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Benthic Ecology of Glory Cove, Stewart Island

By E. J. BATHAM,

Portobello Marine Biological Station, Portobello, New Zealand.

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Abstract

GLORY Cove, near the south end of New Zealand, is a small sheltered bay with a bottom of sandy mud. Five dredge hauls and three trawl hauls indicate that its benthic ecology is relatively uniform. The red alga *Lenormandia chauvinii* is dominant over most of the bottom. Echinoderms are especially in evidence, 17 species being recorded, with *Echinocardium cordatum* and the holothurians *Amphicyclus thomsoni* and *Chiridota nigra* each present in at least three-quarters of the samples. Of infaunal lamellibranchs, *Paphirus largillierti* and *Tawera spissa* are present in moderate numbers. Abundant epifaunal molluscs include *Terenochiton inquinatus, Micrelenchus micans, Chlamys radiata* and *Maoricolpus roseus,* though the shells of the latter frequently house hermit crabs. *Eunice australis* and the amphipod *Maera inaequines* abound.

INTRODUCTION

Two days of intensive bottom sampling of Glory Cove, during the *Munida*-Port Pegasus 1967 Expedition, gave a relatively uniform picture of its benthic ecology. At the present stage, when little has to date been published on New Zealand benthic ecology (Powell, 1937; Skerman, 1964; Ralph and Yaldwyn, 1956; Hurley, 1959; Fleming, 1952), but when much work is in active progress, it is felt that an account of Glory Cove can usefully be presented.

METHODS

Field work was carried out from the University of Otago's 46ft research vessel *Munida.* The trawl used was a 4ft-wide Agassiz beam trawl, with $\frac{3}{4}$in mesh, and with a removable bottom-sampling box in each runner, after the pattern of one used by the New Zealand Oceanographic Institute. The dredge was an 18in-wide Salpa dredge with curved, angled jaws and with a sacking bag that quickly filled with substrate. This was washed gently out on to the deck with a hose, and the animals removed as they appeared. Because the bottom biota was very rich, the Agassiz trawl was hauled each time for less than the usual 10 minutes the writer normally standardises on. In one haul (Mu 67–38), after approximately one minute on the bottom, the trawl bag was so full that difficulty was encountered in getting it on board and only half of the large catch was methodically sorted. Familiar species were identified and recorded on deck; others were brought back and subsequently

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identified, with extensive help by specialists. Numbers or approximate numbers were recorded during catch sortings. These are accurate for large species (where a dash in Table II indicates definite absences), but are approximations only, and probably well below actual numbers, for smaller recorded species, such as *Terenochiton* and

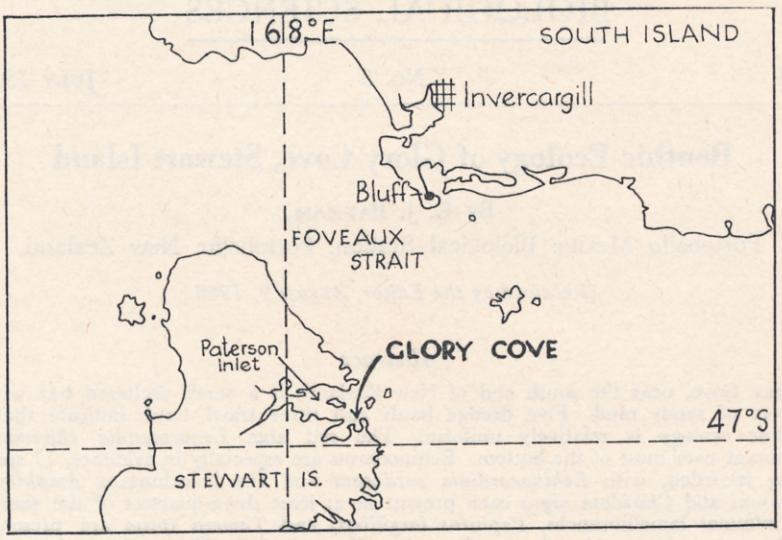

Fig. 1.—Map of portion of southern New Zealand, to show position of Glory Cove.

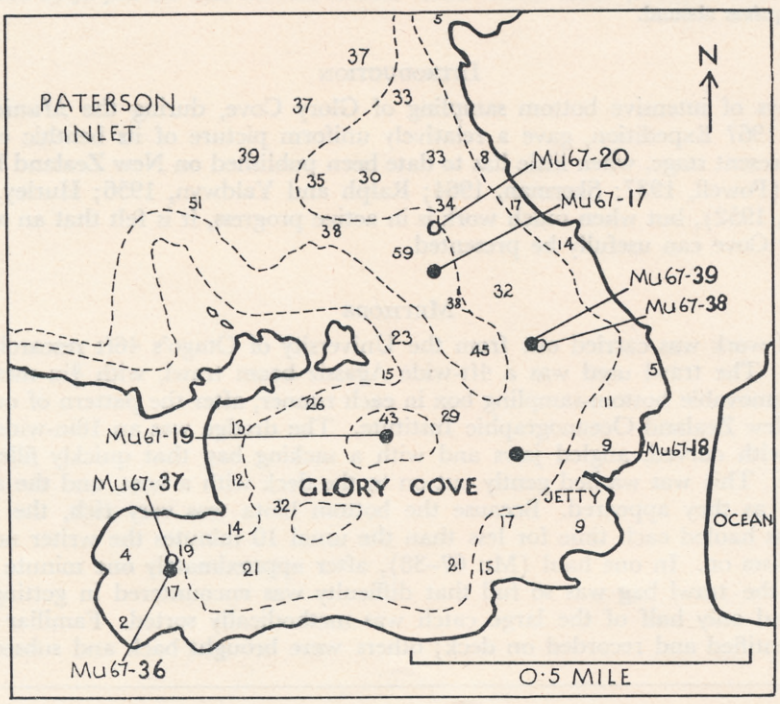

Fig. 2.—Map of Glory Cove, Stewart Island. Depths are shown in feet. Contour lines are at three fathoms and six fathoms. Circles indicate station sites, solid circles being dredge samples and open circles the Agassiz trawl samples. (After *Lachlan* 1951 survey.)

Podarke angustifrons. Tiny animals, such as smaller crustaceans, molluscs and polychaetes, have been omitted; the aim being to give a broad preliminary picture in semi-quantitative terms rather than to present an extensive faunal list or a precisely quantitative study.

Eight bottom samples were analysed by Dr W. A. Hodgson, Otago University Geology Department. Standard grain size analysis was carried out, the sand fractions from 1 to 4 ϕ being sieved into $\frac{1}{4}$ ϕ fractions. Grain size distribution of silt and clay fraction was determined by the pipette method (Krumbein and Pettijohn, 1938). Results were plotted as cumulative frequency curves, and from these the values for Md, M ϕ, etc., were calculated, following the method of Inman (1952).

Physical Environment

Glory Cove is a small, fairly sheltered, deeply indented bay which runs off the south-east of Paterson Inlet, Stewart Island, at the south end of New Zealand (Figs. 1, 2). It lies at latitude 46° 58′ south, longitude 168° 10′ east. Its depth is mostly between 6 and 15 metres. Its opening is $3\frac{1}{2}$ miles from the entrance of Paterson Inlet to the open sea of Foveaux Strait. It is not exposed to open ocean wave action. Bottom sampling was carried out on February 9 and 15, 1967. A surface salinity sample on the second day, after some rain the previous night, gave

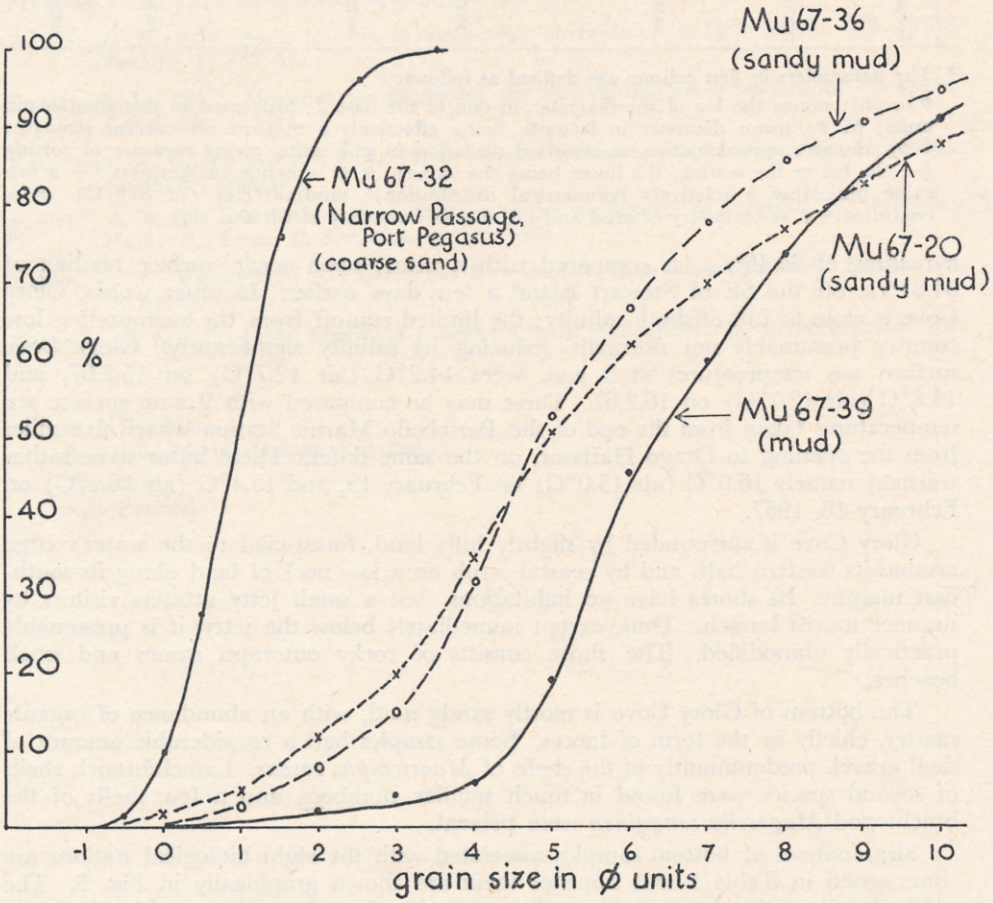

Fig. 3.—Cumulative frequency curve for three of Glory Cove bottom samples, showing their relative uniformity. One Port Pegasus sample is shown on same graph, for comparison.

TABLE I.—Size analysis results of eight Glory Cove bottom samples.

Innermost ..... Outermost

Station Depth	Mu 67–36 22 feet	Mu 67–37 22 feet	Mu 67–19 42 feet	Mu 67–18 32–36 feet	Mu 67–38 36 feet	Mu 67–39 36 feet	Mu 67–17 30–55 feet	Mu 67–20 30–55 feet
Md*	4.80	4.65	6.95	5.80	4.30	6.26	4.50	4.90
M ϕ	5.45	4.78	7.40	6.15	5.08	6.66	5.18	5.82
s ϕ	2.33	2.48	2.55	3.12	3.03	2.34	3.23	3.32
α ϕ	0.28	0.052	0.18	0.11	0.26	0.17	0.124	0.28
Sand/	33	34.2	8.5	21.5	45	9.5	43.5	35
Silt/	34	36.8	27	31.5	24.5	36	21.5	26.5
Clay	33	19.0	64.5	47	30.5	54.5	35.0	38.5
Description	sandy mud	sandy mud	mud	sandy mud	sandy mud	mud	sandy mud	sandy mud

* The parameters in first column are defined as follows:

ϕ or phi: minus the log of the diameter in mm to the base 2; Md: median diameter in phi units; M ϕ: mean diameter in ϕ units, being effectively a measure of current strength; δ ϕ: Inman's approximation to standard deviation in phi units, giving measure of sorting (— the better the sorting, the lower being the value); α ϕ: measure of skewness (— a low value indicating a relatively symmetrical distribution); sand/silt/clay (or S/S/C) ratio, regarding 4 ϕ as boundary of sand and silt, 6 ϕ as boundary of silt and clay.

a reading of 34.46°/$_{oo}$, as compared with a nearly open ocean surface reading of 34.81°/$_{oo}$ off the SE of Stewart Island a few days earlier. In other words, Glory Cove is close to full offshore salinity; the limited run-off from the surrounding low country presumably not normally reducing its salinity significantly. Glory Cove surface sea temperatures at 9 a.m. were 14.2°C (air 12.7°C) on 15.2.67, and 13.8°C (air 12.7°C) on 16.2.67. These may be compared with 9 a.m. surface sea temperatures taken from the end of the Portobello Marine Station wharf, five miles from the opening to Otago Harbour, on the same dates. These latter were rather warmer, namely 16.0°C (air 15.0°C) on February 15, and 15.4°C (air 16.1°C) on February 16, 1967.

Glory Cove is surrounded by slightly hilly land, forest-clad to the water's edge around its western half, and by coastal scrub on a low neck of land along its south-east margin. Its shores have no habitations, but a small jetty attracts visitors by summer tourist launch. Thus, except immediately below the jetty, it is presumably practically unmodified. The shore consists of rocky outcrops, stones and small beaches.

The bottom of Glory Cove is mostly sandy mud, with an abundance of organic matter, chiefly in the form of faeces. Some samples had a considerable amount of shell gravel, predominantly of the shells of *Maoricolpus roseus*. Lamellibranch shells of several species were found in much smaller numbers, and a few shells of the brachiopod *Magasella sanguinea* were present.

Size analyses of bottom samples associated with the eight biological stations are summarised in Table I and some of them are shown graphically in Fig. 3. The sand/silt/clay ratios show most samples to consist of sandy mud, two of mud. Apart from station Mu 67–38, samples show a trend from coarsest in shallowest water to finest in deepest, which is reasonable for an enclosed bay. The high δ_s ϕ values

indicate that all samples are very poorly sorted, presumably because neither wave action not currents are effective in sorting bottom sediments in such a site. Data in Table I and Fig. 3 suggest that current activity is unimportant, and that wind-wave action controls sediment distribution. The s/s/c ratios show the same relations as the median shows.

The dominant biological fraction of sediments in the innermost part of the Cove consists of Foraminifera, whereas near the entrance it is primarily molluscan shell hash, with echinoid spines and test fragments.

BIOLOGICAL DATA

Results are tabulated in Table II. This lists species occurring in at least two of the stations sampled, and of which at least three specimens were present. This list is not exhaustive, but covers more than 95 percent of the bulk of the living material sampled.

Most of the cove floor was dominated by *Lenormandia chauvinii,* a flat more-or-less dichotomously branching red alga, some plants of which were attached to the turret shell *Maoricolpus roseus. Macrocystis pyrifera* was locally abundant, usually with *Spirorbis* and encrusting bryozoans on its fronds. *Carpophyllum flexuosum* was dense sublittorally below the jetty. Dichotomising *Codium* plants, chiefly *C. fragile,* with a little *C. dichotomum,* were fairly frequent. A few other red algal species were present in small amounts in one or another sample. No other greens were sampled sublittorally, and the only other brown noted was a slender *Cystophora* (probably a form of *C. retroflexa*) in small quantities.

Of animals, Echinodermata was the group represented unusually strongly, in numbers of specimens, bulk of organisms, and numbers of species. Some 17 species were taken, many in considerable numbers. Three snorkel dives to about 10–12ft below low tide, near the jetty, showed three large echinoderm species—*Evechinus chloroticus, Stichopus mollis* and *Coscinasterias calamaria*—all in abundance, individuals of each species lying scattered about 1m from each other. This was where rocky reefs ran out to a sandy bottom. In the eight stations worked, the khaki cucumariid holothurian *Amphicyclus thomsoni* proved more abundant than *Stichopus.* Whereas the occasional specimens of *A. thomsoni* taken off Otago have been unadorned, all from Glory Cove, and almost all from Port Pegasus, Stewart Island, were covered with scraps of shell and alga. Not infrequently, from two to six of these holothurians were found sticking closely together, in a common covering. Whether the curious habit of covering themselves serves as camouflage, protection against light, or other function, is not known. An even more abundant though slightly smaller holothurian was *Chiridota nigra,* a wine-coloured apodous species with pale spots. Two smaller, pinkish-coloured apodous holothurians present in several hauls, but not always distinguished from one another in the field, were *Trochodota dendyi* and *Trochodota dunedinensis.* The khaki heart urchin *Echinocardium cordatum* was conspicuous in most catches. *Pectinura gracilis,* a small grey-brown brittle star with barred arms, was because of its size less conspicuous than the larger echinoderms, but present in numbers at practically all stations. Echinoderm species taken in too small numbers to be included in Table II were: *Allostichaster polyplax, Pentagonaster pulchellus, Chiridota gigas,* and a tiny white brittle star, *Ophioceres huttoni.*

Other animals important in the present association will not be considered so much in their systematic order. The turret shell *Maoricolpus roseus* was abundant. Of a sample of about 100 shells, approximately equal numbers were living, contained hermit crabs, or were empty. The more abundant hermit was *Pagurus traversi,* here occurring almost entirely in *Maoricolpus* shells, though one was in a *Melagraphia aethiops* shell, and several were free amongst the algae. With these latter, one was

TABLE II.—Occurrence of species in eight hauls and several snorkel dives at Glory Cove. This list includes only species observed on at least two occasions, including a total of at least three specimens.

	Innermost						Outermost			
Station:	Mu 67–36	Mu 67–37	Mu 67–19	Mu 67–18	Mu 67–38	Mu 67–39	Mu 67–17	Mu 67–20		No. of out of 8 stations at which found:
Depth, metres:	7	7	13	10–11	11	11	9–17	9–11		
Gear:	Dredge	Trawl	Dredge	Dredge	Trawl	Dredge	Dredge	Trawl	Dives	
ALGAE										
Lenormandia chauvinii Harv.	—	1/5 catch	dom.	dom.	dom.	scraps	c.20 pc.	dom.		7
Codium fragile (Suringar) Hariot	—	1/10 catch	—	—	few pc.	—	1	4		4
Codium dichotomum (Huds.) S. F. Gray										
Macrocystis pyrifera (L) C.Ag.	3 pc.	c.90 pc.	—	—	—	—	—	—		2
PORIFERA										
Callyspongia sp.	—	2	3	9	6	—	—	—		4
Tethya aurantium (Pallas)	—	—	—	—	4	1	—	1		3
Tethya ingalli Bowerbank	—	—	—	—		1		1		
Iophon laevistylis (Dendy)					6			2		2
NEMERTINA										
Nemertine, apricot	2	2	1		4	—	—	2		5
POLYCHAETA										
Eunice australis Quatrefages		c.5	100s	10s	100s	4	5	100s		7
Harmothoe ? spinosa Kinberg		few	1	5	15			7		5*
Pherusa horstii (Haswell)			1		2			1		3*
Dorvillea australiensis (McIntosh)					c.20			few		2*
Podarke angustifrons (Grube)	few				1					2*
MOLLUSCA										
Terenochiton inquinatus (Reeve)			c.50	c.50	10s	3	few	100s		6
Maoricolpus roseus (Q. and G.)			100s	c.30	1		c.20	100s		5
Micrelenchus micans (Suter)		5	few	100s	10s	3	10s	few		7
Zegalerus tenuis (Gray)		1			3					2
Buccinulum pertinax (von Martens)	—	5	—	—	1	—	—	—		2
Zeatrophon ambiguus (Philippi)	—	—	1	—	5	—	—	—		2
Pleurobranchaea novaezelandiae Cheeseman	—	3	—	—	1	—	—	—		2
Philine sp.		1			3					2
Chlamys radiata (Hutton)	—	—	—	4	5	—	4	16		4
Paphirus largillierti (Philippi)	5	2	2	—	few	1	1	—		6

Diplodonta globus Finlay			1			1				2*
Tawera spissa (Deshayes)	1	7	1	—	3	—	2	1		6
Leptomya retiaria (Hutton)	15	1					1	2		4
Solemya parkinsoni E. A. Smith	1	—	10	—	—	—	—	—		2
CRUSTACEA										
Maera inaequipes (Costa)		1	few	c.20	100s	1	10	few		7
Maera subcarinata (Haswell)					8					1*
Pagurus traversi (Filhol)		6	3	12	20	1	5	2		7
Pylopagurus cooki (Filhol)					4		11	few		3*
Hymenosomid, small, dark		3			3					2*
Notomithrax minor (Filhol)	1	2	—	—	1	—	—	2		4
ECHINODERMATA										
Echinocardium cordatum (Pennant)	3	11	1	—	7	—	2	1		6
Evechinus chloroticus (Val.)	—	—	—	—	4	1	—	2	abund.	3
Stichopus mollis (Hutton)	1	26	—	10	21	—	1	—	abund.	5
Amphicyclus thomsoni (Hutton)	—	—	7	1	7	11	2	5		6
Chiridota nigra Mortensen	5	54	few	—	5	11	3	4		7
Trochodota dunedinensis (Parker) / *Trochodota dendyi* Mortensen	31	28	—	c.12	5	1	3	—		6*
Pectinura gracilis Mortensen	—	4	100s	15	53	3	3	100s		7
Ophiomyxa brevirima Clark	—	17	few	4	2			few		5
Amphiura magellanica Ljungman				5	18	—	—	—		2
Patiriella regularis (Verrill)	—	42	—	—	2					2
Coscinasterias calamaria (Gray)	—	1	—	—	2	—	—	1	abund.	3
Allostichaster insignis (Farquar)					3			2		2
ASCIDIACEA										
Orange compound ascidian					100s				abund.	1
Cnemidocarpa bicornuata (Sluiter)		9			3					2
? *Pyura* sp., unstalked		1			2					2
PISCES										
Pseudolabrus celidotus (Bl. and Sch.)	—	—	—		1	—	—	—	abund.	1
Acanthoclinus trilineatus Griffin		8	3	4	7			4		5*
Syngnathus blainvillianus Eyd. and Gerv.		2		2	2			1		4*
Callogobius atratus ? Griffin		1			1					2*
Tripterygiid, " mud roughy "			2	4	33			1		4*
Tripterygiid, " yellow, spotted "		4			2		1	1		4*

(dom.—dominant; abund.—abundant; pc.—pieces; c.—circa.)

* May have been present in more stations than recorded.

tempted to wonder whether the dull pink colour of the soft abdomen had protective value in a red algal habitat. In smaller numbers in the *Maoricolpus* shells was the hermit *Pylopagurus cooki,* characterised in the field by its deep blue maxillipeds. A single specimen was taken at Glory Cove of a vermilion hermit crab with mauve first antennules (species as yet unnamed). This is the commonest offshore shelf hermit crab species in Otago waters.

Eunice australis was the most conspicuous polychaete, coming up either free or in flaccid shelly tubes. The tiny tan chiton *Terenochiton inquinatus* and the small pink trochid *Micrelenchus micans* were both generally abundant. The red-shelled *Chlamys radiata,* at times with the purple sponge *Iophon laevistylis* on one valve, was conspicuous amongst the epifauna. Infaunal lamellibranchs of "cockle" type shell were *Paphirus largillierti* and *Tawera spissa.* Although both were present in the majority of catches, neither was taken in great density. Other infaunal lamellibranchs were *Tellina huttoni, Leptomya retiaria* and *Diplodonta globus,* the last coming up in a dense, khaki-coloured covering of fibrous material.

Crabs other than hermits included the small camouflage crab *Notomithrax minor* and a little hymenosomid. A large apricot-coloured amphipod, *Maera inaequipes,* was abundant. Several smaller species were present in limited numbers.

Ascidians were not at all in general evidence, with the exception of an orange compound species. This was abundant both on algae in one trawl haul, and on rock and tins below the jetty. A stout apricot nemertine about 5cm long was in the majority of hauls, and a larger wine-coloured species was taken at one station. A single live brachiopod, *Magasella* (*Terebratella*) *sanguinea,* was taken. No coelenterates were seen sublittorally. Infaunal polychaetes seemed relatively sparse. This was probably partly due to the sampling methods used, though even allowing for this they certainly did not show the density met with in some New Zealand benthic habitats.

Of fish, spotties (the wrasse *Pseudolabrus celidotus*) were seen in numbers during diving and from the vessel, their near-absence from catches reflecting their quick escape response rather than their sparseness. *Acanthoclinus trilineatus* and *Syngnathus blainvillianus* were not infrequent. Both were of the dull red colour of the dominant *Lenormandia.* Several species of Tripterygiid abounded. Pending formal descriptions of New Zealand sublittoral *Tripterygiidae,* Mr J. Moreland's manuscript names have been used for them.

Comments

No obvious correlations were apparent between slight differences in bottom sediments and the species occurring at given stations. Rather, the picture shown by the data is of a relatively uniform sandy-mud environment, with a number of species occurring repeatedly in samples. This suggests that a reasonably typical picture is given of the sea bottom of Glory Cove. Deeper-sampling gear would doubtless have revealed more polychaetes and lamellibranchs, whilst finer sorting would have increased the species list of small animals. Aqualung diving would be expected to show which species are particularly associated with the probably patchy algal covering; and also which are entirely on the substrate, which totally or partially buried. Concurrent Otago studies by several workers, using an assortment of methods, are showing what very different pictures of benthic ecology emerge when different sampling techniques are used.

It does not seem useful at this juncture to compare the results obtained here with the very few other New Zealand benthic ecology studies that have been published to date, as so much more work is at present under way. The particular impression gained in the present instance is of the unusual wealth of echinoderms at Glory Cove.

ACKNOWLEDGMENTS

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E. J. BATHAM,
Portobello Marine Biological Station,
Portobello,
New Zealand.