
C. plebejus (Philippi)	C	C	U
C. cf. *C. flagellatus* (Philippi)	V	—	(F)
Herpetopoma aspersa (Philippi)	V	R	U
H. cf. *H. tasmanica* (Tenison Woods)	V	—	(M)*
Cantharidus pulcherrimus (Wood)	V	C	F
C. kingensis Gabriel	V	—	M*
C. ramburi (Crosse)	C	C	F
Phasianotrochus eximius (Perry)	R	R	U
P. rutilus (A. Adams)	C	—	F
Bankivia fasciata (Menke)	A	R	U
Leiopyrga octona Tate	C	—	F
Thalotia conica (Gray)	V	—	F
Austrocochlea adelaidae (Philippi)	R	R	F
A. concamerata (Wood)	V	C	U
A. constricata (Lamarck)	V	A	U
A. odontis (Wood)	—	R	F
Cantharidella tiberiana (Crosse)	C	—	U
Minopa legrandi (Petterd)	R	—	U
M. petterdi (Crosse)	V	—	F
Gibbula coxi Angas	V	—	U
Calliostoma allporti (Tenison Woods)	V	—	F
Munditia australis (Kiener)	V	—	F
M. subquadrata (Tenison Woods)	V	—	F
M. tasmanica (Tenison Woods)	V	—	F
Subninella undulata (Solander)	V	A	U
Ninella torquata (Gmelin)	V	R	D*
Bellastraea? cf. *B. kesteveni* Iredale	R	R	(P)
Micrastraea aurea (Jonas)	V	—	U
Turbinid sp.	R	—	—
Phasianella australis (Gmelin)	C	—	F
P. ventricosa Swainson	R	—	U
'*Pellax*' *rosea* (Angas)	A	—	U
Lodderia lodderae (Petterd)	V	—	U
Pseudoliotia micans (A. Adams)	V	—	U
Elachorbis cf. *E. homalon* (Verco)	V	—	F
Cirsonella weldii (Tenison Woods)	V	—	U
Argalista rosea (Tenison Woods)	V	—	F
Charisma josephi (Tenison Woods)	R	—	F
Dolicrossea labiata (Tenison Woods)	V	—	U
Melanerita melanotragus (A. E. Smith)	V	R	U
Melarapha paludinella (Reeve)	R	—	M

Species	Locality		
	Drain 1	Bank St 2	Present Range 3
M. praetermissa May	—	C	F
M. unifasciata (Gray)	V	A	U
Bembicium nanum (Lamarck)	V	A	U
Laevilitorina mariae (Tenison Woods)	R	R	U
Acmea scalarina Cox	V	—	F
Notosetia cf. *N. atkinsoni* Tenison Woods	V	—	(F)
N.? sp. A.	V	—	—
N.? sp. B.	V	—	—
Pelecydium cylindraceus (Tenison Woods)	V	—	U
Lironoba cf. *L. agnewi* (Tenison Woods)	V	—	(F)
L. tenisoni (Tate)	V	—	U
Pisinna cf. *P. frenchiensis* (Gatliff & Gabriel)	R	—	(M)*
Microdryas australiae (Frauenfeld)	R	—	P*
Merelina hulliana (Tate)	C	—	F
Linemera filocincta (Hedley & Petterd)	R	—	P*
Tatea rufilabris (A. Adams)	V	—	F
Rissoina d'orbignyi (A. Adams)	V	C	M
R. elegantula Angas	C	—	U
Rissolina angasi (Pease)	V	—	P
Eatoniella cf. *E. aurantiocincta* (May)	V	—	(M)*
E. melanchroma (Tate)	R	—	F
Cochliolepas vincentiana (Angas)	V	—	U
Serpulorbis hedleyi (Finlay)	V	—	U
Magilina caperata Tate & May	V	—	U
Zeacumantis diemenensis (Quoy & Gaimard)	V	C	F
Diala semistriata (Philippi)	C	C	M
D. phasianella Angas	V	—	P*
Cacozeliana cf. *C. icarus* (Boyle)	V	—	(F)
C. granaria (Kiener)	A	C	F
Ataxocerithium? sp.	V	—	—
Batillariella estuarina (Tate)	V	—	F
Hypotrochus monachus (Crosse & Fischer)	V	—	U
Cerithiopsis s. l., aff. *C. (Joculator) oessicus* Hedley	V	—	(F)
Seila crocea (Angas)	V	V	U
Zaclys angasi (Semper)	V	—	U
Notosinister ampulla (Hedley)	V	—	U
N. angasi (Crosse & Fischer)	R	—	F
N. armillata (Verco)	V	—	F
N. granifera (Brazier)	R	—	U
N. maculosa (Hedley)	V	—	U
N. pfeifferi (Crosse & Fischer)	V	—	F
N. regina (Hedley)	V	—	U
N. spica Verco	V	—	F
N. tasmanica (Tenison Woods)	V	—	U
Clathrus jukesiana (Forbes)	R	—	U
Limiscala helicornua Iredale	V	—	P*
Melanella sp. A	V	—	—
M. sp. B	V	—	—

Species	Locality		
	Drain 1	Bank St 2	Present Range 3
M. sp. C	V	—	—
M. sp. D	V	—	—
Stylifer petterdi Tate & May	V	—	U
S.? sp.	V	—	—
Hipponix conicus (Schumacher)	R	R	F
Antisabia foliacea (Quoy & Gaimard)	A	A	U
Capulus violaceus Angas	V	—	U
Polinices aulacoglossa (Pilsbry & Venatta)	V	—	P*
P. conicus (Lamarck)	V	—	U
P. cf. *P. sordidus* (Swainson)	V	—	(P)
P.? sp.	C	—	—
Cymatiella lesueri Iredale	V	—	F
C. verrucosa (Reeve)	V	—	F
Litozamia brazieri (Tenison Woods)	—	V	F
Benthozystus petterdi (Crosse)	V	—	U
Gemixystus? cf. *G. laminatus* Petterd	V	—	(P)*
Dicathais baileyana (Tenison Woods)	—	R	F
D. textilosa (Lamarck)	—	R	F
Lepsiella flindersi (A. Adams & Angas)	—	R	F
L. reticulata (Blainville)	V	—	F
L. vinosa (Lamarck)	—	C	F
Macrozafra remoensis (Gatliff & Gabriel)	V	—	(F)
M. cf. *M. angasi* (Brazier)	V	—	U
M. cf. *M. atkinsoni* (Tenison Woods)	V	—	(U)
M. sp. A	R	R	—
M. sp. B	V	—	—
M.? sp.	R	—	—
Zella? cf. *Z. beddomei* (Petterd)	V	—	(U)
Dentimitrella cf. *D. pulla* (Gaskoin)	V	—	(U)
D.? cf *D. tenebrica* (Reeve)	V	—	(M)
Cominella lineolata (Lamarck)	—	C	F
Niotha pyrrhus (Menke)	—	R	F
Reticunassa paupera (Gould)	R	—	F
Parcanassa cf. *P. burchardi* (Philippi)	V	—	(F)
Tavaniotha optata (Gould)	V	—	U
Alocospira cf. *A. monilifera* (Reeve)	V	—	(F)
Eumitra badia (Reeve)	—	R	F
Lyria mitraeformis (Lamarck)	V	—	F
Euliginella shorehami (Pritchard & Gatliff)	V	—	M*
Mesoginella turbinata (Sowerby)	V	—	U
Cryptospira pygmaeoides (Singleton)	V	R	F
Cloisia cf. *C. flindersi* (Pritchard & Gatliff)	V	—	(M)*
Marginellid spp.	R	R	—
Filodrillia columnaria Hedley	V	—	M*
Etrema denseplicata (Dunker)	V	—	F
Guraleus brazieri (Angas)	R	—	P*
G. cf. *G. cuspis* (Sowerby)	V	—	(F)
G. vincentinus (Crosse & Fischer)	V	—	F

Species	Locality		
	Drain	Bank St	Present Range
	1	2	3
Euguraleus cf. *E. tasmanicus* (Tenison Woods)	V	—	(F)
Marita bella (A. Adams & Angas)	V	—	F
Heterocithara bilineata (Angas)	V	—	P*
Paramontana modesta (Angas)	V	—	U
P.? cf. *P. tincta* (Reeve)	V	—	(F)
Nepotilla minuta (Tenison Woods)	V	—	P
Turrid spp.	V	—	—
Turrid? sp.	V	—	—
Floraconus anemone (Lamarck)	R	R	F
Pervicacia bicolor (Angas)	V	—	U
Puposyrnola tasmanica Tenison Woods	V	—	U
Syrnola cf. *S. tincta* Angas	R	R	(U)
S. victoriae (Gatliff & Gabriel)	V	R	F
S.? sp.	V	—	—
Cingulina spina (Crosse & Fischer)	R	C	U
C. sp. A	V	—	—
Agatha australis (Angas)	V	R	U
'Odostomia' sp.	V	—	—
Chemnitzia acicularis A. Adams	V	R	F
C. mariae (Tenison Woods)	R	—	U
Turbonilla beddomei (Petterd)	V	—	F
Acteon? sp.	V	—	—
Haminoea tenera (A. Adams)	—	R	U
Retusa amphizosta Watson	V	—	F
Cylichnina pygmaea (A. Adams)	R	—	U
Volvulella rostrata (A. Adams)	V	—	U
Acteocina fusiformis (A. Adams)	V	—	U
Edenttellina typica Gatliff & Gabriel	V	—	P
'Berthelinia typica' of Burn	V	—	M
Berthellinops serenitas Burn	—	R	M
Marinula zanthostoma H. & A. Adams	V	R	U
Salinator fragilis (Lamarck)	V	—	U
Gadinia cf. *G. conica* Angas	V	R	(P)*
Siphonaria diemenensis Quoy & Gaimard	C	A	U
S. tasmanica Tenison Woods	A	R	F
SCAPHOPODA			
Cadulus vincentianus Cotton & Godfrey	V	—	U
PELECYPODA			
Pronucula hedleyi Pritchard & Gatliff	R	—	U
Scaeoleda crassa (Hinds)	V	—	P
Anadara trapezia (Deshayes)	—	R[1]	U*
Barbatia squamosa (Lamarck)	V	R	F
B. pistachia (Lamarck)	V	—	U
Tucetilla striatularis (Lamarck)	V	R	F
Lissarca rhomboidalis Verco	C	—	F
Notomytilus rubra (Hedley)	R	—	U
Micromytilus crenatuliferus (Tate)	C	R	F

[1] Not found in collections at hand but recorded by Gill (in Gill & Fairbridge 1953).

Species	Locality		
	Drain 1	Bank St 2	Present Range 3
Modiolus pulex (Lamarck)	C	R	U
Brachidontes rostratus (Dunker)	V	—	U
B. sp.	V	—	—
Trichomya hirsutus (Lamarck)	V	—	U
Lanistina paulucciae (Crosse)	V	—	F
Gregariella barbatus (Reeve)	V	—	U
Electroma georgiana (Quoy & Gaimard)	V	—	F
Chlamys asperrimus (Lamarck)	V	—	U
Cyclopecten favus Hedley	V	—	U
Cuna delta Tate & May	V	—	M*
C. comma Verco	V	—	F
'Cuna' planilirata Gatliff & Gabriel	V	—	M*
Cardita calyculata (Linnaeus)	R	R	M
Carditellona cf. *C. elegantula* (Tate & May)	V	—	(M)*
Condylocuna sp. A.	V	—	—
Cyamiomactra mactroides (Tate & May)	V	—	U
Legrandina aff. *L. bernardi* Tate & May	V	—	(M)*
Neogaimardia rostellata (Tate)	V	—	F
N. tasmanica (Beddome)	V	—	U
Diplodonta tasmanica (Tenison Woods)	V	—	U
Numella adamsi (Angas)	R	—	U
Divalucina cumingi (A. Adams & Angas)	V	—	U
Bellucina crassilirata (Tate)	V	R	F
Wallucina assimilis (Angas)	V	—	R
Epicodakia tatei (Angas)	R	R	U
Lasaea australis (Lamarck)	C	A	U
Melliteryx helmsi (Hedley)	R	R	P
Bornia trigonale (Tate)	A	R	F
Marikellia cf. *M. rotunda* (Deshayes)	V	—	(U?)
M. aff. *M. rotunda* (Deshayes)	V	—	(U?)
Lepton australis Angas	V	—	F
L. ovatum Tate	V	—	F
Notolepton antepodium (Filhol)	R	R	M*
N. sanguineum Hutton	V	—	M*
Mylitta auriculata A. E. Smith	V	—	M*
M. deshayesi d'Orbigny & Reeve	V	—	F
M. tasmanica (Tenison Woods)	V	—	U
M. donaciformis Angas	C	R	F
M. aff. *M. donaciformis* Angas	V	—	(F)
Ephippodonta lunata Tate	V	—	F
Pratulum? cf. *P. thetidis* (Hedley)	V	—	(U)
Sunemeroe aliciae (A. Adams & Angas)	V	—	F
Chioneryx cardioides (Lamarck)	V	—	U
Tawera cf. *T. gallinula* (Lamarck)	V	—	(U)
Placamen placida (Philippi)	C	R	F
Bassina aff. *B. pachyphylla* (Jonas)	V	—	(U)
Eumarcia fumigata (Sowerby)	—	R	U
Katylesia cf. *K. peronii* (Lamarck)	V	—	(F)
K. rhytiphora Lamy	—	C	F

Species	Locality		
	Drain 1	Bank St 2	Present Range 3
K.? sp.	V	—	—
Venerupis exotica Lamarck	R	R	F
Pullastra flabagella (Deshayes)	R	—	U
Venerid sp.	V	—	—
Naranio cf. *N. lucinalis* (Lamarck)	V	—	(F)
Donacilla angusta Reeve	R	R	U
Notospisula parva (Petit)	V	—	U
Mactra australis Lamarck	A	R	F
M. pura Deshayes	—	R	F
M. rufescens Lamarck	V	—	F
Deltachion chapmani (Gatliff & Gabriel)	V	—	F
D. electilis Iredale	R	—	F
Plebidonax deltoidalis (Lamarck)	V	—	U
Soletellina biradiata (Wood)	V	—	U
S. donacioides Reeve	V	—	F
Syndesmya exigua (A. Adams)	—	R	F
Tellina albinella Lamarck	V	—	U
Homalina deltoidalis (Lamarck)	—	R	F
H. mariae (Tenison Woods)	V	—	F
Semelangulus tenuiliratus (Sowerby)	V	—	U
Pseudarcopagia victoriae (Gatliff & Gabriel)	V	—	F
Tellinid sp.	V	—	—
Hiatella subalata (Gatliff & Gabriel)	V	—	U
H. australis (Lamarck)	C	R	U
Corbula coxi Pilsbry	V	—	M
Pholas obturamentum Hedley	V	—	U
Bankia? cf. *B. gabrieli* Cotton	V	—	(F)
Myadora tasmanica Tenison Woods	V	—	F
Thraciopsis elongata (Stutchbury)	V	—	P*
CEPHALOPODA			
Mesembrisepia novaehollandiae Hoyle	V	R	F

The ranges of nearly all the species can be conveniently summarized by referring them to the biotic provinces with which they are chiefly associated. Though this practice results in oversimplification it has some justification at the present state of knowledge of the marine biogeography of SE. Australia. Some elements of the fauna which have special geographic patterns are discussed later. In Table 2, forms are referred to as Peronian-ranging (P) if they live today in the Peronian province alone or in the Peronian and Maugean but not in the Flindersian province; Flindersian-ranging (F) if they live in the Flindersian alone or in the Flindersian and Maugean but not in the Peronian; Maugean (M) if they are endemic to Victorian and/or Tasmanian waters; Disjunct (D) if they inhabit the Peronian and Flindersian but not the Maugean; and Ubiquitous (U) if they inhabit all three of these provinces. The present distributions of forms not well identified with living species cannot be specified.

Taxonomy of Mollusca from SE. Australia is unsettled. Some of the difficulties are owing to the somewhat different taxonomic traditions that have arisen among workers in different provinces; some taxa have been erected on biogeographical grounds alone. It would seem to be desirable to document the distinctiveness of such taxa by anatomical or phylogenetic studies before replacing generic names in use elsewhere. Perhaps many of the new names will prove valid but, on present evidence, there seems to be a superfluity, especially of generic names. In the present work no attempt has been made to study taxonomy above the species level. The nomenclature employed by Macpherson & Gabriel (1962) in their comprehensive survey of Victorian Mollusca has been adopted, with a very few exceptions which are noted below.

A major difficulty encountered at the specific and intraspecific levels is in determining the status of closely allied forms for which separate names are available and which are recorded in different regions. They may be identical, or ecologic variants without special biogeographic significance at present, or geographic races or 'subspecies' or distinct species, and they take on markedly different biogeographic significance according to whether they are 'split' or 'lumped'. Neither time nor material has been available to study the living forms, so the convention has been followed of distinguishing among the fossils closely allied forms (whose biological status has not been documented) whenever available morphological criteria permitted—that is, whenever morphological distinctions described among these forms could be unambiguously applied in selecting a name for the fossil.

Identifications have been made chiefly by comparison with specimens in the molluscan collections of the National Museum of Victoria and by reference to original descriptions and monographs. Also some selected material was compared with the collections of the South Australian Museum. Although care has been taken to achieve consistency in identification of the fossils with the living fauna, comparisons with primary type material have been made in relatively few cases.

In view of the taxonomic difficulties it is inadvisable to discuss the fauna in the format of a conventional systematic catalogue. Instead the condition and abundance of each species is discussed in systematic order, with criteria of identification and taxonomic and biogeographic remarks when appropriate. The unqualified term 'minute' is applied herein to specimens which are less than 2 mm in any dimension.

Phylum MOLLUSCA

Class Polyplacophora

Family Lepidochitonidae

Paricoplax crocinus is represented by a single posterior valve from the drain.

Family Mopaliidae

Large median valves of *Poneroplax*, certainly including the species *P. albida*, are common at Bank St. Most are badly worn but coarse wrinkled sculpture and faint brown colour markings are preserved on a few. It is possible that *P. costata* is also represented. Macpherson (in Bennett & Pope 1953) has indicated that *P. paeteliana*, from the Peronian province, seems to be a small race of *P. albida*. The fossils are the large Victorian form.

Family Cryptoplacidae

Small very rare median valves and a single posterior valve of *Bassethullia mathewsi* were found at the drain. They are chipped but the characteristic longitudinal sculpture is well preserved and one valve is lined with brown zig-zag markings.

At least 3 species of *Acanthochiton* are represented by very rare median valves at the drain. Specimens identified as *A. coxi lachrymosus* have pustules on lateral areas that are elongated into teardrop shapes in rows nearest the jugum, which is striated. Specimens called *A. gatliffi* are very small and have coarser pustulose sculpture on lateral areas than do the other species. The fossils have longitudinally striate jugal areas; the fine pustles present on fresh recent specimens have evidently been eroded. Some recent specimens have similarly eroded jugae. A form identified as *A. kimberi* has a finely granulose jugum and pustules on lateral areas that are fine near the jugum but coarser towards the lateral margin.

Family Ischnochitonidae

Autochiton torri is represented by one well-preserved posterior valve from the drain. *Heterozona cariosa* is very rare at the drain; most valves are worn and a few are broken. 6 small, well-preserved posterior valves from the drain are identified as *Heterozona subviridus*. Very rare smooth anterior and median valves from the drain with brownish and greenish-yellow colour stripes are compared to *Haploplax thomasi*.

The small *Stenochiton cymodocealis* is represented by 74 valves from the drain, of which 69 are posterior and 5 are median valves. The cause of this bias is not known. Several of the other chitons are represented by only or predominantly one type of valve, but so few specimens were collected that the bias in these other forms may be due to chance.

A posterior valve of *Callistelesma meridionalis* was found at the drain; the fine network of ridges creating roundish interspaces on the ante-mucronal area distinguishes it from the similar *Callistassecla mawleyi*, which has strong longitudinal ribs on the ante-mucronal area. *C. mawleyi* is very rare at the drain and is represented by median as well as posterior valves; in addition several anterior valves are compared to this form.

Family Chitonidae

The genus *Rhyssoplax* is represented by 3 species at the drain, all very rare. A coloured median valve of *R. diaphora* has a few ribs on central areas that shorten medially; a posterior valve was also found. A fragment of a median valve and 2 worn tail valves are identified as *R. exoptanda*. The lateral areas are sculptured with low longitudinal ribs that are interrupted medially by a transverse sulcus. *Rhyssoplax tricostalis*, represented by 2 worn and broken median valves and well-preserved anterior and posterior valves, has 3 or 4 noded radials on lateral areas and strong longitudinal ribs on central areas.

Clavarizona hirtosa (Pl. 3, fig. 1) is common at Bank St, where 30 median and 2 anterior valves were found. They are chiefly badly corroded exteriorly, though the ventral sides are in good condition. The best preserved valves have fine radials on lateral areas and on the jugal area of the second valve as characteristic of this form and retain brown colour patterns. This species is not known to be living in Victoria. It has been recorded from South Australia (Cotton & Godfrey 1940) but recent work suggests that it may be restricted to Western Australia (Womersley & Edmonds 1958, p. 256).

Class Gastropoda

Family Scissurellidae

Schismope pulchra is very rare in samples from the drain but is represented by several perfect specimens. This species evidently lives offshore and has been dredged in moderate depths (Cotton 1959) although dead shells are recorded in beach deposits.

Family Fissurellidae

Two minute apical fragments from the drain are questionably compared to *Scutus antipodes*.

Notomella is represented by 2 species found only at the drain; *N. candida* (Pl. 3, fig. 2), which is rare, has a ridge connecting apex and posterior slit; and *N. dilecta*, very rare, has a furrow crossed by rather strong lunulae connecting apex and slit and has slightly finer sculpture. Although *N. dilecta* has been recorded from New South Wales it is evidently restricted to the S. and is considered to be an essentially Maugean-Flindersian form. It is not included in Iredale & McMichael's list of New South Wales Mollusca (1962). *Montfortula rugosa*, a robust form with a short notch and with coarser sculpture than either species of *Notomella*, is rare at Bank St. The fossils are the W. Victorian and South Australian form and not the more E. form sometimes called *M. conoidea* (see Iredale 1924).

Amblychilepas javanicensis is rare at Bank St, where it is represented by mature specimens, and at the drain, where only small to minute specimens were found. *A. crucis* (Pl. 3, fig. 3) is a small form with an oval trema that is nearly circular in juvenile shells, and with broad, high, rounded radiating ribs that are obsolete on some specimens, and fine secondary radials. It is represented by small to minute specimens at the drain, where it is rare. Shells of both *A. javanicensis* and *A. crucis* retain much of their original colour patterns. *A. oblonga* (Pl. 3, fig. 4), a small, narrow form with narrow, unequal radiating ribs and an oblong or keyhole-shaped trema, is very rare at the drain.

Family Haliotidae

A few fragments of moderately large shells of *Schismotis laevigata* were found both at the drain and at Bank St. Other haliotids in the collection are very rare minute fragments from the drain, fragments chiefly of apices which commonly have lost the calcitic layer. Many of these cannot be identified. Specimens compared to *Maurinaurus emmae* are exfoliated but have the irregularly swollen spiral ridge, situated between the tremata and the upper suture, that is characteristic of this form. Apical fragments with round tremata, irregular longitudinal rugae and spiral cords are compared to *Notohaliotis ruber*. The material is not adequate to establish whether it is the South Australian form *N. improbulum*, synonymized with *N. ruber* by Macpherson & Gabriel (1962).

Family Patellidae

Large and robust specimens of *Cellana tramoserica* are common at Bank St, but this species is represented only by very rare small and minute shells at the drain. Juvenile shells of *Patellanax chapmani* are rare at the drain. They are oval with moderately strong primary radial ribs and sinuous secondaries ornamenting both primaries and interspaces. Evidently they are not the markedly stellate form *('perplexa')*, though it is impossible to be certain with such small shells. A similar species with lower and straighter secondary radial ribs and the faint remains of a dark colour between the primaries is compared to *Patellanax peroni*. It is very rare at the drain.

Family Acmaeidae

Patelloida alticostata is common at Bank St, and very rare stellate juvenile shells from the drain that have black chevron colour patterns between the radials are identified as this form. Small to minute specimens of *P. latistrigata* are common at Bank St and rare at the drain. Some are nearly stellate but have colour patterns of black bars between the radials, as is common in low, heavily ribbed variants of *P. latistrigata*.

2 species of *Notoacmea* are in the collections. *N. granulosa*, with a few coarse granular radial ribs, and *N. scabrilirata*, with numerous fine radial striae, are very rare at the drain. Both retain their colour patterns. *N. granulosa* is known to range to Kangaroo Is. in South Australia but is nevertheless considered here to be a Maugean form.

Asteracmea crebristriata (Pl. 3, fig. 5) is rare at the drain. Though most of the fossils are narrow with flattened, nearly parallel sides, some are wider posteriorly than anteriorly and are broader and relatively lower than typical *A. crebristriata*, suggesting the form called *roseoradiata*. The sculpture of both broad and narrow fossils appears to be similar. Neither form is recorded living in Victoria; they are chiefly South Australian. However, a set of 70 specimens in the Gatliff collection, National Museum of Victoria (No. 4265), labelled Portsea, Victoria, contains *Asteracmea crebristriata*. Many of the shells have rose-coloured radiating rays and are broad posteriorly; others are an even light rose, including a few that are narrow, nearly flat-sided, and high. Possibly these are situs variants; *A. crebristriata* is said to live on *Zostera*, and variability in height, width, and apertural configuration of forms from such a habitat is often high, partly corellating with variability among blades of *Zostera*. *Asteracmea stowae* (Pl. 3, fig. 6) is abundant at the drain and common at Bank St.

A posterior fragment of a minute, smooth, patelliform shell from the drain is questionably identified as a species of *Naccula*.

Family Trochidae

Clanculus limbatus, represented by well-preserved brightly coloured shells, and *C. ochroleucus*, represented by a single worn shell, are very rare at the drain. Coloured apical fragments of *C. plebejus* are common at the drain, and broken mature shells are common at Bank St. A minute apical fragment from the drain is compared to *C. flagellatus*.

A well- preserved mature shell of *Herpetopoma aspersa* was found at Bank St, and fragments of this form are very rare at the drain. 5 small shells of *Herpetopoma* from the drain are compared to *H. tasmanica*. It was not possible to satisfactorily identify several minute specimens of *Herpetopoma* from the drain; they are probably one of the above species.

4 species of *Austrocochlea* are in the collections, all with colours well preserved. *A. adelaidae* is rare at the drain, chiefly as juveniles and minute apical fragments, and rare at Bank St. *A. concamerata* is common and *A. constricta* abundant at Bank St, and each is represented by very rare small fragments and juvenile shells at the drain. *A. odontis* was found only at Bank St, where it is rare.

The small *Cantharidella tiberiana* (Pl. 3, fig. 8) is common at the drain, chiefly as juveniles. *Minopa legrandi* (Pl. 3, fig. 11, 12) is rare at the drain. This minute species is shaped similarly to and broadly overlaps in hue and colour pattern with juvenile *Austrocochlea adelaidae*. However, the latter species has very faint incised spiral lines on young shells (which become rib interspaces on succeeding whorls) and often though not always has a slightly angled periphery, while *M. legrandi* is smooth with a rounded periphery. The purple and white *Minopa petterdi* (Pl. 3, fig. 13) is very rare at the drain.

Gibbula coxi is represented by a few mature and several juvenile shells in samples from the drain. Iredale & McMichael (1962) indicate that *G. bicarinata* A. Adams is the proper name for this species. Very rare minute apical fragments of *Calliostoma allporti* were found at the drain.

Cantharidus pulcherrimus, very rare at the drain and common at Bank St, is represented by mature as well as juvenile shells at both localities. *C. ramburi* is common at the drain and at Bank St; a few mature shells were found but most are juveniles. The minute species *C. kingensis* was recently described from off King Is., Bass Strait (Gabriel 1956) and is not known to be living in Victoria. It is very rare at the drain (Pl. 3, fig. 7). The colours of all 3 species of *Cantharidus* have faded only slightly.

2 species of *Phasianotrochus* have also retained their colours well; *P. eximius*, of which small and minute specimens are rare at the drain and worn mature specimens rare at Bank St; and *P. rutilus*, found only at the drain where small and minute specimens are common.

Bankivia fasciata is represented by mature specimens which are rare and by minute shells including numerous broken apices which are abundant at the drain, and by worn mature shells which are rare at Bank St. *Leiopyrga octona* is common at the drain, most specimens being minute shells. Small specimens of these 2 species have ranges of purplish colour pattern and shape which overlap, but the fine spiral striae of *Leiopyrga* serves to separate it easily from the smooth *Bankivia*. *Thalotia conica* is very rare at the drain; most specimens are of moderate size and are brightly coloured. The E. range end-point of this species may lie in New South Wales, but it is recorded here as an essentially Maugean-Flindersian form.

Family Turbinidae

Munditia is represented by 3 species, all very rare at the drain. *M. australis*, although represented only by fragments, is regarded as securely identified since the base of some early whorls is preserved with their characteristic cancellate sculpture and spine-like umbilical projections of axial ribs, reduced to lamellae where crowded near the axis. Good specimens of *M. subquadrata* (Pl. 3, fig. 10) were found. An apical fragment identified as *M. tasmanica* is similar to 2 immature shells in the National Museum of Victoria, No. F8745, from South Australia. This species may live in S. New South Wales (Macpherson & Gabriel 1962) but is tallied here as an essentially Maugean-Flindersian form.

Shells of *Subninella undulata* are abundant and large at Bank St but very rare and chiefly small at the drain. *Ninella torquata* is very rare at the drain and rare at Bank St, large specimens being found at both localities. Calcareous opercula of both these species were found at each locality.

Numerous minute turbinids, apical fragments and juvenile shells, are in the collections from the drain. Discoidal forms without spines and with a double-keeled profile may be *Subninella undulata*. Some of these shells bear a subsutural spiral swelling, and on a few this swelling is defined as a rib and bounded anteriorly by an incised line. Shells with such definite subsutural ribs may be *Ninella torquata*. Minute keeled discoidal specimens with gently convex spires ornamented with noded subsutural ribs and strong triangular spines projecting laterally from the periphery, and with rounded bases bearing 2 or 3 noded spiral cords, are probably *Bellastrea kesteveni*. A shell of this sort was also found at Bank St. However, sufficient juvenile comparative material is not available to confirm these questionable identifications.

A single mature shell of *Micrastrea aurea* was found in float at the drain.

Family Phasianellidae

Phasianellids are represented in the collections by juvenile shells or small shell fragments, identification of which is difficult. A relatively high-spired species with moderately convex whorls that meet at high angles (chiefly above 140°) at the sutures is identified as *P. australis*. Many specimens have a colour pattern of irregular, vertical, broad, cream and brown stripes, while a few have delicately embroidered spiral colour bands. This species is common at the drain. A lower-spired species with more convex whorls that meet at lower angles (about 100°) is identified as *P. ventricosa*. It is less brightly coloured at Port Fairy, chiefly with faint brown spirals and networks on cream backgrounds. It is rare at the drain.

Family Liotiidae

Lodderia lodderae (Pl. 3, fig. 14) is very rare at the drain. Fine secondary spirals are present between the strong primary spirals. A fragment of the last whorl of a minute species from the drain is identified as *Pseudoliotia micans* (Pl. 4, fig. 18). The characteristic strong beaded spiral ribs, some of which turn anteriorly near the aperture to meet the apertural margin at right angles, the rib-like longitudinal elongations and connections of the beads on the basal spirals, and other sculptural details are believed to make this identification secure.

'Liotiidae'

The minute gastropods, presumably rhipidoglossids, grouped here as 'Liotiidae' have at times been assigned to the liotids but at present reside in various families, the numbers and limits of which are in dispute. They are treated together as a convenience.

Minute rose-tinted specimens of *Argalista rosea* are very rare in samples from the drain. The form identified as *Elachorbis* cf. *E. homalon* (Pl. 3, fig. 15a, 15b) is discoidal and sculptured by variable spiral riblets. On some specimens 1 or 2 of the spirals on the outer part of the base are stronger than the rest. No spirals are as strong as those near the periphery in *E. harriettae*, nor is the sculpture so coarse as in that form. Recent shells identified as *E. homalon* and evidently conspecific with the fossils are in the collections of the National Museum of Victoria, from unknown depths off Wilson's Promontory and from moderate depths off Capes Borda and Jaffa, South Australia (62 and 130 fathoms respectively). This form is very rare at the drain.

Shells of *Cirsonella weldii* and *Dolicrossea labiata* (Pl. 3, fig. 9) are very rare but well preserved at the drain. *Cirsonella australis* Angas is synonymized with *C. weldii* by Macpherson & Gabriel (1962), an arrangement which is followed here, thus extending the range of *C. weldii* into New South Wales. *Charisma josephi* (Pl. 4, fig. 1) is rare at the drain. Many of the shells are worn and corroded so that the fine spirals are erased.

Family Neritidae

Melanerita melanotragus is rare at Bank St, where mature specimens in excellent condition were collected, and very rare at the drain, where it is represented by minute shells. Iredale & McMichael (1962) indicate that the correct name for this species is *M. atrementosa* Reeve.

Family Littorinidae

The minute species *Melarapha paludinella* is rare at the drain but was not found at Bank St. On the other hand *Melarapha praetermissa* and *M. unifasciata* are common and abundant, respectively, at Bank St, while only the latter was represented at the drain, by a single small shell. The original colours of all these species, though faded, are clear.

Abundant mature shells of the common *Bembicium* of rock platforms in Victoria, *B. nanum* (see Anderson 1958, Macpherson & Gabriel 1962), were found at Bank St. Their spires are badly eroded but their last whorls commonly retained some sculpture and colour. Living specimens often have similarly eroded shells. Minute juveniles (Pl. 4, fig. 1a, 1b) in excellent condition are very rare at the drain. *Laevelitorina mariae* (Pl. 4, fig. 3) is rare at both localities. Specimens are brown or white and are very well preserved.

Family Acmeidae

A single minute worn and chipped shell of *Acmea scalarina* was found at the drain. Probably it is the decollated apex of a larger individual.

'Rissoidae'

Treatment of the following minute forms together under this heading is a matter of convenience.

4 specimens from the drain are compared to *Notosetia atkinsoni* (Pl. 4, fig. 7). They are slimmer than recent shells of *N. atkinsoni* in the National Museum of Victoria, including those from Victorian localities at Western Port and Shoreham. Their heights range from 1·4-1·8 mm, the diameter of their last whorls from 1·1-1·2 mm, and their apical angles from about 29°-34°. 2 other species from the drain are questionably referred to *Notosetia* but could not be specifically identified. One, *N.*? sp. A, is represented by a single specimen with a broad 48° apical angle and markedly convex whorls; it is 2·4 mm in height and 1·6 mm in width, the largest shell assigned to *Notosetia*. The other species, *N.*? sp. B, has an apical angle of about 37°, a small aperture and flattened base and gently convex whorls. Two complete shells measure respectively 1·8 by 1·1 and 1·9 by 1·3 mm in height and diameter of their last whorls. All 3 of these forms are very rare.

Pelecydium cylindraceus (Pl. 4, fig. 2) is represented by 2 shells from the drain. The spires of the fossils appear bent, for the whorl anterior to the bend is larger than provided by normal whorl size increase for both previous and subsequent whorls. A single apical fragment from the drain is questionably compared to *Lironoba agnewi*. It has no axial riblets on the 5 whorls that are preserved, and may be a variant of *Linemera filocincta*. These 2 forms may in fact be conspecific, *L. filocincta* being a narrow axially ribbed form. *Lironoba tenisoni* (Pl. 4, fig. 9) is very rare at the drain. Iredale & McMichael (1962) synonymize this form under *L. australis* Tenison Woods.

About 50 specimens of *Pissina* were found at the drain. Most are rather thick-shelled and stout, tinted brown, with traces of a narrow dark brown colour band just beneath the suture. A few have colour bands above the suture as well. These shells closely resemble *P. frenchiensis*, to which they are all compared (Pl. 4, fig. 4, 5). They vary in stoutness, the slimmest resembling *P. tasmanica*.

Well-preserved specimens of *Microdryas australiae* (Pl. 4, fig. 8) are rare at the drain. *Merelina hulliana* (Pl. 4, fig. 12) is common, and *Linemera filocincta* (Pl. 4, fig. 13) rare, at the drain. The brackish-water species *Tatea rufilabris* (Pl. 4, fig. 16) is represented by a single specimen from the drain.

Family Rissoinidae

The large, coarsely sculptured, thick-shelled species *Rissoina d'orbignyi* is very rare at the drain, where chiefly small shells were found, and common at Bank St, where several large and unworn shells were collected. *R. elegantula* (Pl. 4, fig. 15) is a smaller form with finer sculpture which is common at the drain; about half the fossils are in good condition and half are worn or broken. *Rissolina angasi* is represented by very rare small shells and fragments at the drain.

Well-preserved dark purple specimens of the minute *Eatoniella melanchroma* are rare at the drain (Pl. 4, fig. 10). A form compared to *E. aurantiocincta* (Pl. 4, fig. 11) is very rare at the drain. It has a broader apical angle and slightly more inflated whorls than recent specimens at hand. Dark reddish-brown subsutural colour bands are preserved on the fossils.

Family Tornidae

2 excellent specimens of *Cochliolepas vincentiana* (Pl. 4, fig. 17) are in collections from the drain.

Minute planispiral shells ornamented with close-set annular rings are identified as *Serpulorbis hedleyi*. Another minute form which has tightly-coiled nuclear whorls and an uncoiled, irregular post-nuclear shell is *Magilina caperata*. Both are very rare at the drain.

Family Potamidiidae

Zeacumantis diemenensis is very rare at the drain, where shells are chiefly fragmental, and common at Bank St, where mature shells in good condition were found.

Family Cerithiidae

Diala semistriata (Pl. 4, fig. 19) is common at both localities. Nearly all shells are worn, a common condition among living specimens, but retain traces of their colour patterns. *Diala phasianella* (Pl. 4, fig. 20), which has a much narrower spire than the allied *D. monile*, is very rare at the drain. Spiral colour bands of white and brown spots decorating the lower half of the whorls are preserved on some fossils.

Cacozeliana granaria is abundant at the drain and common at Bank St. The shells are chiefly worn, and are especially concentrated in thin lenses containing other small cylindrical molluscs such as *Diala* and abundant echinoid spines at the drain. *C. granaria* is recorded from New South Wales but is evidently an essentially Maugean-Flindersian form. Minute apical fragments of a slim cerithid with axials slightly predominating in a cancellate sculpture are compared to *Cacozeliana icarus*. They are very rare at the drain.

Ataxocerithium may be represented by a single damaged minute shell from the drain which is slimmer and has a less convex whorl profile and more closely-spaced axials than minute specimens of the common shallow-water species *A. serotinum*. Perhaps the fossil is allied to offshore forms such as *A. scruposum*.

Minute shells of both *Batilleriella estuarina* and *Hypotrochus monachus* (Pl. 5, fig. 1) are very rare at the drain. Colour is well preserved in the latter form.

Family Cerithiopsidae

A broad cerithiopsid represented by a single minute specimen from the drain is similar to small specimens of *Joculator cessicus* in the National Museum of Victoria, F25104, from Western Port but has slightly coarser sculpture. *Seila crocea* is very rare at the drain and at Bank St; shells are chiefly broken and lack apical whorls, so that identification is based on detailed agreement of shape and sculpture between the fossils and recent specimens. The fossils are tinted brown. *Zaclys angasi* is very rare at the drain where it is represented by small worn specimens that retain a light brown tint.

Family Triphoridae

Although triphorids are not common at Port Fairy, they are diverse; 9 forms are identified with living forms. Most of the fossils retain traces of their original colours, a great aid to identification in this family.

Notosinister ampulla (Pl. 5, fig. 4) is represented by 2 specimens from the drain; they are small with moderately coarse sculpture, anterior and posterior spirals that are nearly equal in strength, and faded brown maculations. *N. angasi* (Pl. 5, fig. 2) has fine sculpture with fairly equal anterior and posterior spirals, a narrow apical angle, and a faded brown colour usually over the entire shell though a few specimens have white maculations near the base. It is rare at the drain. *N. armillata* (Pl. 5, fig. 3) has fine sculpture, a broad apical angle, and flat-sided whorls; at about the 6th whorl, 1½ whorls are brown, forming a colour band around the spire. It is very rare at the drain.

N. granifera (Pl. 5, fig. 7) has fine sculpture, a narrow apical angle, and brown colour maculations; it is rare at the drain. *N. maculosa* (Pl. 5, fig. 6) is coloured much like *N. ampulla* but has coarser sculpture and unequal spirals, the posterior spiral being slightly stronger. It is very rare at the drain.

N. pfeifferi (Pl. 5, fig. 8), rare at the drain, has a narrow apical angle, coarse sculpture, and unequal spirals, the anterior being the stronger. The fossils are white with a faint brown tint apically. *N. regina* is a small pupaeform species with moderately coarse and even sculpture; on relatively large shells the anterior spiral is coloured brown. It is close to *N. ampulla*. A single specimen was found at the drain.

N. spica, represented by a single broken specimen from the drain, nevertheless is firmly identified by the characteristically narrow spire with sub-parallel sides and

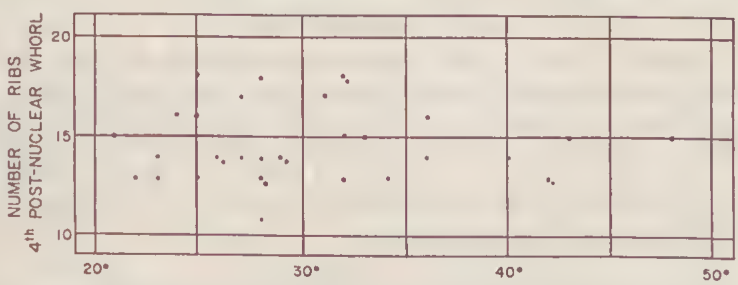

Fig. 4—Relation between apical angle and ribs on fourth post-nuclear whorl of epitonids from Port Fairy.

fine sculpture with anterior and posterior spirals nearly equal. *N. tasmanica* (Pl. 5, fig. 5) is large and evenly granulate on later whorls, for the central spiral rapidly becomes equal in strength to the anterior and posterior spirals. The fossils, rare at the drain, are white.

Family Eptionidae

Small and minute shells of epitonids in the collection fall into 3 groups on the basis of their apical angles: 20-30°; 30-40°; and greater than 40° (Fig. 4). Shells with apical angles greater than 40° were tested to determine the probability that they are from the same 'population' as shells with apical angles less than 40° on the basis of the number or ribs per 4th post-nuclear whorl (Fig. 4). The t-test is used because the variances of the 2 groups are not significantly different based on an F-ratio, and the frequency distributions of rib counts are not greatly skewed. The t value of 2·84 with 32° of freedom shows that the probability of the means of the populations being identical lies between 0·01 and 0·001. Evidently the means are distinct, and on the basis of comparisons with epitonids in the National Museum of Victoria, shells with apical angles of 40° or more are identified as *Limiscala cornuta,* those with a smaller apical angle as *Clathrus jukesiana.* The rib counts of shells with apical angles in the 20's and those in the 30's do not average significantly different, and all are assigned to *C. jukesiana.* On shells of both forms the 1st post-nuclear whorls average between 4 and 5 more ribs than the 4th, with fewer ribs on each succeeding whorl.

Family Melanellidae

Melanellids are very rare in collections from the drain and have not been specifically identified. At least 4 forms are present. One, *Melanella* sp. A (Pl. 5, fig. 9), has a slim spire that is not quite bilaterally symmetrical but curves very slightly, flat-sided whorls, and a long gently curved base. A 2nd form, *M.* sp. B has a straight spire, gently convex whorls and a short base; it is represented by only a single broken specimen. A 3rd form, *M.* sp. C, has a straight slim spire with flat-sided whorls and a short base angulated at its periphery. *M.* sp. D has a bent spire, moderately convex whorls, and a short inflated last whorl and base.

Family Styliferidae

A single fragment of the spire of a small shell identified as *Stylifer petterdi* was found at the drain. 3 other minute apical fragments from the same locality appear to represent *Stylifer* and may be *S. petterdi* also.

Family Hipponicidae

Hipponix conicus is represented chiefly by well-preserved juvenile specimens; they are patelliform, trapezoidal in apertural outline, with anterior apices twisted towards the left. Some specimens have faint spiral ribs which appear radial in these shells. The juveniles are rare at the drain. A badly worn mature specimen was found at Bank St. *Antisabia foliacea* is abundant at the drain, chiefly as well-preserved small to minute shells but with several mature shells also. It is abundant at Bank St, chiefly as well-preserved mature shells.

Family Capulidae

2 small specimens of *Capulus violaceus* were found at the drain.

Family Naticidae

Minute, well-preserved naticids are common at the drain. As most of these shells do not possess well-developed calluses they could not be identified; probably more than one species is represented. 3 minute shells are compared to *Polinices sordidus*. They have a moderately thick parietal callus which narrows below and then expands into a pad which completely covers the umbilicus.

Mature specimens of *Polinices aulacoglossa* and *P. conicus* were found in float at the drain.

Family Cymatiidae

Cymatiella lesueri is represented by small and minute worn shells, and *Cymatiella verrucosa* by small apical and apertural fragments. Both forms are very rare at the drain. *C. verrucosa* may range into S. New South Wales but is tallied here as a Maugean-Flindersian form.

Family Muricidae

A single small worn shell of *Litozamia brazieri* was found at Bank St. *Benthoxystus petterdi* is very rare at the drain, all specimens being small to minute shells and apical fragments, commonly worn. Very rare minute shells from the drain are questionably compared to *Gemixystus laminatus;* they have close-set axial laminae and compare well with the early whorls of that form.

Family Thaididae

Dicathais baileyana is represented by a large worn shell, and *D. textilosa* by one large and 2 small broken shells, at Bank St. A large well-preserved shell of *Lepsiella flindersi* and common well-preserved shells of *L. vinosa* were found at Bank St. On the other hand very rare small to minute shells of *L. reticulata* were found only at the drain; they retain traces of their original colour patterns.

Family Columbellidae

Numerous species of columbellids are in the collections from the drain, and one was found at Bank St. Most of them are represented by minute forms, identification of which is not made with complete confidence, except for *Macrozafra remoensis* (Pl. 5, fig. 10). This form is sculptured by spirally arranged nodes and beads; a row of strong, axially elongate nodes encircles the periphery, a row of smaller rounded beads lies just above the suture, and just below the basal suture and thus visible only on the last whorl is a 2nd row of beads. Specimens of *M. remoensis* are very rare but well preserved at the drain.

The form compared to *Macrozafra atkinsoni* (Pl. 5, fig. 11), very rare at the drain, is probably that species; it is slim with a narrow apical angle, and may be smooth or bear low axial ribs. The apertural profile is characteristic, for the outer lip, after forming a narrow posterior sinus-like reflection, descends anteriorly in a straight line until bending inwards near its rounded anterior margin. The aperture is thus narrow, the last whorl rather flat-sided near the aperture and narrowly shouldered posteriorly.

A form compared to *M. angasi* [which may be called *M. fulgida* (Reeve) according to Iredale & McMichael 1962] is ornamented by 1 or 2 spiral rows of white dots or crescents either just above or just below the suture; all the fossils are smooth. They are very rare at the drain. A slimmer form with similar colour patterns that occasionally bears low axial ribs is called *Macrozafra* sp. A (Pl. 5, fig.

12). It is rare at the drain and at Bank St. Another form called *Macrozafra* sp. B, is broad, with moderately convex, shouldered whorls, sculptured by rather prominent axial ribs; it is very rare at the drain.

A large broad smooth columbellid represented at the drain by several mature shells and evidently by several apical fragments is compared to *Dentimitrella pulla*. A single apical fragment of a less robust form with a smaller nucleus, questionably compared to *D. tenebrica*, is from the drain.

A form compared to *Zella beddomei* (Pl. 5, fig. 10) is represented by very rare small and minute shells and fragments at the drain.

Other unidentified small columbellids are chiefly forms with broad apical angles and convex whorls, more convex than those of any minute specimens of living forms that were available for comparison. These probably represent species of *Macrozafra;* they are rare at the drain.

Family Buccinidae

Cominella lineolata was found at Bank St, where mature shells are common.

Family Nassariidae

Well-preserved mature specimens of *Niotha pyrrhus* are rare at Bank St. A small species of *Reticunassa* is identified as *R. paupera;* it is rare at the drain where many minute and several small shells were found. Minute nassarids sculptured by vertical ribs which are interrupted just beneath the shoulder by a spiral groove (which does not affect the interspaces) are compared to *Parcanassa burchardi*. Somewhat similar shells with noded vertical ribs are identified as *Tavaniotha optata* (Pl. 5, fig. 14). Both these forms are very rare at the drain.

Family Olividae

A single apical fragment of a large olivid which bears traces of spiral sculpture is compared to *Alcospira monilifera*. It was found in float at the drain.

Family Mitridae

A single well-preserved specimen of *Eumitra badia* was found at Bank St. It retains a faint brownish tint. The geographic range of *E. badia* is uncertain (see Macpherson & Gabriel 1962, p. 212) but it is tallied here as a Maugean-Flindersian form.

Family Volutidae

A juvenile shell from the drain that includes a large nucleus and one complete whorl is identified as *Lyria mitraeformis*.

Family Marginellidae

Minute marginellids are rare both at the drain and at Bank St. Most are immature and do not possess those characters, acquired at a later ontogenetic stage, that are necessary for identification. However, a few small specimens from the drain are identified as *Mesoginella turbinata*. They have low axial ribs which are strongest at the shoulder and dwindle to obsolescence anteriorly. A few specimens shaped similarly to the ribbed forms but without sculpture nevertheless are compared to *M. turbinata;* small recent shells of this form with obsolete sculpture are contained in the collections of the National Museum of Victoria. A small, thick-shelled, robust form is identified as *Cryptospira pygmaeoides* (Pl. 5, fig. 17). It is very rare at the drain and rare at Bank St.

A form that, though minute, appears to be mature, is compared to *Euliginella shorehami* (Pl. 5, fig. 16). The fossils, very rare at the drain, closely resemble topotypes of *E. shorehami* in the National Museum of Victoria. A single broken shell from the drain, which lacks a base and outer lip, is compared to *Cloisia flindersi*. The comparison is based on its size, shape, numbers of spiral ribs, and other sculptural details.

Family Turridae

Turrids, chiefly mangeline, are not very common in the collections but are represented by numerous species at the drain. A single well-preserved *Filodrillia* is identified as *F. columnaria*. *Etrema denseplicata* (Pl. 5, fig. 15) is represented by a single minute specimen. This form is considered to be restricted to Victoria and Tasmania, for a closely allied New South Wales form, said to possess weaker axial ribs, has been separated as *E. denseplicata tasmantis* by Laseron (1954).

Guraleus brazieri (Pl. 6, fig. 4), rare at the drain, is the most common turrid at Port Fairy. A single minute shell that is worn and chipped is compared to *G. cuspis*. *G. vincentinus* (Pl. 6, fig. 2), very rare, is represented both by fragments and by small well-preserved shells. A worn apical fragment is questionably compared to *Euguraleus tasmanicus*. It compares well with specimens of that species from Stanley, Tasmania and Lorne, Victoria, National Museum of Victoria collections F25105. A little-known form from New South Wales that is said to be slimmer than typical *E. tasmanicus* has been called *E. tasmanicus peronianus* by Laseron (1954). It is known from 50 fathoms off Montague Is. and seems not to be the form at hand.

Shells of *Marita bella* (Pl. 6, fig. 3), very rare at the drain but the second most common turrid in the collections, are chiefly small and minute although one well-preserved mature shell was found. *Heterocithara bilineata* (Pl. 6, fig. 1) is represented by very rare but well-preserved shells that retain orange colour markings. *Paramontana* is represented by the clathrate *P. modesta*, which is very rare, and perhaps by a single worn shell that resembles *P. tincta*.

A small shell is identified as the daphnelline species *Nepotilla minuta*, described from Tasmania and also recorded from South Australia. A lot in the National Museum of Victoria, F25106, from Portsea, Victoria is evidently *N. minuta* and agrees closely with the fossils.

At least 6 additional species of turrids, which could not be identified, are represented by very rare minute specimens in collections from the drain.

Family Conidae

Minute juvenile shells of a cone are rare at the drain. They have moderately high spires and several bear beads at the shoulder. Sufficient comparative juvenile material was not available to confirm their identification but they are compared to *Floraconus anemone*. Large shells of undoubted *F. anemone* are rare at Bank St and were found in float at the drain.

Family Terebridae

Pervicacia bicolor is very rare at the drain. A few small worn and broken shells from the drain that evidently have flat-sided whorls with little sculpture exhibit the characteristically twisted columella of terebrids but could not be specifically identified.

Family Pyramidellidae

Syrnola cf. *S. tincta* is rare at the drain and at Bank St. The columellar plait is weaker among the fossils than among recent specimens of *S. tincta* in the collections of the National Museum of Victoria. *Syrnola victoriae* is very rare at the drain and rare at Bank St. 2 broken shells probably of *Syrnola* from the drain may represent a 3rd species. A single well-preserved shell of *Puposyrnola tasmanica* was found at the drain.

Cingulina spina is common at the drain and rare at Bank St. A robust species of *Cingulina* represented by a single broken shell from the drain has whorls sculptured by 3 broad spiral ribs separated by narrow incised grooves, much like the sculpture of *Seila insignis* (May). However, the form at hand is holostomatous, with a strong columellar plait, and has a broad apical angle. Evidently it is a new species. *Agatha australis* (Pl. 6, fig. 7) is very rare at the drain and at Bank St. Another odostomiine species is represented by minute shells at the drain.

3 species of turbonillines are in the collections, all identified with well-defined living forms: the slim, elongate *Chemnitzia acicularis* (Pl. 6, fig. 9), very rare at the drain and rare at Bank St; *C. mariae,* rare at the drain; and *Turbonilla beddomei* (Pl. 6, fig. 8), very rare at the drain. *T. beddomei,* though provisionally tallied as a 'ubiquitous' form here, may not range into the Peronian province (Iredale & McMichael 1962, p. 85). Iredale & McMichael (1962) imply that the form here called *Chemnitzia acicularis* A. Adams is to be called *C. macleayana* Tenison Woods.

Family Acteonidae

A fragment of a minute shell with fine spiral sculpture appears to be a form of *Acteon.*

Family Atyidae

A single small well-preserved specimen of the delicate *Haminoea tenera* was found at Bank St. The fossil is somewhat slimmer than recent shells available for comparison.

Family Retusidae

Rutusa amphizosta (Pl. 6, fig. 6) is very rare at the drain.

A small species of *Cylichnina* (Pl. 6, fig. 5) is rare at the drain. Smaller specimens closely resemble the form called *C. atkinsonii,* said to be a variant of *C. pygmaea* (see Macpherson & Gabriel 1961); larger specimens are somewhat contracted medially, and the largest have an outer lip that flares anterior to the contraction, thus resembling the form called *C. iredaleana.* All the fossils seem conspecific, however, the variations being correlated with size; this species is identified as *C. pygmaea.* The forms of *Cylichnina* living in SE. Australia merit review.

2 chipped specimens of *Volvulella* from the drain are evidently *V. rostrata.* Iredale & McMichael (1962) imply that the correct name for the form at hand is *V. parata* Iredale.

Family Scaphandridae

Acteocina fusiformis is very rare at the drain; the fossils are stouter than the specimen illustrated by Macpherson and Gabriel (1961, Fig. 284). Shells of this stout form are labelled *A. apicina* in the collections of the National Museum of

Victoria, a form which Macpherson & Gabriel consider to be conspecific with *A. fusiformis*.

Family Berthelinidae

An account of the occurrence at Port Fairy of these bivalve gastropods has appeared recently (Valentine 1963). 2 species are present, both of which are very rare at the drain. *Edenttellina typica* (Pl. 6, fig. 10) is represented by one right and 2 left valves. The left valve bears a small protoconch which is inclined towards the opposite valve. The other species (Pl. 6, fig. 11) does not yet have a valid name, but is the form discussed and illustrated as *Berthelinia typica* Gatliff & Gabriel by Burn (1960a). It is represented by one left and one right valve and probably by an additional right valve. The left valve bears an erect and relatively large protoconch (approximately 0·3 mm in vertical diameter). *E. typica* lives in C. Victoria and was found living on the green algae *Caulerpa browni* in the lower littoral zone on the N. side of Griffith's Is., Port Fairy, in February 1963. '*B. typica*' of Burn is not known to live in W. Victoria at present but lives on *Caulerpa scalpelliformis* in C. Victoria and probably ranges up the New South Wales coast at least to Port Hacking (Burn 1960b).

Family Pleurobranchidae

A single well-preserved pleurobranch shell from Bank St has kindly been identified by Robert Burn. It is *Berthellinops serenitas* (Pl. 6, fig. 12), recently described from Flinders and known also from Warrnambool (Burn 1962). As the record from Warrnambool demonstrates its presence well W. of the Otways it is not regarded here as extralimital.

Family Elobiidae

A low-spired form of *Marinula zanthostoma* is very rare at the drain and rare at Bank St.

Family Amphibolidae

Salinator fragilis is represented by very rare minute shells at the drain. They lack the slight basal angulation usual on large recent shells, as do some small recent shells in the National Museum of Victoria. Some of the fossils retain faint spiral colour bands. A single minute shell from the drain appears to be a *Salinator* or closely related form but is not *S. fragilis*.

Family Gadiniidae

Small and minute shells compared to *Gadinia conica* are very rare at the drain and rare at Bank St. Probably these are *G. conica*, but it is not always possible to distinguish this form from the South Australian *G. albida* on the basis of such juvenile specimens.

Family Siphonariidae

Siphonaria diemenensis is abundant at Bank st, where several large and some small to minute shells were found, and common at the drain, where it is represented chiefly by minute shells. The shells retain much of their original colour, with radial ribs brown and interspaces white. *Siphonaria tasmanica* (Pl. 6, fig. 13) is abundant at the drain and a single shell was found at Bank St. All shells are minute juveniles, coloured brown; about one-third of them have corroded apices.

Class Scaphopoda

Family Siphonodentaliidae

Well-preserved mature specimens of *Cadulus vincentianus* are very rare in collections from the drain. Iredale & McMichael (1962, p. 97) employ the name *C. acuminatus* Deshayes for the New South Wales form often identified as *C. vincentianus*. If these 2 forms are conspecific, Deshayes's name has priority. The form called *C. vincentianus* herein is conspecific with the common Victorian species identified by that name in the collections of the National Museum of Victoria, and is considered to range into New South Wales.

Class Pelecypoda

Family Nuculidae

A form identified as *Pronucula hedleyi* (Pl. 7, fig. 1) is rare at the drain. Some small specimens have regular, concentric growth undulae, which are commonly obsolete on larger shells. Faint radial striae are visible on especially well-preserved shells. A few of the valves are paired.

Family Nuculanidae

Scaeoleda crassa is represented by small and minute specimens, including paired valves. It is very rare at the drain.

Family Arcidae

Anadara trapezia was found by Gill (1953) at Bank St. This form was locally abundant in W. Victoria and E. South Australia at times during the Pleistocene and mid-Holocene, but is not known to be living in those regions at present. It does not occur in the collections at hand.

Barbatia is represented by 2 species that are very rare at the drain: *B. pistachia* which has relatively fine sculpture, and *B. squamosa* which is coarsely sculptured. *B. squamosa* is also found at Bank St, where it is rare.

Family Glycymeridae

Small, more or less worn glycymerids are rare at the drain and at Bank St. Several of the larger shells, the largest being 10·7 mm in width, exhibit primary radial ribbing overlaid with fine radial striae on a scale identical with the sculpture of *Tucetilla striatularis* (Pl. 7, fig. 2). They have a more circular outline than adult *T. striatularis*, but no juvenile recent specimens were available for comparison. That all specimens at hand are conspecific is not certain.

Family Limopsidae

The rather elongate *Lissarca rhomboidalis* (Pl. 7, fig. 3) is common at the drain. Most specimens have a faint yellowish tint and are very well preserved.

Family Philobryidae

Notomytilus rubra, rare at the drain, is represented by well-preserved rose-tinted specimens. *Micromytilus crenulatiferus* (Pl. 7, fig. 4) is common at the drain and is represented by 4 specimens from Bank St. Most of the shells from the drain have a purplish-red tint, but those from Bank St are white.

Family Mytilidae

Modiolus pulex is common at the drain and rare at Bank St. Most shells are small to minute and broken, but only a few are worn and most retain their brown colour. 2 small shells from the drain with radial ribbing are *Branchidontes*, almost certainly *B. rostratus*. Also found at the drain are very rare minute white mytiliform shells about 3 to 4 mm long which have faint, low, irregular radiating riblets (Pl. 7, fig. 5a, b); they are evidently juvenile *Brachidontes*, but closely resemble *Notomytilus rubra* in size and shape.

A single fragment that includes a segment of the posteroventral margin of a large, finely ribbed valve is identified as *Trichomya hirsutus;* the fragment matches recent shells perfectly. *Lanistinia paulucciae* (Pl. 7, fig. 7) is very rare at the drain; some of the fossils retain colour patterns. *Gregariella barbatus* is represented by very rare, chiefly broken shells at the drain.

Family Pteriidae

Several minute hinge fragments of *Electroma georgiana* were found at the drain. The presence of this form in New South Wales was not verified by Iredale & McMichael (1961); however specimens from stations in the S. of that State are in the National Museum of Victoria. Evidently it is an essentially Maugean and Flindersian species.

Family Pectinidae

A small worn valve of *Chlamys asperrimus* was found in float at the drain, and several chips of a *Chlamys* collected in situ there are probably that species. The small transparent *Cyclopecten favus* (Pl. 7, fig. 8) is very rare at the drain.

Family Crassatellidae

Cuna delta (Pl. 7, fig. 9) is very rare at the drain. Several specimens consist of articulated valves in excellent condition. A single left valve of a large *Cuna* from the drain is identified as *C. comma* (Pl. 7, fig. 10). The valve is corroded externally so that sculpture is erased, but the hinge is in good condition, and consists of a thick wedge-shaped anterior cardinal, a thin curved posterior cardinal that is convex anteriorly, a thin anterior lateral and 2 thin posterior laterals, the most external of which strengthens into a projecting flange near the beak. The hinge plate is solid and is prolonged posteriorly beneath the laterals.

'Cuna' planilirata (Pl. 7, fig. 11) is very rare at the drain. The dentition of this form suggests that it is allied to *Notolepton* rather than *Cuna.*

Family Carditidae

Cardita calyculata is rare at the drain and at Bank St. Most specimens are small but well preserved.

Family Condylocardiidae

A corroded right valve of *Carditellona* from the drain is compared to *C. elegantula*. External sculpture has been obliterated, but faint radial stripes of the magnitude appropriate to the radial sculptural elements of *C. elegantula* are visible on the interior. The hinge is worn but its elements are identifiable.

A single well-preserved right valve from the drain represents probably a new species of *Condylocuna*. The shell is obliquely ovate, similar to *C. ovata,* and is sculptured by low concentric growth undulae. A worn prodissoconch, small for the genus, is marked off by a ring encircling the beak. There are 2 strong cardinals, the anterior of which is the thicker; both are more robust than the cardinals of *C. ovata*. No anterior laterals can be seen. The valve is 2·3 mm long and 1·9 mm high, slightly larger than recorded sizes among living Australian species of *Condylocuna*.

Family Cyamidae

Well-preserved shells of *Cyamiomactra mactroides* (Pl. 7, fig. 12) are very rare at the drain. A worn right valve of a small cyamid is similar to *Legrandina bernardi*. Posterior dental crenulae are strong but anteriorly they are not present; the hinge is somewhat worn however. The anterior cardinal is more nearly parallel to the valve margin than in available recent specimens of *L. bernardi* from Port Albert, Victoria, in the collection of C. J. Gabriel. The fossil is stained brown dorsally, as are recent shells of *L. bernardi*.

Family Gaimardidae

Neogaimardia rostellata (Pl. 7, fig. 13) and *N. tasmanica* (Pl. 7, fig. 14) are each represented by very rare but well-preserved specimens at the drain.

Family Ungulinidae

Small well-preserved valves of the moderately inflated *Diplodonta tasmanica* are very rare at the drain. *Numella adamsi*, a more robust, compressed shell, is represented by chiefly well-preserved valves, including numerous mature valves; it is rare at the drain.

Family Lucinidae

Divalucina cumingi is represented by very rare small and minute shells at the drain. *Bellucina crassilirata*, an inflated form with strong concentric ridges that are radially crenulate, is very rare at the drain and rare at Bank St. Valves are small but well-preserved. *Wallucina assimilis*, with finer concentric ridges than the preceding form, crossed by very fine radial striae, is very rare at the drain though represented by mature shells. Following Macpherson & Gabriel (1962) this form is considered to range from West Australia across S. Australia and into New South Wales. *Epicodakia tatei*, the most abundant of the lucinids at Port Fairy, is rare at the drain, where most shells are small and many are drilled. A single well-preserved mature valve was found at Bank St.

Family Erycinidae

Lasaea australis (*Kellia* of Macpherson & Gabriel 1962) is common at the drain and abundant at Bank St. Valves are chiefly well-preserved and tinted red; those from Bank St are large and robust and include paired specimens. Well-preserved valves of *Melliteryx helmsi* (Pl. 7, fig. 15) are rare at the drain and at Bank St. The hinges and dorsal interiors and occasionally the umboes are tinted rose.

Bornia trigonale (Pl. 8, fig. 2) is the most abundant pelecypod in the collections; it is abundant at the drain, where over 1,800 valves were collected, but rare at Bank St. It is generally well-preserved.

Marikellia is represented by an ovate, moderately inflated form with low umboes and by a markedly inflated form with prominent umboes and with a straight or concave ventral margin. The former is compared to *M. rotunda* (Pl. 7, fig. 17); the latter, which may be a variant of the former, is tentatively identified as *M.* aff. *M. rotunda* (Pl. 7, fig. 16). Specimens labelled *Kellia suborbicularis* from Holdfast

Bay, South Australia, in the Gatliff collection of the National Museum of Victoria (No. 4992) are evidently this latter form.

Lepton australis and *L. ovatum* (Pl. 8, fig. 9) are both very rare at the drain, where they are represented by well-preserved specimens. The genus *Notolepton* is represented by at least 2 species. A relatively large form (the largest specimen is 2·6 mm long, 2·3 mm high) with fine concentric sculpture and a strong hinge with moderately thick cardinals is identified as *N. antepodium*, the type species (Pl. 7, fig. 19). A smaller form (the largest specimen is 2·3 mm long, 2·1 mm high), also concentrically sculptured but with a more delicate hinge with cardinals markedly shorter and more ventrally directed than those of *N. antepodium*, is identified as *N. sanguineum* (Pl. 7, fig. 18). This form is variable in outline, a common variant being elongate anteroposteriorly, and is tinted yellowish or pinkish in the umbonal region. *N. antepodium* is rare at the drain, and a single valve from Bank St is compared to this form. *N. sanguineum* is very rare at the drain. Both are represented by a few paired specimens. In addition to these 2 species, *'Cuna' planilirata* may be referable to *Notolepton*.

3 species of *Mylitta* are present, all very rare at the drain: *M. auriculata* and *M. deshayesi*, each represented by a well-preserved single valve, and *M. tasmanica*, represented by several well-preserved valves and hinge fragments.

FAMILY MONTACUTIDAE

Mysella donaciformis (Pl. 8, fig. 5) is common at the drain and rare at Bank St. A large, flat *Mysella* that is higher, less elongate and less inflated than large specimens of typical *M. donaciformis* is very rare at the drain. It is more sharply truncated anteriorly than specimens of *M. anomala* or *M. ovata* available for comparison, and may be simply a variant of *M. donaciformis*. It is identified as *M.* aff. *M. donaciformis*.

FAMILY GALEOLEMMATIDAE

The unusual minute *Ephippodonta lunata* (Pl. 8, fig. 8) is represented by a single, chipped, smooth valve from the drain. The hinge is well preserved and the identification is regarded as firm. Although *E. lunata* has a finely papillose sculpture when alive, there is a tendency for the thin sculptured layer to exfoliate after death, as noted by Cotton (1938). Valves of this species in the collection of C. J. Gabriel show this tendency clearly. The left valve of smooth paired valves of *E. lunata* in National Museum of Victoria, F25107, from St Vincent's Gulf, South Australia, agrees closely with the fossil.

FAMILY CARDIIDAE

Small worn fragments of shells with cyclodont hinges are very rare at the drain. One of them is questionably compared to *Pratulum thetidis*.

FAMILY VENERIDAE

A single mature valve of *Sunemeroe alicae*, in excellent condition, was found at the drain. A small venerid with dentition typical of *Notocallista* is represented by a single specimen from the drain. The postero-dorsal margin is slightly concave near the beak and then straightens posteriorly, turning down abruptly to form a blunt posterior. The internal margin, except in hinge and ligamental regions, is finely crenulate. External sculpture consists of low concentric growth undulations. This form is evidently not known to be living.

Chioneryx cardioides, represented by small hinge fragments and juvenile shells, is very rare at the drain. Small and minute valves of a *Tawera* compared to *T. gallinula* are very rare at the drain. The dentition and the possession of crenulate margins places this form generically, but specific identification is difficult in this group with such small shells. *Placamen placida* is common at the drain, chiefly as small and minute valves, and is represented by a single broken mature valve at Bank St. An allied form called *P. placida molimen* Iredale has been described from Twofold Bay, New South Wales (Iredale 1925). However, the fossils are considered to represent a Maugean-Flindersian form.

An excellent left valve of a *Bassina* from the drain (Pl. 8, fig. 1) seems allied to *Bassina pachyphylla.* It is relatively lower and more elougate, however, than most recent shells of *B. pachyphylla,* the type of which came from Port Fairy. *Eumarcia fumigata* is represented by a small broken shell from Bank St; the hinge is well-preserved except for a broken anterior cardinal, so that the identification is fairly secure.

Very rare small and minute shells of *Katylesia* from the drain are compared to *K. peroni,* and are probably that species, though specific identification of juvenile *Katylesia* is difficult. Mature but badly broken shells of *Katylesia rhytophora* are common at Bank St.

Venerupis exotica is rare at the drain and at Bank St, being represented chiefly by small valves, a few of which are paired, though all valves from Bank St are large and well-preserved. Some valves are distorted, suggesting a nestling habitat. *Pullastra flabagella* is rare at the drain; many valves are broken and all are small. Although recorded from South Australia by Macpherson & Gabriel (1962) it is not listed by Cotton & Godfrey (1938b) and is evidently an essentially Maugean and Peronian form.

Several minute hinge fragments of venerids from the drain, probably juvenile venerines, represent a few species that could not be identified with previously described forms. Their generally poor condition makes their definition impractical and they are omitted from the list of species.

Family Petricolidae

A posterior fragment of a minute but rather thick-shelled left valve is compared to *Naranio lucinalis*. The fine divaricating sculpture of narrow ribs crossing to form a reticulate network, and details of the posterior muscle scar and pallial line agree well with specimens of *N. lucinalis* in the South Australian Museum.

Family Donacillidae

Donacilla angusta, represented by a few mature shells and many fragments, is rare at the drain.

Family Mactridae

Mactra australis is abundant at the drain, where it is the most conspicuous species in thin shell seams. Many of the valves are medium to large, though most are small to minute; many are broken. Despite their abundance no paired valves were observed. This form is rare at Bank St, where worn and broken hinge fragments were found.

A large broken right valve identified as *Mactra pura* was found at Bank St; the chondrophore, cardinals, and posterior laterals are preserved and match recent valves of *M. pura*. *Mactra rufescens* is represented by 2 small valves from the drain. The hinge of one is well preserved. This species is recorded in S. New South Wales but is tallied here as an essentially Maugean-Flindersian form.

Notospisula parva is very rare at the drain, where small to minute well-preserved valves are found. This species ranges widely along the S. Australia coast. A form in New South Wales has been separated as *N. parva producta* (Angas). Whatever the validity of this latter form, the typical *N. parva* of Victorian waters, represented by the fossils, is considered to range well into New South Wales.

FAMILY DONACIDAE

Deltachion chapmani is very rare at the drain; the valves are mature and well preserved. *D. electilis* is rare at the drain, chiefly as small and minute or broken shells, though a few mature specimens were found, especially in association with seams of *Mactra australis*. A closely allied form, *D. brazieri* Smith, lives in New South Wales, but the fossils are considered to be identical with the living form that ranges from Western Australia into at least W. Victoria.

Two excellent mature valves of the robust *Plebidonax deltoides* were found at the drain.

FAMILY GARIIDAE

Soletellina biradiata and *S. donacioides* are both very rare at the drain, where they are preserved chiefly as hinge fragments. The latter form is the more abundant.

FAMILY SEMELIDAE

One well-preserved mature valve of *Syndesmya exigua* was found at Bank St.

FAMILY TELLINIDAE

Tellina albinella is represented at the drain by a hinge fragment of a right valve which retains a faint rosy tint. It was originally a large shell, evidently on the order of 1½ in. long. A single large broken valve of *Homalina deltoidalis* was found at Bank St. Small valves of *Homalina mariae*, together with hinge fragments, are very rare at the drain. *Semelangulus tenuiliratus* (Pl. 8, fig. 6) is represented by small but well-preserved shells that are very rare at the drain. *Pseudarcopagia victoriae* is represented at the drain by a small broken left valve with a well-preserved hinge.

FAMILY HIATELLIDAE

Small shells of *Hiatella australis* are common at the drain and rare at Bank St. *Hiatella subalata* is very rare at the drain. This form has been placed in the Thraciidae as *Eximothracia* by Cotton & Godfrey (1938a) and as *Thraciopsis* by Iredale & McMichael (1962).

FAMILY CORBULIDAE

Well-preserved valves of *Corbula coxi* (Pl. 8, fig. 3) are very rare at the drain.

FAMILY PHOLADIDAE

Pholas obturamentum is represented by 2 minute but well-preserved specimens at the drain.

FAMILY TEREDINIDAE

A single right valve of a marine borer from the drain is very questionably compared to *Bankia gabrieli*. It agrees well with specimens from Dunnekin Slip, Port Adelaide, the type locality of *B. gabrieli*, in the National Museum of Victoria. The sculpture of the anterior auricle and anterior median area is exceedingly fine, finer than on available specimens of the other terredinids of Victoria and South Australian waters. The posterior auricle is broken off and the median area chipped. No pallets were recognized among the sediments examined.

Family Myochamidae

Small and minute right valves of *Myadora tasmanica* (Pl. 8, fig. 7) are very rare at the drain. They are similar to small valves of *M. pandoriformis* but have stronger sculpture; furthermore the upper surface of the strong antero-dorsal flange forms nearly a right angle with the outer valve surface in *M. tasmanica,* while in *M. pandoriformis* it forms a high angle and the flange itself is not so prominent.

Family Thraciidae

Very rare fragile but well-preserved valves of a *Thraciopsis* from the drain are identified as *T. elongata* (Pl. 8, fig. 4). Several hinge fragments presumably of this species were also found.

Class Cephalopoda

Family Sepiidae

Fragments of the gladulus of *Mesembrisepia novaehollandiae* were found both at the drain and at Bank St. That from the drain is a small posterior tip with spine (Pl. 6, fig. 14), while a larger posterior fragment from Bank St includes part of the inner cone and sulcus but lacks the tip. A third fragment of a sepioid gladulus from the drain includes part of the region where the striated and non-striated areas meet; it may be *M. novaehollandiae* also but cannot be certainly identified. Gladuli of *M. novaehollandiae* were common on the Port Fairy beaches during the summer of 1963.

Palaeoecology

General Ecologic Composition of the Fossil Assemblages

The general range of habitats from which the fossils at each locality have been derived is clearly indicated by the assemblages. At Bank St, common and abundant forms are those which live today chiefly along open rocky shores. Some species are nearly or completely restricted to intertidal zones at present, as *Poneroplax albida, Clavarizona hirtosa, Cellana tramoserica* and several other limpets, *Melarapha praetermissa* and *M. unifasciata, Bembicium nanum, Lepsiella vinosa*, and *Siphonaria diemenensis.* Others found intertidally are also common in shallow subtidal zones, as *Austrocochlea adelaidae* and *A. odontis, Subninella undulata, Antisabia foliacea, Cominella lineolata,* and *Lasaea australis* (on algae or among mussels). These forms dominate the assemblage, but species that live on algae or marine phanerogams offshore, commonly but not exclusively along rocky coasts, such as *Cantharidus pulcherrimus, C. ramburi,* and *Diala semistriata,* or that are common on sandy bottoms along open coasts, such as *Zeacumantis diemenensis* and *Katylesia rhytiphora,* form important elements. The Bank St association is thus closely similar to associations found today along open rocky coasts. Most of the shells are of medium to large size, with minute forms poorly represented.

The assemblage at the drain, although including many forms that live today in habitats associated with rocky shores, has quite a different aspect. The dominant element, including most of the common and abundant forms, is composed of species that are said to live on algae or marine phanerogams, as *Asteracmea stowae, Cantharidus ramburi, Bankivia fasciata, Leiopyrgia octona, Cantharidella tiberiana, Pellax rosea,* and *Rissoina elegantula.* Other well-represented species are benthonic on sandy substrates in shallow water, and live commonly along sandy beaches that are somewhat protected; *Placamen placida* and *Mactra australis* for example. Common and abundant rocky-shore forms, including *Siphonaria diemenensis* and *S. tasmanica,* are represented chiefly by small and minute shells; in fact, except for *Mactra australis* and a few algae-dwelling gastropods, no species is regularly represented by large shells, the assemblage consisting chiefly of species that are small to minute when mature, young individuals of species that grow to larger sizes, and small fragments of large shells.

In view of the general ecological composition of the two fossil assemblages it is pertinent to review knowledge of molluscan biocoenoses and thanatocoenoses associated with open rocky shores and sandy beaches in W. Victoria and nearby regions at present.

Recent Rocky Shore Biota, W. Victoria and Allied Regions

Fig. 5 represents some aspects of the intertidal zonation of rocky shores in W. Victoria and faunally similar regions—E. South Australia and Tasmania. Bennett & Pope (1953, 1960) and Womersley & Edwards (1958) have given the most comprehensive account of these regions. The term used here for tidal levels and shore zones follow the usage of Bennett & Pope (1953, p. 107) and degree of exposure is also based on the usage of these authors (1960, p. 221). In Fig. 5, column 1 depicts zoning organisms at Portland, Victoria, where exposure is submaximal (modified from Bennett & Pope 1953). It is the locality nearest Port Fairy for which such data have been published. Column 2 represents a 'sheltered' open coast fairly typical of the Maugean province; it is a generalized zonation scheme for N. Tasmania (modified from Bennett & Pope 1960). Columns 1 and 2 are not strictly comparable since different organisms were emphasized in the two reports. Column 3 is the generalized molluscan intertidal pattern found along the N. and NE. sides of Griffith's Is., Port Fairy, in the summer of 1963. In constructing this column the position of the *Galeolaria* zone, taken to indicate the upper part of the lower littoral (lower 'Balanoid') zone, was used as a datum, together with the position of the zone of pure *Melarapha,* taken to indicate the supralittoral ('littorinid') zone. Therefore column 3 does not represent a critical evaluation of the local zonal levels compared with independently determined tidal levels. However, in this case, the use of analogy as a yardstick does not reduce the usefulness of the data for the purposes at hand. Molluscs were emphasized in the construction of this column.

On open rocky shores, both protected and exposed, the supralittoral zone is characterized by the littorinids *Melarapha unifasciata* (usually the highest) and *M. praetermissa.* The upper littoral zone on submaximally exposed open shores is occupied by various limpets (including *Patelloida latistrigata*) and siphonarias (*Siphonaria diemenensis* and *S. tasmanica*) and the carnivorous *Lepsiella vinosa.* The mussel *Modiolus pulex* is often found here, locally forming a band, and *Lasaea australis* is common. In more sheltered open coastal areas, as along N. Tasmania and at Griffith's Is., *Bembicium nanum* (= *B. melanostoma* of Bennett & Pope and at least in part of Womersley & Edwards), *Austrocochlea constricta* (= *A. obtusa* of Bennett & Pope) and *A. concamerata* become common in

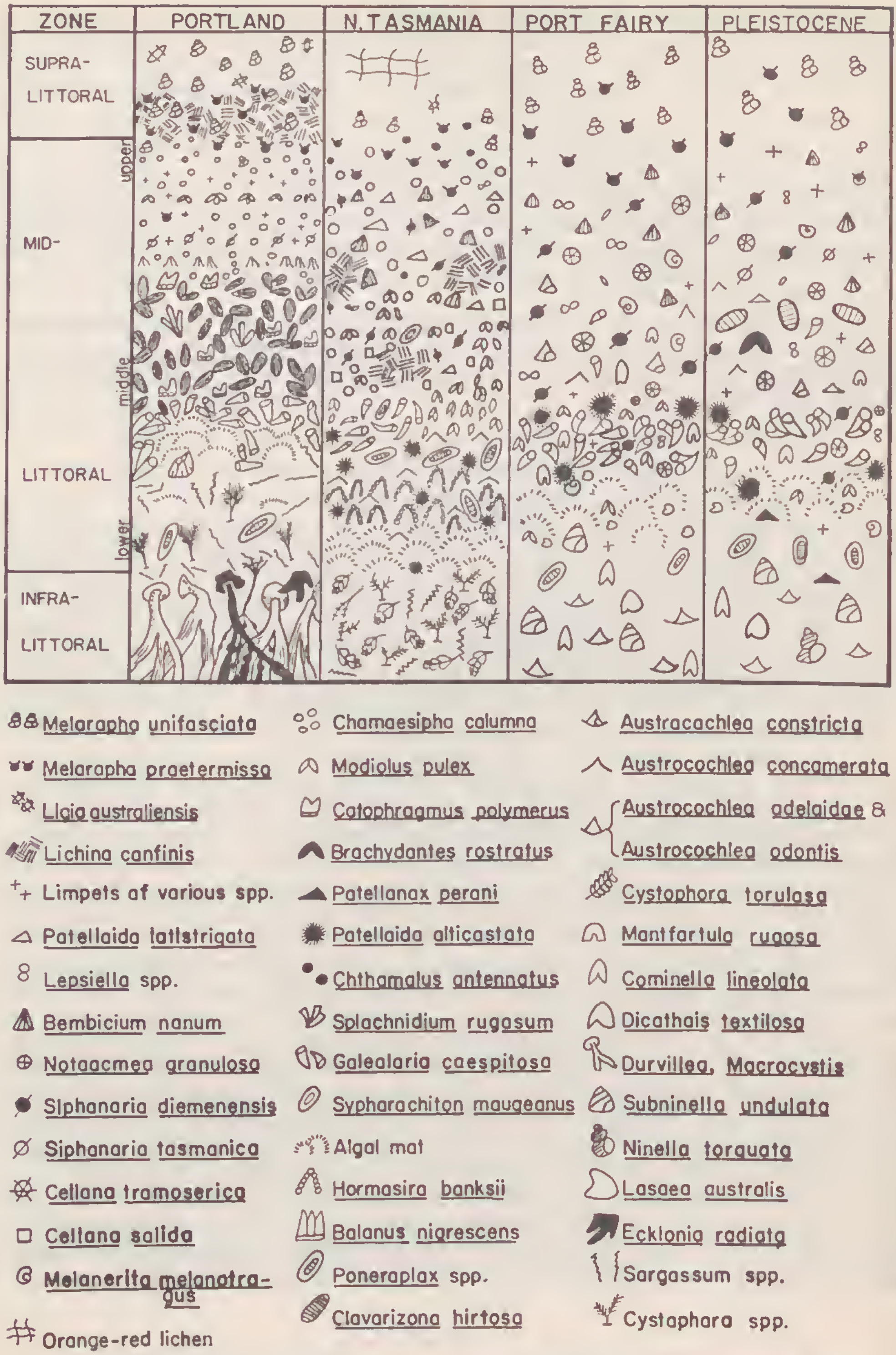

FIG. 5—Intertidal zonation; columns 1 to 3, present zonation at various localities in Maugean province; column 4, inferred intertidal zonation of Pleistocene molluscs respresented in the Port Fairy beds. Column 1, after Bennett & Pope 1953; column 2, after Bennett & Pope 1960.

this zone. At Griffith's Is. the common species of *Lepsiella* in this zone has well-developed axial ribs and therefore a cancellate spire, and is identified as a small form of *Lepsiella flindersi*. On the sheltered coasts the *Modiolus pulex* band is usually absent in this zone, though *M. pulex* may occur in lower zones.

The middle littoral zone in areas of submaximal exposure is often dominated by the mussel *Brachidontes rostratus* (sporadic in Tasmania) and *Lasaea australis* is common. However, on many protected shores *Brachidontes* is reduced or absent (Fig. 5, columns 2 and 3). Instead, *Cellana* and scattered clusters of *Modiolus pulex* may be found, together with species of *Austrocochlea* and *Lepsiella*. *Cominella lineolata* and *Melanerita melanotragus* were especially common in this zone at Griffith's Is.

The lower littoral zone with submaximal exposure is commonly divided into an upper band of *Galeolaria* succeeded below by an algal mat or turf, and below that by a zone with the chiton *Poneroplax*, usually *P. costata*. Living among the *Galeolaria* tubes are various limpets, *Montfortula* and *Lasaea australis*, and the algal mat harbours numerous minute forms. The entire zone is also frequented by several species of trochids, turbinids, and thaidids which range at times into higher zones and also live subtidally. Along more protected shores the fauna changes slightly. *Patelloida alticostata* was especially common just at the top of the *Galeolaria* band at Port Fairy and may be favoured by shelter; it is common in the lower littoral zone of N. Tasmania (Bennett & Pope 1960, p. 189, 193). The chiton *Poneroplax albida* is more often found in the lower parts of this zone at protected localities (May 1923).

A comparison of the algal turf molluscs of exposed and of protected open coasts has not been made, but this fauna deserves special mention here because it assumes some importance in interpreting the Pleistocene assemblages. The 'turf' is composed chiefly of *Corallina* and *Caulerpa*, with other algae, growing in mats and tussocks. Its molluscan inhabitants are numerous and diverse: at Griffith's Is. they include among the gastropods minute scissurellids, trochids, turbinids, liotids, 'rissoids', rissoinids, columbellids, marginellids, and members of most Victorian families of shelled marine opisthobranchs (including berthelinids); and among the pelecypods small and minute limopsids, philobryids, mytilids (including *Modiolus pulex*), cyamids, gaimardids, erycinids (including *Lasaea australis*) and montacutids; and many other molluscan families which are represented by rarer forms. In addition to these very small forms, juveniles of many larger species shelter here, including forms that are commonly found in higher intertidal zones when mature, as several species of *Austrocochlea, Subninella undulata, Bembicium nanum,* and forms that inhabit larger, more offshore algae when mature, as *Phasianotrochus* and *Phasianella*. Young *Bembicium* were also found in pits in basalt boulders in higher zones, but the smallest and presumably youngest individuals were among the algal turf. The matted algae of this zone thus provides habitats for numerous minute species and nurseries for many larger forms. That juveniles of intertidal forms may inhabit lower zones than adults has been noted several times, e.g. by Bennett & Pope (1960, p. 191-193) for several Australian species.

In deep pools and in the shallow sublittoral zone, numerous molluscs are found on rocks (*Austrocochlea adelaidae, A. odontis, Subninella undulata, Dicathais textilosa, Floraconus anemone, Cominella lineolata*), and on some of the larger brown algae (*Cantharidus, Phasianotrochus, Phasianella*). Many of these species, especially those favouring rocks and sandy patches, are not uncommon in the littoral zone proper at some localities.

Recent Thanatocoenoses Associated with Rocky Shores at Port Fairy

Intermittently developed at the rear of the basalt boulder beach on the N. side of Griffith's Is. is a thick deposit of shells, evidently thrown up by storms. Shell pockets are also common among the boulders themselves, especially near the top of the beach. The shells are generally large and their matrix when present at all is of pebbles and very coarse sand. A bulk collection was made from a sandy pocket. It contained 455 identifiable shells, which are listed in Table 3.

Table 3

Molluscan thanatocoenose from a single sandy pocket, back beach, N. side of Griffith's Is., Port Fairy. Collection includes 455 identifiable shells

Species	Abundance[1]	Remarks
Polyplacophora		
Several unidentifiable valves	C	
Gastropoda		
Montfortula rugosa (Quoy & Gaimard)	C	
Cellana tramoserica (Sowerby)	C	Large
Patellanax chapmani (Tenison Woods)	R	
Patelloida alticostata (Angas)	R	
P. latistrigata (Angas)	C	
Notoacmea granulosa Macpherson	R	
Clanculus plebejus (Philippi)	C	
Cantharidus pulcherrimus (Wood)	R	Broken
C. ramburi (Crosse)	C	Good
Phasianotrochus bellulus (Dunker)	R	Broken
Bankivia fasciata (Menke)	R	
Austrochochlea adelaidae (Philippi)	C	
A. concamerata (Wood)	C	
A. constricta (Lamarck)	R	
A. odontis (Wood)	C	
Subninella undulata (Solander)	S	78 + 22 opercula
Micrastrea aurea (Jonas)	C	
Phasianella ventricosa Swainson	R	Broken
Melanerita melanotragus (E. A. Smith)	R	Excellent
Melarapha praetermissa May	R	
M. unifasciata (Gray)	C	
Bembicium nanum (Lamarck)	R	
Laevilitorina mariae (Tenison Woods)	R	Excellent
Lironoba tenisoni (Tate)	R	Broken
Pissina cf. *P. tasmanica* (Tenison Woods)	R	Inflated form
Merelina hulliana (Tate)	R	
Rissoina sp.	R	Worn, broken
Eatoniella melanchroma (Tate)	R	
Velacumantis australis	R	Large, broken
Zeacumantis diemenensis (Quoy & Gaimard)	C	
Cacozeliana granaria (Kiener)	C	Large
Opalia australis (Lamarck)	R	Apical fragments
Granuliscala granosa (Quoy & Gaimard)	R	
Hipponix conica (Schumacher)	C	
Antisabea foliacea (Quoy & Gaimard)	A	
Polinices conicus (Lamarck)	R	
Cymatiella verrucosa (Reeve)	R	

[1] For explanation of abundance symbols see Table 2.

Species	Abundance[1]	Remarks
Dicathais textilosa (Lamarck)	C	
Lepsiella flindersi (A. Adams & Angas)	C	
L. reticulata (Blainville)	C	
L. vinosa (Lamarck)	R	
Cominella lineolata (Lamarck)	A	
Alocospira petterdi (Tate)	R	
Eumitra australis (Swainson)	R	
E. badia (Reeve)	R	
Proximitra pica (Reeve)	R	
Cryptospira pygmaeoides (Singleton)	C	Worn
Guraleus vincentinus (Crosse & Fischer)	R	
Mitraguraleus mitralis (Adams & Angas)	C	
Floraconus anemone (Lamarck)	C	
Marinula zanthostoma H. & A. Adams	R	Broken
Siphonaria diemenensis Quoy & Gaimard	C	
S. tasmanica Tenison Woods	R	
PELECYPODA		
Lissarca rhombiodalis Verco	R	Hinge fragments
Micromytilus crenulatiformis (Tate)	R	Hinge fragments
Modiolus pulex (Lamarck)	R	Small
Electroma georgiana (Quoy & Gaimard)	R	
Neogiamardia tasmanica (Beddome)	C	1 pair
Lasaea australis (Lamarck)	R	
Melliteryx helmsi (Hedley)	R	
Mysella donaciformis Angas	R	
Donacilla angustata Reeve	R	
Mactra pura Deshayes	R	Large hinge fragments
Deltachion electilis Iredale	R	Broken
Plebidonax deltoidalis (Lamarck)	R	Hinge fragment
Soletellina donacioides Reeve	R	Hinge fragment
Pseudarcopagia? cf. *P. victoriae* (Gatliff & Gabriel)	R	Fragment
Hiatella australis (Lamarck)	R	

Heterogeneity among samples of this size in coarse storm-driven assemblages is doubtless high, and species frequencies cannot be given too much weight. Nevertheless, the Recent thanatococnose at Griffith's Is. contains common to abundant medium to large specimens of *Cellana tramoserica,* species of *Austrocochlea, Subninella undulata*, species of *Melarapha, Antisabea, Lepsiella, Cominella lineolata,* and other forms which are common among the littoral and sublittoral rocks nearby. Algal dwellers such as *Cantharidus* are less common but are present, and *Zeacumantis diemenensis* is common. However, there is also a striking contrast between this thanatocoenose and the molluscan biocoenose of the adjacent shore. Small species such as small limpets, siphonarias, *Modiolus pulex* and *Lasaea* are much rarer than their living representation would merit. The rich minute fauna of the algal turf zone, in fact, is scarcely represented. Thus the larger shells are present in much greater relative abundance than their living representation merits, including species that live only in the lowest littoral or in sublittoral zones. Observation of the shell deposit indicated that this bias would have been even stronger had not a sandy pocket been deliberately chosen for sampling.

TABLE 4

Molluscan thanatocoenose from sandy bottom 100 yds N. of Griffith's Is., Port Fairy

SPECIES	ABUNDANCE[1]	REMARKS
POLYPLACOPHORA		
Acanthochiton coxi lachrymosus May & Torr	V	
Heterozona cariosa Carpenter	V	
Rhyssoplax cf. *R. diaphora* Iredale & May	V	
GASTROPODA		
Amblychilepas javanicensis (Lamarck)	V	
Clanculus plebejus (Philippi)	C	Small & minute
Cantharidus ramburi (Crosse)	C	
Phasianotrochus eximius (Perry)	V	
P. rutilus (A. Adams)	C	
Bankivia fasciata (Menke)	V	
Thalotia conica (Gray)	V	Minute
Austrachochlea adelaidae (Philippi)	V	One large
A. concamerata (Wood)	V	Minute
A. odontis (Wood)	R	Small & minute
Cantharidella tiberiana (Crosse)	C	
Minopa petterdi (Crosse)	V	
Calliostoma allporti (Tenison Woods)	V	
Subninella undulata (Solander)	A	Small
Bellastrea? cf. *B. kesteveni* Iredale	V	Minute
Phasianella australis (Gmelin)	V	Small
P. ventricosa Swainson	R	Small to minute
Pellax rosea (Angas)	V	Worn
Lodderia lodderae (Petterd)	V	
Melarapha praetermissa May	V	Minute
M. unifasciata (Gray)	V	Minute
Bembicium nanum (Lamarck)	V	Minute
Laevilitorina mariae (Tenison Woods)	S	
Pissina frenchiensis (Gatliff & Gabriel)	V	
P. tasmanica (Tenison Woods)	R	
Microdryas australiae (Frauenfeld)	V	
Merelina hulliana (Tate)	V	
Linemera filocincta (Hedley & Petterd)	R	
Rissoina elegantula Angas	V	Small
R. sp.	V	Large for genus
Eatoniella melanchroma (Tate)	S	
Zeacumantis diemenensis (Quoy & Gaimard)	V	
Diala phasianella Angas	V	
D. semistriata (Philippi)	V	
Cacozeliana granaria (Kiener)	R	
Cerithiopsis sp. *s. l.*	V	
Zaclys angasi (Semper)	V	
Notosinister granifera (Brazier)	R	
N. maculosa (Hedley)	V	
N. pfeifferi (Crosse & Fischer)	V	
N. cf. *N. spica* Verco	V	Broken
N. cf. *N. tasmanica* (Tenison Woods)	V	Worn, broken
N. sp.	R	
Clathrus jukesiana (Forbes)	V	
Hipponix conicus (Schumacher)	V	Large to small
Antisabea foliacia (Quoy & Gaimard)	C	Medium to minute
Polinices sp.	V	Minute
Litozamia brazieri (Tenison Woods)	V	

[1] Abundances are subjective estimates that species would fall into abundance classes explained in Table 2 if entire collection were identified.

Species	Abundance[1]	Remarks
Benthoxystus petterdi (Crosse)	V	
Dicathais textilosa (Lamarck)	V	Minute
Lepsiella reticulata (Blainville)	V	
Macrozafra atkinsoni (Tenison Woods)	R	
M. remoensis (Gatliff & Gabriel)	V	
M. sp. A[2]	V	
M. sp. B[2]	V	
M.? sp.	R	
Zella beddomei (Petterd)	V	
Dentimitrella? cf. *D. pulla* (Gaskoin)	V	Minute, worn
Cominella lineolata (Lamarck)	V	Small
Reticunassa puapera (Gould)	V	
Parcanassa cf. *P. burchardi* (Philippi)	V	
Mitra sp.	V	
Cryptospira pygmaeoides (Singleton)	R	Small
'Marginella' sp.	V	
Guraleus vincentinus (Crosse & Fischer)	V	Small
Euguraleus tasmanicus (Tenison Woods)	R	
Floraconus anemone (Lamarck)	R	Minute
Syrnola victoriae (Gatliff & Gabriel)	V	
Odostomia australis (Angas)	V	
Turbonilla beddomei (Petterd)	V	
T. fusca (A. Adams)[3]	V	
T. mariae (Tenison Woods)	R	
Cylichnina pygmaea (A. Adams)	V	
Acteocina fusiformis (A. Adams)	R	
Midorigai australis Burn[3]	V	Single left valve
Marinula zanthostoma H. & A. Adams	V	Minute
Salinator fragilis (Lamarck)	C	Small & minute
Coxiella striata (Reeve)[3]	V	Minute
Siphonaria diemenensis Quoy & Gaimard	V	Small and minute
Pelecypoda		
Pronucula cf. *P. hedleyi* Pritchard & Gatliff	V	Minute
Lissarca rhomboidalis Verco	V	
Micromytilus crenulatiferus (Tate)	V	
Modiolus pulex (Lamarck)	R	
Cyamiomactra communis Hedley[3]	V	Paired
Neogaimardia tasmanica (Beddome)	R	Paired
Wallucina assimilis (Angas)	V	Small hinge fragment
Lasaea australis (Lamarck)	V	
Melliteryx helmsi (Hedley)	V	
Bornia trigonale (Tate)	V	
Notolepton antepodium (Filhol)	V	
N. sanguineum Hutton	V	
Mysella donacioides Angas	R	Paired
Chioneryx cardioides (Lamarck)	V	Paired
Venerupis exotica Lamarck	R	Paired
Pullastra flabagella (Deshayes)	V	
Mactra australis Lamarck	V	Small hinge fragment
Hiatella australis (Lamarck)	R	

[2] Same nomenclature as for fossils.
[3] Not found fossil at Port Fairy.

In a search for shells of the smaller rocky shore molluscs, bottom samples from offshore stations about 100 yds N. of the N. shore of Griffith's Is. were collected by divers of the Victorian Sub Aqua Group. Water depth was between 10 and 14 ft. The bottom was sandy with occasional small boulders, and the water turbid with suspended sediment. Strong currents were encountered. Despite the unexpectedly high energy of the depositional environment the thanatocoenose in these samples contains most of the species observed living in the algal turf zone, with chiefly small specimens of larger species that are common among littoral rocks and offshore algae; plus forms from phanerogams and other habitats. Most of the species in 100 gm of the fraction larger than 1 mm from one of the samples is listed in Table 4. With few exceptions, only species found fossil at Port Fairy are identified. All of the few other forms are rare or very rare. Presumably, samples from still farther offshore at lower energy sites would contain an even larger proportion of small and minute shells.

The Pleistocene Intertidal Zone at Port Fairy

It seems reasonable to assume that the rocky-shore elements dominant in the assemblage at Bank St and important at the drain are biased in the same general ways as the recent thanatocoenoses from the back beach and from offshore at Griffith's Is., respectively. That is, Bank St yields chiefly large shells of larger forms from the former intertidal and subtidal zone and, in fact, resembles the recent back-beach thanatocoenose. The fossil assemblage from the drain, on the other hand, yields chiefly small and minute shells of the rocky shore element, including many species known to inhabit the algal turf zone, as well as littoral rocks and near-shore algae. Insofar as its rocky shore element is concerned, it closely resembles the offshore thanatocoenose though it also includes strong elements not found in the offshore sample in any abundance. From these data, a general picture of the former intertidal zone that contributed to the fossil assemblages can be reconstructed (Fig. 5, column 4). Only molluscs that actually occur in the Port Fairy beds are depicted. Algae, however, are included on the basis of the present habitats and food habits of the molluscs. *Galeolaria* tubes are not uncommon in the Port Fairy beds, especially at the drain.

The former rocky shore is inferred to have been less than submaximally exposed, judging partly from the abundance of *Poneroplax albida, Patelloida alticostata, Bembicium nanum,* and *Siphonaria diemenensis.* The relative abundance of *Modiolus pulex* and relative scarcity of *Brachidontes rostratus* fits this interpretation well. That the beach was not a truly sheltered open coast is suggested by the abundance of *Siphonaria tasmanica* and the presence of *Patellanax peroni* and *Brachidontes rostratus* (which, however, are very rare). It is possible, of course, that rocky-shore elements in the Pleistocene thanatocoenoses, especially at the drain, have been derived from a stretch of coast around the old headland which included rather exposed shores on the weather side and rather protected shores on the lee. Still the predominant aspect of the rocky-shore element suggests moderate exposure, 'when surf without much force constantly washes over the rocks' (Bennett & Pope 1960, p. 221), and this suggestion is not entirely a compromise among conflicting data. Habitats along such a shore could evidently accommodate the entire rocky-shore element. In the reconstructed zonation, species are positioned therefore according to their present patterns on moderately exposed shores.

The supralittoral zone was evidently inhabited by the species of *Melarapha* common there today in the Maugean and Flindersian provinces; *Notolittorina* of the Peronian province is unknown in the Victorian Pleistocene. Upper littoral forms included the characteristic littorine *Bembicium nanum,* species of limpets and siphonarias, and the carnivorous *Lepsiella.* Only scattered occurrences of *Modiolus pulex* are visualized, in keeping with its rareness at Bank St and with the inferred moderate exposure. Species of *Austrocochlea* probably lived here at moist, shaded sites.

Several of these forms were probably common at midlittoral horizons also, where they were joined by *Cellana tramoserica* and the chiton *Clavarizona hirtosa.* This latter species does not live near Port Fairy today, but is said to be a common zoning species of the mid-littoral horizon of Western Australia. *Brachidontes rostratus* is characteristic of this zone, but as it is very rare in the collections it is not depicted as forming a *Brachidontes* band, which is usually a feature of more exposed shores.

The lower littoral zone can be interpreted as very similar to that of the Maugean province today, with a *Galeolaria* band giving way below to an algal turf replete with a diverse minute fauna chiefly represented at the drain. *Modiolus pulex* and *Lasaea australis* were probably most abundant here. That *Caulerpa browni* and *C. scalpelliformis* formed part of the turf association is suggested by the berthelinids collected at the drain. Below the turf a *Poneroplax* horizon is documented by common valves at Bank St. Significantly, no *Poneroplax* from this lowest of intertidal horizons were found at the drain, though small intertidal forms from upper and supralittoral zones are not uncommon there.

The shallow sublittoral zone evidently supported an association of fairly large brown algae ('kelp') with common subtidal forms such as *Subninella undulata, Austrocochlea odontis, Cominella lineolata,* and *Floraconus anemone* on rocks and sand among the holdfasts and with *Cantharidus, Phasianella,* and others on the algae itself. Some of these forms doubtless invaded the littoral zone. *Ninella torquata,* a disjunct Flindersian-Peronian species not known to live in Victoria today, was presumably a member of this association. The large kelp *Durvillea potatorum* unfortunately does not support epizoonts which could serve as fossil witnesses to its former presence, and so we are deprived of evidence on the Pleistocene distribution of this important cool-temperate form.

Although based on present patterns, the relative levels assigned in column 4 of Fig. 5 to characteristic intertidal zoning species such as littorines, limpets, and siphonarias are conjectural; conditions were certainly somewhat different from those of today and this might have resulted in differences in zonation. When changes in relative vertical ranges occur at present they are commonly associated with biological factors. Hewatt (1935) has shown that in Monterey Bay, California, the lower portions of the potential vertical ranges of several intertidal species of limpets and barnacles were occupied by a mussel association, which excluded the former species. When the mussels were removed the limpets and barnacles extended their ranges downward. Cases of the (usually temporary) depletion of mussel beds by predators such as starfish or thaidid gastropods are well documented (Fauvel 1901, Fischer-Piette 1935). What effect the extra-limital forms, e.g. *Clavarizona hirtosa,* might have had on the intertidal position of other species at Port Fairy is not known. The levels of forms with less characteristic zonal distributions, such as trochids and turbinids, vary according to local conditions and the details of their relative positions in column 4 of Fig. 5 should not be taken too seriously.

Despite these uncertainties, the preparation of the column is justified on the grounds that is underlines the essentially Maugean aspect of the rocky-shore element of the Port Fairy beds while, at the same time, it depicts the presence of some extra-limital forms in an ecological context. And since the present marine provinces of SE. Australia are defined almost entirely on the basis of rocky-shore biotas, it provides a useful point of discussion for palaeobiogeographic considerations.

Pleistocene Associations from Beach and Offshore Biotopes

Descriptions of associations inhabiting offshore biotopes today are not available for Victorian waters. It is necessary, therefore, to rely on scattered information on present habitats of the species found fossil in the Port Fairy beds for interpretation of offshore elements. On the basis of this information the species may be grouped by generalized habitat types into several somewhat theoretical biotopes. For some of the fossils that are most abundant at the drain there is no specific habitat data, and it is necessary to exclude them from consideration in attempting to define the ancient biotopes. However, from such data as is available on their present habitats culled from dredging records and museum labels, and from the general niche occupied by their congeners and to which they are presumably but not certainly adapted, it is possible to suggest their ecological origins once the range of probabilities has been indicated by species for which better data are available.

One element of some importance at the drain is regarded as representing shallow sandy and silty bottoms in moderately quiet water. A characteristic species of this element, and the most abundant form represented by large shells at the drain, is *Mactra australis*, reported to live at low water along sandy beaches (Macpherson & Gabriel 1962) and also as common subtidally. Macpherson has found it especially common off moderately protected beaches such as in Bridgewater Bay where protection from the roughest seas is afforded by Cape Bridgewater (pers. com.). Other forms which may be included in this element are *Scaeoleda crassa, Tucetilla striatularis, Chioneryx cardioides, Tawera gallinula, Placamen placida, Mactra rufescens, Deltachion chapmani, D. electilis, Soletellina biradiata,* and *S. donacioides,* most of which are not common in the Port Fairy beds. Probably some of the naticid and nassariid gastropods belong with this element. Other species may represent this element at its rough-water (*Plebidonax deltoidalis*) and quiet-water (most of the lucinids) extremes.

A second element which includes common and abundant species at the drain has probably been drawn from offshore (submerged) rocky bottoms and associated algal communities. *Bankivia fasciata, Leiopyrga octona,* and *'Pellax' rosea* are common or abundant forms that are evidently fairly characteristic algal dwellers in such biotopes. Large numbers of species that are common along rocky shores today are found also offshore on rocky bottoms, as the large species *Austrocochlea adelaidae, A. odontis, Subninella undulata, Cymatiella verrucosa,* and *Dicathais textilosa,* and numerous small and minute species including many members of the algal turf association. It is not possible to estimate the magnitudes of the contributions from shore and from offshore rocky bottoms, and both habitat types must have made important contributions to judge from the abundance of forms characteristic of each. The characteristic species convey the impression that the rocky shore biotope is quantitatively the more important of the two.

A third molluscan element which can be somewhat arbitrarily distinguished from the others inhabits the marine cryptogams *Zostera, Poseidonia,* and *Cymodocea* in waters of more or less normal salinity. In some situations, cryptogams form submarine meadows in sheltered shallow waters which may extend downward into moderately deep water where light is strong and waters clear. In other cases, cryptogams are present as a patchy or fringing stand interfingering with algae where rocky bottoms give way to finer substrates, especially at sheltered localities. *Stenochiton cymodocialis, Asteracmea stowae. A. crebristriata,* and *Melliteryx helmsi* are evidently especially characteristic of the cryptogam biotope and species of *Zeacumantis, Cacozeliana, Diala,* and *Mysella* are common in this environment, but flourish in other habitats as well. Some of the very abundant forms for which no habitat data are available, such as *Bornia trigonale,* are suspected to belong with this element.

The presence of other elements which are of small importance quantitatively in the Port Fairy beds is indicated by (a) estuarine or lagoonal forms which are usually found living on mudflats and/or among algae or cryptogams, often in brackish water (*Batillariella estuarina, Tatea rufilabris,* and *Melliteryx helmsi*); and (b) a form which has probably come from deeper water than is represented by the other elements (*Cyclopecten favus*).

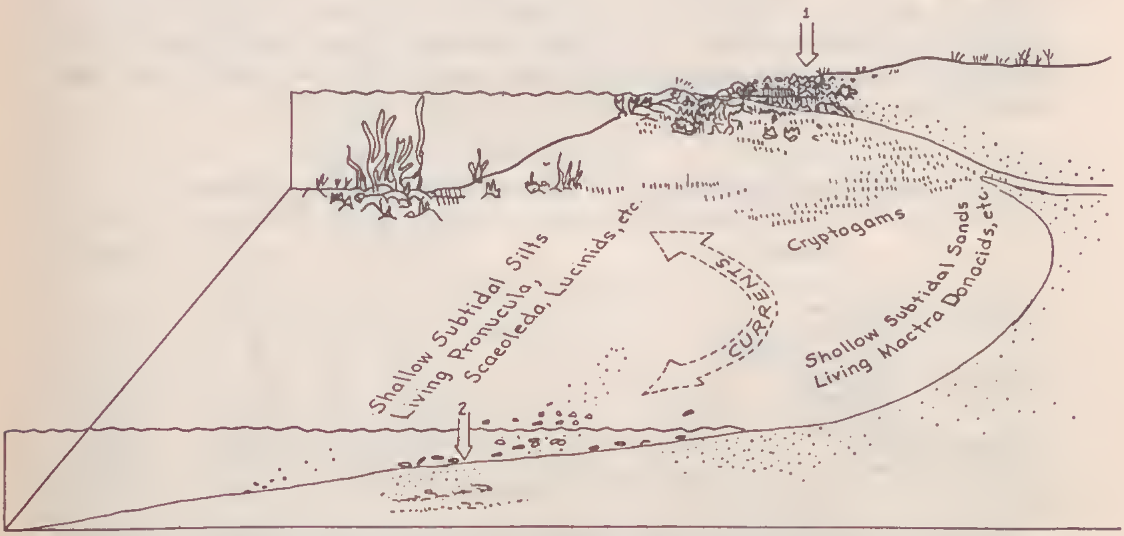

Fig. 6—Generalized reconstruction of molluscan habitats during deposition of the Pleistocene Port Fairy beds: (1) Bank St; (2) drain.

Summary of Habitats

A diagrammatic summary of the biotopes from which the Port Fairy molluscs are believed to have been assembled is presented in Fig. 6. At the point, the rocky shore element indicates moderate protection from waves, suggesting the presence of offshore rocks at shallow depths to break the main force of the waves. Such rocks occur today off Griffith's Is. At some depth offshore, boulders or basalt outcrops are presumed to have supported a rocky-bottom and offshore kelp element. The present basalt outcrops near the beach would have been under between 10 and 20 ft of water during deposition of the Port Fairy beds, a reasonable depth for the submerged rocky-bottom elements. In Fig. 6 the rocky-shore algal association is depicted as interfingering with cryptogams in sheltered spots, and cryptogam meadows may have flourished on appropriate bottoms offshore in relatively quiet water. The stream in the figure is hypothetical in position and is included to depict the presence of a brackish-water habitat. Shallow sandy bottoms N. of the point supported populations of mactrid, donacid and other pelecypods inshore while, offshore, on finer bottoms lived nuculaceans, some lucinids, and others. Details of the distribution of biotope types are not meant to be taken literally.

Feeding Types

The composition of fossil assemblages by feeding type provides evidence of the nature of the original trophic structure and of the environment which supported it. Gastropods, a trophically diversified group throughout the late Mesozoic and Cainozoic, lend themselves well to feeding-type studies.

Gastropods may be conveniently classed in 6 feeding categories. Three are chiefly or entirely of herbivores: browsers, which eat large living plants or masses of small plants; detritus feeders, which eat dead plant material and diatoms; and suspension feeders, whose food is phytoplankton and minute particulate plant detritus. Three other categories are of carnivores: predators, parasites, and scavengers. The relative numbers of gastropod species of these feeding types differ considerably among communities inhabiting certain different environments and probably among certain climatic zones (Valentine, MS in progress).

Table 5

Percentages of feeding types of marine species of shelled gastropods

Feeding Type		Maugean Province	Bank St	Drain
Herbivores:	Browsers	6-10	19-21	12-17
	Detritus Feeders	29	47	44
	Suspension Feeders	3	0	2
Carnivores:	Scavengers	2	2	2
	Parasites	7	9	0
	Predators	48-52	21-23	26-31
Total Herbivores		38-42	66-68	58-63
Total Carnivores		58-62	32-34	37-42

Records of food preferences and feeding methods of Maugean species are few. However, records of feeding habits of numbers of congeneric or at least co-familial species are available from other provinces. From these data, culled from several score references, the most probable feeding habits of each Maugean species has been inferred. In Table 5 are tallied percentages of feeding types of the shelled marine gastropod fauna of the Maugean province, together with the percentages within the two fossil collections from Port Fairy. Documentation for these figures is impracticable here; perhaps the best general references for feeding-type data are Pelseneer 1935, Ankel 1936, and Fretter & Graham 1962. The range of percentage indicated for some feeding types is owing to uncertainties within families which contain forms that have two or more chief feeding habits and for which data are scanty, e.g. the Columbellidae. None of the figures can be exact.

Nevertheless, the differences between the fossil associations and the whole Maugean fauna are striking. About 40% of Maugean forms are herbivores, while about 60% or more of the forms in the fossil assemblages are herbivores. Both browsers and detritus feeders are represented by much greater proportions of species among the fossils. Predator species, on the other hand, are relatively fewer among the fossils—by approximately half. The environment was not an average one for the province, by today's standards at least, but was evidently relatively high in herbivorous niches and low in predatory ones. This suggests the former presence of a varied flora. Of the 8 gastropods that are abundant at either locality all are browsing or detritus-feeding herbivores, and of the 22 forms that are common at either locality, 18 are browsers or detritus feeders, one is a parasite, and 3 are predators (of which one is questionably identified). Thus herbivores are represented by many more specimens than are carnivores, and were more abundant as well as more diversified, suggesting a fairly abundant flora.

Between the two fossil assemblages, the Bank St locality contains more herbivores and fewer carnivores than that at the drain. This suggests that the latter association represents a community which was the poorer in plant variety, or has been assembled from several communities, some of which had few herbivorous types and presumably few plant forms as well.

The relative diversities of feeding types in the Maugean province are similar to those exhibited by other temperate provinces, and relative diversities among the fossil assemblages are well within the range found to be characteristic of rocky-shore and shallow rocky-bottom associations elsewhere (Valentine, MS in progress). Sandy or muddy bottom associations, even in shallow water, often support relatively few herbivorous types and frequently contribute a great diversity of carnivorous types to shallow assemblages. Consideration of feeding-type diversity of the fossil associations thus reinforces the inferences, based on empirical data on habitat preference of the species, as to the nature of the sources of the Port Fairy assemblages.

Biogeography

In discussing biogeographic aspects of the Port Fairy fauna it is convenient to employ provincial terms in use for the present-day open rocky-shore biota: Peronian (Hedley 1904) for the E. coast of New South Wales and N. into S. Queensland; Maugean (Iredale & May 1916, Bennett & Pope 1953, 1960) for Victoria, Tasmania and SE. South Australia; and Flindersian (Cotton 1930) for the South Australian Gulfs, the Bight, and SW. Western Australia. The boundaries, nature and degree of biotic overlap, and distinctiveness of these provinces are not completely understood.

The patterns of currents and water temperatures that presumably control the major molluscan biogeographic pattern in SE. Australia are known in a general way. Recent work by members of the CSIRO (Vaux & Olsen 1961) has demonstrated surface drift patterns which can be partly reconciled with temperature patterns recorded on the charts prepared by the Royal Netherlands Meteorological Institute (1949). Fig. 7, after Vaux & Olsen (1961), depicts surface currents inferred from drift card experiments between the summers of 1958 and 1960; Fig. 8 summarizes average summer (February) and winter (August) isotherms around Australia, taken from RNMI data by Womersley & Edmonds (1958).

For most of the year surface drift along SE. Australia is easterly, bringing waters along shore from the W.; little temperature difference is found along the entire S. Coast of the continent. However, from November to February 1958-59, October to November 1959, and February to April 1960, Vaux & Olsen found a change in the current pattern; relatively warm water entered Bass Strait from the E., and cool southern water drifted northward along W. Tasmania and westward along W. Victoria (Fig. 7a). A body of cool water off W. Victoria and SE. South Australia is evident in the summer isotherms of Fig. 8, and the average annual temperature range is thus small in this region.

FIG. 7—Surface drift pattern off Victoria and Tasmania; A, summer, B, winter. From drift bottle experiments, after Vaux & Olsen 1961.

The biotic change between the Peronian and Maugean provinces is said to be relatively strong, which accords well with the crowding of isotherms along the S. New South Wales coast. On the other hand, the Maugean-Flindersian biotic change is said to occur through a broad transition zone, which the more gradual thermal changes in SE. South Australia may reflect. In addition to these provincial boundaries an intraprovincial biotic change within the Maugean province, centered near Cape Otway, has been described by Bennett & Pope (1953). These authors emphasize that the water bathing W. Victorian shores is often cooler in summertime than along neighbouring shores, and point out that intertidal temperatures may be different from the offshore temperatures recorded in the literature. Although an obvious cool spot does not appear in Fig. 8, persistent local temperature differences that may be biologically important are often masked in generalized isothermal patterns. More precise data are evidently necessary to document the basis of this intraprovincial biotic change.

The biogeography of species in the Port Fairy beds may be conveniently discussed with reference to the patterns outlined above. All but two of the 234 forms that are firmly identified with fairly well-defined living species inhabit the Maugean region today and all but three are recorded from Victorian waters. Most of these species live in other provinces as well. About 40% range from the Flindersian through the Maugean and well into or through the Peronian and hence are ubiquitously distributed as far as interpretation of the Port Fairy beds is concerned.

About 47% are known to be living only in the Flindersian and Maugean provinces and do not range into the Peronian. Some of these forms are recorded from only as far E. as W. Victoria, while numbers of them range as far as Western Port. Several are known to live E. of the Western Port district, and a few of these are found in bays in S. New South Wales (e.g. *Electroma georgiana*), which is Peronian as far as the open rocky shore biotope is concerned. In habitats other than rocky shores, the position and nature of the provincial change are less well known, and in view of their essentially W. ranges these few forms are regarded here as Flindersian-Maugean types.

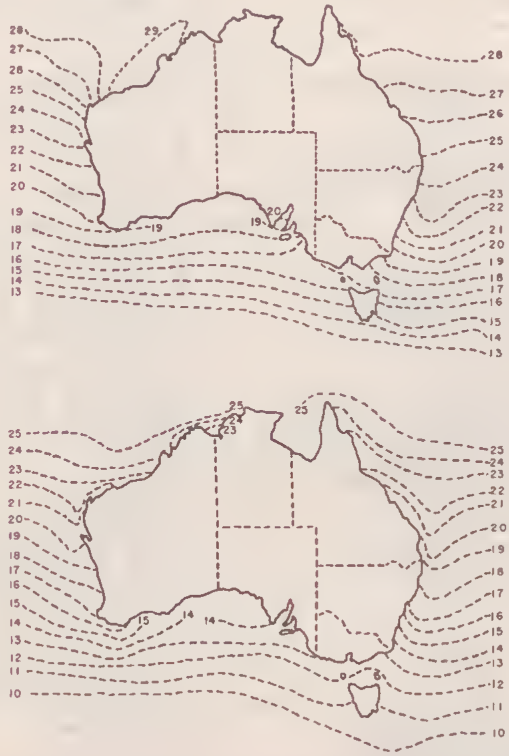

Fig. 8—Surface isotherms around Australia: upper, Summer (February) average; lower, winter (August) average. After Womersley & Edmonds 1958.

Only about 6% of these species live in the Peronian and Maugean provinces but not in the Flindersian. Many of these live in embayments along the Gippsland coast and in Western Port and Port Phillip, but are not known living in W. Victoria, so that their fossil occurrences at Port Fairy lie outside their present known ranges. A few forms tallied as Peronian-Maugean types do reach the Port Fairy district today, and some even live along the SE. coast of South Australia, S. of about Kangaroo Is.; however, their essential E. ranges are patent.

A modest 7% consists of endemic Maugean species, most of which are not known to live in W. Victoria. One form (*Cantharidus kingensis*) is not recorded outside Tasmanian waters, though it is known from King Is., Bass Strait. Finally, there are the two species discussed previously, *Clavarizona hirtosa* and *Ninella torquata*, which evidently do not live in the Maugean province at all today.

Marine temperatures are known to be a major factor in limiting the ranges of marine molluscs. Although for a given species there are certainly thermal limits beyond which it cannot support populations, the actual range end-points at any

TABLE 6

Recent species identified or compared with forms in the Port Fairy beds which are not known to include Port Fairy within their living ranges ('extralimital' forms)

SPECIES	RECORDED LIVING RANGE
POLYPLACOPHORA	
Heterozona subviridus Iredale & May	C. Vict., Tas.
Clavarizona hirtosa (Blainville)	Wtn Aust.; W. Sth Aust.?
GASTROPODA	
Amblychilepas crucis (Beddome)	C. Vict., N. Tas.
Herpetopoma tasmanica (Tenison Woods)	C. Vict., Tas.
Cantharidus kingensis Gabriel	King Is.
Ninella torquata (Gmelin)	N.S.W., Sth Aust., Wtn Aust. (but not Vict. nor Tas.)
Pissina frenchiensis (Gatliff & Gabriel)	C. Vict., Tas.
Microdryas australiae (Frauenfeld)	N.S.W., E. & C. Vict., Tas.
Linemera filocincta (Hedley & Petterd)	N.S.W., E. Vict., Tas.
Eatoniella aurantiocincta (May)	C. Vict., Tas.
Diala phasianella Angas	N.S.W., E. & C. Vict.
Limiscala hemicornua Iredale	N.S.W., E. & C. Vict., Tas.
Polinices aulocoglossa (Pilsbry & Vanatta)	Qld., N.S.W., E. & C. Vict., Tas.
Gemixystus laminatus Petterd	N.S.W., Tas.
Euliginella shorehami (Pritchard & Gatliff)	C. Vict.
Cloisia flindersi (Pritchard & Gatliff)	C. Vict.
Filodrillia columnaria Hedley	C. Vict., Tas.
Guraleus brazieri (Angas)	N.S.W., E. Vict., Tas.
Heterocithera bilineata (Angas)	N.S.W., E. Vict., Tas.
Puposyrnola tasmanica (Tenison Woods)	N.S.W., E. Vict., Tas.
Gadinia conica Angas	N.S.W., E. & C. Vict., Tas.
PELECEPODA	
Anadara trapezia (Deshayes)	N.S.W., E. & C. Vict., Wtn Aust. (but not W. Vict. nor Sth Aust.)
Cuna delta (Tate & May)	C. Vict., Tas.
'Cuna' planilirata Gatliff & Gabriel	C. Vict., Tas.
Carditellona elegantula (Tate & May)	C. Vict., Tas.
Legrandina bernardi Tate & May	C. Vict., Tas.
Notolepton antepodium (Filhol)	C. Vict.
N. sanguineum (Hutton)	C. Vict.
Myllita auriculata Smith	C. Vict., Tas.
Thraciopsis elongata (Stutchbury)	N.S.W., E. & C. Vict., Tas.

time may be determined by other factors—physical habitat failure, biotic competition of some sort (the geography of which may or may not be partially thermally controlled itself), and so on. Since the factors that actually determine the range end-points of the individual species under consideration have not been studied, it is not certain to what extent their present ranges are temperature-controlled. Furthermore, there is no assurance that some of these forms have not evolved new temperature adaptations since deposition of the Port Fairy beds. Thus, climatic inferences based on their range changes must be regarded as provisional.

The present recorded distributions of species not known to include the Port Fairy region in their present ranges—'extralimital species'—are listed in Table 6; the list will probably be eroded by range extensions as more collecting is done. Of these extralimital forms 12 range from New South Wales into Tasmania but not into W. Victoria, although 7 are known from E. Victoria. Factors that prevent their dispersal into W. Victoria are not known, but they are obviously not frigophilic (cool-water types) relative to W. Victorian water temperatures. Many of them are small forms whose ranges may be incompletely known. *Polinices aulocoglossa,* however, is a larger species; in Tasmania it is restricted to the N. coast (May with Macpherson 1958). It is possible that *P. aulocoglossa* and some other species of this element are excluded from W. Victoria by low temperatures, and harbour in local warm spots in C. Victoria and Tasmania.

9 of the extralimital forms that do not range into New South Wales live in C. Victoria and Tasmania, and 6 more live only in C. Victoria. The thermal significance of these species relative to E. Victorian waters is obscure. However, if the several extralimital species reaching C. Victoria from New South Wales are not regarded as frigophiles, then the C. Victorian and N. Tasmanian endemics may not be frigophilic either, unless peculiarities of habitat or distribution restrict them to cooler sites. No such restriction is evident from available collecting records.

Bennett & Pope (1960) have described the chief faunal differences in characteristic exposed-shore forms between Tasmania and the mainland. Among Tasmanian molluscs the chief differences are: *Melarapha praetermissa* is numerically equal or dominant to *M. unifasciata; Cellana solida* is abundant, but *C. tramoserica* is absent; *Notoacmea mayi* is more common; and *Sypharochiton maugeanus* is present. *C. solida, N. mayi,* and *S. maugeanus* were absent as fossils at Port Fairy, *C. tramoserica* was present, and *M. unifascisata* was more abundant than *M. praetermissa.* Thus, despite the presence of extra-limital species that range into Tasmania today, there was no clear tendency towards the establishment of species characteristic and important along S. shores at present.

Thus, among extralimital forms, there is a small N. probably thermophilic element (*Clavarizona, Ninella*), a larger element which does not range W. of the Otway Mountains today which probably includes some thermophiles, and a small element the thermal significance of which is too equivocal to support speculation. All of this distributional evidence is admittedly somewhat equivocal but, on balance, it suggests a marine climate little or no cooler than today and probably a bit warmer.

Since the modernity of the Port Fairy fauna precludes a preglacial age, and its thermal aspect suggests a mild climate, it may well be a interglacial fauna. Consider the probable effects of a period of cool marine climates visualized as occurring after the Port Fairy fauna lived and related to (at least) the last major continental glaciation. Relatively thermophilic species or ecotypes would have then been eliminated from the Victorian littoral and sublittoral with a possibility of some hardier forms remaining as replict populations at especially favourable localities. At the same time relatively frigophilic forms would have immigrated from the S. In Australia, fossil records of the resulting faunas are expectable only offshore today due to the lowered sea levels of glacial times. No such faunas are now known from off Victoria, although they are known off other coasts, including some in the Mediterranean (Mars 1959).

Rewarming associated with the close of the last glacial age would be expected to eliminate frigophiles, again except for possible relict populations in refugia, and to allow immigration of thermophiles. Since the cool climates were probably considerably cooler and the warm climates only a little warmer than today, frigophilic relicts would be more likely during interglacials than thermophilic relicts during glacials. Small but biologically significant post-glacial climatic fluctuations are well known also.

Glacial-associated cooling is inferred to have eliminated species such as *Clavarizona hirtosa, Ninella torquata, Anadara trapezia, Polinices aulocoglossa* and others from W. Victoria. Some of these forms may have reappeared during the 'mid-Holocene', but none of the molluscan assemblages of that age has been extensively studied. *A. trapezia* and *N. torquata* have widely disjunct distributions today, although it may well be that limiting factors other than temperature are restricting their present ranges (as suggested for *A. trapezia* by Kendrick & Wilson 1959). Thus, the fauna of the Port Fairy beds represents only a passing phase in a changing system, as does the present Maugean fauna, and perhaps neither of these faunas achieved equilibrium with its associated climate.

The Port Fairy fauna seems to suggest a temperature rise of about 1-2°C, which may have been only seasonal. If the summer flow of cool S. water (Fig. 7) were eliminated or modified, a shift of mean isotherms of about this magnitude should result (Fig. 8). A climatic model that involves a slight rise in winter temperatures also would help to account for the thermophiles in a more convincing manner but requires that evidence from S.-ranging species be given less weight than that from N.-ranging species. Although there is some slight theoretical justification for this, as noted above, it is really special pleading at the present state of knowledge. A slight extension of the present mean temperature range at Port Fairy involving a summer rise of about 2°C results in a satisfactory climatic model.

Faunal Comparisons and Correlation

Fossil molluscan assemblages that resemble those at Port Fairy in species composition and in general modernity are known from other localities in Victoria, and from South Australia and Tasmania.

In South Australia, particularly in the lower SE., a series of former high sea-stands is recorded by calcareous terrace and dune complexes which form a series of parallel 'ranges' well described by Sprigg (1952). The general aspects of fossil assemblages associated with these sea-stands are recounted by Crocker & Cotton (1946) and Sprigg (1952). Crocker & Cotton in particular describe the environmental significance of 4 associations: fine sand beach, estuarine beach, 'reef' (the term reef being applied to firm wave-resistant inorganic shallow bottoms), and 'weed' (forms that live chiefly on algal and cryptogam substrates). Unfortunately, detailed faunal lists of the fossil assemblages are not recorded. However, forms specified as characteristic of 'reef' and 'weed' assemblages include many species found in the Port Fairy beds.

The presence of the extralimital *Anadara trapezia* in South Australia has long been noted (Howchin 1912, 1923). In the SE. it is found within one of the younger ranges (Woakwine range: Hossfeld 1950) as well as in deposits of a late high sea level that flooded the flats between the lower ranges. These late deposits are packed with *Anadara* in appropriate facies.

In Tasmania, Macpherson has identified Quaternary molluscs from low terrace deposits on King Is. (Jennings 1959). They are modern associations which resemble the Port Fairy assemblages insofar as their general ecological background is similar. No extralimital forms were found. *Anadara trapezia* is recorded from Tasmania (May 1921), probably as a fossil, but its provenance is not certain.

In the Victorian Quaternary, extralimital species are known to occur in at least two stratigraphic contexts: in assemblages associated with calcareous sediments that are too old for radiocarbon age estimates, but which are of distinctly modern aspect, such as at Port Fairy and Port Campbell (Baker & Gill 1957), and in younger sediments which Gill (1954, 1956) has shown by radiocarbon methods to be on the order of 5,000 years old. The Port Fairy beds evidently represent an E. extension of conditions similar to those prevailing during deposition of the lower 'ranges' in SE. South Australia. Thorough documentation of the South Australian molluscan assemblages is desirable as a prelude to more detailed correlation. Quaternary biostratigraphy is so complicated by sea level fluctuations, minor tectonic events, and faunal migrations that further correlations even of a general nature are not attempted until more data are available.

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Explanation of Plates

Unless otherwise stated, the measurements given are for length (L), width (W), height (H), and diameter of the last whorl (D). Registration numbers are those of the National Museum of Victoria.

Plate 3

Fig. 1—*Clavarizona hirtosa* Blainville. Bank St. Median valve, W 24·4 mm. P22984.
Fig. 2—*Notomella canidida* (A. Adams). Drain, unit A. L 10·6 mm, W 8·0 mm, H 1·5 mm. P22920.
Fig. 3—*Amblychilepas crucis* (Beddome). Drain, unit A. L 5·1 mm, W 3·3 mm, H 1·7 mm. P22921.
Fig. 4—*Amblychilepas oblonga* (Menke). Drain, unit C. L 7·8 mm, W 4·0 mm, H 1·7 mm. P22922.
Fig. 5—*Asteracmea crebristriata* (Verco). Drain, unit A. L 2·6 mm, W 1·0 mm, H 1·5 mm. P22924.
Fig. 6—*Asteracmea stowae* (Verco). Drain, unit A. L 3·6 mm, W 2·7 mm, H 0·9 mm. P22923.
Fig. 7—*Cantharidus kingensis* Gabriel. Drain, unit A. H 2·1 mm, D 1·5 mm. P22942.
Fig. 8—*Cantharidella tiberiana* (Crosse). Drain, unit A. H 2·6 mm, D 2·6 mm. P22932. Apex tilted slightly away from viewer.
Fig. 9—*Dolicrossea labiata* (Tenison Woods). Drain, unit A. H 2·2 mm, D 1·8 mm. P22980.
Fig. 10—*Munditia subquadrata* (Tenison Woods). Drain, unit A. H 2·3 mm, D 3·5 mm. P22935.
Fig. 11—*Minopa legrandi* (Petterd). Drain, unit A. H 1·6 mm, D 2·0 mm. P22927.
Fig. 12—*Minopa legrandi* (Petterd). Drain, unit A. H 1·7 mm, D 2·1 mm. P22928.
Fig. 13—*Minopa petterdi* (Crosse). Drain, unit A. H 1·9 mm, D 2·0 mm. P 22929.
Fig. 14—*Lodderia lodderae* (Petterd). Drain, unit A. H 1·2 mm, D 2·2 mm. P22934.
Fig. 15—*Elachonbis homalon* (Verco); a, apical view; b, umbilical view. Drain, unit A. H 0·9 mm, D 2·2 mm. P22933.
Fig. 16—*'Pellax' rosea* (Angas). Drain, unit A. H 9·3 mm, D 2·5 mm. P22949. Base less angulate and whorls more convex than usual.

Plate 4

Fig. 1—*Charisma josephi* (Tenison Woods). Drain, unit A. H 1·9 mm, D 1·8 mm. P22969.
Fig. 2—*Pelecydium cylindraceus* (Tenison Woods). Drain, unit A. H 3·2 mm, D 1·2 mm. P22976.
Fig. 3—*Laevilittorina mariae* (Tenison Woods). Drain, unit A. H 2·7 mm, D 1·7 mm. P22943.
Fig. 4—*Pissina* cf. *P. frenchiensis* (Gatliff and Gabriel). Drain, unit A. H 2·5 mm, D 1·3 mm. P22939.
Fig. 5—*Pissina cf. P. frenchiensis* (Gatliff and Gabriel). Drain, unit B. H 2·6 mm, D 1·3 mm. P22938.
Fig. 6—*Bembicium nanum* (Lamarck). Juvenile; a apertural view; b, apical view. Drain, unit C. H 1·1 mm, D 3·1 mm. P22966.
Fig. 7—*Notosetia* cf. *N. atkinsoni* Tenison Woods. Drain, unit C. H 1.6 mm, D 1·1 mm. P22977.
Fig. 8—*Microdryas australiae* (Frauenfeld). Drain, unit A. H 2·5 mm, D 1·5 mm. P22947.
Fig. 9—*Lironoba tenisoni* (Tate). Drain, unit A. H 2·5 mm, D 1·2 mm. P22998.
Fig. 10—*Eatoniella melanchroma* (Tate). Drain, unit A. H 1·9 mm, D 1·2 mm. P22937.
Fig. 11—*Eatoniella* cf. *E. arantiocincta* (May). Drain, unit A. H 2·9 mm, D 1.6 mm. P22971.
Fig. 12—*Merelina hulliana* (Tate). Drain, unit A. H 3·2 mm, D 1·8 mm. P22944.
Fig. 13.—*Linemera filocincta* (Hedley and Petterd). Drain, unit A. H 2·6 mm, D 1·4 mm. P22945.
Fig. 14—*Rissolina angasi* (Pease). Drain, unit A. H 5·1 mm, D 2·2 mm. P22946.
Fig. 15—*Rissoina elegantula* Angas. Drain, unit A. H 5·1 mm, D 2·2 mm. P22936.
Fig. 16—*Tatea rufilabris* (A. Adams). Drain, unit C. H 3·7 mm, D 1·5 mm. P22968.
Fig. 17—*Cochliolepas vincentiana* (Angas). Drain, unit A. H 2·4 mm, incomplete, D 1·9 mm, incomplete. P22956.
Fig. 18—*Pseudoliotia micans* (A. Adams). Drain, unit A. Aperture and fragment of last whorl. Inside diameter of aperture 0·9 mm. P22981.

Fig. 19—*Diala semistriata* (Philippi). Drain, unit A. H 5·5 mm, D 2·4 mm. P22940.
Fig. 20—*Diala phasianella* Angas. Drain, unit A. H 4·5 mm—estimated (specimen broken), D 2·1 mm. P22941.

PLATE 5

Fig. 1—*Hypotrochus monachus* (Crosse & Fischer). Drain, unit A. H 2·3 mm, D 1·5 mm. P22957.
Fig. 2—*Notosinister angasi* (Crosse & Fischer). Drain, unit A. H (incomplete) 4·2 mm, D 1·3 mm. P22961.
Fig. 3—*Notosinister armillata* (Verco). Drain, unit A. H (incomplete) 3·2 mm, D 1·4 mm. P22965.
Fig. 4—*Notosinister ampulla* (Hedley). Drain, unit B. H 3·6 mm, D 1·4 mm. P22974.
Fig. 5—*Notosinister tasmanica* (Tenison Woods). Drain, unit A. H (incomplete) 6·1 mm, D 2·1 mm. P22979.
Fig. 6—*Notosinister maculosa* (Hedley). Drain, unit A. H 4·8 mm, D 1·8 mm, P22962.
Fig. 7—*Notosinister granulata* (Brazier). Drain, unit A. H 4·2 mm, D 1·3 mm. P22963.
Fig. 8—*Notosinister pfeifferi* (Crosse and Fischer). Drain, unit A. H 4·5 mm, D 1·5 mm. P22964.
Fig. 9—*Melanella* sp. A. Drain, unit A. H 4·2 mm, D 1·3 mm. P22972.
Fig. 10—*Macrozafra remoensis* (Gatliff & Gabriel). Drain, unit A. H 3·6 mm, D 1·6 mm. P22967.
Fig. 11—*Macrozafra* cf. *M. atkinsoni* (Tenison Woods). Drain, unit A. H 3·2 mm, D 1·2 mm. P22954.
Fig. 12—*Macrozafra* sp. A. Drain, unit A. H 3·6 mm, D 1·6 mm. P22955.
Fig. 13—*Zella* cf. *Z. beddomei* (Petterd). Drain, unit B. H 4·4 mm, D 2·0 mm. P22973.
Fig. 14—*Tavaniotha optata* (Gould). Drain, unit A. H 5·8 mm, D 3·5 mm. P22978.
Fig. 15—*Etrema densiplicata* (Dunker). Drain, unit A. H 4·2 mm, D 2·1 mm. P22982.
Fig. 16—*Euliginella shorehami* (Pritchard & Gatliff). Drain, unit A. H 1·8 mm, D 1·3 mm. P22975.
Fig. 17—*Cryptospira pygmaeoides* (Singleton). Bank St. H 5·6 mm, D 3·6 mm. P22983.

PLATE 6

Fig. 1—*Heterocithara bilineata* (Angas). Drain, unit A. H 4·6 mm, D 2·1 mm. P22950.
Fig. 2—*Guraleus vincentinus* (Crosse & Fischer). Drain, unit C. H 5·9 mm, D 2·8 mm. P22952.
Fig. 3—*Marita bella* (Adams & Angas). Drain, unit A. H 10·8 mm, D 3·9 mm. P22951.
Fig. 4—*Guraleus brazieri* (Angas). Drain, unit A. H 7·8 mm, D 2·7 mm. P22953.
Fig. 5—*Cylichnina pygmaea* (A. Adams). Drain, unit A. H 4·1 mm, greatest diameter 1·9 mm. P22930.
Fig. 6—*Retusa amphizosta* Watson. Drain, unit A. H (incomplete) 2·4 mm, greatest diameter 1·2 mm. P22931.
Fig. 7—*Agatha australis* (Angas). Drain, unit A. H 3·2 mm, D 1·3 mm. P22958.
Fig. 8—*Turbonilla beddomei* (Petterd). Drain, unit A. H 3·5 mm, D 1·2 mm. P22959.
Fig. 9—*Chemnitzia acicularis* (A. Adams). Bank St. H 6·9 mm, D 1·4 mm. P22960.
Fig. 10—*Edenttellina typica* Gatliff and Gabriel. Drain, unit A. Left valve, H 1·6 mm, L 2·2 mm. P22618.
Fig. 11—*'Berthelinia typica'* of Burn. Drain, unit A. Left valve, H 1·6 mm, L (incomplete) 1.7 mm. P22615.
Fig. 12—*Berthellinops serenitas* Burn. Bank St. L 7·4 mm, W 4·5 mm. P22970.
Fig. 13—*Siphonaria tasmanica* Tenison Woods. Drain, unit A. L 4·2 mm, W (incomplete) 3·2 mm, H 1·5 mm. P22925.
Fig. 14—*Mesembrisepia novaehollandiae* Hoyle. Bank St. W (incomplete) 16·2 mm. P22985.

PLATE 7

Fig. 1—*Pronucula hedley* Pritchard & Gatliff. Right valve. Drain, unit A. L 2·8 mm, H 2.4 mm. P22895.
Fig. 2—*Tucetilla striatularis* (Lamarck). Drain, unit C. L 12·5 mm, H 11·5 mm. P22896.
Fig. 3—*Lissarca rhombaidalis* Verco. Left valve. Drain, unit A. L 2·8 mm, H 2·3 mm. P22901.

Fig. 4—*Micromytilus crenatuliferus* (Tate). Left valve. Drain, unit A. L 2·3 mm, H 1·9 mm. P22904.

Fig. 5—*Brachidontes* cf. *B. rostratus* (Dunker). Right valve. Drain, unit A. L 2·9 mm, H 1·9 mm. P22909.

Fig. 6—*Lanistina paulucciae* (Crosse). Right valve. Drain, unit A. L 3·3 mm, H 2·1 mm. P22902.

Fig. 7—*Cylopecten favus* Hedley. Left valve. Drain, unit A. L 2·3 mm, H 2·1 mm. P22915.

Fig. 8—*Cuna delta* Tate & May. Right valve. Drain, unit A. L 2·0 mm, H 2·0 mm. P22898.

Fig. 9—*Cuna comma* Verco. Left valve. Drain, unit A. L 2·4 mm, H (incomplete) 3·3 mm. P22916.

Fig. 10—*'Cuna' planilirata* Gatliff & Gabriel. Right valve. Drain, unit A. L 1·8 mm, H 1·6 mm. P22918.

Fig. 11—*Cyamiomactra mactroides* (Tate & May). Right valve. Drain, unit A. L 2·1 mm, H 1·2 mm. P22910.

Fig. 12—*Neogaimardia rostellata* (Tate). Right valve. Drain, unit A. L 2·1 mm, H 1·8 mm. P22908.

Fig. 13—*Neogaimardia tasmanica* (Beddome). Right valve. Drain, unit A. L 1·9 mm, H 1·5 mm. P22903.

Fig. 14—*Marikellia* aff. *M. rotunda* (Deshayes). Right valve. Drain, unit A. L (incomplete) 3·9 mm, H (incomplete) 3·4 mm. P22891.

Fig. 15—*Marikellia* cf. *M. rotunda* (Deshayes). Right valve. Drain, unit A. L 3·5 mm, H 3·1 mm. P22890.

Fig. 16—*Notolepton sanguineum* Hutton. Right valve. Drain, unit C. L 2·0 mm, H 1·8 mm. P22917.

Fig. 17—*Notolepton antipodium* (Filhol). Left valve. Drain, unit A. L 2.3 mm, H 2·2 mm. P22905.

PLATE 8

Fig. 1—*Bassina* aff. *B. pachyphylla* (Jonas). Left valve. Drain, unit C. L 28·2 mm, H 21·4 mm. P22914.

Fig. 2—*Bornia trigonale* (Tate). Left valve. Drain, unit A. L 3·7 mm, W 3·0 mm. P22889.

Fig. 3—*Corbula coxi* Pilsbry. Left valve. Drain, unit A. L 7·0 mm, H 4·6 mm. P22897.

Fig. 4—*Thraciopsis elongata* (Stutchbury). Left valve. Drain, unit A. D 10·6 mm, H 4·6 mm. P22913.

Fig. 5—*Mysella donaciformis* Angas. Right valve. Drain, unit A. L 5·2 mm, H 4·1 mm. P22907.

Fig. 6—*Semelangulus tenniliratus* (Sowerby). Left valve. Drain, unit B. L 4·8 mm, H 2·6 mm. P22906.

Fig. 7—*Myadora tasmanica* Tenison Woods. Right valve. Drain, unit A. L 4·9 mm, H (incomplete) 3·5 mm. P22912.

Fig. 8—*Ephippondonta lunata* (Tate). Left valve. Drain, unit A. L (incomplete) 3.4 mm, H (incomplete) 1·6 mm. P22894.

Fig. 9—*Lepton ovatum* Tate. Left valve. Drain, unit A. L 2·6 mm, H 1·8 mm. P22911.